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Evolutionary Medicine: Navajo Nation Kids Learn the History of Evo Med

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Content

Introduction

The recent pandemic has alarmed many people about how a virus could deplete almost a generation of people. As teachers, we did not have a complete concept of a coronavirus related to those causing a simple common cold, that evolved into a scary and deadly variant. How could the SARS CoV-2 virus evolve to cause the COVID-19 pandemic which killed so many people all over the world? Many questions linger in our minds, but education on how pathogens evolve would be a great topic to study and teach in school. The knowledge of how viruses and diseases come into existence could be covered at the beginning of the curriculum. Teaching at a middle school in the Navajo Nation does not isolate us from any pathogens or viruses. Teaching and explaining viruses' makeup and transmission is a high priority.

During the pandemic, our native people resorted to natural remedies. Traditional herbalists and practitioners of traditional ceremonies turned to plants near Navajo Nation springs, mesas, and mountains. The herbalists and practitioners knew specific plants that were believed to counteract SARS CoV-2 and the COVID disease. A plant called sage familiar to many households near and around the Navajo Nation is not domesticated like the modern sage we cook with in the kitchen. The native plant sage is used to treat various health problems such as the common cold, sprained muscles, broken bones, and respiratory issues. By explanation, Native American Indians knew of viruses and pathogens before Europeans crossed the Atlantic Ocean, and they used local plants known for medication against illnesses. In my unit, I would tie-in medical practices of Native American Indians in history, which could be compared to how more recent understanding of pathogen evolution is perceived in evolutionary medicine that seeks to better understand the health problems in humans through knowledge of evolutionary biology over time. There are similarities and differences, but they have in common the notion of solving human illnesses and it is important to appreciate the history of how medicinal plants helped the Native American Indians address health problems.

Explaining and spending one week on the biology of virus and bacteria pathogens can help students understand how and why disease causing germs are transmitted. In addition, teaching students about evolution by natural selection is essential because this process affects all living species, and human hosts do not evolve as quickly as our pathogens. How did living organisms come to be? The process of natural

selection explains the species biodiversity on Earth. Darwin's theory of natural selection describes how populations are challenged to better survive and reproduce when challenged by their environments, and that the most successful variants are the ones that evolve to become most common and to form new species over time. During all this evolution, disease pathogens such as viruses were evolving and adjusting to challenges quicker than their hosts. In the current day, it is essential that students understand that this same process causes viruses to quickly adapt to overcome our medicines, such as vaccines. The fast ability for viruses to adjust to changes in their environments is mind-blowing.

Evolutionary medicine is sometimes called Darwinian Medicine because of Darwin's impact in describing how evolution by natural selection works. Darwinian medicine applies modern evolutionary theory to understanding human health and disease. (Wikipedia, 2024) Jonathan B. Losos and Richard E Lenski explain that evolution is not just about what is presented at museums with fossils of extinct creatures, but also how humans and Neanderthals evolved from common relatives long ago. Thus, the study of evolution is necessary to learn more in-depth about humans and our distant relatives, and can be studied using ancient DNA samples. So, how does this relate to what students should know? This information helps us understand how every living thing on Earth has an interconnecting genetic relationship. Questions in evolutionary medicine include how humans evolved to have the traits we show today, and why we suffer from certain diseases. The questions are essential because they help us trace back through time to look at evolution of our unique traits and behaviors, and to compare and contrast our health problems to those of other living organisms. The simple statement from Wikipedia explains it well: Modern biomedical research and practice have focused on the molecular and physiological mechanisms underlying health and disease, and this can be best understood through knowledge of evolution by natural selection.

Evolutionary medicine focuses on why evolution has shaped the mechanisms that may leave us susceptible to disease. As our seminar leader, Dr. Paul Turner (Yale University), explained in our lectures, human development involves our growth from a single fertilized egg into a multicellular adult with specialized cells and organs. As we develop our cells must divide and reproduce so that we grow in size, and throughout our lifetime we make new cells to replace older ones. However, we face a mishap if the cells that are duplicating experience mutations (mistakes), which are not always corrected. These mutations can make cells continue to grow uncontrolled in our body, forming masses of cells called tumors and the disease cancer. Therefore, the study of cancer is best understood as an evolution problem, because the cells in your body can mutate and evolve to grow when they ordinarily should not, and this is an example of how understanding evolution can help explain a common disease problem (Turner Seminar, 2024).

Demographic

Kayenta Unified School District is in the upper northeastern part of Arizona. Our school is the entrance to one of the famous landmarks in the United States; the beautiful Monument Valley buttes stand tall on an arid desert land on the border of the Arizona and Utah state lines. Geologists and tourists are among our visitors to this beautiful country. Our students on the Navajo Reservation know that this part of the Navajo Nation lands is vital to our culture, just like the great Grand Canyon near Flagstaff, Arizona. Our school vision is to have students be recognized and respected for instructional excellence, academic success, and lifelong learning. Kayenta.k12.az.us/o/kms: the letter grade B is on record with the Arizona School Report Card. Kayenta Middle School, now known as Baker Middle School, has a B letter grade. The total enrollment at Baker

Middle School is 479. Most students attending Baker Middle School are Native American ethnic, 2.3% are multiracial, and 4.38% are not disclosed under specific ethnicity. Students ride public school buses from surrounding rural communities to attend Kayenta Middle School. The communities are at least 40 miles to 50 miles away from Kayenta School District. Students wait at the bus stop in rural areas from around 6:00 to 6:45 a.m.; the bus rides are well over an hour long. Most students from rural areas are comfortable with outdoor activities and have some livestock to oversee. Most of the rural students live science every day. Students who live closer to Kayenta or in housing compounds must travel to tend to their livestock but are also exposed to outside science. Therefore, the combination of the study of evolution and medicine should be fascinating to our students in our area.

Background

Why are diseases like diabetes, heart disease, high blood pressure, Parkinson's, Alzheimer's, lactose intolerance, and allergies common among people today? Many of these diseases are on the rise in human populations around the world, and cancer is an increasing health problem that is familiar to almost everyone. Lately, a big newsmaker is the disease called obesity, because it is also becoming more common. Why do we gain weight fast, and why isn't it easy to lose weight? The book *Zoobiquity, the Astonishing Connection between Human and Animal Health* by Barbara Natterson-Horowitz, M.D., and Kathryn Bowers explains the similarities between human and animal diseases, such as our extreme weight gain and the obesity experienced by animals in the zoo. Diet pills, shots, and surgery give us some capacity to battle obesity, and for many people these approaches create false hope of completely repairing their weight gain. The latest trend is Ozempia often seen on mainstream television and described in social media. But what causes obesity to become a problem for humans in the first place? Immediately, we can guess this is caused by the foods we eat in modern times, which tend to have more calories, sugar and fat than many foods we used to eat earlier in human history. These foods can lead to weight gain, and also contribute to onset of other diseases, such as cardiovascular problems, diabetes, glucose intolerance, some cancers, musculoskeletal disorders, and high blood pressure (Natterson-Horowitz & Bowers, 2012). Humans and animals cannot afford to have issues with our vital organs, including the heart, liver, lungs, and kidneys because these organs are essential to make the human body healthy and to run properly.

What about diseases caused by pathogens such as viruses? This can also be explained by evolutionary medicine, beginning with ideas from scientists from the 1990s. " In the 1990's, George Williams and Randy Neese, followed by other, developed Darwinian (evolutionary) medicine, applying the principles of evolutionary biology to the broader question 'Why do we get sick?' ", (Johnson, 2022) In the time since, evolutionary medicine is becoming a separate dreading about evolutionary medicine, I learned that pathogens reproduce and evolve very quickly, whereas hosts like humans reproduce much slower and cannot rely on our evolution to keep pace with the changes happening in virus pathogens. Instead, we use our quickly changing immune system cells to fight against pathogens, but this is often not sufficient to do the job and increasingly modern medicine like vaccines have to be used. The thought that pathogens and bacteria are essential challenges to human medicine gave me the idea of balance.

Evolutionary Medicine

We listen to neighbors, and our colleagues at work speak about many medical issues such as allergies, being

overweight, having high blood pressure, struggling with high cholesterol, being annoyed with skin irritation, confusion about having cancer, and not knowing there are different types of cancer. So, how does evolutionary medicine connect to this topic?

Evolution

In biology, living organisms appeared on Earth in the distant past, perhaps 4 billion years ago. Some organisms like bacteria have been around since the early days of life on Earth and are still here today. As time passed, the biodiversity of living organisms increased to include larger numbers of species, which became better suited to their specific environments. The ability to change over time to match environmental challenges holds for all living creatures on Earth, and today organisms continue to experience evolution by natural selection to better thrive and adapt to their environments. However, species that cannot adapt to finding food, protecting themselves, or in other ways to meet these challenges can become extinct.

The genetic change necessary to go from living in water to instead thriving on land requires very many genetic changes. Long ago, plants, animals and other life forms evolved traits that let them survive and reproduce in terrestrial habitats. But Futurity.org has an article that reminds how marine tetrapods, the group of animals that includes whales, dolphins, seals, and sea turtles, have moved from the land back to the oceans over the last 350 million years-requiring radical changes to their lifestyles, body shapes, physiology, and sensory systems. During this process, not all variants (genotypes) were successful. Imagine how certain dolphins with faster ability to move through water had adaptations that were advantageous compared to other members of their populations. The ones that survived had the genes which provided better ability to make offspring which were also successful. For example, dolphins have tails that are excellent for moving quickly through water to chase prey such as fish, replacing other variants that were less capable of fast movement through water.

Charles Darwin's famous idea of natural selection is based on his theory of this process of evolution, which states that the variants with better ability to survive and reproduce will cause the population to evolve and take on these successful traits. Darwin observed that birds' beaks on the Galapagos Islands looked different than those of close relatives on the mainland, because different beak shape can evolve to use seeds and other food resources found on certain islands, a challenge in the bird's environment (Johnson, 2022). Not only is it important to adapt by changing traits such as those useful for movement and obtaining food resources, but it is also important to consider how variants can be advantaged in interacting with other species, such as outsmarting their predators. To stay alive, a species must evolve defense attributes, to better escape predators and to combat parasites.

Reproduction allows organisms to make a new generation of individuals of the same species. (Kratz and Spock, 2024) Gregor Mendel famously studied reproduction in pea plants, and how they can produce a diversity of traits each generation when individuals inherit different combinations of the variation (alleles) in the parent plants. As time goes by, a species can change its traits according to the genes that are combined this way, and depending on which combinations are best suited to overcome environmental challenges. Researchers examine how these changes occur in natural populations over very long periods of time, such as by studying flies, birds, and bats, which have all evolved the ability to fly but independently of each other because theya re not close genetic relatives (yourgenome.org/theme/what-is-evolution/). Co-evolution also occurs frequently in natural populations, where two species or groups of species have evolved alongside each other to change each other's traits (Yourgenome.org). For example, the shape or smell of a flowering plant species can evolve to attract a specific pollinator species, where bees and certain other animals are great co-

evolution examples.

The book *Darwin's Reach: 21st Century Applications of Evolutionary Biology* by Norman A. Johnson has a section that explains how evolutionary medicine can help us understand the process by which the traits evolve in organisms like humans, to create certain disease problems. The information from evolutionary biology and how other animals have evolved to overcome disease problems can also help guide our abilities to create medicines useful against a wide variety of health issues, like autoimmunity, antibiotic resistant bacterial pathogens, mismatched-diet diseases, sickle cell disease, and cancer (Natterson-Horowitz, and Bowers, 20212.

Evolutionary medicine is a field study that examines human health and disease using evolutionary principles and the evolutionary history of humans as a species. This field emerged in the early 1900s, especially through the work credited to its founders George Williams, Randolph Nesse, and Stephen Stearns. These scientists looked beyond the role of medicine to treat disease in the present, and instead focused on how human evolution has shaped our vulnerability to health and disease problems. Evolutionary medicine describes how many chronic diseases we have today result from cultural changes that happen much more rapidly than human biology can evolve to keep pace. For example, obesity and Type 2 diabetes are both becoming global epidemics as high-sugar and high-fat foods have become plentiful, replacing healthier foods in our typical diets. Evolutionary medicine looks at how essential nutrients important for our cells are not compatible with processed foods which lack them, and can explain why the function of our genes is not adjusted to modern diets.

Viruses and Bacteria

What are the similarities and differences among viruses and bacteria, which are both important for infectious diseases in humans? Both bacteria and viruses are microscopic, but bacteria are cellular organisms whereas viruses are not made of cells and are generally hundreds of times smaller than bacteria. Bacteria traits are passed across generations through DNA, just like in humans and other large multicellular species. But viruses can have either RNA or DNA, surrounded by a shell made of proteins called a capsid that is a coat-like structure which protects the virus against environmental stressors such as heat (Dr. Sarah Finch's Youtube).

Viruses cannot multiply on their own like bacteria. Instead, a virus needs to infect a cellular organism host, like a multicellular human or a single-celled bacterium, to make virus copies. The virus takes over the metabolism of a cell, instructing the cell to use energy to make new virus copies that can exit to infect more cells. The rate of the virus reproduction through hijacking the cell can be very fast. In addition, some viruses can live outside of a cell attached on a nonliving object surface for a few days, until a new host is encountered. This type of virus behavior was studied in a meat packaging plant during the COVID-19 pandemic, to help understand why workers were getting sick. I will share that study in the latter part of this section.

It is important for students to learn that not all bacteria are harmful to humans, and many bacteria species are essential for our health, for example. In our seminar with Dr. Paul Turner, we learned that our skin sometimes has bad bacteria, but there are also many good bacteria that help prevent pathogens from entering the human body. The same holds for bacteria within our bodies, such as the gut microbiome that contains species that aid in digesting food and found in the human stomach and intestines. Clearly, we need good bacteria to help us digest and break down our food into useful resources.

Featherstone, A. B., Arnald, J.T.M.M., Brown, A.,& Dass, S. C. (2024) studied how viruses can cling to surfaces which is an adaptation to help infect hosts such as humans at a later time. Viruses can remain on surfaces

like stainless steel, PVC, and ceramics for up to five days. Featherstone and colleagues studied this situation in meat packaging plants, to explain how COVID-19 might have changed to different variants by 2020 that better survive on surfaces. Many meat packaging plant workers worked at the plant without knowing that other variants of COVID-19 mutated to live longer on surfaces—which helps explain how the virus continues to spread through an epidemic. The virus had many ways to be transported, like the viruses passing through the HVAC, standing close to other workers, sharing equipment, and sharing living space. The media described how COVID disease was easily spread through droplets (such as in a sneeze), because viruses clinged to the droplets allowing movement between host individuals. It was hard to understand the speed and amount of time the virus stayed alive outside of hosts and traveled between hosts. The virus lived long enough on stainless steel, PVC, and ceramic surfaces for up to 5 days to help its spread. The workers at the plant had to take extra precautions at work once this information became known. Featherstone, A. B., Arnald, J.T.M.M., Brown, A.,& Dass, S. C. (2024)

The Navajo elders and ancestors had a saying for our generation: “Everything is alive; respect nature, acknowledge nature, and all will come back to balance.” The readings and study of evolutionary medicine, such as the book we read by Norman A. Johnson, emphasize that it is useful to understand this balance and to respecting what nature has given. The book describes the problem of widespread antibiotic resistance in bacteria, and how their naturally evolved enemies, phages (bacteria-specific viruses), can be used to combat these infections. This is evolutionary medicine at its finest, working to find a solution to combat the rise of antibiotic resistant bacteria by understanding molecule-level interactions between these microbes. Chan, B.D., M. Sistrom, J.E. Wertz, K.E. Kortright, D. Narayan, and P.E. Turner, 2016. Phage selection restores antibiotic sensitivity in MDR Pseudomonas aeruginosa. Nature Scientific Reports 6:26717 was a study described in Johnson’s book, where scientists used specific phages that attacked antibiotic-resistant bacteria and selected for the bacteria to evolve phage-resistance, making the bacteria less capable of causing disease or switching back to being sensitive to antibiotics. By focusing on evolution in response to the phage, natural selection causes the population of cells to become re-sensitized to antibiotics and, in turn, makes antibiotics work again as we intended.

Objective

How can evolutionary medicine be applied to our ailing world? Is the connection between medicine and bacteria drastically overlooked? In the 6th grade, I would like to include the concept of evolutionary medicine as a foundational approach.

Middle school students may begin to wonder about the same medical issues due to family members dealing with some of the above health problems. Students know that more and more students in their classroom are sensitive or allergic to nuts, fruits, and spices. How do young middle school students begin to wrap their minds around all these health issues? The day will come when our middle school students will question why a family member has passed due to diabetes or cancer. In the Navajo Nation, diabetes is very prevalent. Our local health aids or health workers try to remedy this by teaching our community to have a balanced diet at every meal. The factors of allergies to food and processed food are not explained in total to help the people of the Navajo Nation, and most of the processed food in our local grocery stores could be the problem. A nutritionist or healthy-living expert entering our grocery stores in the Navajo Nation would be appalled. Fifty years ago, the food in the local grocery stores was not part of a typical Navajo Family today. Most of all, the

food eaten in the past was fresh and not processed like canned food. A time may come when our bodies evolve to adjust to eating processed foods, but currently our bodies are mismatched to the chemicals and additives in food that cause some malfunctions. The same story is true for our pets and domesticated animals in our corrals, which often have less healthy diets than in the past. The dependence on humans to feed them instead of foraging to get their food has caused them to develop health issues too. So, owners use medicines like antibiotics, vaccinations, and other pills or manmade medicine to try and cure the animals. The evolution of how our body is adjusting and how our body is feeding back needs to be balanced.

Evolutionary medicine demonstrates that evolutionary biology is a valuable science that poses new medical, relevant questions and raises hypotheses and possible answers. In our Yale National Initiative seminar lectures, Dr. Paul Turner stated simple questions such as why humans become susceptible to disease. Why is the human body not adjusting fast enough to change the problem of being overweight by burning excessive amounts of food stored in the body? The processed foods in our diets are not being digested differently to avoid the extra fat and high starch food raising blood sugar. Evolutionary medicine would help my students understand that processed food was unavailable in the past, and creates a health problem in the present. Human's typical consumption long ago was wild plants and wild animals for meat. Mayo Clinic's Healthy Life Style article indicated that genes are not well adjusted for modern diets that grew out of farming practices. Farming made gathering food a lot easier. Growing domesticated food like grains and legumes made food plentiful. Not only did the people make grain and legumes readily available, but humans also made meat easily available. Humans domesticated wild pigs, cows, and sheep for meat. As the Mayo Clinic said, Dr. Paul Turner reiterated that the change in food gathering happened quickly. Still, the evolution of humans' ability to adjust to modern food has not happened.

As Florence Yaun indicated, evolutionary medicine can also reshape how we view specific human characteristics. Only some humans can digest the sugar lactose in dairy milk as adults. The study of genetics and mutations in human populations, particularly those of European and African descent, explains how lactose tolerance is a response to cattle domestication. Because domesticated cattle can be milked as a food resource, it is an advantage if you are a variant that is capable of digesting lactose throughout life, as opposed to only during childhood. It was interesting to hear Yaun on YouTube: this means that lactose-intolerant people may be the "normal" ones because this was the same in our long ago ancestors before cattle domestication became popular (Yaun, 2024).

Connection to the Navajo Nation student for cultural relevance

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The Navajo Nation language has a content standard in the oral history of connecting today's saying to daily living. It is believed the origin of our Navajo Creation story had some science concepts, such as microbes. Microbes live right along with the deities and the first people. A deity called White Shell Woman gave birth to twin boys. The Twins were tasked with eradicating all the Giants because the Giants on the land were causing mishaps to the people and other creatures on Earth. The Task was given to the Twins to get rid of the Giants. Long story short, one of the Giants was associated with the microbes. This giant was the leader of the microbes in the Navajo story. Specifically, consider the lice. Life was under the category of microbes, and the lice were begging the twins to spare them and continue to live on Earth with a purpose for the people to stay a family and be netted closely as a family. The twins had mercy and gave the Giants representing the microbes or lice the will to live. Culturally, this particular Giant is still present on Earth to this day. As the

traditional story is told, the twin's decision not to slay the Giant, who represented lice and microbes, was to help families congregate. To this day, when a young person is presented with lice, the entire family, aunts, sisters, and mothers come together to remove the lice from the young child's hair.

It is said that the giants were the children of the sun, and the sun was very protective of his children. Knowing that the twins were the children of the sun as well, eliminating the Sun's children would be challenging.

I share this cultural piece of what we, as Navajos, share with our children. The stories are not carried on to the next generation, and it is very important to present lessons in science with cultural relevance. It has to be known that people like Arnold Clifford, a gentleman with a Bachelor's degree in geology who collected plant species for colleges like San Juan College in Farmington, New Mexico, are essential scholars in the Navajo Nation. Becoming a true botanist and a Navajo ethnobotanist, he studies plants at San Juan College under his professor, Kenneth Heil. Arnold has collected plants and native plants from surrounding areas of Durango, Colorado; Black Mesa, Arizona; Navajo Mountain, Arizona; Flagstaff Peaks, and most buttes and plateaus in the Four Corners area for New Mexico State University, University of New Mexico, Northern Arizona University, and Brigham Young University. Arnold became aware of his knowledge of edible plants, plants used for dyes, useful plants, medicinal plants, ceremonial plants that provide protection, and plants used in warfare. Most of the teaching came from his grandmother and his ancestors of 7 generations back. His grandmother, Sarah Charley, taught him the awareness of plants and their uses. His article, *Nature the Navajo Way*, narrates Arnold Clifford's mission of documenting life, ancient, modern, and endangered plant species. All his documentation is an actual teaching of traditional Navajo understanding of nature and science. Western scientific methods are used in collecting and documenting all plant species. The collaboration of traditional and modern science interpretations of plant existence tells a whole story to him. In turn, he hopes to change the scientific narratives by adding what academia often leaves out.

Arnold is aware that most of the information from his lineage is outside of textbooks. One of the plants that Western scientists should have been aware of is used for blessing ceremonies. These velveteen leaves with small flowers did not have a name in English. So, the plant used for smoking oneself for good thoughts, good plans, and good health was named after him. The scientific name for this plant is *Aliciella cliffordii*, the "beautyway" smoke ceremonial plant. Arnold studies the traditional plants as a relationship between plants and the earth. Navajo teachings and principles state that plants are alive. The plant society has a deity. It is proper to talk to the plants and their deity. Once the deity acknowledges your request or your need to use them to eat, heal, take part in a ceremony, use to wash and dye, or used to protect, the plants will show themselves to you as a patient. Arnold stated, "I'm thinking about these plants as Holy Plant People and being reverent about my science. When you think of them that way, they the plants, reveal themselves to you."

At the 6th grade level, students study microbes, cells, DNA, and RNA. During this curriculum's teaching period, the student will be given science vocabulary.

The influence of evolutionary history on human health and disease by Benton and. Labella was published. 2021. In this article, it focuses on chronic inflammatory disease, and some of the Diseases are very familiar to the Navajo Nation, for instance. Diabetes type two is one of the inflammatory diseases that I will touch on. How does evolutionary medicine work? Hand in hand with microbes, viruses, and pathogens. In this curriculum it will show. The students have to learn how microbes, viruses, and pathogens are interrelated in how they are transmitted from human to human. In addition to this section, the topic of how viruses and pathogens can cross from animals to humans is discussed. By explaining how this occurs, children at the 6th-grade level will

understand that it cannot just happen by a cough or touching an animal. They will know that such diseases can be transmitted directly from animals to humans, and SARS-CoV-2 is an example. Some transfers are made by insect vectors such as mosquitoes and somehow into the human blood system. One example is the Zika virus that can attack a human's nervous system. Many of these Zika outbreaks are in South America but close to northern Central America. Zika can be found in warm places with an abundance of vegetation. There will be a section in this curriculum that will talk about our defense system against pathogens. There are limitations and constraints on what selection can do in host defense against such sdisease, often resulting from constraints, including evolutionary trade-offs. In this content area, I will explain what the evolutionary tradeoff is. But as in teaching it to the students, it will be just mentioned, and a short video on what evolutionary trade-off means and why it is essential to learn more about it at a higher grade level. This paragraph will state that no matter how fast humans work on vaccines, students need to know human evolution, and that our evolved human defenses as well as our medical technologies are essential but cannot keep pace. Environments, especially those of our own making, lead to non-infectious diseases that result from a mismatch to maternity.

Teaching Strategies

An input chart with basic information will become an anchor chart for students to use during the entire curriculum teaching. Most of my science content is from a textbook that teaches essential life science. Life science is mainly covered in the fifth grade. Still, our sixth-grade curriculum has specific content: cells, DNA, RNA, genetics, bacteria, viruses, and ecology, and several topics are covered. Life science is covered at the end of the school year, but this curriculum will be introduced in the first quarter of the school year. Our seventh and eighth-grade science teachers would like our fifth-grade and sixth-grade students to know science terms, understand the scientific methods, learn to make observations, and be willing to discuss any thoughts and feedback about learning. The school’s goal is to make students see the world through a lens of being curious. Evolutionary medicine is the topic due to the interesting case studies that will be shared. Sharing how the history of living organisms evolved to what we see today. In addition, we are attaching the idea of using bacteria and phage or probiotics with cell mutations. The mutation of an organism is natural and sometimes helps scientists cure or alter the path of a bacteria or virus's existence. Teaching them how cells communicate in layman’s terms would make learning much more straightforward.

Direct Instruction on vocabulary: An anchor chart activity using a graphic organizer explains what a virus, a pathogen, and a bacteria look like in the cartoon version. This mini vocabulary lesson entails content-rich definitions with graphic pictures as anchor charts. These anchor charts will be used to refer to during direct instruction. Students will have accumulated at least 20 words. These words will be user-friendly and can be used for future instruction in life science lessons.

Direct Instruction with interactive group reading, group video, and group chart. Using this strategy, students will take notes on how the history of organisms and the history of medicine join to make evolutionary medicine. This will be taught in three days. The school textbook Life Science will provide a short background knowledge and a simple explanation of the evolution of all living things. On the second day, the students will use YouTube to search for medicine and problems with antibiotics for humans.

Think-pair-share is a strategy to clarify any misconceptions about vocabulary or readings. A group of three students will read short passages and discuss the critical ideas. After each student shares the main ideas,

students write their responses in summary style for others to read. Once the group shares with the class, they will post their responses near the anchor charts. Students will be allowed to ask questions about the summary later for clarity.

Classroom activities

The activity of evolutionary medicine is to create a slide show or a graphic novel to show the roles of pathogens, bacteria, and viruses in Evolutionary Medicine since writing is the lowest score in our Arizona Academic Standards Assessment. The strategy is to put all the scientific terms and their meanings in a written format. The students will improve their understanding of evolutionary medicine through a writing lesson by approaching the vocabulary with student-centered ideas and expression. A graphic novel explains that bacteria are often friends to living organisms like humans and plants. The story's main topic would be how bacteria and antibiotic resistance can be resolved. A case such as a cut on a human boy infected by antibiotic resistant bacteria is instead cured using phage. The novel's exposition would be in a hogan setting with a dirt floor, and a family from nearby cities will attend a traditional blessing way ceremony. Developing a graphic in a conventional setting will meet the Navajo Nation's cultural and language standards.

The graphic organizer is downloaded from Alima McKnight, Yale National Initiative participant. This graphic organizer of the comic-style strip allows students to express how they view the teaching of the content. In this case, the cartoon of pathogens, viruses, bacteria, and the science term of evolutionary medicine will be expressed with their unique thinking of show and tell presentation. As McKnight explains in our discussion, students feel less anxiety about complicated ideas and vocabulary. The plan is to pre-upload vocabulary at the beginning of the unit and present two to three terms as the unit is being taught. By the end of the unit, the students will have two graphic novels to show others in the middle school hallways of evolutionary medicine is about. The title on the bulletin board would be the unit’s title: Navajo Kids Learn about Evo Medicine.

The third activity is to learn about the Navajo Nation’s botanist, Arnold Clifford. Read his blog about understanding through traditional stories of grandparents’ teaching about plants. As Arnold has done in the article, the writing will be separated into five categories. The study will be on the native yucca plant. Yucca plants can be used for food, because the fruit of the yucca can be served as a treat or a vegetable. Next, yucca can be used as a medicinal plant. The root of the yucca is used to slow down hair loss and strengthen hair. In a “beautyway” ceremony, the root of the yucca is used to cleanse the physical and spiritual body of the patient who is having the ceremony. The yucca stem holds the fruits and can be used as a fire starter, like how campers and hikers use rocks to start a fire. Yucca can be woven into shoes or baskets. The last use is categorized as warfare. The sharpness of the yucca's sharp leaves can cut and harm.

The research about Arnold Clifford can be accumulated into mini posters for others to learn. The posters can be displayed at local cultural centers and school board members' offices. The yucca activity will be tied to how traditional food and plants keep people healthy. If we can begin to reintroduce nature and its natural food, maybe obesity can be lowered.

Appendix.

Implementing District Standards

Arizona State Standard website has its science standards for three areas to study. Physical science, earth science, and life science are categorized separately but are not by any means to be taught separately. Most science is core ideas. For sixth-grade life science standard, students learned about cells, genetics, traits, etc. The foundations are life science is introduced at first grade level and on to sixth grade level. The science core ideas are in sequential order but can be taught separately to meet the student's needs. Arizona public schools must teach at least 50 minutes per day or 250 minutes per week. The reading and researching components count a great deal of time, and I see my students working hours to search for content knowledge on evolutionary medicine. As a base to what the entire curriculum will be about, students will review the foundational information of cells, viruses, and bacteria. Once the students review the functions of cells, viruses, and bacteria, evolutionary medicine will be defined by using the back ground knowledge I have covered at the beginning of this curriculum.

Under 6th-grade life science, teachers are to teach, develop, and use models to demonstrate the interdependence of organisms and their environment, including biotic and abiotic factors.

In sixth grade, the ideas of teaching life science are interrelated to the environment and what humans put into the environment that balances the ecosystem. At the beginning of the school year, the four learning topics on genes, DNA, and characteristic traits of living organisms are taught. This unit of evolutionary medicine content can be added to the basic information of living organisms.

L1: Organisms are organized on a cellular basis and have a finite life span. This life science goal will allow the content area to teach the basics of evolution and connect the ideas that living organisms' history to all living things help science understand genes and traits' behaviors. This standard will be taught from district resources such as Beyond Textbook. Our sixth-grade textbook will be used to learn the specific living organisms. A short lab experience will be implemented to see how mold grows on food such as a slice of bread.

L2: Organisms require a supply of energy and material for which they often depend on or compete with other organisms. While teaching about obesity, students will write and take note of how extra food energy is stored in the body. What happens to the liver, kidney, heart, and sugar blood level when the extra food energy is stored? An anchor poster of how food is digested would be great to write about. In addition to this standard, students can create a standard-size poster board of the supply of energy in the body. In conclusion, they will demonstrate how the cells can not adjust to food with a lot of additives and preservatives. A quick comparison of how natural food is processed naturally and how process food makes human gain food. The digestive system is not able to leave the body easily.

L3: Genetic information is passed down from one generation of organisms to another. When covering this standard, students will write a short piece about how the "Paleo" diet and Native American diet can show how the genetics of traditional food gather and how hunters cope with digesting food. While writing about genetics of traditional food, students will compare this type of food to the "Paleo" diet.

L4: Evolution results in the unity and diversity of organisms, living and extinction. Students will use their notes

about the evolutionary biology of living and extinct organisms to demonstrate this standard.

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