



## **Evolutionary Medicine: Pathogen (COVID-19, Influenza) and the Navajo People**

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### **Introduction and Rationale**

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"A lot of the elders have helped in sharing that story of the twins, fighting off monsters, and the younger generation related to that and put on the armor and the protection that is needed to fight COVID-19". Jonathan Nez, Sandia Lab News<sup>1</sup>

Beginning in March 2020, COVID-19 invaded many communities on the Navajo Reservation. An unknown disease our people had to fight. How COVID-19 spread rapidly on the Navajo reservation happened through its introduction in a tiny town called Chilchinbeto, fifteen miles southeast of Kayenta. A Christian education meeting at the local church had believers from across the reservation attend the large meeting. The preacher was infected with the virus and coughed constantly during the meeting. The meeting concluded, and people went home, unknowingly infected with the virus that went on to infect their families.

Not only did the dangerous virus 'monster' hurt many families on the reservation, but it also attacked other communities globally. The monster in Navajo legend and stories is a name that referred to sickness, cold, hunger, poverty, and old age. The twin warriors killed many monsters and left a few of them because the monsters will remind humans that we experience the unpleasantness and to stay humble. As Jonathan Nez mentioned the monster, it is one of the unseen sicknesses.

The sickness impacted many poor nations and Indigenous Communities. People with underlying sickness and the elderly were severely impacted, especially when losing family members. The social interactions, economics, and health of people have been affected negatively by SARS CoV-2 virus, and the world's livelihood and well-being have been endangered too. Low-income and middle-income countries, weaker health systems, limited resources, and lower socioeconomic status can make the life of people challenging.<sup>2</sup>

### **Rationale**

Many students had to deal with the loss of a family member, went through a traumatic change when attending school during the COVID-19 pandemic, and experienced the guidelines of CDC and tribal mandates like curfew hours and wearing masks. Families were forced to follow the requirements during the COVID-19 lockdown when shopping for food and supplies at the local markets was not allowed. Individuals not following the

mandates were fined and ticketed by the regional authorities.

The school system had to follow national, state, and tribal protocols to continue educating students. The school district distributed laptops and hotspot devices so students could access Zoom for their online learning from home. Many of the students took advantage of their home/school education by not connecting to Zoom, blacking out their screens, or participating in lunch and logging off.

Many students needed to know what COVID-19 entailed, and teachers had to scramble and research information about the new virus. Teachers explained what COVID-19 is to the students and why they had to stay home while attending school. Explaining the virus' function and mutations was complex for fifth-grade students during the lockdown and with homeschooling being online. The primary communication with the students was Zoom, email on their Google accounts, and calling and texting their parent(s) and guardians.

The following year, students were allowed to physically attend school in the classroom with many requirements and protocols from the government and tribal entities. Eventually, students began attending school full-time.

With the decline of COVID-19, the community is more relaxed, and most students do not wear masks. However, some people still wear masks, a reminder of the ongoing threat. The 2023-2024 students taught in the past year were the online COVID-19 students who homeschooled on Zoom for the entire school year. Even though COVID-19 is a minimal threat today because of vaccines and antiviral medicines, our students must understand how viruses' function and mutate to affect human health, as the pandemic virus and others will continue to be relevant in their lives.

Teachers must prepare for the type of students they will teach when planning to write and teach the fifth-grade curriculum unit. Teachers who teach in the Dine Nation at the Kayenta Unified School District will have students who are Native Americans and Navajo. An estimated percentage of native students is about 8%, others represent other nationalities, and 1% are white. Kayenta is located in the northwestern part of Arizona and is about the size of West Virginia. Arizona, Utah, Colorado, and New Mexico are the "four corner" states encompassing the Navajo reservation. The community of Kayenta is a hub for smaller communities in the surrounding area, like Black Mesa, Chilchinbeto, Cowsprings, Dennehotso, Oljato, Rough Rock, Shonto and Tonalea. The distances of the communities range from fifteen to sixty miles from school to home. These communities rely on Kayenta for shopping, laundry, fast food, schooling, the local Black Mesa movie theater, and the weekly flea market.

Many of the students within the surrounding communities prefer attending school at Kayenta Unified School District (KUSD) because of the sports programming provided to students from the third grade through high school. Basketball and football are the two sports that attract fans. Additionally, students have access to the school swimming pool and the culture center events like Miss Navajo Nation, beading, and sewing classes, which are some of the activities families attend. KUSD is a K-12 school with one high school, one middle school, an elementary school, and a Pre-K school. Many students ride buses from outlying smaller communities, about 30 to 120 miles roundtrip.

Most students know the basics of how viruses' function. They know viruses are minute and can be viewed only through powerful microscopes. They also know some viruses of humans can enter the body through oral cavities such as the nose and mouth and multiply rapidly. However, students do not fully comprehend how these viruses invade and multiply in the body, causing severe sickness and sometimes death. How viruses mutate into various strains is another factor students need to gain sufficient knowledge about microscopic

organisms.

The structure of the SARS CoV-2 virus includes the genome, lipids, proteins, and membrane cover. The outer part of the virus has protein structures, which need to bind with receptors of the host cell to begin infection. Then, the virus enters the airway of the trachea lining and begins to incubate and multiply. As the viruses multiply within cells of the infected human host, they replicate to create more viruses. As more and more viruses replicate, they increasingly infect cells of the lungs and attack the alveoli and damage them.

COVID-19 is divided into three stages, for the asymptomatic phase resides in the nose, for symptomatic phase the virus infection is mostly in the epithelium of trachea where intense damage occurs. The third phase is the most vigorous and damaging because the alveoli are important for the gases to exchange in the lungs.<sup>3</sup> The lining cells of the alveoli and the capillaries are damaged. These damages affect oxygen flow efficiently through the bloodstream.<sup>4</sup>

Many people will survive COVID-19 disease, but some will die because of contributing factors such as their age, underlying health issues, and poorly functioning immune systems. With the advancement of medical technology, some patients overcome sickness. The advanced technologies are the usage of CAT scans, X-rays, and Artificial Intelligence (AI) that could be used to identify, track, and diagnose diseases caused by virus pathogens. The drones and robots are used to deliver food and medicine supplies as well as in sterilizing public places. AI is helping to develop drugs and coronavirus vaccines using the power of super computers.<sup>5</sup>

## Content Objectives

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Evolutionary medicine is using what medical science knows about evolution to improve our health, explain how we can prevent and treat diseases, and explain why we get sick. The evolutionary process matters in our everyday lives through the food we eat, the medicine we administer, and the influences of the environment. For example, these factors impact our microbiome because our body has a variety of bacteria, viruses and other microbes that help or hurt our health, depending on how they react to environmental changes.

The central organizing question of evolutionary medicine—why, in a body of such exquisite design, are there a thousand flaws and frailties that make us more vulnerable to disease?<sup>6</sup> The human body is an amazing machine that needs constant care to live to a ripe old age. Food and water intake, exercise, and preventive medicine are natural balancing acts an individual needs to do to beat the odds against survival.

When bacteria or viruses attack the body, underlying factors can kill a person, make the individual very sick, or cause a mild sickness. These pathogens usually can evolve countermeasures faster than we evolve defenses because of their short generational time and immense potential reproductive output.<sup>7</sup> These microbes can mutate and change their genetics faster than our cells, and faster than our immune defenses that try to attack them.

Medical doctors and medical and evolutionary scientists need to generate and test the hypothesis of human vulnerabilities to disease and sickness. As part of the maturation of evolutionary medicine, increasingly more care has gone into rigorous formulation and testing of evolution hypotheses relating to our health.<sup>8</sup> As long as there are diseases and sicknesses, evolutionary medicine will need to know what, why, and how.

Evolutionary medicine is built upon an edifice of study by evolutionary biologists, medical doctors, functional biologists, and natural theologians that stretches back centuries.<sup>9</sup> The pioneers of scientists and doctors tested and practiced using medical vaccines on a trial-and-error basis to find a cure for a particular sickness. These practices of trial and errors helped pave the way in using modern vaccines, such as those important in fighting the COVID-19 pandemic. Evolutionary medicine provides numerous opportunities to help researchers and doctors understand the evolution of humans and why we are vulnerable to certain illnesses and diseases, to have better disease prevention, and to analyze what earlier studies have conducted to see what worked and what did not work which involved historical traits and environmental mismatches. For example, life history evolution research in human traits and the current environment helped paved the way in studying women's health. Life history includes growth, reproduction, and survivorship dynamics.<sup>10</sup> (the future) Life history can identify trends in the future versus the past, like the reproduction of women in our earlier history and how this has changed extensively today. The offspring produced per woman has reduced over time, which can impact the occurrence of short- and long-term health problems, such as postpartum depression, and pelvic organ prolapse later in life.<sup>11</sup> (the future)

Researchers also apply lessons from evolutionary medicine to prepare us for future challenges like with COVID-19 pandemic and other novel zoonotic diseases that may occur.<sup>12</sup> (future of EM) AIDS, Influenza, and COVID-19 are viral pandemic sicknesses. Doctors and scientists are currently utilizing the understanding of evolution to determine when and how viral mutations can lead to new variants that escape our immune defenses and vaccines.

The curriculum unit will cover topics such as COVID-19, the Influenza pandemic of the early nineteenth century, and asthma. The three topics are respiratory diseases that affect the lungs, due to either pathogen infections or because of allergy responses.

## **COVID-19**

COVID-19 is the disease caused by coronavirus SARS-CoV-2, which has RNA as its genetic material<sup>13</sup> The viruses affect humans and some other animals. Contact tracing from humans and animals was challenging to conduct in finding the source of the virus. The Wuhan area had an open market that sold a variety of exotic animals for food, which might have been the original source for early infections in humans. Such a combination of diverse wild animals is a recipe for possible disease spread. Science experts analyzed likely possibilities of SARS-CoV-2 carriers (reservoir species), such as the horseshoe bat, the civet (a cat-like animal), and the possible transmission that happened to humans. Bats are likely a major source of spillover viruses because they contain many different virus species within their bodies, compared to other mammals.<sup>14</sup>

The frequent transmission of SARS-CoV-2 between different host species gives the virus opportunities to evolve into new strains and various sources of possible spillover into humans. One observed change (mutation) during the virus;' evolution is an insertion of four amino acids in the spike protein found in the pathogenic, but not in the non-pathogenic coronavirus.<sup>15</sup> The pathogenic and non-pathogenic variants are distinguished by their predicted effects of these viruses for causing severe sickness when entering the human body. Another signature trait is in the nuclear localization signal domain of the N protein.<sup>16</sup> This part of the protein directs it to the nucleus of host cells.<sup>17</sup>

On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a pandemic. By this time, the virus had reached 114 countries, with 118,000 known cases and 4,300 deaths worldwide. That was only the

beginning.<sup>18</sup> These countries' businesses began to shut down. The stores, banks, schools, and transportation all decreased to a standstill. The United States government, with the Centers for Disease Control (CDC), created mandated guidelines to protect their citizens. The stay-at-home order was announced to try to contain and slow the spread. Within days and weeks, many infected people died, including celebrities, famous musicians, and everyday citizens. Families lost mothers, daughters, sisters, fathers, uncles, sons, grandparents, colleagues, and friends. The four epicenters of the virus spread in the USA were in New York City, Washington State, New Rochelle's New York suburb, and Washington state in Snohomish County. The virus had spread and circulated among the various communities, making it difficult to contain the outbreak.

The uniqueness of the COVID-19 pathogen allows its patterns to be traced as the virus spreads through the human population, producing data that describes this pandemic spread. Because the coronavirus evolves over time, phylogenetics methods can be used to track its transmission patterns.<sup>19</sup> Using these methods will help evolutionary studies in containment protocols, which seek to understand how the virus evolves and how its spread can be limited. The virus evolves more slowly than many other RNA viruses, due to its lower mutation rate. Unlike influenza viruses, coronavirus has a gene that encodes a protein (nsp14) that proofreads the replication of the virus RNA, so that fewer mutations occur.<sup>20</sup> Another beneficial factor for the virus is the population size that was infected. The larger the virus population size, the more changes in gene frequencies can occur, causing more mutations to happen, making natural selection efficient in driving evolved changes that make the virus persist in humans. Thus, the large number of active cases of the virus during much of the calendar year 2020 gives the virus more opportunity to evolve by natural selection than if the virus has been checked at low numbers.<sup>21</sup> It was difficult to predict the variability of the virus, whether it will become better at transmitting, whether the virus becomes more damaging to cause severe sickness in the population, or whether it will be less damaging. These changes make the virus better to infect, which causes more deaths. From the initial report of the virus till the early fall of 2020, there was only a single change in the virus for which we had evidence that its rise was driven by selection.<sup>22</sup>

## **Influenza**

The influenza pandemic of the early 1900s killed more people than the soldiers who died in World War I (WWI). An estimated twenty to forty million died around the world from the flu pandemic. It was known as the "Spanish Flu". The name of Spanish Flu came from the early affliction and significant mortalities in Spain, where it allegedly killed eight million in May 1918.<sup>23</sup> The focus was on men joining the war cause and were busy with transporting war shipments and supplies. As the men crowded, they brought the virus and exposed it to others. The virus killed about 200,000 in October of 1918.<sup>23</sup>

Influenza, a formidable foe, affected the war, causing entire fleets to become sick. The flu hit both sides, killing more men than their weapons. The Great War and the pandemic tested the resilience of doctors and nurses. They were away with the troops, and only medical students had to care for the sick, or the sickness took them. Despite the shortage of medical staff, the Red Cross asked the civil sector to assist the sick at home and soldiers arriving from overseas. The responses of the public health officials reflected the new allegiance to science and wartime society. The medical and scientific communities have developed new studies and applied them to the prevention, diagnostics, and treatment of Influenza patients.<sup>24</sup>

As early as 412 BC, Hippocrates, the father of modern medicine, described the first known account of an influenza illness in his sixth "Book of Epidemics".<sup>25</sup> Here, he recounted an annual recurring upper respiratory tract infection characterized by pharyngitis, coryza, and myalgia, which peaked around the winter solstice.<sup>26</sup> In

1510, 1557, and 1580 were the first documented influenza pandemics that originated in Asia, then spread to Africa, the European continents, and finally to the Americas. The 1830 and 1889 pandemics began in China and spread to Russia rapidly within four months. The virus, suggested to be of subtype H3N8, reappeared at least three more times in successive years, resulting in an estimated one million global fatalities.<sup>27</sup>

The Influenza of the early 1900s came in the years beginning 1918, 1957, 1968, and 2009. Additionally, each of the pandemics occurring in 1957, 1968, and 2009 were caused by descendants of the 1918 pandemic influenza virus strain, earning the 1918 viral strain the nickname “The Mother of all Pandemics”.<sup>28</sup> However, improved understanding regarding the emergence of the 1918 virus and factors (biological, social, environmental) that contributed to viral transmission and pathogenesis have been vital to the development of the current epidemic and pandemic influenza outbreak response effects.<sup>29</sup> During the nineteenth and early twentieth century, major outbreaks were increasing, the 1918-1919 Spanish flu, the 1957-1958 Asian flu, the 1968-1970 Hong Kong flu, the 2009-2010 swine flu origins in Mexico causing millions of deaths which effects the world’s economy and healthcare systems. These outbreaks, occurring across different continents, underscore the global impact of Influenza. Within a century, data shows that the flu can evolve rapidly. This is problematic because medical experts worry more about the virus potential in becoming another deadly pandemic. This evolution is why a previous year's flu shot may not be effective on this year's flu and why vaccine developers devote considerable time to attempting to predict the evolutionary tracks viruses will take.<sup>30</sup>

Flu shots are ineffective because the pathogen is constantly evolving and can invade and continue to threaten the hosts. The virus has two primary mechanisms for antigenic change: antigenic drift and antigenic shift.<sup>31</sup> Antigenic drift creates minor changes in viral epitopes through mutations in the viral genome. When epitope-altering mutations occur, viruses containing them are rapidly selected by host immunity, driving antigenic drift.<sup>32</sup> The antigenic regions have the highest rate of drifts because viruses with antigenic changes escape the preexisting immunity. A hallmark of influenza virus antigenic drift in humans is the replacement of older viruses by new drifted variants. However, at rates dependent on subtype, the antigenically variant population has been shown to co-circulate for extended periods in A(H1N1) and influenza B viruses. In contrast, turnover is more rapid with A(H3N2) viruses.<sup>33</sup> The antigenic shift is another factor that completely exchanges HA or NA genes and only occurs in the Influenza A virus because of many animal reservoirs. Influenza B viruses do not have animal reservoirs and do not go through an antigenic shift. When the human population has limited immunity, the virus's transmission increases and becomes a pandemic. To avoid pandemics, public health entities react with vigor to detections of novel subtypes, such as A(H5N9) and A(H7N9), in humans.<sup>34</sup>

New vaccines are produced to pinpoint viruses, which require months of production. By the time the vaccines are produced, the virus might have evolved. For example, influenza B viruses undergo a reassortment of deletions and insertions of segments in humans, resulting in good or bad outcomes. Understanding the evolutionary processes in viruses is important for the progress by researchers that was made during the nineteenth century, and we are moving into the twenty-first century. There is no doubt that the virus will constantly evolve, and humans need to keep up with the changes in diseases. There is no perfect vaccine that will cure all pathogens, but analyzing past data will help generate valuable information for future research.

## Culture Significance

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The health of individuals, whether young ones, adults, or older people, affects their outcome in combatting COVID-19. Monitoring diet and exercising will help individuals fight illnesses. Having the amenities of running water and electricity also makes life a lot easier when sicknesses arise.

In Navajo culture, stories and songs help individuals maintain the traditional way of life. The songs and ceremonies of the Navajo Shoe game and the Circle of Life say the Navajo people are supposed to live up to 102 years because of the four divisions in the Circle of Life and the 102 yucca sticks used in the shoe game represents years of life

Along with the stories and songs, Navajos survived on their traditional food: the three sisters, various melons, apricots, peaches, venison, buffalo, and wild plants like onions, spinach, and many seeds. That may be why many elders live to age 102 and beyond.

Drugs and alcohol are not in our traditional culture, just songs and ceremonies to heal and live a good life. Most traditional songs and ceremonies subsided during the Long Walk of 1863-1866. Some traditional Navajos are trying to revive the old way of life by replanting the cornfields and returning the songs and ceremonies.

Teaching our students some traditions and songs can help them learn to live a healthy life. Adding other healthy lifestyles from the dominant society will also help infuse students' contemporary living for today. Teaching the available resources will help students live a good life.

## Teaching Strategies

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The teacher creates large visuals charts for students to provide chunking of information of a narrative story or informational context. These charts are known as pictorial strategies because visuals are created beforehand in pencil then traced over with colored poster markers in front of the students to show chunking of information with academic vocabulary words. The teacher explains the information for ten minutes then stops to provide students with comprehension about the chart. Known as 10/2, the teacher talks for ten minutes then students share their understanding for two minutes.

The Cognitive Content Dictionary are key vocabulary words students need to know. One word a day is introduced to the students and with the teacher they provide their prediction of the word meaning, syllables, and part of speech. Next, a sketch of the word is shared, and finally students independently create a sentence using the word. The word of the day is used throughout the day.

The process grid chart is a poster chart divided by key topic being studied (for example covid-19 viruses, influenza viruses which includes types of mutation, affected the population, preventive medicine, and prediction of viruses in the future. The grids compare ideas for students to begin writing about their learning of viruses. The teacher conducts and explains the whole process grid strategy so students will eventually create their own grid with other topics.<sup>35</sup>

## Classroom Activities

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The classroom activities implemented are teacher-made visual charts of the topic, pictorial and narrative input charts about a story about COVID-19, and information about the virus. Students use the charts to write a Text & You paragraph about the information and how the information connects to their personal life.

The Cognitive Content Dictionary are collection of words students review throughout the unit taught and is used for other activities like the sentence patterning chart, their learning log, added to pictorials, in the inquiry and exploration chart, and begin to form a booklet of words.

Process grid, students create their own grids to from topics they have learned. They can extend the grid using the writing process for narrative or expository text.

YouTube videos are additional information in providing visuals and explanation about the topic students need to know. While viewing the video students conduct note taking skills assist their understanding and learning about the videos.

The cultural connection is having students create a big book about living healthily and a poster about preventing COVID-19 and the Influenza. The poster will be unique because students will use the Navajo language with visuals while embedding the Circle of Life and 102 years. In the Navajo language, COVID-19 is Dikos Ntsaaigii-Nahast'eits'aadah meaning Big Cough 19. Students explain what COVID-19, and the influenza virus are, its effect on our people, and how they can learn how to use preventive medicine to her their families and clan.

Teaching students' preventive techniques will help them live longer, healthier lives and help prepare them for the future. They will be aware of upcoming sicknesses and know how to educate themselves to combat other mass sicknesses. For example, the flu virus still infects the population, but they know how to use preventive practices.

## Appendix on Implementing State and Navajo Standards

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Physical Sciences: Students develop an understanding that changes can occur to matter/objects on Earth or in space, but both energy and matter follow the pattern of being conserved during those changes.

5.P1U1.1 Analyze and interpret data to explain that matter of any type can be subdivided into particles too small to see and, in a closed system, if properties change or chemical reactions occur, the amount of matter stays the same. Students complete an augur plate activity to get an idea of germs and compare it to viruses.

5.P1U1.2 Plan and carry out investigations to demonstrate that some substances combine to form new substances with different properties and others can be mixed without taking on new properties. Students analyze how viruses travel and mutate in time.



## Navajo Nation Standards

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Concept 2 Natat'á PO 3. Nilch'I al'aan anaa'niligii baa hane' yisnists'aa'go shil beehozin dooleel. (I will listen to and retell stories related to elements of nature).

Concept 2. Nisahakees PO 2. Iiyisii bineeye saad bee yadaati'igii bika iisnist'aa dooleel. (I will listen and see for specific information).

Concept 4 Nihina'nitin PO 4. Hodeeyaadaa' doo diishjijii' adahoot'iidigii alkee' honi'aago baa nahashne'. (I will retell major Dine historical events).

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## Endnotes

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