West Nile, Dengue and Zika…. Oh My!

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Abstract

West Nile, Dengue and Zika…. Oh My! will familiarize students with emerging mosquito-borne pathogens through the simulation of a local outbreak of an unknown pathogen. Through simulated field work, mapping activities and the application of biotechnology, students will adopt the role of an epidemiologist racing to discover the identity of an emerging pathogen. This action plan is designed to engage students enrolled in AP Environmental Science in an immersive lesson taking place over the course of three class periods.

Activities:

mapping, reading and interpreting case studies, gel electrophoresis, CER poster

Rationale:

AP Environmental Science is an interdisciplinary science course, designed to be the equivalent of a one-semester college level science course. This laboratory based course focuses on human-environment interactions, including emerging pathogens (College Board, 2019). Students are expected to be familiar with the vectors for emerging pathogens, the effects of climate change on these pathogens and anthropogenic factors leading to a global increase in these pathogens. By focusing the lesson on mosquito borne illnesses with documented occurrences in South Florida, this activity will enable students to establish real-world connections to a complex topic.

The approximately 50 students enrolled in the AP Environmental Science Course are primarily 9th grade students who are concurrently enrolled in Honors Biology and who all read at or above grade level. This lesson will be implemented at a Career and Technical Education focused Title I high school, with over 90% of the students enrolled on Free and Reduced Lunch Plans and an 86% minority enrollment (U.S News Best High Schools , 2019).

Through the incorporation of biotechnology and the application of real-world examples, “West Nile, Dengue and Zika…. Oh My!” will engage students in the process of science through inquiry-based learning. When working with disenfranchised student populations, this engagement is vital to ultimately increasing diversity in traditionally male-dominated, culturally homogenous STEM fields.

Learning Outcomes, activities, and assessments :

- Students will be able to apply patient and geographic information to identify the source of a local outbreak.
    - Lesson 1: Mapping a Florida Outbreak
      Students will match patient case reports to locations on a laminated population density map of Florida (United States Census Bureau). This will enable students to determine where the current patient contracted the illness.
    - This will be assessed through the successfully completed lab reports (Bokor, 2013) (Csikari, 2016) and through observational notes on student engagement.
- Students will be able to differentiate between gel electrophoresis results in order to identify the exact pathogen causing a local outbreak.
    - Lesson 2: Gel electrophoresis
      Students will use simulated samples of arbovirus/ patient samples (Edvotek Detecting Influenza Virus kits) to perform gel electrophoresis (Bokor, 2013)in order to determine the pathogen causing the outbreak (dengue, Zika or West Nile).
    - This will be assessed through the successfully completed lab reports and through observational notes on student engagement.
- Students will be able to describe anthropogenic actions that increase the occurrence of emerging pathogens.
    - Lesson 3: Putting it all together
      Students will work in small groups (2-4) to create a claim evidence reasoning (CER) poster (Wheeler-Toppen, 2012) to present their claims about the type of pathogen and the site of the initial infection.
    - This will be assessed using a rubric developed for the CER poster.

Pedagogy:

- West Nile, Dengue and Zika…. Oh My! expands my current pedagogical practice by incorporating new research, focusing on local problems and through combining geographic focused case studies with the application of biotechnology. This action proposal builds on my existing teaching practice by expanding the problem-based inquiry learning taking place in my classroom and by incorporating the Universal Design for Learning through the integration of learning through multiple modalities.

Standards [1] :

AP Environmental Science Topic: 8.15 Pathogens and Infectious Diseases

Enduring Understanding *-3 Pollutants can have both direct and indirect impacts on the health of organisms, including humans.*

Learning Objective**:** *3.D Explain human pathogens and their cycling through the environment.*

Essential knowledge:

- 3.D.3 As equatorial-type climate zones spread north and south in to what are currently subtropical and temperate climate zones, pathogens, infectious diseases, and any associated vectors are spreading into these areas where the disease has not previously been known to occur.
- 3.D.8 West Nile virus is transmitted to humans via bites from infected mosquitoes.
- 3.D.11 Zika is a virus caused by bites from infected mosquitoes. It can be transmitted through sexual contact.

If applicable, use of equipment lockers and/or UF visit (either in the classroom or UF campus):

I have the equipment needed to run gel electrophoresis in my classroom but the CPET equipment lockers are available if other participants needed the equipment to conduct this lab.

CATALySES summer institute elements specifically included (UF connections):

Presentations:

- So What is an emerging pathogen? (Morris, 2019)
- Efficacy Trials for Emerging Pathogens (Dean, 2019)
- Mapping mosquitoes: Applications in medical geography for predicting and preventing vector-borne disease (Mundis, 2019)
- All About Arboviruses (Erika Schwarz, 2019)

Labs/ Activities:

- Dengue Dilemma (Bokor, 2013)
- Disease Detectives (Csikari, 2016)
- Ebola Epidemic (Csikari, 2016)

[1] *This lesson also assesses FL Life Science Next Generation Sunshine State Standards SC.912.L.14.6: Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health.*

Literature Cited

Ball, J. e. (2019). Clinical and Epidemiologic Patterns of Chikungunya Virus Infection and Coincident Arboviral Disease in a School Cohort in Haiti, 2014–2015. *Clinical and Infectious Diseases*, 919-926.

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College Board. (2019). *College Board Courses AP Environmental Science.* Retrieved from College Board: https://apcentral.collegeboard.org/courses/ap-environmental-science/course/updates-2019-20

Csikari, M. a. (2016, December). Disease Detectives. Howard Hughes Medical Institute . Retrieved from HHMI .

Dean, N. (2019, June). Vaccine Efficacy Trials for Emerging Pathogens. *University of Florida CPET CATALySES program*.

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U.S News Best High Schools . (2019, June 27). Retrieved from U.S. News : https://www.usnews.com/education/best-high-schools/florida/districts/school-district-of-palm-beach-county/south-tech-academy-5391

Wheeler-Toppen, J. (2012). How Do You Know That? Helping Students Write About Claims and Evidence. *National Science Teacher Association Webinar.* NSTA.

Budget and budget justification:	
(2) Edvotek Ready-to-Load DNA Class Lab Kits	**$250.00**
For this action proposal, I plan to order two of the Edvotek kits "Detection of Influenza Virus " (enough for 16 lab groups). These kits come with the agarose, stain, buffer solution and prepared DNA samples needed to conduct the gel electrophoresis portion of the lab. The DNA sample strips are labeled by letter so it will be simple to provide the students with a modified key that identifies the samples as simulated patient sample, positive Zika control, positive Dengue control and a positive West Nile control.	
(12) Color, laminated population density maps of FL	**$15.00**
For this action proposal , students will use simulated patient case studies to track an outbreak of an arbovirus in South Florida. The laminated maps enable students to annotate the maps while solving the mystery and will allow me to reuse the materials every year.	
	$265.00

West Nile, Dengue and Zika…. Oh My! Lesson 2 Gel Electrophoresis

Meghan Hess Shamdasani

West Nile, Dengue and Zika…. Oh My! is a three-part lesson designed to familiarize students with emerging mosquito-borne pathogens through the simulation of a local outbreak of an unknown pathogen. Through simulated field work, mapping activities and the application of biotechnology, students will adopt the role of an epidemiologist racing to discover the identity of an emerging pathogen. This second lesson is focused on the biotechnology aspect of the lesson, during which students will identify the viral pathogen infecting a patient.

Activities:

gel electrophoresis

Vocabulary:

Dengue, Zika, West Nile, arbovirus, vector, gel electrophoresis,

Learning Outcomes, activities, and assessments :

- Students will be able to differentiate between gel electrophoresis results in order to identify the exact pathogen causing a local outbreak.
    - Students will use simulated samples of arbovirus/ patient samples (Edvotek Detecting Influenza Virus kits) to perform gel electrophoresis (Bokor, 2013)in order to determine the pathogen causing the outbreak (dengue, Zika or West Nile).
    - This will be assessed through the successfully completed lab reports and through observational notes on student engagement.

Standards:

AP Environmental Science Topic: 8.15 Pathogens and Infectious Diseases

Enduring Understanding -*3 Pollutants can have both direct and indirect impacts on the health of organisms, including humans.*

Learning Objective**:** *3.D Explain human pathogens and their cycling through the environment.*

Essential knowledge:

- 3.D.3 As equatorial-type climate zones spread north and south in to what are currently subtropical and temperate climate zones, pathogens, infectious diseases, and any associated vectors are spreading into these areas where the disease has not previously been known to occur.
- 3.D.8 West Nile virus is transmitted to humans via bites from infected mosquitoes.
- 3.D.11 Zika is a virus caused by bites from infected mosquitoes. It can be transmitted through sexual contact.

FL Life Science Next Generation Sunshine State Standards

SC.912.L.16.10

Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues.

SC.912.L.14.6: Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health.

West Nile, Dengue and Zika…. Oh My! Identifying a pathogen using PCR and Gel Electrophoresis

Name _____

Background

Dengue, West Nile and Zika are all arboviruses (viruses spread by insect bites). More specifically, these viruses are classified as flaviviruses all spread through *Aedes Aegypti* mosquito bites (Bokor, 2013). While these diseases are endemic to tropical areas, the increase in travel, trade and average global temperatures due to climate change has increased the range of the *Aedes Aegypti* and the spread of arboviruses.

Symptoms of arboviruses include fever, headache, rash and joint pain and many infected individuals experience no symptoms. However, all of the viruses can cause neurological symptoms and all can have severe complications (i.e hemorrhagic fever associated with dengue fever, microcephaly in infants whose mothers were infected with Zika during pregnancy and encephalitis associated with West Nile).

Purpose : Students will be able to differentiate between gel electrophoresis results in order to identify the exact pathogen causing a local outbreak.

Patient History

The patient was examined in the doctor's office in the August of 2016. The patient was a 30-year old female, experiencing a rash, a fever and mild joint-pain. The patient resides in Palm Beach County, FL but often works from Broward County and Miami-Dade County, FL. The patient attended a wedding in Bay County FL about one week before her visit and earlier in the summer had traveled to both Puerto Rico and Costa Rica. The patient's hope to start a family combined with her travels and symptoms prompted her to visit her doctor to ask about mosquito borne illnesses.

By using updates from the Florida Department of Health and the CDC, the doctor was able to narrow possible mosquito borne illnesses to three arboviruses: Dengue, Zika and West Nile.

Pre-lab:
In this lab, you will use gel electrophoresis to determine which mosquito-borne arbovirus is infecting the patient. The samples we are testing contain real DNA samples, amplified through PCR. These samples do not contain the RNA of any of the arboviruses. We are using simulated DNA samples.

Based on the mapping an outbreak activity and the patient history, generate a hypothesis about which pathogen is causing the patient's symptoms.

Hypothesis:

Independent variable:

Dependent variable:

Control(s):

Lab materials:

- Micropipette (20-200 µL)
- Prepared gel casting tray
- Gloves for each lab group member
- Safety goggles for each lab group member
- Prepared DNA samples and sample key
- Micropipette tips
- Silicon lab mat
- Paper towels
- Sharpie
- Container to dispose of micropipette tips
- Gel staining trays
- Gel stain (Instastain or Flashblue)
- Quart size plastic bags

Lab procedure

1. Gather all lab materials/ supplies.
2. **Make sure to wear safety goggles and gloves the entire time you are working with lab samples.**
3. Set-up the silicon lab mat.
4. Place the gel casting tray on the mat.
5. Set the dial on the micropipette for 20 µL and make sure a clean pipette tip is loaded onto the micropipette.
6. Load 20 µL of sample A into the first well in the gel. Discard the tip.
7. Load a clean tip onto the micropipette and then then load 20 µL of sample B into the second well. Discard the tip.

8. Load a clean tip onto the micropipette and then then load 20 µL of sample C into the third well. Discard the tip.
9. Load a clean tip onto the micropipette and then then load 20 µL of sample D into the fourth well. Discard the tip.
10. Load a clean tip onto the micropipette and then then load 20 µL of sample E into the fifth well. Discard the tip.
11. Load a clean tip onto the micropipette and then then load 20 µL of sample F into the sixth well. Discard the tip.
12. Bring the gel casting tray to the teacher (or the electrophoresis apparatus).
13. While the gel is running, read the gel staining instructions and complete the data table below.
14. Once the gel is finished, follow the provided directions for staining the gel.
15. Place the gel in a plastic bag to store overnight.
16. Analyze the results of the gel, using the LED lightbox.

Sample Key:

Sample ID	**Sample contains**	**Gel well #**
Sample A	DNA Standard Marker	
Sample B	Negative Control	
Sample C	Patient Sample	
Sample D	Dengue Positive Control	
Sample E	Zika Positive Control	
Sample F	West Nile Positive Control	

Sketch the gel once is has been stained.

Lab Conclusion:

1) **What is the mosquito borne- pathogen that has infected the patient?**
2) **Based on your background knowledge, our classroom activities and the patient history, where did the patient acquire this illness?**
3) **What should the next steps be for the patient?**
4) **The patient's doctor provided her with information about preventing mosquito bites. Why did the doctor provide her with this information?**

Teacher Information

Materials Provided in Edvotek Kit: (Edvotek , 2019)

- UltraSpec- Agarose
- Electrophoresis Buffer (50X)
- FlashBlue DNA Stain
- InstaStain Blue Cards
- 1 mL pipet
- DNA Standard Marker
- Negative Control
- Positive Control
- Sample 1
- Sample 2
- Sample 3

Required Materials (not included in kit): (Edvotek , 2019)

- Electrophoresis chamber
- Power supply
- Gel casting tray and combs
- Staining tray
- Gloves
- Pipette and tips
- Balance
- Microwave, hot plate or burner
- 250 mL flasks or beakers
- Hot gloves
- Safety goggles
- DNA visualization system
- Distilled or deionized water

Prelab Bulk Preparations (Edvotek , 2019)

Buffer solution

- Combine 60 mL of 50X concentrated buffer solution with 2,940 mL of distilled water to create 3000 mL of electrophoresis buffer solution.

Agarose gels

- Combine 7.5 mL of 50X concentrated buffer solution with 382.5 mL of distilled water.
- Add 3.0 grams of UltraSpec-Agarose. Swirl to break up any clumps.
- Boil the solution for 1 minute. Then continue to heat the solution while stirring until the agarose is completely dissolved and is clear (if using a microwave, bring the solution to a boil and then heat in 15 second intervals until the agarose is completely dissolved and is clear).
- Cool the agarose solution to 60 °C. Swirl the flask or beaker to ensure that the solution cools evenly.

- While the agarose is cooling, seal the gel casting tray with the rubber endcaps and insert the well combs into the notches.
- Pour the cooled agarose solution into the casting tray. The agarose should solidifies in about twenty minutes.
- You can make the gels ahead of time. Just seal them with plastic wrap or place in plastic bags. Then put the gels into a lab refrigerator.

Sample preparation

- The Edvotek kit comes with the following samples:
    - DNA Standard Marker
    - Negative Control
    - Positive Control
    - Patient sample 1
    - Patient sample 2
    - Patient sample 3
- Key for the samples:
    - Tube A- DNA Standard Marker
    - Tube B- Negative Control
    - Tube C- Patient Sample
    - Tube D- Dengue Positive Control
    - Tube E- Zika Positive Control
    - Tube F- West Nile Positive Control

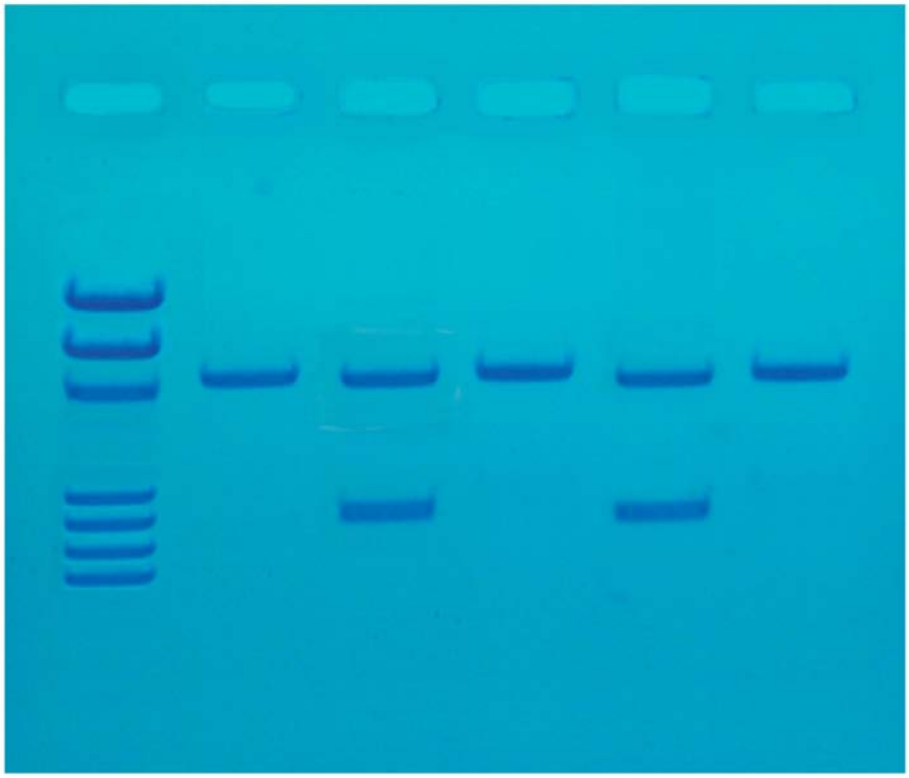
Running gels: follow the Edvotek instructions

Staining gels:

- Lab kits come with different stains. Follow the directions included with the lab kits to stain the gels.
- Students may need to finish the lab the next day. Allow them to place the unstained or destained gels into a plastic bag in order to analyze the following day.

Gel results:

Once the gels are stained, they should look like this. In this gel, the patient was infected with Zika (Edvotek , 2019).



Literature Cited

Ball, J. e. (2019). Clinical and Epidemiologic Patterns of Chikungunya Virus Infection and Coincident Arboviral Disease in a School Cohort in Haiti, 2014–2015. *Clinical and Infectious Diseases*, 919-926.

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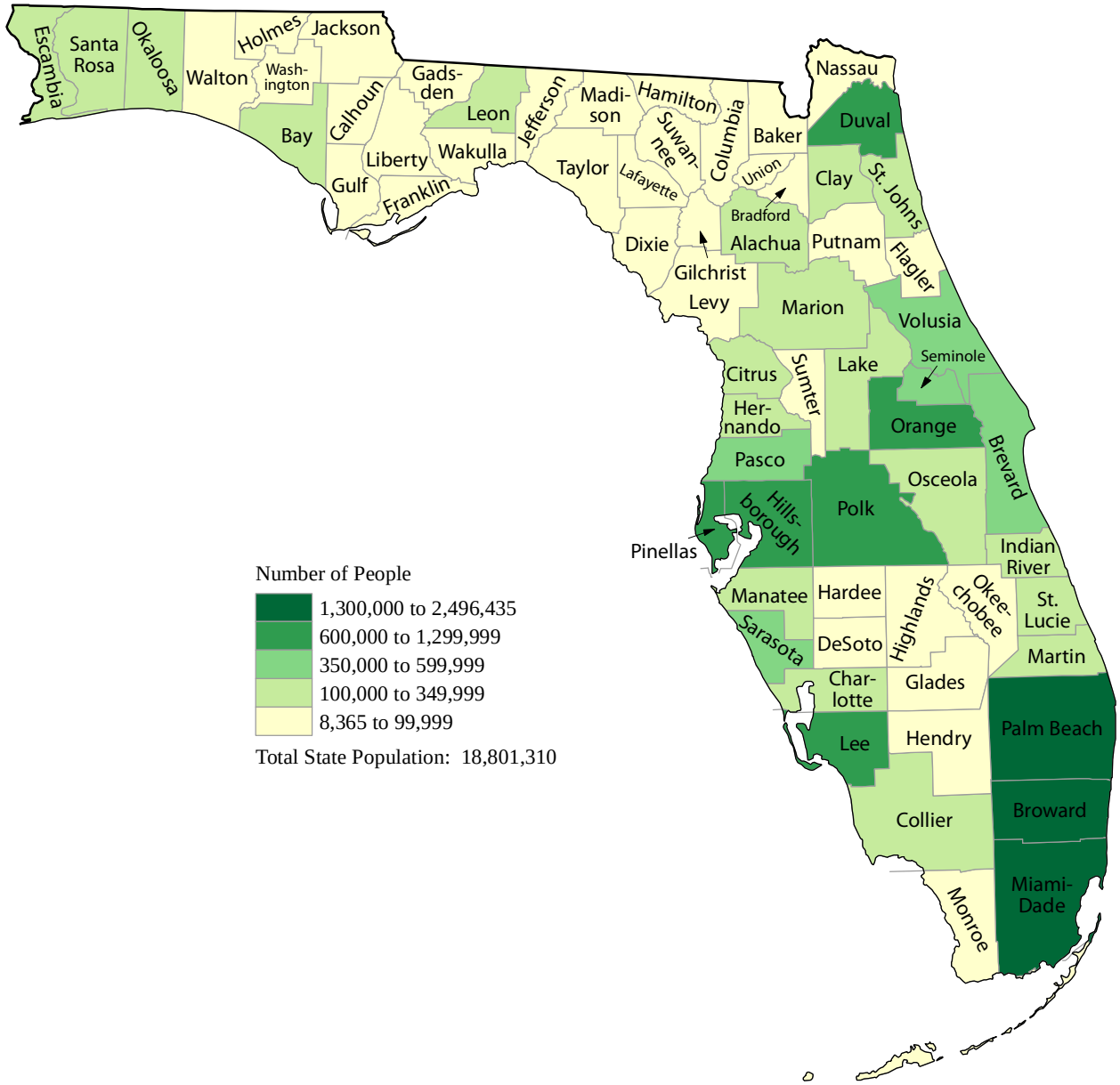
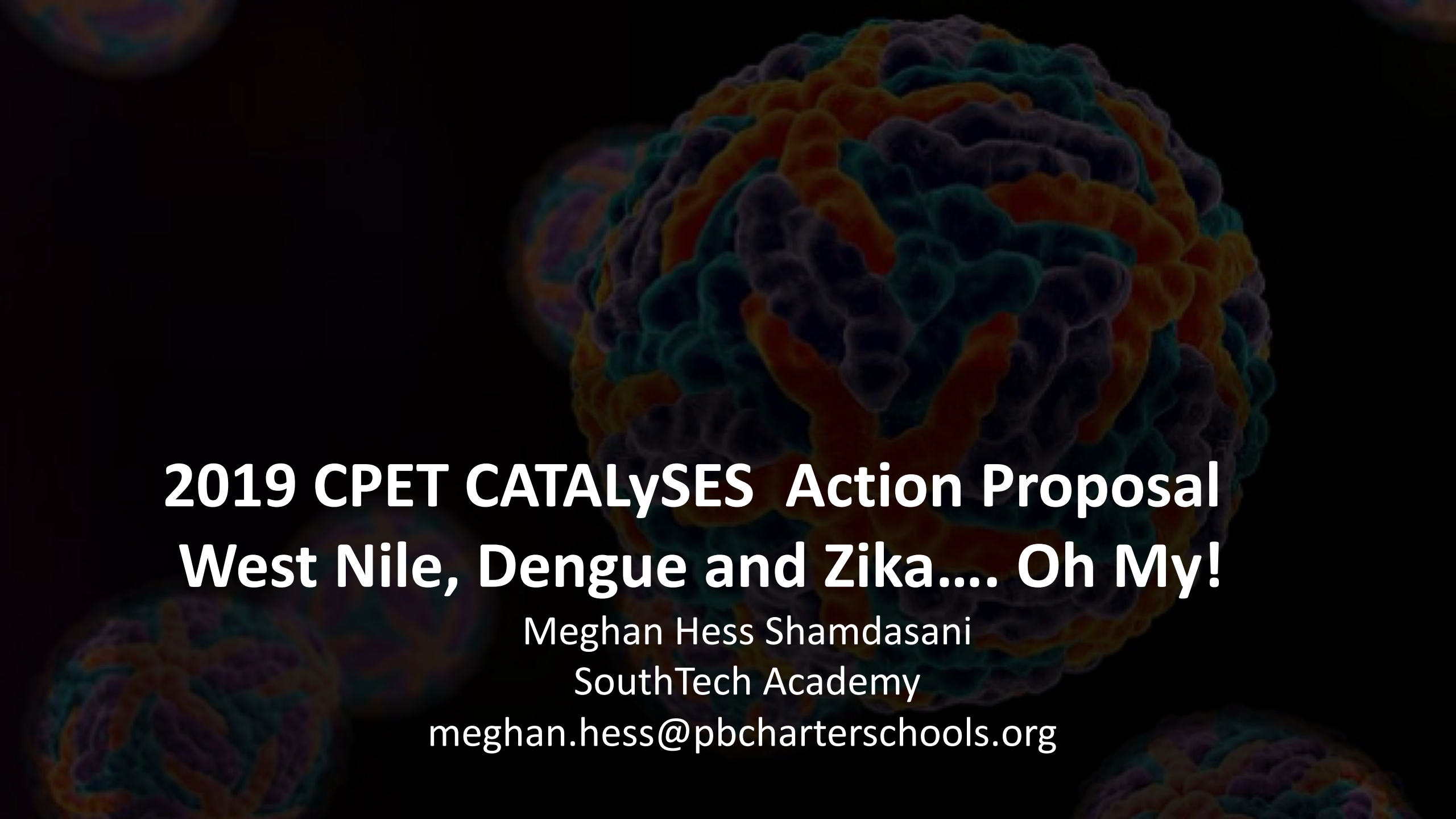
FLORIDA - 2010 Census Results

Total Population by County



Source: U.S. Census Bureau, 2010 Census Redistricting Data Summary File
For more information visit www.census.gov.

United States Census Bureau



2019 CPET CATALySES Action Proposal
West Nile, Dengue and Zika…. Oh My!

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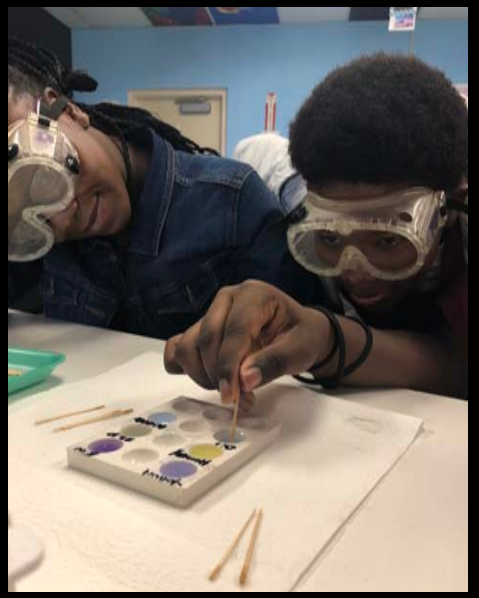
Students and demographics:

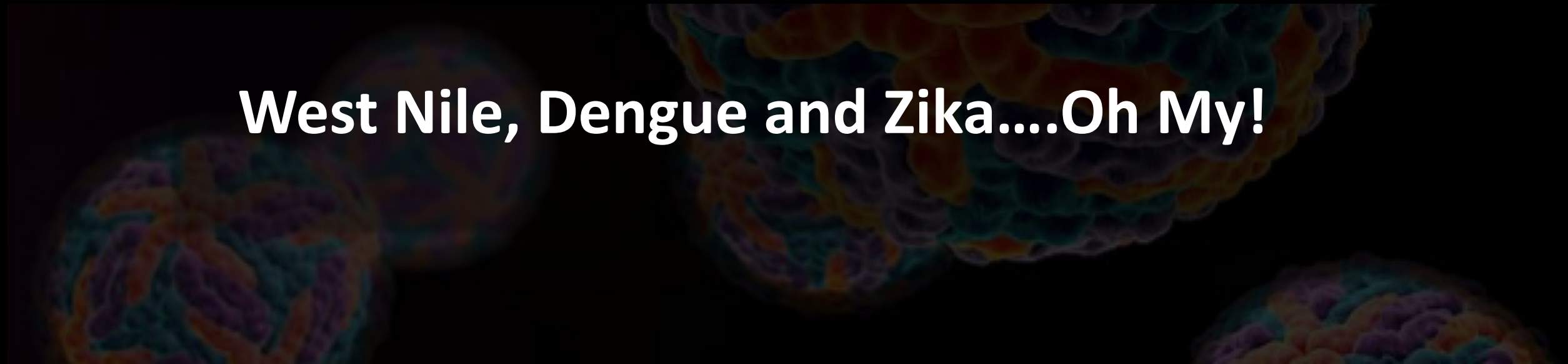
- 50 AP Environmental Science Students
- Primarily 9th students
- Title I School (+90% FRL)



West Nile, Dengue and Zika….Oh My!

Course constraints

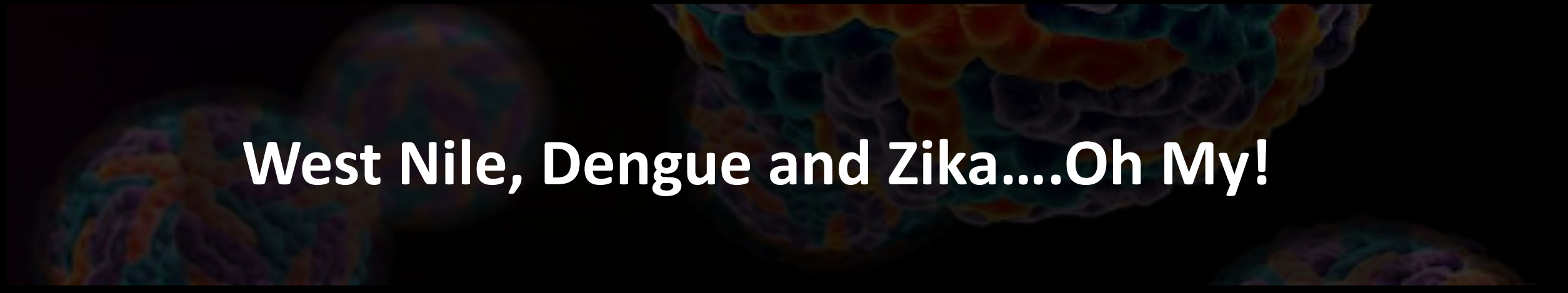
- Students attend class for 90 minutes per day, Monday-Friday.
- Students enrolled in course read at or above grade level
- Students are concurrently enrolled in Honors Biology



West Nile, Dengue and Zika….Oh My!

AP Environmental Science Topic: 8.15 Pathogens and Infectious Diseases

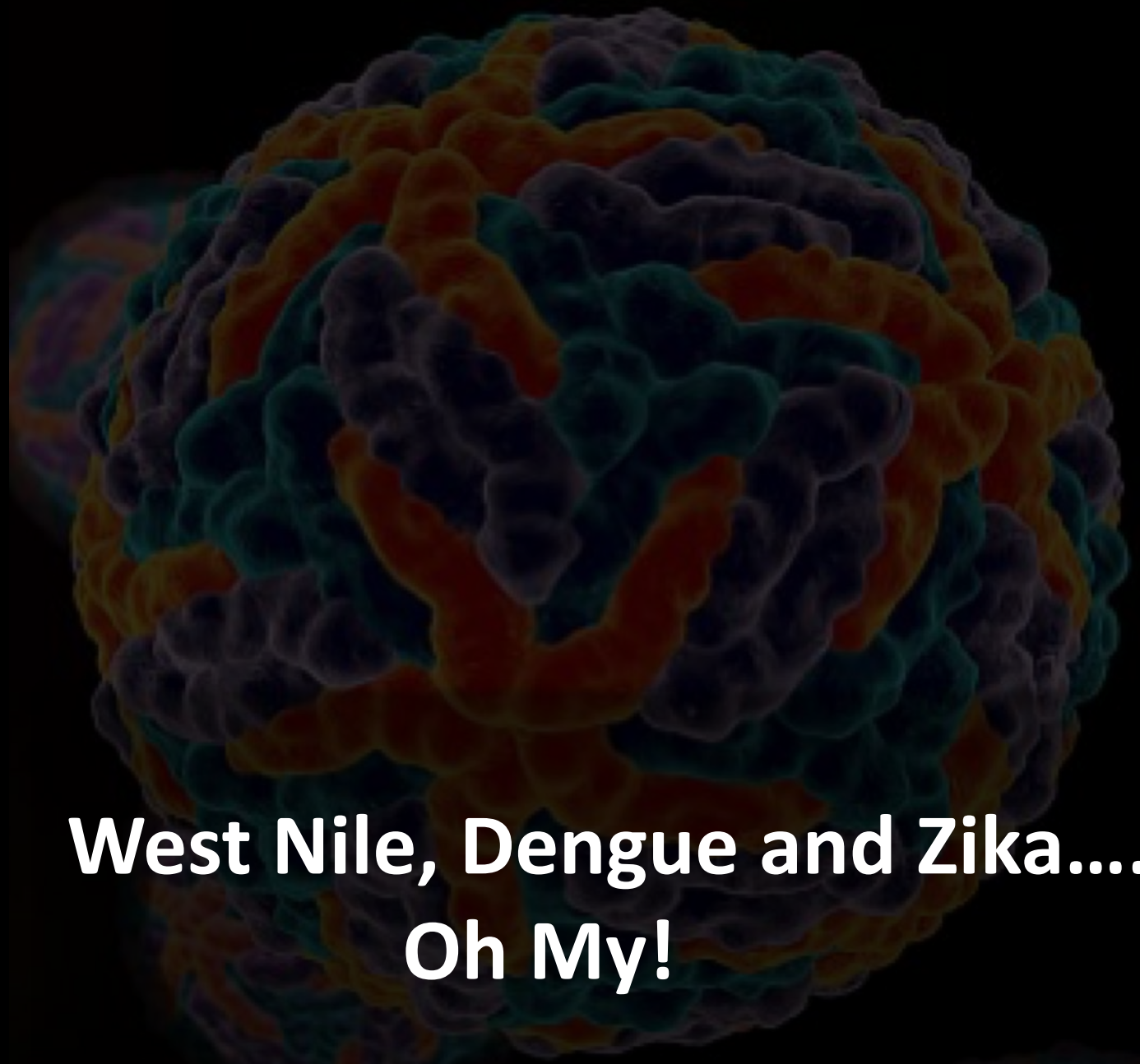
- **3.D.3** As equatorial-type climate zones spread north and south in to what are currently subtropical and temperate climate zones, pathogens, infectious diseases, and any associated vectors are spreading into these areas where the disease has not previously been known to occur.
- **3.D.8** West Nile virus is transmitted to humans via bites from infected mosquitoes.
- **3.D.11** Zika is a virus caused by bites from infected mosquitoes. It can be transmitted through sexual contact.



West Nile, Dengue and Zika….Oh My!

Students will adopt the role of an epidemiologist racing to discover the identity of an emerging pathogen by:

Using a laminated population density map of Florida to record the location of documented outbreaks of West Nile, Dengue and Zika.



West Nile, Dengue and Zika…. Oh My!

Students will adopt the role of an epidemiologist racing to discover the identity of an emerging pathogen by:

Using patient case studies to determine where the outbreak began and to predict which arbovirus the patient has contracted.

West Nile, Dengue and Zika…. Oh My!

Students will adopt the role of an epidemiologist racing to discover the identity of an emerging pathogen by:

Using simulated samples of arbovirus/ patient samples to perform gel electrophoresis in order to determine the pathogen causing the outbreak.

West Nile, Dengue and Zika…. Oh My!

Students will adopt the role of an epidemiologist racing to discover the identity of an emerging pathogen by:

Creating a claim evidence reasoning poster to present their final results.

West Nile, Dengue and Zika…. Oh My!

Special thanks to:

CATALySES

Collaborating to Advance Teaching And Learning of Science Educators & Students

SOUTHTECH SCHOOLS

Virginia Harvey & Kimmel Family STEM Lab SOUTHTECH ACADEMY