Forensic Microbiology in the 21st Century: A New Approach to Forensic Science

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Abstract

This action proposal will immerse high school students (Grades 11 and 12) into an intensive investigation covering new research, a DNA typing laboratory, and forensic compiled evidence to discover how Forensic Microbiology can be ancillary to the known methods of DNA printing and sequence in solving crime. The set of lessons added to the proposal can be used as part of the units of Crime Scene Investigation, The Nature of Evidence, or DNA Typing, or as an extension. It can also be added as a unit introducing Forensic Microbiology, since it is a new approach in forensic investigation. The lessons are part of a five day series that can extend, considering class time available, students accommodations, and lower level student performance.

Rationale

In the early 1980's, scientists demonstrated that certain parts of the DNA molecule were different enough within the human population to distinguish individuals. Since then, DNA typing has been the preferred method to identify victims and to match a suspect to a crime case. PCR or Polymerase Chain Reaction is the method used to make millions of copies of any desired strand of DNA, large or small in a relatively short time, using extremely small amounts of material. Nevertheless, many cases resulted in false-positives, relating suspects to the crime, only because their DNA was present in the crime scene. To date, more than 300 falsely convicted have been exonerated by post-conviction DNA testing, and of these, more than twelve were sentenced to death.

Microbiome is the name given to communities of microorganisms that live on or in people, plants, soil, oceans, and the atmosphere. The study and understanding of microbiomes can aid in the development of useful applications in health care, agriculture, energy, the environment, as well as the field of forensic science. There are research projects in US dedicated to the development of forensic applications of microbiomes since the year 2011 in the areas of: the microbiome as an indicator of time-since-death in the investigation of human remains, the microbiome found in different soils as a means of linking a victim, suspect, or evidence to a particular outdoor environment, and the trace of human microbiome as a great source DNA acting to supplement the use of human DNA for associating people to with evidence and environments.

Applications of microbiome in forensic science are new. This lessons are intended to send the students into brain storming new ways of using the microbiome DNA to justify legal claims in Forensic Science.

Description of the teaching unit:

This teaching module contains five instructional periods of 50 minute classes, and will focus on the following Life Science NGSSS:

FL.SC.912.N.1.2 Describe and explain what characterizes science and its methods.

Fl.SC.912.L.16.12 Describe how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, polymerase chain reaction, ligation, and transformation) is used to construct recombinant DNA molecules (DNA cloning).

FL.SC.912.N.1.3 Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depend on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented.

Lessons:

Day 1: Students will read interactively about the uses of both human DNA and Microbiome DNA using   WISE platform.

Days 2 and 3: Students will isolate human DNA and perform DNA PCR.

Days 4 and 5: Students will read and analyze a crime case to find possible applications of the use of the human microbiome in Forensic Science. They will construct a protocol to follow, prepare a presentation and share with the class.

Assessments:

Pre-Test

Formative assessments of the interactive reading (not graded)

Reading comprehension Quiz

Project Product and Presentation

Learning objectives:

*Students will **describe** and compare human DNA and microbiome DNA.*

*Students will **practice** the polymerase chain reaction (PCR) method, and explain its importance as a forensic application.*

*Students will **construct** a possible alternative method to use in the identification of a victim or a suspect of a crime.*

*Students will **justify** their projects.*

Use of equipment lockers from UF:

PCR locker

Gel Electrophoresis

Pipetting Stations Locker

Literature Cited:

Siegel, J., 2016. Forensic Science: the Basics. CRC Press

www.genome.gov/aboutg-genomics/teaching-tools/Teaching-Microbiome

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SUBJECT	TEACHER	GRADE	DATE
Forensic Science	Elia R. Ortiz-Berberena	11-12	8-2-2019

OVERVIEW

In the early 1980's, scientists demonstrated that certain parts of the DNA molecule were different enough within the human population to distinguish individuals. Since then, DNA typing has been the preferred method to identify victims and to match a suspect to a crime case. PCR or Polymerase Chain Reaction is the method used to make millions of copies of any desired strand of DNA, large or small in a relatively short time, using extremely small amounts of material. Nevertheless, many cases resulted in false-positives, relating suspects to the crime, only because their DNA was present in the crime scene. To date, more than 300 falsely convicted have been exonerated by post-conviction DNA testing, and of these, more than twelve were sentenced to death.

Microbiome is the name given to communities of microorganisms that live on or in people, plants, soil, oceans, and the atmosphere. The study and understanding of microbiomes can aid in the development of useful applications in health care, agriculture, energy, the environment, as well as the field of forensic science. There are research projects in US dedicated to the development of forensic applications of microbiomes since the year 2011 in the areas of: the microbiome as an indicator of time-since-death in the investigation of human remains, the microbiome found in different soils as a means of linking a victim, suspect, or evidence to a particular outdoor environment, and the trace of human microbiome as a great source DNA acting to supplement the use of human DNA for associating people to with evidence and environments.

Applications of microbiome in forensic science are new. **These lessons are intended to send the students into brainstorming new ways of using the microbiome DNA to justify legal claims in Forensic Science.**

Phases	Teacher Guide	Student Guide
Objectives	This teaching module contains five instructional periods of 50 minute classes, and will focus on the following Life Science NGSSS: **FL.SC.912.N.1.2 Describe and explain what characterizes science and its methods. Fl.SC.912.L.16.12 Describe how basic DNA technology (restriction digestion by endonucleases, gel**	**Day 1**: Students will read interactively about the uses of both human DNA and Microbiome DNA using Nearpod platform. **Days 2 and 3: Students will isolate human DNA and perform DNA PCR.** **Days 4 and 5: Students will read and analyze a crime case to find possible applications of the use of**

	electrophoresis, polymerase chain reaction, ligation, and transformation) is used to construct recombinant DNA molecules (DNA cloning). FL.SC.912.N.1.3 Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depend on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented.	the human microbiome in Forensic Science. They will construct a protocol to follow, prepare a presentation and share with the class.
Information	Teacher will direct students through a series of interactive readings and questions to review prior knowledge about DNA and learn new content about PCR and the human microbiome.	Power points in the Nearpod platform. https://learn.genetics.utah.edu/content/labs/pcr Video
Assessment	Pre-Test Formative assessments of the interactive reading (not graded) Reading comprehension Quiz Project Product and Presentation	Jigsaw activity: The Human Microbiome Readings
Activity	Main Project	Power points in the Nearpod platform. https://learn.genetics.utah.edu/content/labs/pcr Video
Summary		

REQUIREMENTS	RESOURCES	NOTES
●Students need basic	●Nearpod	Students will follow the information

Biology knowledge of the DNA molecule.

- They will take a short pre-test of DNA structure.

about DNA and answer questions as they go along the presentation.(Formative assessments)

DAY 2

REQUIREMENTS	RESOURCES	NOTES
DNA PRIOR KNOWLEDGE	NEARPOD	STUDENTS WILL FOLLOW THE NEARPOD PRESENTATION

DAY 3

PCR LAB

DAY 4 AND 5

STUDENTS WILL WORK ON THE PROJECT.

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Catalyses Action Proposal 2019
Elia Ortiz

Standards

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- **Fl.SC.912.L.16.12** Describe how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, polymerase chain reaction, ligation, and transformation) is used to construct recombinant DNA molecules (DNA cloning).

- **FL.SC.912.N.1.3** Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depend on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented.

- Thank you Catalyses!!!!!!!!

The Basics

► DNA typing has been the preferred method to identify victims and to match a suspect to a crime case. PCR or Polymerase Chain Reaction is the method used to make millions of copies of any desired strand of DNA, large or small in a relatively short time, using extremely small amounts of material.

► Microbiome is the name given to communities of microorganisms that live on or in people, plants, soil, oceans, and the atmosphere. The study and understanding of microbiomes can aid in the development of useful applications in health care, agriculture, energy, the environment, as well as the field of forensic science.

Students will...

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► **Days 2 and 3**: Students will isolate human DNA and perform DNA PCR.

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