UNIVERSITY OF FLORIDA CENTER FOR PRECOLLEGIATE EDUCATION AND TRAINING (CPET)

BENCH TO BEDSIDE 2016 PROGRAM

ACTION RESEARCH PROPOSAL

# AN ANALYSIS ON THE EFFICACY OF THE USE OF BIOMEDICAL TECHNOLOGIES AND MODELS TO TEACH THE SIGNIFICANCE OF MOLECULAR BIOLOGY IN LEARNING HUMAN PATHOPHYSIOLOGY THROUGH TEAM-BASED INQUIRY

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**ABSTRACT**

This study will analyze the efficacy of the use of models and inquiry-based learning to teach biomedical science to youth at an inner-city school. Each class will use topics specific to the course standards and will reinforce themes annually assessed on the Biology EOC. As of last year, over 80% of the students registered were on free and reduced lunch. Those students who are at-risk and who will be registered for the Human Body Systems, Marine Science / Biology and the UTAP class will learn topics and the lab skills necessary to evaluate diseases specific to the main body systems. This introduction to human anatomy, hierarchal systems, biology, medical pathophysiology, biomedical technology, diagnostic technology, agricultural technology, natural resources, and public health via team-based instruction should foster novel interest and positively impact scores not only on the teacher-made assessment but also for those who have yet to take the Biology EOC. Class averages will be used to determine the benefit of biomedical topics, introduced and reinforced in a hierarchal system, as a constructive tool in science education. All of the classes will use team-based instruction but will, at the conclusion of the application, test independently using questions similar to those found on an industrial biotechnology exam in preparation for the Biotechnician Assistant Credentialing *Exam* (BACE) their third year in the Medical Magnet Program / Academy.

Key words: anatomy, hierarchy, biology, pathology, biomedical technology, diagnostic technology, agricultural technology, environmental resources, public health

**RATIONALE**

For the 2016-2017 school year, I anticipate teaching Human Body Systems, Marine Biology, and the Urban Teacher Academy Program (UTAP-Teacher Assisting) course to high school students who are looking for opportunities to explore the science behind current medical issues prevalent in our community and to understand the mechanism(s) behind recent epidemics sensationalized in media reports. As a result, these students will view the current state standards from a hierarchical and biotechnological perspective. They will navigate the human body from the atomic to the organ system level of development through the eyes of a biomedical technologist treating a specific disease. As a team, these students will use the tools provided to understand the skills and responsibilities of biomedical engineers. They will apply their research skills to determine the etiology of a disease, as well as deduce the appropriate treatment based on whether it was hereditary or pathologic. They will explore natural and man-made resources used to develop technologies to diagnose and treat patients. The students will also consider any environmental or biogeographical public health issues that might arise, like the Zika virus, and heart or liver disease (GSD), and explore medical innovations that could lead to better care for these individuals. During their investigation, other careers associated with biomedical technology such as pathology and public heath can be used to investigate the genetics and transmission of a specific disease using applicable literature, labs and BLAST. They will then plan a course of action to share their findings with the public during a colloquium. By providing a challenging curriculum that is current and relevant I hope to motivate my students to learn content that will be applicable in their post-secondary studies in the medical field. The hierarchal strategies used will assist them in realizing their constructive potential within our society based on the skills taught using real-world scenarios to reinforce a variety of careers in medicine involved in diagnosing and treating disease.

**ACTION RESEARCH INTERVENTION**

Students will be taught the content thorough theme-based units, starting with the circulatory system and working through the other main body systems, augmented by lessons provided by the Center for Precollegiate Education and Training. Each unit will be supported by an incrementally layered system that guides the students through the molecular pathways that lead to function and dysfunction in the human body. By using interactive labs that apply tactile, visual and kinesthetic skills to investigate medical and socially relevant issues like Pompeii Disease, the Zika virus or Glycogen Storage Disease (GSD) students will relate, apply and broaden their understanding of real-world medical problems as a team. By analyzing the content as a biotechnologist would, like DNA replication, transcription and translation, the students will develop a more clinically minded perspective and be able to better discern and confer new content knowledge to consecutive units based on the established hierarchy (molecules, cells, tissue, organ...). Three of the courses, consisting of approximately 90 - 10$^{th}$ grade students, will receive the application (biomedical instruction using hierarchal and team based systems). The other three courses will represent the control group comprised of approximately 74 students.

**CHANGES TO ACTION RESEARCH INTERVENTION**

No changes were made.

**CONNECTION TO BENCH-TO-BEDSIDE**

**Connections to Bench to Bedside summer institute**:

Students will be introduced to macromolecules through the eyes of a biomedical technologist evaluating a GSD patient case (macromolecules: carbohydrates).

Using the STEM challenge lab, students will be able visualize the basis of conditions like heart disease and then apply their understanding to specific content as the class progresses through the biological hierarchy (lipids).

Students will use the Pompeii lab to analyze the mechanism behind transcription and translation in terms of their selected disease (macromolecules: protein). "Pompe Predicament, How a Community of Scientists and Patients are Fighting for a Cure" UF Center For Precollegiate Education & Training, Updated 6/13/13 copyright 2013 University of Florida; Author: Julie Bokor.

The students will also analyze the human papilloma virus and prostate specific antigen in combination with the introductory pipetting lab conducted during the workshop.

Students will use the protein synthesis handout and BLAST to analyze a segment of code and relate it to the cause, diagnosis or treatment of their selected disease (macromolecules: nucleic acid). (Alternative: Finch TV with comparative anatomy and environmental studies)

**Data collection and analysis**: Teacher-made pre and post-tests will be given to assess the students understanding of the content given. Averages will be taken of each class using the strategy and compared to a control group not receiving the treatment (T-test).

| **Topic 1** | **Group 1** | **Group 2** |
|---|---|---|
| **iRAT%** | **22.15%** | **21.27%** |
| **tRAT%** | **74.43%** | **75.72%** |

The data showed that students did markedly better on the team-based assessment as opposed to the independent assessment in this one area.

**Literature cited**: "Pompe Predicament, How a Community of Scientists and Patients are Fighting for a Cure" UF Center For Precollegiate Education & Training, Updated 6/13/13 copyright 2013 University of Florida; Author: Julie Bokor.

**Permissions:** The results used will be averaged and therefore no formal permission is needed.

**SIMONE BARNES LESSON PLAN**

**TITLE:** Step up the Beat

**KEY QUESTION(S):** How can biomedical models and experimentation elucidate the impact of the metabolism of organic macromolecules in the body in relation to heart disease using a hierarchical system.

**SCIENCE SUBJECT**: Anatomy, Biochemistry, Microbiology, Medical Pathophysiology, Biotechnology, Research

**GRADE AND ABILITY LEVEL**: 9-12 Biology, Biotechnology, students (regular, honors).

**SCIENCE CONCEPTS**:

| | | | |
|---|---|---|---|
| SC.912.L.18.1 | Macromolecule | | |
| | | Carbohydrates | (Pompeii- GSD ) |
| | | Lipids | (Pompeii- GSD) |
| | | Proteins | (Transcription / Translation) |
| | | Nucleic acid | (Pompeii- GSD, Point Mutation) |
| SC.912.L.14.2 | Cell Function | | (endo-membranous system, protein Synthesis) |
| SC.912.L.16.14 | Cell Cycle | | |
| SC.912.L.14.36 | Blood flow | | (Medical Engineering- Heart plaque tube) |
| SC.912.L.14.6 | Factors affecting… / public health | | (Cardiovascular Disease) |
| SC.912.L.16.10 | Biotechnology | | (De- cellularization of organs- heart) |

**OVERALL TIME ESTIMATE:** three 50-minute classes.

**LEARNING STYLES**: Visual, auditory, kinesthetic, tactile, interpersonal, intrapersonal

**VOCABULARY:** carbohydrates, lipid, proteins, nucleic acid, metabolism, catabolism, anabolism, glycoproteins, glycolipids, transcription, translation, codon, anticodon, mutation, point mutation, insertion, deletion, frame shift, induced-pluripotent stem cells.

**LESSON SUMMARY:** The students will use manipulatives and experimentation to analyze the mechanisms behind disorders of the heart and associated systems.

**STUDENT LEARNING OBJECTIVES WITH STANDARDS:**

- **SC.912.L.14.36 Blood flow (Medical Engineering- Heart plaque tube)**
- **SC.912.L.14.6 Factors affecting immunity / public health (Cardiovascular Disease)**
- **SC.912.L.16.10 Biotechnology (De-cellularization of organs- heart)**
- **SC.912.L.14.2 Cell Function (endo-membranous system, protein Synthesis)**
- **SC.912.L.18.1 Macromolecule**

**MATERIALS:**

ESSENTIAL: GSD Lesson, Atherosclerosis - heart tube kits, Tangles Toy (macromolecules), DNA extraction, chicken heart, SDS, Triton, pipe cleaners or tangle toys.

SUPPLEMENTAL: Reading material (see resources)

**BACKGROUND INFORMATION**: Biotechnology is the use of organic material or living organisms in medicine, agriculture or industry to make life better. Often times, when scientists observe mechanisms in the natural world that need explanation or discover maladies that are found across multiple kingdoms they first conduct an inquiry. Students can use databases like the CDC or NIH to collect information, data and compare genetic information on the cause, diagnosis and treatment of the disease/disorder.

Health Corps University

My plate.com

Citizen Science

(http://www.jopm.org/citizen-science-genomics-as-a-model-for-crowd-sourced-preventive-medicine-research-supplementary-material/)

CDC (http://search.cdc.gov/search?query=heart+disease&utf8=%E2%9C%93&affiliate=cdc-main)

NIH (http://www.ncbi.nlm.nih.gov/nuccore/KJ776791)

**ADVANCE PREPARATION**: Request kits, copy articles or provide technology to access literature.

**PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:**

LESSON PLAN: Macromolecules- Proteins, Transcription & Translation & Enzymes 7 (Quick Reference)

Teacher Simone Shim-Barnes Date 10/5/2015 – 10/9/2015

Subject Biology / Research/Biotechnology Grade Level 9-12 Length of Lesson 50 minutes each

I. (Behavioral/Instructional) Learning Objective (s)/Outcomes (SSS):

After the PowerPoint presentation and discussion on organic macromolecules specifically proteins,

the student will connect how monomers form larger structures, or polymers, that are functional in living things (aa Proteins).

Ex. Enzymes, channel proteins , antibodies…)

II. Subject Matter Content: The forms of proteins-amino acids to polypeptide. The function of proteins from skin, muscle, hair and nails to catalysts and as transport molecules in membranes. Cofactors, and antibodies… Production on proteins from DNA. Protein confirmation in perpetration for discussions on mutations, malfunctioning proteins, disease in humans, env. impact. & technology.

III. Instructional Procedures:

a. Set/Lesson Initiating Activity The students will use the comic strip to determine the applications of proteins in everyday life.

b. Core Activities The students will take notes on the elements, shapes and functions of proteins in plants and animals.

c. Closure Activity Reflect on concepts learned and apply them to products associated with biotech domains. or everyday life.

IV. Materials and Equipment: Overhead projector, computer, internet, images of branching carbohydrates, rings and chains.

pHET animation- Lac operon showing protein synthesis to lead in discussion of what might happen when mutations occur.

Tangle toy to help demonstrate protein confirmation in conjunction with the handout/template.

V. Assessment/Evaluation: Written quiz on the structure and function of lipids.

Summative assessment will be given using a county instrument.

VI. Follow-up Activities: . Visually distinguish between carbohydrates, lipids, proteins and nucleic acids using the characteristics learned in this lesson. Analyze the impact of mutations on the function of polypeptides like hemoglobin on life in preparation for the next level in the hierarchy of life- cells, cell processes like cellular respiration & photosynthesis and later cardio. system

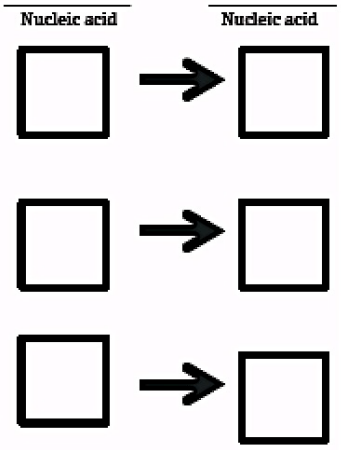
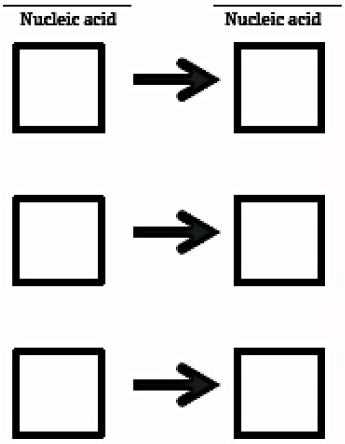
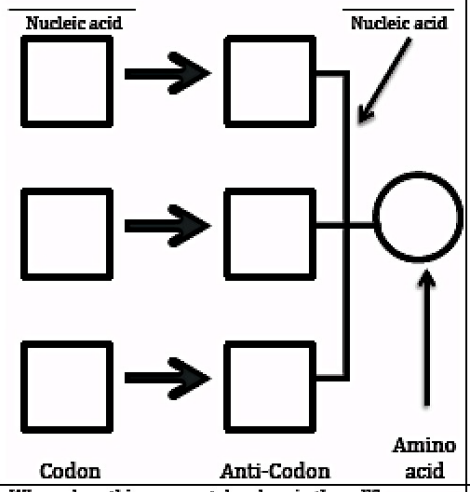
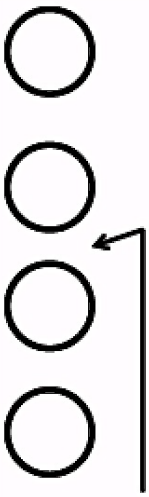
VI. Self-Assessment: (On a separate sheet of paper, typed, double-spaced twelve-point font, one page)

VII. State Standards / Accommodations:

New ☐LAFS ☐MAFS ☐SSS SC.912.L.18.1Macromolecules SC.912.L.16.5 Transcription/Translation, SC.912.L.18.11 Enzymes

ESOL or ELL C13 Visual Representation

ESE Accommodation/Enrichment Peer Pair

| Replication (DNA→DNA) | Transcription (DNA→RNA) | Translation (RNA→Proteins) | Protein |
|---|---|---|---|
| Directions: Make a complementary strand using the corresponding base pair in the squares provided. | Directions: Write the corresponding base pair in the squares. | Directions: RNA will now go from the language of nucleic acids to the language of proteins. Use the codon to create an anticodon and record the corresponding amino acid in the space provided. | Draw the bonds between the amino acids to complete the polypeptide. Look out for start and stop amino acids. |
|  |  |  |  |
| Where does this take place in the cell?<br><br>During what phase of cell division does this occur? | Where does this process take place in the cell? | Where does this process take place in the cell?<br><br>What is the name of your amino acid?<br>_____ | What is the name of this bond? |

Optional: Students can form groups of four to share and label amino acids, create 3D balloon models or hunt for their segment of protein in a sample strand of DNA provided by the teacher to model BLAST.

## Protein Confirmation

What happens after the polypeptide is made? _____

| 1° Primary Confirmation | 2° Secondary Confirmation | 3° Tertiary Confirmation | 4° Quaternary Confirmation |
|---|---|---|---|
| Draw the step. | Draw the step. | Draw the step. | Draw the step. |
| Describe the step: | Describe the step: | Describe the step: | Describe the step: |

Discussion Topics:

When would a mutation like happen?

What types of mutations can occur?

What factors can cause mutations to occur?

LESSON PLAN: Macromolecules- Nucleic Acids, DNA Replication & the Genetic Code (Quick Reference) 8

Teacher Simone Shim-Barnes Date 10/12/2015 – 10/16/2015

Subject Biology / Research/Biotechnology Grade Level 9-12 Length of Lesson 50 minutes each

I. (Behavioral/Instructional) Learning Objective (s)/Outcomes (SSS):

After the PowerPoint presentation and discussion on organic macromolecules specifically nucleic acids, the student will relate the structure of carbohydrates, lipids and proteins to the structure of nucleic acids. They will then compare RNA to DNA and analyze their role in replication, transcription, translation and the organization and modification of the genetic code.

II. Subject Matter Content: Nucleic acids RNA & DNA, Chargaff's base pairing rule, complimentary vs. anti-parallel structure DNA replication, genetic code.

III. Instructional Procedures:

a. Set/Lesson Initiating Activity The students will compare the characteristics of RNA and DNA in relation to other organic molecules

b. Core Activities The students will use a template to design a novel sequence of nucleotides that they will later combine.

c. Closure Activity The students will analyze the entire (class)sequence of codons to identify potential mutations in an actual gene.

IV. Materials and Equipment: Overhead projector, computer, internet, images of branching carbohydrates, rings and

V. Assessment/Evaluation: Completed nucleotide template. Written quiz on the structure and function of nucleic acids. Summative assessment will be given using a county instrument.

VI. Follow-up Activities: Visually distinguish between carbohydrates, lipids, proteins and nucleic acids using the characteristics learned in this lesson. Add varying multiples of lipids using dehydration synthesis.

VI. Self-Assessment: (On a separate sheet of paper, typed, double-spaced twelve-point font, one page)

VII. State Standards / Accommodations:

New ☑LAFS ☐MAFS ☑SSS SC.912.L.18.1Macromolecules, SC.912.L.16.3DNA Replication, SC.912.L.16.9 Genetic Code

ESOL or ELL C13 Visual Representation

ESE Accommodation/Enrichment Peer Pair

Question: How do macromolecules result in mutations and ultimately disease? Chemical signals during development and modifications of the genetic code during replication transcription and translation can result in non-functional proteins.

**ASSESSMENT SUGGESTIONS**: Describe specific assessments for EACH objective:

1. The student will distinguish between the four major organic macromolecules (carbohydrates, lipids, proteins, nucleic acids).
2. The students will connect through illustration the endo-membranous system to mutations in the products of protein synthesis.
3. The students will follow the flow of blood through the cardiovascular system and understand the change in flow due to age, heredity or environmental stimuli initiated dysfunction of the cardiovascular system. (Heart plaque tube)
4. The students will research factors affecting immunity / public health and develop an informative workshop to raise public awareness.
5. The students will use current biotechnology techniques like the de-cellularization of organs (heart transplants) or BLAST to present their findings and reflect on the the significance of Biologics in all four domains (Medicine, Diagnostic, Industrial and Agricultural)

Assessment will be made using teacher-made instruments using the the annually assessed benchmarks for standards covered on the Biology EOC

iRAT, TRAT

**EXTENSIONS:**

ACTIVITIES: Utah Genetics interactive tutorial and BLAST

LITERATURE: http://annualreviews.org/doi/abs/10.1146/annurev.genom.2.1.343, https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwjwl42NtqrSAhUU02MKHSWiDkMQFggpMAE&url=https%3A%2F%2Fwww.med.illinois.edu%2Ffacultydev%2Ftbl%2Fppts%2FDMEHCOMFDVisitUrbanaTBL.ppt&usg=AFQjCNETso-ygqWstvBOW3RiWrDdcTZxJw&sig2=jW_aFEAh9Cx9nkEIuXYSkA

**RESOURCES/REFERENCES:**

Health Corps University

My plate.com

Citizen Science

(http://www.jopm.org/citizen-science-genomics-as-a-model-for-crowd-sourced-preventive-medicine-research-supplementary-material/)

CDC (http://search.cdc.gov/search?query=heart+disease&utf8=%E2%9C%93&affiliate=cdc-main)

NIH (http://www.ncbi.nlm.nih.gov/nuccore/KJ776791)