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

BENCH TO BEDSIDE 2015 PROGRAM

ACTION RESEARCH PROPOSAL

A STUDY OF BIOMEDICAL APPLICATIONS IN CHEMISTRY CLASSES TO PRESENT RELEVANCE, AND INCREASE POSITIVE ATTITUDE, INTEREST AND CONCEPTUAL UNDERSTANDING OF SCIENCE

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ABSTRACT

A series of biomedical applications will be used to bring relevance to the high school chemistry curriculum with the purpose of promoting positive attitude and spark interest in science. There is evidence that supports the relationship between positive attitude and interest in a subject and attaining learning goals for high school students. Portions of the 'The Pompe Predicament' curriculum will be used. Students will study biochemical concepts within the context of a real-world scenario. Students will be able to see the human side of this devastating disease, think like research scientists (bench), analyze data like medical personnel, and formulate possible pathways to treat the disease (bedside). Students' attitude and interest in science will be assessed before and after the intervention using reliable instruments and teacher-generated assessments. With this intervention I expect my students to generate positive attitudes and interests in science and increase their conceptual understanding of science.

Key words: biomedical applications, Pompe disease, chemistry curriculum, real-world scenario

RATIONALE

I teach chemistry to high school students. The majority of my classes are 10^{th} and 11^{th} grade students who are assigned to chemistry as one of the three science classes the state requires them to take. Even though the state does not require the Chemistry class specifically, in my school, it is usually the science class assigned to the students who have successfully completed the biology year. Students walk into my classroom wondering what chemistry is all about. Some of them think that it is the class to take because 'you will explode things'. When asked, many students answer that they are taking the class because they have to. I tell them that chemistry will make them understand the world they live in. I try to hook them the very first day in the wonderful world of chemistry by asking questions as to what do they do in a regular day and mentioning that every single action they do is related to chemistry somehow. However, this first day introduction to chemistry does not convert students into science-lovers, nor does it necessarily changes their attitude or interest in science.

Chemistry is a subject with a lot of abstract concepts which makes the subject difficult for majority of people. From my own experience, if the student does not see the relevance of the chemistry concept, the more likely it is for the student not to meet the learning goals. I believe that relevance is important in the chemistry classroom because it creates a connection between 'invisible' concepts and the students' world. "Relevance refers to the activities that give students satisfaction and meet their needs, including the chance to achieve personal learning goals. In order to capture students' attention and activate their motivation to learn, teachers must consider the relevance of each topic" (Staver, 2007, p. 17).

Nieswandt's studies (2007) also present the importance of students' attitudes and perceptions in how well they understand scientific concepts in the context of everyday phenomena. Attitude is how we think and feel about a person or a thing. In the highly social high school environment, most students walk in the classroom the first day of school with preconceived attitudes. These are usually established based on what they hear from other students about the class or the teacher. Their attitudes can also be defined by their previous science class experiences. Students who have a positive attitude have motivation and persevere when they encounter a challenging situation. Students with poor or negative attitude tend to exert little effort in class (Kurtek, Sampson, and Williams, 2011) and therefore, their performance is not optimal. These students are caught in a vicious cycle, with their poor performance fueling their negative attitudes towards the sciences. The study of the students' attitude towards sciences has been the subject of many educational journal articles in the last 50 years, especially in light of a decline in the number of students

selecting a career in the sciences (Osborne, J., Simon, S., & Collins, S., 2003). In a more recent comprehensive literature review Kier, Blanchard, Osborne and Albert (2014) indicate that one of the reasons for students not to select mathematics and sciences as classes or as a career is because of "psychological barriers (such as believing that mathematics and sciences are too difficult'". Again, the perception or attitude towards an academic subject can determine the student's performance in that subject. On the other hand, Aschbacher, et.al. (2009) presented evidence that the more engaged students are with their science studies, the greater the likelihood of the students pursuing a science career.

This Action Research area of focus is to bring relevancy to the unit of Chemical Bonding in my Chemistry classes by introducing biomedical techniques and applications learned during the Bench to Bedside Summer Program at the University of Florida. These biomedical applications are based on current research where the basic chemical and biological concepts learned at the high school level are applied. The selected biomedical applications will be tied to actual real patient stories. The development of treatments for diseases will be part of the intervention. Connecting biological and chemical basic concepts to real world scenarios and current scientific research will bring relevance to the high school chemistry curriculum. Making connections between the high school chemistry classroom and the real world can spark a positive attitude and interest in students. The positive attitude towards the sciences can enhance students' motivation and their learning process.

ACTION RESEARCH INTERVENTION

In order to increase relevance and positively affect the attitude and interest of chemistry students, I plan to add lessons from the "Pompe Predicament" in my chemical bonding unit. I will present the conceptual information to the students regarding chemical bonding, starting with ionic and followed by covalent (molecular) bonding. I will also present to students the concepts of intramolecular forces which includes hydrogen bonding and its role in physical properties of water and macromolecules in living organisms. Every year I follow the conceptual presentations with a Water Analysis laboratory where students analyze water from different sources (sea, tap, distilled, and home) for dissolved ions. This provides a connection between the concepts of ionic compounds and their presence in water, including their own drinking water and possible environmental issues.

In the first semester of the upcoming year, I will also present the biomedical applications found in the curriculum found in "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; designated as "The Booklet" here. Author: Julie Bokor. The lessons that I will use are listed below. Research-based effective pedagogical strategies used in each lesson are also highlighted in Table 1.

Biomedical applications are not part of the current Chemistry curriculum. All my students have completed one year of high school biology but they generally are not exposed to biomedical applications and discussions in those classes either. There is Genetics class offered at my school but normally it is reserved for seniors and it is usually capped at around 30 students. The majority of my students will never be exposed to biomedical research and much less to the issues that this subject can bring to the surface for discussion and awareness (enzyme replacement therapy, gene therapy, orphan diseases, clinical trial participation). This Action Research is the perfect mechanism to introduce my students to the current research and development in the biomedical field in university centers within our own state. If any of my students register for the Genetics class in their senior year, they will be better prepared from their experiences in my class.

Students in my classes normally think of only two or three professions in the 'medical' world: physicians, veterinarians, and nurses. By exposing my students to biomedical research techniques and research (from the bench) that directly impact real-world diseases (to the bedside) they will be able to appreciate the multitude of career possibilities in this field.

By adding the Pompe Predicament lessons to my classes, I will not only cover the required Next Generation Sunshine State Standard in the Physical Science regarding chemical bonding and strength (SC912.P.8.6) with a real world application, I will also be covering the NGSSS Nature of Science standards that permeate through scientific research and investigations (SC.912.N.1.1, SC.912.N.1.2, SC.912.N.1.3, SC.912.N.1.5, SC.912.N.1.6, SC.912.N.1.7, SC.012.N.2.4, SC.912.N.2.5, SC.912.N.3.5, SC.912.N4.1,, SC.912.N.4.2), also known as the Scientific Method benchmarks. The lessons used in this intervention will also cover the benchmark of NGSSS related to biotechnology and its impact on societal issues (SC.912.16.10), as well as the Common Core Language Arts standards related to (LA.910.2.2.3 and LA.910.4.2.2) related to organizing and recording information from primary and secondary sources to show understanding or relationships among facts, ideas, and events.

I plan to conduct the intervention described here initially with 2 of my classes (of approximately 60 students) and use 2 other classes (approximately 60 students) as a control group for the purpose of data collection for this Action Research. Data analysis will then be conducted and the study will be completed. If this study shows positive results, I will follow up with the implementation of the Action Research proposal in all my classes to benefit all my students. This Action Research could potentially impact up to 180 students (6 classes of approximately 30 students each).

For detail sequencing, learning goals, teaching benchmarks, and specific activities and strategies, see the attached Lesson Plans Pompe Days 1 through 5 for my Chemical Bonding Unit, these are the five days assigned for the Action Research intervention.

Hollywood Hills High School will provide:

- Filter Paper
- Butcher paper and markers for class presentations and discussions
- Copies - handouts, information, guide question sheets

CONNECTION TO BENCH-TO-BEDSIDE

I will include several lessons (#1, #2, #4, #5, #6, and part of #7) from the curriculum outlined in "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. This curriculum was presented at the Bench-to-Bedside (June 17, 2015) by the author Julie Bokor and we were able to do several of the lessons, acting as students.

The Pipet by Design activity was activity an activity that preceded the Pompe Predicament ones. We were able to practice and sharpen our pipetting skills on June 16, 2015. This is a critical activity since the volumes used during the biomedical assays are in the microliter range.

I will rely on the Bench-to-Bedside Equipment Locker Loan Program to supply the following.

- Eppendorf Micropipettes P20, P200 (8 sets) and Micropipette tips 2-200uL (8 packs)
- Microplates 96 wells (pack of 50)
- Vortex (4x)
- 3D Modell of GAA protein, glycogen, and glucose

TABLE 1. Summary of Action Research Intervention in the Chemistry Curriculum

Day	"The Booklet"	Lesson Summary	Strategies
#1	Lesson #1: Looking Through a Father's Eyes	A first person story is presented to the students to hook their interest in the disease. Using a jigsaw approach, students will learn about the fundamentals of Pompe disease and share information during a whole class discussion. This activity sets the stage for further investigation of Pompe disease specifically.	• Cooperative learning groups • Jigsaw reading • Think and Share • Guided reading
#2	Lesson #2: The Road to Treatment	Working in groups, students will read Pompe fact cards and use text clues to sequence the events in the discovery and treatment of Pompe disease. This lesson illustrates scientific discovery as a collaborative effort of many individuals building on prior knowledge.	• Building on prior knowledge • Cooperative learning • Guided reading • Time line and sequencing organizer
#2	Students will learn how to properly use micropipettes	Using the activity called Pipetting by Design, found at: http://www.cpet.ufl.edu/wp-content/uploads/2012/10/Pipetting-by-Design-lesson-plan-6_2012.pdf	
#3	Lesson #4: From DNA to Protein Structure and Function	With a commercially available kit from Science Take Out, students step through the process of translating and transcribing a DNA sequence. Using the student worksheet provided here, students then consider how the acid alphaglucosidase gene is affected by mutations and how the change in structure affects the function of the enzyme. • Technology: Biotechnology assay kit	• Making connections to chemical and biological basic concepts • Making inferences • Inquiry investigation • Data analysis from different sources • Synthesizing information • Whole class discussion
#4	Lesson #5: Putting it all Together	Students perform a colorimetric assay on patient samples to determine % activity of GAA. They then perform a confirmatory test by comparing the patient DNA sequence to the reference and identifying any mutations. They will transcribe their sequence into mRNA and translate into amino acids. • Technology: Biotechnology assay; Computer assisted investigation	• Making connections to chemical and biological basic concepts • Making inferences • Inquiry investigation • Data analysis from different sources • Synthesizing information • Whole class discussion
#5	Lesson #6: Grand Rounds	Building on the previous activity, students will present a summary of their patient case along with the lab results they found in a grand rounds fashion. This activity allows students the opportunity to read actual patient cases and work together to summarize the findings.	• Making connections with real world scenarios based on scientific evidence • Whole class discussion
#5	Parts of Lesson #7: Exploring Gene Therapy	Students will learn about the benefits, dangers, and ethical dilemmas associated with gene therapy. • Technology: computer assisted web quest	Evaluation of biotechnology on the individual and societal ethical issues.

DATA COLLECTION AND ANALYSIS

A literature search of instruments used to assess attitude and interest in science shows a several options (Wood et.al. 2010, Kier 2014, Liang 2006, Bouvier and Connors 2011). All instruments reviewed use similar type of questions in the multiple choice format or a combination of multiple choice and open response format. For the multiple choice questions, a Linkert scale is always used.

I will use one of these published instruments to assess the attitude and interest of my students. Assessments will be given to the students before and after the Action Research intervention. I currently use the Quia system (http://www.quia.com) and plan to use the same online system to have my students respond to the questionnaires. The online service will facilitate data collection and analysis.

Additionally, the student understanding of science will be assessed by teacher-generated tests. These will also be administered before and after the intervention. Student interviews, teacher observations and student interactive science notebooks will also be used to correct qualitative data regarding their understanding of science.

There will be two groups of students participating in this Action Research. I will teach the same Chemical Bonding unit to both groups. I will also collect assessment data from both groups before and after the end of the Chemical Bonding unit. Each group will consist of 50-60 students taking the same class (Chemistry Honors). One group will be considered as the control group and the second group will be the experimental group. Only the experimental group will have the Action Research intervention.

LITERATURE SITED

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BUDGET

I am requesting a total of $219.59 to the University of Florida Center for Precollegiate Education and Training (CPET) Bench to Bedside 2015 Program to cover the following expenses.

Description Source Catalog # Price	Source	Catalog#	Price
Phenol red indicating solution 0.2% aqueous solution (100mL)	Fisher Scientific www.fishersci.com	S71434	$ 5.85
pH 3.0 buffer solution	Fisher Scientific www.fishersci.com	S06487	$ 8.25
pH 10.0 buffer solution	Fisher Scientific www.fishersci.com	S06494	$ 8.25
Disposable transfer pipets (3mL total volume)	Fisher Scientific www.fishersci.com	13-711-7	$ 49.60
Microfuge tubes (1.5mL), assorted colors, nonsterile	Fisher Scientific www.fishersci.com	02-682-556 pk 500	$ 33.64
From DNA to Protein Structure and Function 3X10 packs	Science Take-Out	STO-106U	$ 114.00
		TOTAL	$ 219.59

In the event that this money is not granted, I will request these materials from the Bench-to-Bedside Equipment Locker Loan Program.

PERMISSIONS

There is no permission needs to implement this Action Research. All equipment and chemicals are approved to be used in the Broward County Public School System.

I will share this Action Research Proposal with my administrative team to solicit their support and approval.

SINGLE LESSON PLAN

Teacher: PAYAN	Content Area/Grade: CHEMISTRY	Date:

Unit Name:	CHEMICAL BONDING. THE POMPE PREDICAMENT – LESSON 1 LOOKING THROUGH A FATHER'S EYES. -RELEVACE

Unit Goal What unit goal does this daily lesson address?	**Standard(s)/Benchmark(s)** What standard(s)/benchmark(s) does this daily lesson address?
Using a jigsaw approach, students will learn about the fundamentals of Pompe disease and share information during a whole class discussion. This activity sets the stage for further investigation of Pompe disease specifically, but more generally the steps of translational research.	SC.912.L.14.6 SC.912.L.14.19 SC.912.L.14.20 SC.912.L.16.2 SC.912.L.16.3 SC.912.L.18.1 SC.912.L.18.2
Students will understand that… What should the students understand by the end of today's lesson?	**Essential Questions** What essential question(s) does this lesson address?
The student will be able to... 1. Describe an enzyme. 2. Explain the role of an enzyme in the human body. 3. Define gene and understand how a gene relates to a protein 4. Explain where a lysosome is located and its role in the function of a cell 5. Explain the genetics of Pompe disease	What is Pompe Disease?
Connecting Concepts How will you review yesterday's content and connect today's lesson to it?	**Organizing Students for Learning** How will students be organized today for the lessons activities?
This is an introductory lesson that will eventually (day 3) connect with chemical bonding of the amino acids making up a defective protein.	Students will be form groups of 4 to participate in a Jigsaw activity.

LEARNING EXPERIENCES, INSTRUCTION AND RESOURCES

What activities or experiences (from your Unit Plan) will students engage in today?

Lesson Sequence

Activating Prior Knowledge	Reviewed vocabulary words: Lysosome, Enzyme, DNA	☐ ABC Brainstorming ☐ KWL ☐ Anticipation Guide ☐ Card Sort ☒ Think-Pair-Share
Explicit Instruction	Reading the passage: Calum's Story will be a motivational hook to get the students interested in Calum's disease.	☒ Motivational Hook ☐ Lecture ☐ Demonstration ☐ Note-taking Guide

Lesson Sequence				Resources and Materials
Group Processing of New Information	Jigsaw activity will engaged all students. All students have an individual responsibility to bring back some knowledge to their home group.	☒ Jigsaw ☐ Reciprocal Teaching ☐ Concept Attainment ☐ Think-Pair-Share	☐ Lab / Inquiry Activity	☐ Computer ☐ LCD Projector ☒ Paper ☒ Pencils ☐ Whiteboards ☐ Markers ☐ Butcher Paper ☐ Response Cards ☐ Post-it Notes ☐ Video Clip(s): ☐ Website(s): ☐ Lab Materials:
Elaborative Questioning	n/a	☐ Inferential Questions ☐ Analytic Questions ☐ Philosophical Chairs		
Demonstrating Understanding	Students will be asked to flowchart (or use a graphic organizer) to describe how the protein functions properly and what happens when it is not working properly.	☒ Graphic Organizers ☐ Picture Notes ☒ Flow Charts ☐ Concept Maps ☐ Mnemonics ☐ Graffiti		
Reflection	N/a	☐ Reflective Journals ☐ Think Logs ☐ Exit Ticket (Student Learning)		
Daily Progress Monitoring Assessment	As students exit, they will answer the question: How is the DNA related to the structure of proteins?	☐ Quiz ☐ Journal ☒ Exit Ticket (for Content) ☐ Response Cards		
Based in the results from your Daily Progress Monitoring Assessment, what concepts need to be revisited in the next lesson?				**Homework**

SINGLE LESSON PLAN

Teacher: PAYAN	Content Area/Grade: CHEMISTRY	Date:

Unit Name:	CHEMICAL BONDING. THE POMPE PREDICAMENT LESSON 2: THE ROAD TO TREATMENT-– RELEVANCE TO REAL

Unit Goal What unit goal does this daily lesson address?	**Standard(s)/Benchmark(s)** What standard(s)/benchmark(s) does this daily lesson address?
Working in groups, students will read Pompe fact cards and use text clues to sequence the events in the discovery and treatment of Pompe disease.	SC.912.L.16.10 SC.912.L.18.1 SC.912.N.1.1 SC.912.N.1.2 SC.912.N.1.3 SC.912.N.1.5 SC.912.N.1.7 SC.912.N.2.4 SC.912.N.2.5
Students will understand that… What should the students understand by the end of today's lesson?	**Essential Questions** What essential question(s) does this lesson address?
1. Sequence scientific discoveries 2. Discover that science is a collaborative effort 3. Consider the role technology has played in the rapid advances in biomedical science during the last twenty years 4. Students will also learn how to properly use a micropipette.	What is the fundamental biology and chemical processes of this disease. What is a micropipette used for?
Connecting Concepts How will you review yesterday's content and connect today's lesson to it?	**Organizing Students for Learning** How will students be organized today for the lessons activities?
This lesson builds up from yesterday. The students learn today the techniques currently being used to treat this disease.	Students will continue to work in the same groups formed the previous day.

LEARNING EXPERIENCES, INSTRUCTION AND RESOURCES

What activities or experiences (from your Unit Plan) will students engage in today?

Lesson Sequence

Activating Prior Knowledge	Opening class discussion as to how can Calum could have been treated to prevent his death.	☐ ABC Brainstorming ☐ KWL ☒ Anticipation Guide ☐ Card Sort ☒ Think-Pair-Share
Explicit Instruction	Describe enzyme preplacement therapy.	☐ Motivational Hook ☒ Lecture ☐ Demonstration ☐ Note-taking Guide

Lesson Sequence				Resources and Materials
Group Processing of New Information	Instruct students that they will learn the historical events to lead to the current treatment of the disease. Students will create a timeline with the information given. Additionally, students will learn how to pipet properly with micropipettes, using the activity called Pipetting by Design.	☐ Jigsaw ☐ Reciprocal Teaching ☒ Concept Attainment ☐ Think-Pair-Share	☐ Lab / Inquiry Activity	☐ Computer ☒ LCD Projector ☒ Paper ☒ Pencils ☐ Whiteboards ☒ Markers ☒ Butcher Paper ☐ Response Cards ☐ Post-it Notes ☐ Video Clip(s):
Elaborative Questioning	n/a	☐ Inferential Questions ☐ Analytic Questions ☐ Philosophical Chairs		
Demonstrating Understanding	Once the timeline is created properly, a message will be uncovered. For the micropipette activity, upon completion, the students will have a fun design to discover, if their pipetting skills are acceptable.	☒ Graphic Organizers ☐ Picture Notes ☐ Flow Charts ☐ Concept Maps ☐ Mnemonics ☐ Graffiti		☒ Website(s) Pipetting by Design, found at: http://www.cpet.ufl.edu/wp-content/uploads/2012/10/Pipetting-by-Design-lesson-plan-6_2012.pdf
Reflection	Students will use their Interactive Science Notebook to journal three key issues that they have discovered as they prepare their timeline.	☒ Reflective Journals ☐ Think Logs ☐ Exit Ticket (Student Learning)		
Daily Progress Monitoring Assessment	Exit ticket will be the uncovered message, available only after students correctly complete the timeline.	☐ Quiz ☐ Journal ☒ Exit Ticket (for Content) ☐ Response Cards		☒ Lab Materials: Micropipettor and tips; micro plates
Based in the results from your Daily Progress Monitoring Assessment, what concepts need to be revisited in the next lesson?				**Homework**

SINGLE LESSON PLAN

Teacher: PAYAN	Content Area/Grade: CHEMISTRY	Date:

Unit Name:	CHEMICAL BONDING. POMPE PREDICAMENT LESSON 4 – FROM DNA TO PROTEIN STRUCTURE AND FUNCTION

Unit Goal What unit goal does this daily lesson address?	**Standard(s)/Benchmark(s)** What standard(s)/benchmark(s) does this daily lesson address?
Using the student worksheet provided here, students then consider how the acid alphaglucosidase gene is affected by mutations and how the change in structure affects the function of the enzyme. Students will practice the process of trancribing a sequence of DNA, using complementary base pairing rules, creating the complementary single stranded RNA, and coding for the synthesis of the protein.	SC.912.L.14.6 SC.912.L.16.2 SC.912.L.16.3 SC.912.L.16.4 SC.912.L.16.5 SC.912.L.16.9 SC.912.L.18.1 SC.912.L.18.4 SC.912.L.18.11
Students will understand that… What should the students understand by the end of today's lesson?	**Essential Questions** What essential question(s) does this lesson address?
1. Discuss observed inheritance patterns caused by recessive mode of inheritance 2. Describe the basic process of DNA replication and the transmission of genetic information 3. Explain how mutations in the GAA gene may or may not result in phenotypic change 4. Model the basic processes of transcription and translation and how they result in the expression of the GAA gene to produce a protein 5. Explain how and why the genetic code is universal and is common to almost all organisms 6. Describe the basic molecular structures and primary functions of DNA and proteins (biological macromolecules)	How does a mutation at the DNA level affect the protein structure and function? What are the chemical interaction (forces) involved in the 3-dimensional folding of the protein? What are the types of chemical bonds involved in the protein synthesis?
Connecting Concepts How will you review yesterday's content and connect today's lesson to it?	**Organizing Students for Learning** How will students be organized today for the lessons activities?
Students will use a commercially available kit (from Science Take-Out) to model the cellular translation/transcription process. Essential questions will be used as guiding questions to make connections to chemical bonding.	Group work will continue.

LEARNING EXPERIENCES, INSTRUCTION AND RESOURCES

What activities or experiences (from your Unit Plan) will students engage in today?

Lesson Sequence

Activating Prior Knowledge	Review translation/transcription process with a short videos	☒ ABC Brainstorming ☐ KWL ☐ Anticipation Guide ☐ Card Sort ☐ Think-Pair-Share
Explicit Instruction	Give a brief demonstration of the procedure to be followed. Review safety protocols.	☐ Motivational Hook ☐ Lecture ☒ Demonstration ☐ Note-taking Guide

Lesson Sequence				Resources and Materials
Group Processing of New Information	INQUIRY: Given the results of their testing kit, students will consider how the gene is affected by mutations and how this will impact the structure and function of the coded enzyme.	☐ Jigsaw ☒ Reciprocal Teaching ☒ Concept Attainment ☐ Think-Pair-Share	☒ Lab / Inquiry Activity –	☐ Computer ☐ LCD Projector ☐ Paper ☐ Pencils ☐ Whiteboards ☐ Markers ☐ Butcher Paper ☐ Response Cards ☐ Post-it Notes ☒ Video Clip(s): ☒ Website(s): http://www.sciencetakeout.com/ ☒ Lab Materials: Science Take-Out Kit – From DNA to Protein Structure and Function
Elaborative Questioning	How the incorrect amino acid physical properties affect the protein folding? How is the defective protein function altered and what symptoms are observed by patients? How do these (protein defect and patient symptoms) related?	☒ Inferential Questions ☒ Analytic Questions ☐ Philosophical Chairs		
Demonstrating Understanding	Interactive class discussion of the questions provided in a Guided Questions sheet.	☐ Graphic Organizers ☐ Picture Notes ☐ Flow Charts ☐ Concept Maps ☐ Mnemonics ☐ Graffiti		
Reflection	See above for Demonstrating Understanding.	☐ Reflective Journals ☐ Think Logs ☐ Exit Ticket (Student Learning)		
Daily Progress Monitoring Assessment	See above for Demonstrating Understanding.	☐ Quiz ☐ Journal ☐ Exit Ticket (for Content) ☐ Response Cards		
Based in the results from your Daily Progress Monitoring Assessment, what concepts need to be revisited in the next lesson?				**Homework**

SINGLE LESSON PLAN

Teacher: PAYAN	Content Area/Grade: CHEMISTRY	Date:

Unit Name:	CHEMICAL BONDING. POMPE PREDICAMENT LESSON 5 PUTTING IT ALL TOGETHER – RELEVANCE TO REAL LIFE

Unit Goal What unit goal does this daily lesson address?	**Standard(s)/Benchmark(s)** What standard(s)/benchmark(s) does this daily lesson address?
Students perform a colorimetric assay on patient samples to determine % activity of GAA. They then perform a confirmatory test by comparing the patient DNA sequence to the reference and identifying any mutations. They will transcribe their sequence into mRNA and translate into amino acids.	SC.912.L.14.6 SC.912.L.16.2 SC.912.L.16.3 SC.912.L.16.4 SC.912.L.16.5 SC.912.L.16.9 SC.912.L.18.1 SC.912.L.18.4
Students will understand that… What should the students understand by the end of today's lesson?	**Essential Questions** What essential question(s) does this lesson address?
1. Discuss observed inheritance patterns caused by recessive mode of inheritance 2. Describe the basic process of DNA replication and the transmission of genetic information 3. Explain how mutations in the GAA gene may or may not result in phenotypic change 4. Model the basic processes of transcription and translation and how they result in the expression of the GAA gene to produce a protein 5. Explain how and why the genetic code is universal and is common to almost all organisms 6. Describe the basic molecular structures and primary functions of	Can DNA mutations predict the protein structure and function and the resulting disease state?
Connecting Concepts How will you review yesterday's content and connect today's lesson to it?	**Organizing Students for Learning** How will students be organized today for the lessons activities?
The essential question will be used as the guiding question in making connections with chemical bonding	Group work will continue.

LEARNING EXPERIENCES, INSTRUCTION AND RESOURCES

What activities or experiences (from your Unit Plan) will students engage in today?

Lesson Sequence

Activating Prior Knowledge	Students will use a model for patient blood and will test for enzyme activity (colorimetric assay).	☐ ABC Brainstorming ☐ KWL ☒ Anticipation Guide ☐ Card Sort ☐ Think-Pair-Share
Explicit Instruction	The motivational hook will be the perception that they are testing 'real human specimens'. They will be playing the role of laboratory technician.	☒ Motivational Hook ☐ Lecture ☐ Demonstration ☐ Note-taking Guide

Lesson Sequence				Resources and Materials
Group Processing of New Information	INQUIRY – Students will making inferences of patient symptoms based on the protein structure.	☐ Jigsaw ☐ Reciprocal Teaching ☐ Concept Attainment ☐ Think-Pair-Share	☒ Lab / Inquiry Activity	☒ Computer ☐ LCD Projector ☐ Paper ☐ Pencils ☐ Whiteboards ☐ Markers ☐ Butcher Paper ☐ Response Cards ☐ Post-it Notes ☐ Video Clip(s): ☒ Website(s): http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/C/Codons.html ☒ Lab Materials: Materials are listed on page 60 of the Pompe Predicament Booklet (2013).
Elaborative Questioning	What can you infer from the defective protein structure?	☒ Inferential Questions ☐ Analytic Questions ☐ Philosophical Chairs		
Demonstrating Understanding	Interactive class discussion of the questions provided in a Guided Questions sheet.	☐ Graphic Organizers ☐ Picture Notes ☐ Flow Charts ☐ Concept Maps ☐ Mnemonics ☐ Graffiti		
Reflection	See above Demonstrating Understanding	☐ Reflective Journals ☐ Think Logs ☐ Exit Ticket (Student Learning)		
Daily Progress Monitoring Assessment	See above Demonstrating Understanding	☐ Quiz ☐ Journal ☐ Exit Ticket (for Content) ☐ Response Cards		
Based in the results from your Daily Progress Monitoring Assessment, what concepts need to be revisited in the next lesson?				**Homework**

SINGLE LESSON PLAN

Teacher: PAYAN	Content Area/Grade: CHEMISTRY	Date:

Unit Name:	CHEMICAL BONDING. POMPE PREDICAMENT LESSON 6 GRAND ROUNDS – RELEVANCE TO REAL LIFE

Unit Goal What unit goal does this daily lesson address?	**Standard(s)/Benchmark(s)** What standard(s)/benchmark(s) does this daily lesson address?
Building on the previous activity, students will present a summary of their patient case along with the lab results they found in a grand rounds fashion. This activity allows students the opportunity to read actual patient cases and work together to summarize the findings.	SC.912.L.14.6 SC.912.L.16.2 SC.912.L.16.4 SC.912.L.16.5 SC.912.L.18.1 SC.912.L.18.4 SC.912.L.18.11
Students will understand that… What should the students understand by the end of today's lesson?	**Essential Questions** What essential question(s) does this lesson address?
1. Explain the significance of genetic factors to health from the perspective of the individual. 2. Discuss recessive inheritance. 3. Discover how mutations in the DNA sequence may result in phenotypic changes and Pompe disease. 4. Explain the basic processes of transcription and translation and how they result in the expression of the GAA gene. 5. Describe the basic structure and function of DNA and protein. 6. Create proteins and amino acids structures. 7. Explain the function of proteins in living organisms. Relate the structure and function of enzymes.	Can DNA mutations predict the protein structure and function and the resulting disease state?
Connecting Concepts How will you review yesterday's content and connect today's lesson to it?	**Organizing Students for Learning** How will students be organized today for the lessons activities?
The essential question will be used as the guiding question in making connections with chemical bonding	Group work will continue.

LEARNING EXPERIENCES, INSTRUCTION AND RESOURCES

What activities or experiences (from your Unit Plan) will students engage in today?

Lesson Sequence

Activating Prior Knowledge	Each group will have their results from yesterday's assay. We will come together as a class to identify the 'story behind the results' from each of the groups in the class.	☒ ABC Brainstorming ☐ KWL ☐ Anticipation Guide ☒ Card Sort ☐ Think-Pair-Share
Explicit Instruction	The motivational hook will be personal symptoms from different patients.	☒ Motivational Hook ☐ Lecture ☐ Demonstration ☐ Note-taking Guide

Lesson Sequence				Resources and Materials
Group Processing of New Information	INQUIRY – Students will correlate their findings from yesterday to actual patient stories. The case stories are adapted from actual stories given by parents and patients combined with information published regarding specific phenotypes. The whole class will move into a discussion regarding gene therapy.	☐ Jigsaw ☐ Reciprocal Teaching ☐ Concept Attainment ☐ Think-Pair-Share	☒ Lab / Inquiry Activity: Inferences	☐ Computer ☐ LCD Projector ☐ Paper ☐ Pencils ☒ Whiteboards ☒ Markers ☒ Butcher Paper ☐ Response Cards ☐ Post-it Notes ☐ Video Clip(s): ☐ Website(s): ☐ Lab Materials:
Elaborative Questioning	What can you infer from the defective protein structure?	☒ Inferential Questions ☐ Analytic Questions ☐ Philosophical Chairs		
Demonstrating Understanding	Interactive class discussion of the questions provided in a Guided Questions sheet.	☐ Graphic Organizers ☐ Picture Notes ☐ Flow Charts ☐ Concept Maps ☐ Mnemonics ☐ Graffiti		
Reflection	See above Demonstrating Understanding	☐ Reflective Journals ☐ Think Logs ☐ Exit Ticket (Student Learning)		
Daily Progress Monitoring Assessment	See above Demonstrating Understanding	☐ Quiz ☒ Journal ☐ Exit Ticket (for Content) ☐ Response Cards		
Based in the results from your Daily Progress Monitoring Assessment, what concepts need to be revisited in the next lesson?				**Homework**

UNIT PLAN

Unit Title: Chemical Bonding with Biomedical Applications	**Content Area/Grade: Chemistry – 10, 11, 12 grades**
Teacher: I. Payan	**Implementation Time Frame: 18 days**

STAGE 1: THE DESIRED RESULTS
What are my learning goals?

Unit Goal
Students will understand that…

Chemical bonding is at the center of all compounds. Compounds make up the world around us, living and non-living systems cannot exist without chemical compounds.

Standard(s)/Benchmark(s)
What standard(s)/benchmark(s) does this daily lesson address?

SC912.P.8.6 SC.912.N.1.1 SC.912.N.1.2
SC.912.N.1.3 SC.912.N.1.5 SC.912.N.1.6
SC.912.N.1.7 SC.012.N.2.4 SC.912.N.2.5
SC.912.N.3.5 SC.912.N4.1 SC.912.N.4.2
LA.910.2.2.3 LA.910.4.2.2. SC.912.16.10

Related Misconceptions
What misconceptions are predictable?

1. Chemical bonding occurs because atoms tend to become neutral.
2. Forces that keep atoms together in chemical bonding are all the same.
3. Molecular compounds do not possess partial charges.
4. Water is the only polar substance.
5. Students fail to make connections between chemically bonded compounds and cellular processes like DNA transcription and RNA translation into making proteins.
6. Students fail to make connections between defective proteins and human diseases.

Students will know…
Vocabulary, terminology, definitions

- Anion and Cation
- Covalent bond and Ionic bond
- Hydrogen bond
- Intermolecular forces and Intramolecular forces
- Polar molecule and Nonpolar molecule
- Pompe disease
- Enzyme and Lysosome
- DNA, RNA, and Enzyme
- Enzyme replacement therapy
- Pharmacological chaperone
- Transcription and Translation
- Gene therapy
- Genotype and Phenotype

Essential Questions
What questions will foster inquiry, understanding and transfer of learning?

1. What is the role of the valance electrons in chemical bonding?
2. What keeps two atoms together in a chemical bond?
3. Why and How is a chemical bond formed?
4. How is chemical bond related to me?
5. What is Pompe Disease and how it is related to chemical bonding?

Students will know…
key facts, formulas, critical details, important events, important people, timelines

Other Essential Knowledge-

- Lewis dot structures and representation of single and multiple bonds.
- Structure and function of DNA, RNA, and proteins
- Enzyme replacement and gene therapy mechanisms
- Pompe disease

Students will be able to…
Specific skills students will acquire as a result of this unit

1. Compare and contrast ionic and covalent bonding. Predict the type of bond if given a chemical formula
2. Differentiate between intra and inter molecular forces. Analyze how the relative strength of intermolecular forces affects polar and non-polar molecules.
3. Evaluate and synthesize data from different sources to reach a conclusion based on evidence. Establish connections between chemical bond forces and human diseases in real-world scenarios.

STAGE 3: LEARNING EXPERIENCES, INSTRUCTION, AND RESOURCES
What activities will help my students achieve the learning goals?

What **H**ere	**What** is expected? How will you ensure that students are aware of the learning goals? **Where** are your students? How will you establish your students' prior knowledge?
	Daily learning goals are posted on the front board. At the beginning of class, I review the learning goals with the students and express my expectations for the day. This unit starts with a discussion of what bonding is outside the chemical world. I ask probing questions and students give their input. We scaffold new knowledge based on their prior experiences.
Hook **H**old	How will you **hook** students at the beginning of the unit? How will you **hold** their attention throughout the units?
	Chemical bonding is at the center of all chemical compounds. A discussion of the student daily routine and how many different ways they are dealing and interacting with chemical compounds hooks the students. I hold their attention with an interactive discussion and storytelling about biochemical macromolecules (DNA, RNA, proteins) and how essential they are for living organisms.
Experience **E**xplore **E**quip	What critical input **experience** will help students **explore** the key ideas and essential questions? How will you **equip** your students with needed skills and knowledge?
	Input experiences will come in the form of short lectures, video clips, reading passages. Students will then explore key ideas with activities that elicit new information processing, interactions, and connections; example: Process Oriented Guided Inquiry Learning (POGIL) activities and Biomedical applications.
Reflect **R**ethink **R**ehearsing **R**evising **R**efining	How will you encourage students to **reflect** and **rethink**? How will you guide students in the process of **rehearsing**, **revising**, and **refining** their work?
	Student reflection will come in the form of journaling in their ISN, as they answer reflective prompts. They will rehearse, revising, and refining their work as they work in cooperative learning groups, interacting with peers, class discussions with teacher as facilitator, and time to reflect on the learning objectives.
Exhibit **E**valuate	How will you help students to **exhibit** and **self-evaluate** their developing skills, knowledge and understanding throughout the unit?
	Students will participate in several POGIL activities, allowing them to self-evaluate their newly acquired knowledge. Students will also be guided into laboratory skills needed to perform biochemical assays. They will have time to practice and exhibit proficiency in these skills (pipetting, colorimetric assay).
Tailor	How will you **tailor** your instruction to meet the different needs, interests and abilities of all learners in your classroom?
	Lessons target all types of learning modalities by incorporating a variety of proven pedagogical strategies, as examples: cooperative learning, note-taking and lecturing, student presentations, preparing timelines, reflective journaling in ISN, hands-on activities, data gathering and evaluation, interactive whole class discussions, web quest, internet video clips, role playing.
Organize	How will you **organize** and sequence the learning activities to maximize the engagement and achievement of all students?
	1. Students learn the chemical basic knowledge for the formation of compounds (chemical bonding). 2. Students practice and expand their new knowledge using inquiry activities (POGIL). 3. Students apply their knowledge to identify a gene mutation in a real-world disease scenario.