Pasadena Unified School District

BIOLOGY: 9 – 12TH

Unit 1 – Cell Biology

Stage 1: Desired Outcomes

Students will know the major structures of the cell and how their functions are the foundation of life.

Priority Standards

What Priority Common Core and Content Standards frame the learning objectives of this unit?

c. Students know how prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.

d. Students know the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm.

f. Students know usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide.

h. Students know most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors.

Supporting Standards

What supporting Common Core and Content Standards are important to the objectives of this unit?

a. Students know cells are enclosed within semi-permeable membranes that regulate their interaction with their surroundings.

b. Students know enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium and the activities of enzymes depend on the temperature, ionic conditions, and the pH of the surroundings.

e. Students know the role of the endoplasmic reticulum and Golgi apparatus in the secretion of proteins.

21st Century Skills

What 21st Century Skills will students be expected to demonstrate upon completion of this unit?

☒ *Learning & Innovation (4 C's)* ☒ *Information, Media & Technology*

☒ *Life & Career* ☒ *21st Century Themes*

Enduring Understandings

Big ideas at heart of the discipline; specific understandings desired about them.

- Prokaryotic, eukaryotic, and viruses differ in complexity and general structure.
- Cells are the major unit of structure and function of all living things.
- Cells are composed of smaller building blocks called macromolecules, which are essential for the cell's life processes.
- Each cell, individually and as part of a whole organism, is designed to be self-sufficient and allow for the continuity of life.
- Cells are able to store, replicate and transfer genetic information in all living organisms.
- Cells are able to capture, convert and transfer energy.

Essential Questions

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

- What makes an organism alive?
- If you discovered an infection, how would you determine if it was caused by a virus, bacterium or other microorganism?
- What is the most important cell function? Explain why.
- If your life was that of an organelle, which one would you be? What would a day in your life be like?
- How do cells give rise to other cells?
- How would life on Earth be affected if the sun were to burn out?
- How would our lives be different if our cells had chloroplasts?

Key Knowledge

As a result of this unit, students will know…

- How to distinguish between prokaryotic cells, eukaryotic cells, and viruses.
- How energy is captured and stored
- Synthesis (monomer to polymer) and secretion of macromolecules
- Regulation of cell processes
- Catalysis of reactions
- How altering the cell's environment affects homeostasis
- **Key Vocabulary**
  - Prokaryotic cells
  - Eukaryotic cells
  - Viruses
  - RNA
  - Nucleus
  - Protein
  - Ribosomes
  - Cytoplasm
  - Sunlight
  - Chloroplast

Key Skills

As a result of this unit, students will be able to…

- Generate questions that can be explored through scientific investigation.
- Differentiate between prokaryotic vs. eukaryotic and animal vs. plant cells.
- Understand how cell structure relates to cell function.
- Understand how each of the different macromolecules are important for life processes.
- Understand how energy flows through living systems.

○ Sugar ○ Carbon dioxide ○ Macromolecules (polysaccharides, nucleic acids, proteins, lipids) ○ Cells ○ Organisms ○ Membranes ○ Enzymes ○ Biochemical reactions ○ Temperature ○ Ionic ○ pH ○ endoplasmic reticulum ○ Golgi apparatus	

Stage 2: Assessment	
Performance Task: Enzyme Action: Testing Catalase Activity (Method 1–O_2 Gas Sensor)	Other Evidence: *(project benchmarks quizzes, unit tests, multiple choice tests, etc)*
See attached document for detailed explanation. **THE INVESTIGATION** In this experiment, students will use an O_2 Gas Sensor to determine the rate of enzyme activity by measuring the concentration of oxygen gas formed as H_2O_2 is destroyed. . If a plot is made, it may appear similar to the graph shown. At the start of the reaction, there is no product, and the concentration is the same as that in the atmosphere. After a short time, oxygen accumulates at a constant rate. The slope of the curve at this initial time is constant and is called the ***initial rate***. As the peroxide is decomposed, less of it is available to react and oxygen is produced at slower rates. The slope of the curve gradually decreases. When no more peroxide is left, O_2 is no longer produced. **OBJECTIVES** In this experiment, students will: • Use a computer and an Oxygen Gas Sensor to measure the production	• Assigned readings and reading assignments • Class notes • Videos/visual aids • Lab notebook • Other related activities ○ Toothpickase Enzyme Lab (*see attached example*)

of oxygen gas as hydrogen peroxide is decomposed by the enzyme catalase or peroxidase. • Measure and compare the initial rates of reaction for this enzyme when different concentrations of enzyme react with H_2O_2. • Measure the production of oxygen gas as hydrogen peroxide is decomposed by catalase or peroxidase under various conditions.	

Name of Project:	Enzyme Action: Testing Catalase Activity (Method 1 -- O2 Gas Sensor)		**Duration:**	2 weeks
Subject/Course:	Science: Biology	**Teacher(s): Secondary Biology Teachers**	**Grade Level:**	9 - 12th
Other Subject Areas to Be Included:	Math -- Students will graph and calculate rates of enzyme activity. History -- Students will understand the impact of the discovery of various molecules (i.e. enzymes). English -- Students will write lab reports using proper grammar and syntax.			

Project Idea
Summary of the issue, challenge, investigation, scenario, or problem:

- In this experiment, you will use an O_2 Gas Sensor to determine the rate of enzyme activity by measuring the concentration of oxygen gas formed as H_2O_2 is destroyed. . If a plot is made, it may appear similar to the graph shown.
- At the start of the reaction, there is no product, and the concentration is the same as that in the atmosphere. After a short time, oxygen accumulates at a constant rate. The slope of the curve at this initial time is constant and is called the ***initial rate***. As the peroxide is decomposed, less of it is available to react and oxygen is produced at slower rates. The slope of the curve gradually decreases. When no more peroxide is left, O_2 is no longer produced.

Driving Question

- How and why are enzymes important in living organisms?
- What makes an organism alive?
- What is the most important cell function? Explain why.

Content Standards to be taught and assessed**:**

What **Key Knowledge** will students master? What will they know? Enduring Understandings?

Key Knowledge

- Regulation of cell processes
- Catalysis of reactions
- How altering the cell's environment affects homeostasis

Enduring Understandings

- Cells are the major unit of structure and function of all living things.
- Each cell, individually and as part of a whole organism, is designed to be self-sufficient and allow for the continuity of life.
- Cells are able to capture, convert and transfer energy.

What Key Skills will students be asked to develop and/or apply?

- Generate questions that can be explored through scientific investigation.
- Understand how cell structure relates to cell function.
- Understand how energy flows through living systems.
- Understand how each of the different macromolecules are important for life processes.

21st Century Skills to be taught and assessed**:** *How will they be taught and assessed?*	Collaboration Students will • Work in small groups to design experiments using the scientific method. • Analyze and discuss data obtained during their lab investigation and decide on the best way to process and present their findings.	☒	Creativity/Innovation Students will • Think and work creatively. • Use critical thinking and problem solving skills. • Make judgments and decisions as Individuals and part of a group to effectively analyze and evaluate evidence, major alternative points of view, and interpret and draw conclusions. • Design inquiry-based labs.	☒
	Communication (Oral Presentation) Students will • Learn to present their experimental findings in a clear and concise manner and explain their significance.	☒	Critical Thinking/Problem Solving Students will • Think and work creatively. • Use critical thinking and problem solving skills. • Make judgments and decisions as individuals and as part of a group to effectively analyze and evaluate evidence, analyze and evaluate major alternative points of view, interpret and draw conclusions.	☒

	Life & Career:
	Students will
	• Learn to be flexible and adapt to various learning situations (i.e. group settings)
	• Learn to take Initiative and be self-directed learners by
	  ○ Managing goals and time
	  ○ Working independently and in a group setting.
		☒	Other:	☐

<table>
<tr><td rowspan="2">Major Products & Performances</td><td>Group:</td><td>• Students will learn to present their experimental finding in a clear and concise manner and explain their significance. They will also learn to collaborate in small group setting and learn to be flexible and adapt to various learning situations. Students will also learn to plan, implement and evaluate experimental findings in a group as well as individually.</td><td colspan="2">Presentation Audience (entire project)
Presentation Audience:

Class
School</td></tr>
<tr><td>Individual:</td><td>• Students will learn to keep and maintain a laboratory notebook. they will also learn to properly record experimental findings and present them in written form in their lab notebook.</td><td>☒</td><td>Class – presentation of processed data
School – students will present their findings to the school during open
Community– students will present their findings to the school during open
Experts – Students may present their findings to other teachers.
☐ Web – students may choose to share information with other students, schools, and
☒ Other: Caltech and CAPSI</td></tr>
</table>

LEARNING PLAN	Does it incorporate Authenticity, Choice, Inquiry & students playing the Active Role?
PBL Guiding Principles: ☒ **Authentic,** compelling scenario that matters to student, field, or community ☒ Considers multiple roles/perspectives ☒ Leads to a product for an **authentic** audience	☒ Allows for student **choice** ☒ Point of view/argument that faces opposition ☒ Engaging, high stakes, with a sense of urgency ☒ Transforms or creates content, and opens new questions or cycles of inquiry

What Performance Assessment Task(s) will be generated by this project *that is aligned to standards and key skills*:	
☒ Math Analysis (Problem Solving) – students will analyze, interpret and process data obtained during the experiment and present it appropriately. ☒ English Textual Analysis – Students will write their own lab reports, which will present their experimental design and findings. ☒ English Research/Argumentation -- students will research their selected topic of investigation. ☒ Scientific Research – Students will evaluate other scientific research and report on the relevance and importance of those findings. ☒ Scientific Inquiry – students will design their own lab investigations. ☒ History/Social Science Research/Inquiry – students will evaluate the impact that scientific research and findings. ☐ Other:	Notes: See attached Stage 2 Task Planning Chart – ENZYME FUNCTION (CATALASE)

L E A R N I N G P L A N					
Entry Event to launch inquiry, engage students: *Students will conduct a data based activity, which will serve as a model to help them understand the major goals and objectives of the Performance Assessment Task Lab Activity*		**Benchmark Order**	**Benchmark Category**	**Benchmark Description - what is the assessment?**	**Benchmark Skills – what will this help them to be able to do?** *If a benchmark asks them to report on what they have researched, then they will be able to complete independent research, summarize information, synthesize information, etc.*
Assessments *Under each type of assessment there are ideas as to some you might use. These lists are not exhaustive. You may choose to include others not listed.* *The number of benchmarks may be more or less than the number listed. Feel free to document the amount that you will use. If you need more, you may use another sheet.*	**Formative Assessments** (During Project) i.e., *Quizzes/Tests, Journal/Learning Log, Preliminary Plans/Outlines/Prototypes, Rough Drafts, Practice Presentations, Notes, Checklists, Concept Maps*	**Benchmark 1:** Energy and Chemical Reactions	☒ Know (mastery) ☐ Do (application) ☐ Reflect (metacognition)	Students will be assessed on the various types of energy and reactions and factors affecting the way those reactions work.	This will help students understand the various forms of energy and how they participate or influence various types of chemical reactions.
		Benchmark 2 : Energy-absorbing vs. energy-releasing reactions and activation energy.	☒ Know (mastery) ☐ Do (application) ☐ Reflect (metacognition)	Students will learn to differentiate energy-absorbing vs. energy-releasing reactions and the products of each reaction. Students will also learn that in order for reactions to occur, a certain amount of energy needs to be invested.	Students will learn that; based on the type of reaction, their products will be different in terms of their energy content. In addition, students will understand that even reactions that produce mass amounts of energy need a certain amount of energy investment in order to get started.
		Benchmark 3: Enzyme structure and specificity.	☒ Know (mastery) ☒ Do (application) ☐ Reflect (metacognition)	Students will use modeling clay or play dough to model enzyme structure, including active site and substrate. Students will also be assessed on their understanding the Lock-and-Key Model of enzyme activity.	Students will learn that all enzymes have a specific shape, which dictates their function. Also, students will understand that enzyme-catalyzed reactions will only happen if the appropriate substrate is present to react with the enzyme. Students will create models that demonstrate the concepts of enzyme-substrate specificity, active site and lock-and-key model of enzyme activity.

		Benchmark 4: Toothpickase Enzyme Lab	☒Know (mastery) ☒Do (application) ☐Reflect (metacognition)	Students will model enzyme activity under optimum conditions and compare that with enzyme activity under various factors, which affect its activity. Students will simulate these conditions and record data.	Students will be able to draw conclusions about what factors/conditions affect enzyme activity the most. They will collect and graph data to represent the rates under various conditions.
		Benchmark : Class/Student Demo: Catalase/H_2O_2 sample enzyme reaction.	☒Know (mastery) ☒Do (application) ☐Reflect (metacognition)	Students will see one example of an enzyme/substrate reaction. Students will become familiar with s very specific example of an enzyme catalyzed reaction and understand the products of that reaction.	Using this demo, students will have some background as to what the products of an enzyme-catalyzed reaction are. Students will then be have an idea as to how to use various sensors to measure the rate of activity in an enzyme catalyzed reaction.
	Summative Assessments (End of Project) i.e.,*Written Product(s) with rubric, Oral Presentation with rubric, Multiple Choice/Short Answer Test, Essay Test, Other Product(s) or Performance(s) with Rubric, Self-Evaluation, Peer Evaluation*	**Benchmark :** Enzyme Action: Testing Catalase Activity (Method 1–O_2 Gas Sensor)	☒Know (mastery) ☒Do (application) ☒Reflect (metacognition)	In this experiment, students will use an O_2 Gas Sensor to determine the rate of enzyme activity by measuring the concentration of oxygen gas formed as H_2O_2 is destroyed. . If a plot is made, it may appear similar to the graph shown. At the start of the reaction, there is no product, and the concentration is the same as that in the atmosphere. After a short time, oxygen accumulates at a constant rate. The slope of the curve at this initial time is constant and is called the ***initial rate***. As the peroxide is decomposed, less of it is	In this experiment, students will: Use a computer and an Oxygen Gas Sensor to measure the production of oxygen gas as hydrogen peroxide is decomposed by the enzyme catalase or peroxidase. Measure and compare the initial rates of reaction for this enzyme when different concentrations of enzyme react with H_2O_2. Measure the production of oxygen gas as hydrogen peroxide is decomposed by catalase or peroxidase under various conditions.

				available to react and oxygen is produced at slower rates. The slope of the curve gradually decreases. When no more peroxide is left, O_2 is no longer produced.	
		Benchmark :	☐ Know (mastery) ☐ Do (application) ☐ Reflect (metacognition)		
		Benchmark :	☐ Know (mastery) ☐ Do (application) ☐ Reflect (metacognition)		

PART B:

Project Launch – Start with a Bang!

Launch Guiding Principles:

☒ High interest, provocative, communicates a sense of urgency
☒ Provides overview of project without going into too much detail
☒ Provides models/examples of culminating products
☒ Provides timeline with major benchmarks
☒ Motivating - urges students to explore what is possible within the project
☒ Presents an exciting challenge that also feels attainable, students can imagine themselves accomplishing the project
☒ Addresses the question of "So what…?"

What venue will you use to launch this project (community meeting, multiple classes, within your class, field trip, etc.)?	Who will be involved in the launch (multiple teachers, just you)?	When will you launch this project?
Launch Agenda: In-class	Staff Roles: Teacher – Facilitator Students – Participants	September 24 thru October 5, 2012

Action Steps/Follow Up after the launch:

REVIEW – Enzymes as organic compounds (proteins)

- How do enzymes work?
  - Saltine cracker/flour demo using indicators
    - When you test a saltine cracker using Benedict's' indicator for the presence of monosaccharides, the test will come out negative. Howeve when you test a saltine cracker using Iodine (IKI) indicator for the presence of polysaccharides, the test will come out positive. If you chewed the cracker, spit it out into a test tube, and test for monosaccharides, the test will now yield a positive result, but will be negative for polysaccharides. Why did this happen? How did this happen?
- Enzyme structure and function – Review protein structure and factors affecting its function.
  - Review enzyme activity and rates
    - Factors affecting enzyme function

Resources Needed	**On-site people, facilities:**	• Teacher, TA(to help students with set up or other related questions), lab classroom with internet access and electric outlets.
	Equipment:	• Computers (laptops), Vernier software and Interface, O2 probe, reaction chamber/bottles with cap
	Materials:	• Thermometer, test tube rack, test tube, beaker, graduated cylinder, H2O2, pH buffers, Catalase enzyme suspension, ice, dropper pipettes
	Community resources:	• CAPSI/Caltech

		• Oak Crest Institute of Science • Amgen-Bruce Wallace			
Reflection Methods	**(Individual, Group, and/or Whole Class)**	**Journal/Learning Log** • *Individual* ○ Students will write in their lab notebook. Students are responsible for maintaining their notebook. • *Group* ○ Students will record data and observation as it pertains to their experiments. They will also write/record their final conclusions and evaluations at the end of each experiment.	☒	Focus Group	☐
		Whole-Class Discussion • *Individual/Group* ○ As part of the lesson, students will be presented with information as it pertains to the lesson and the experiment they might conduct. • *Group* ○ Students can present their findings to the class.	☒	Fishbowl Discussion	☐
		Survey	☐	Other:	☐