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Belleville Public Schools

Curriculum Guide

AP Biology

Unit 3: Cellular Energetics

Belleville Board of Education

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Board Approved: not approved

Unit Overview

In Unit 3, students build on knowledge gained in Unit 2 about the structure and function of cells, focusing on cellular energetics. Living systems are complex in their organization and require constant energy input. This unit will provide students with the knowledge necessary to master the concepts of energy capture and use. Students work through enzyme structure and function, learning the ways in which the environment plays a role in how enzymes perform their function(s). Students gain a deeper understanding of the processes of photosynthesis and cellular respiration, knowledge they will use in Unit 6 while studying how cells use energy to fuel life processes.

Enduring Understanding

- **3.1 Enzyme Structure-**The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules.
- **3.2 Enzyme Catalysis-** The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules.
- **3.3 Environmental Impacts on Enzyme Function-** The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules.
- **3.4 Cellular Energy-** The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules.
- **3.5 Photosynthesis-** The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules.
- **3.6 Cellular Respiration-** The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules.

- **3.7 Fitness-** Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

Essential Questions

- How is energy captured and then used by a living system?
- How do organisms use energy or conserve energy to respond to environmental stimuli?
- How do biological systems utilize free energy to grow, to reproduce, and to maintain homeostasis?
- How do organisms capture, use, and store free energy?

Exit Skills

By the end of AP Biology Unit 3, Cellular Energetics, the student should be able to:

- Describe the properties of enzymes.
- Explain how enzymes affect the rate of biological reactions.
- Explain how changes to the structure of an enzyme may affect its function.
- Describe the role of energy in living organisms.
- Describe the photosynthetic processes that allow organisms to capture and store energy.
- Describe the processes that allow organisms to use energy stored in biological macromolecules.
- Explain the connection between variation in the number and types of molecules within cells to the ability of the organism to survive and/or reproduce in different environments.

New Jersey Student Learning Standards (NJSLS-S)

NextGen Science Standards

HS-LS1	From Molecules to Organisms: Structures and Processes
HS-LS1-1	Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
	Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
	Planning and carrying out in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.
HS-LS1-4	Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
LS1.B	Growth and Development of Organisms
HS-LS1-5	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
LS1.C	Organization for Matter and Energy Flow in Organisms
HS-LS1-6	Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
HS-LS1-7	Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
HS-ESS2-2	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
ESS2.D	Weather and Climate

Interdisciplinary Connections

8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
8.1.12.CS.2	Model interactions between application software, system software, and hardware.
8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
LA.RST.9-10.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
LA.RST.9-10.2	Determine the central ideas, themes, or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

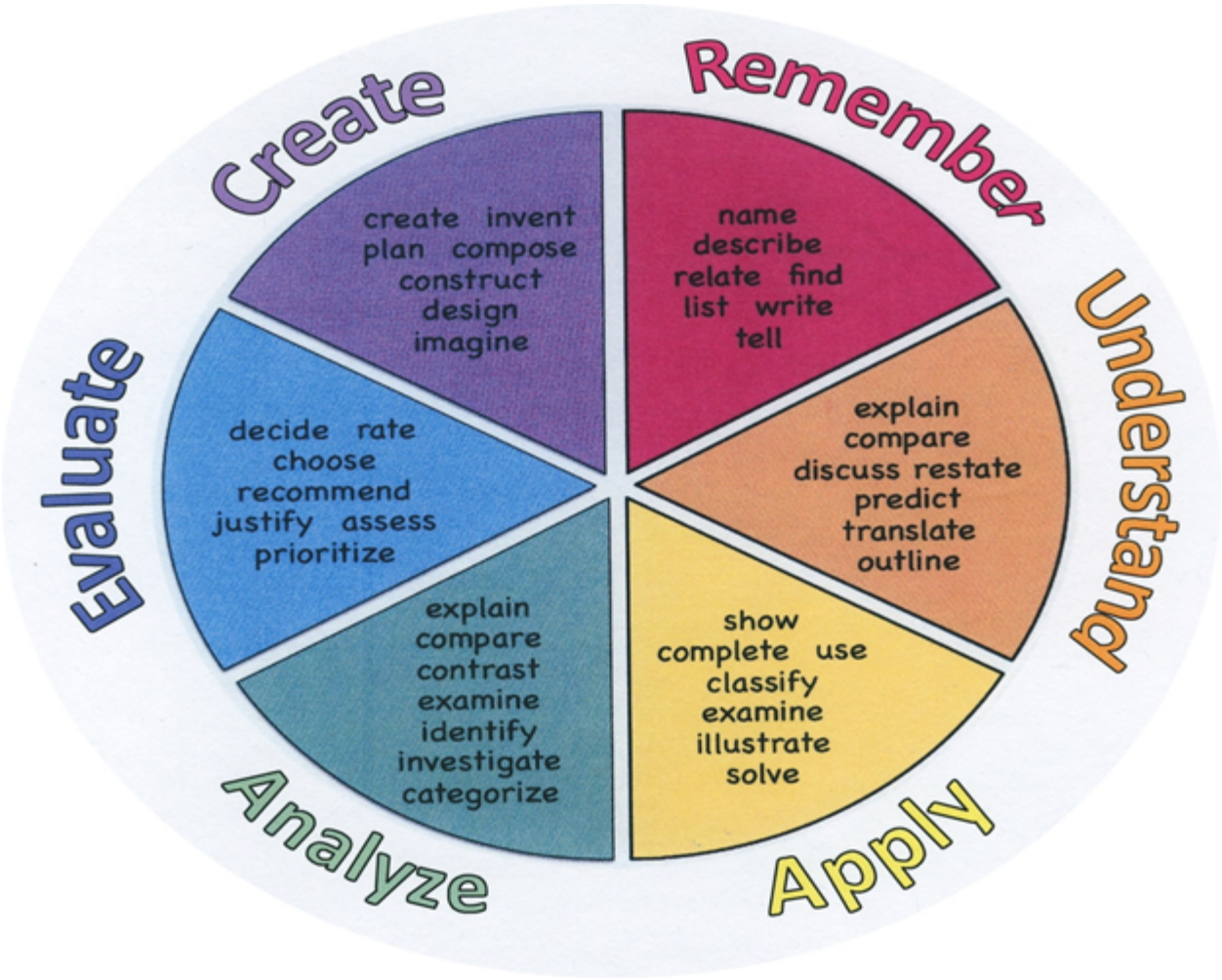
LA.RST.9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
LA.RST.9-10.7	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
LA.RST.9-10.8	Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
LA.RST.9-10.9	Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
LA.WHST.9-10.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant sufficient textual and non-textual evidence.
LA.WHST.9-10.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
8.2.12.ED.5	Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
LA.WHST.9-10.9	Draw evidence from informational texts to support analysis, reflection, and research.
8.2.12.ED.6	Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
8.2.12.ITH.1	Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.
8.2.12.ITH.2	Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation.

Learning Objectives

- SWDAT explain how biological systems use free energy based on empirical data that all organisms require constant energy input to maintain organization, to grow, and to reproduce.
- SWDAT justify a scientific claim that free energy is required for living systems to maintain organization, to grow, or to reproduce, but that multiple strategies exist in different living systems.
- SWDAT predict how changes in free energy availability affect organisms, populations, and ecosystems.
- SWDAT use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter.
- SWDAT use representations to pose scientific questions about what mechanisms and structural features allow organisms to capture, store, and use free energy.
- SWDAT construct explanations of the mechanisms and structural features of cells that allow organisms to capture, store, or use free energy.
- SWDAT describe specific examples of conserved core biological processes and features shared by all domains or within one domain of life, and how these shared, conserved core processes and features support the concept of common ancestry for all organisms.

Action Verbs: Below are examples of action verbs associated with each level of the Revised Bloom's Taxonomy.

Remember	Understand	Apply	Analyze	Evaluate	Create
Choose	Classify	Choose	Categorize	Appraise	Combine
Describe	Defend	Dramatize	Classify	Judge	Compose
Define	Demonstrate	Explain	Compare	Criticize	Construct
Label	Distinguish	Generalize	Differentiate	Defend	Design
List	Explain	Judge	Distinguish	Compare	Develop
Locate	Express	Organize	Identify	Assess	Formulate
Match	Extend	Paint	Infer	Conclude	Hypothesize
Memorize	Give Examples	Prepare	Point out	Contrast	Invent
Name	Illustrate	Produce	Select	Critique	Make
Omit	Indicate	Select	Subdivide	Determine	Originate
Recite	Interrelate	Show	Survey	Grade	Organize
Select	Interpret	Sketch	Arrange	Justify	Plan
State	Infer	Solve	Breakdown	Measure	Produce
Count	Match	Use	Combine	Rank	Role Play
Draw	Paraphrase	Add	Detect	Rate	Drive
Outline	Represent	Calculate	Diagram	Support	Devise
Point	Restate	Change	Discriminate	Test	Generate
Quote	Rewrite	Classify	Illustrate		Integrate
Recall	Select	Complete	Outline		Prescribe
Recognize	Show	Compute	Point out		Propose
Repeat	Summarize	Discover	Separate		Reconstruct
Reproduce	Tell	Divide			Revise
	Translate	Examine			Rewrite
	Associate	Graph			Transform
	Compute	Interpolate			
	Convert	Manipulate			
	Discuss	Modify			
	Estimate	Operate			
	Extrapolate	Subtract			
	Generalize				
	Predict				



Suggested Activities & Best Practices

1. “toothpickase” activity- students use their fingers to break as many as 100 toothpicks in 10-second intervals (without looking) onto a paper towel. All broken toothpicks must remain mixed with the unbroken. Broken toothpicks should not be removed from the pile, and each toothpick can only be broken once. Continue breaking toothpicks for these total time intervals (60, 120, and 180 seconds). Students then graph the number of toothpicks broken versus time (10, 20, 30, 60, 120, and 180 seconds).

2. Students perform a yeast fermentation lab using the sucrose solutions from the Diffusion and Osmosis Lab your students may have performed in Unit 2. Students can measure the amount of carbon dioxide produced as the dependent variable. At the conclusion of the lab, collect class data. Students then graph the class data, including error bars on their graphs. To enhance this activity, students can test different kinds of fresh and processed fruit juices and then compare the rates of fermentation among the different solutions

3. “Bean Brew”- an inquiry-based investigative case study on the fermentation process used to develop soy sauce.

4. **AP Biology Investigation 6: Cellular Respiration**. Students use microrespirometers or gas pressure sensors to investigate factors that affect the rate of cellular respiration in multicellular organisms.

5. **AP Biology Investigation 5: Photosynthesis**. Using the floating leaf disk procedure, students investigate factors that affect the

rate of photosynthesis in living leaves.

6. Online investigation: Students research the connections between paraquat (or other herbicides), the pathways of photosynthesis, and possible effects of herbicides on ecosystems.

7. In teams, students create a visual representation (e.g., diagram with annotation) to explain the interdependent relationships of cellular respiration and photosynthesis and how the processes of cellular respiration and photosynthesis support life on Earth. Visual representations are displayed in the classroom for peer review and revision and to generate questions for further investigation.

8. Students will identify an Asian/Pacific islander figure in the science community and report their contributions.

9. Students will identify an African american figure in the science community and report their contributions.

10. Students will identify an LGBTQ figure in the science community and report their contributions.

Assessment Evidence - Checking for Understanding (CFU)

• Common Benchmarks (Benchmark)

• Unit tests- Unit 3 Personal Progress Check from AP Classroom (Summative)

• Quizzes- enzyme quiz, photosynthesis quiz, cellular respiration quiz (Summative)

• Unit review/Test prep- Campbell and Reece chapter 8,9,10 study guides (Formative)

• Web-Based Assessments- google form quizzes (Summative)

• DBQ's (Formative)

• Written Reports- CER's for lab activities (Alternate)

• Surveys (Alternate)

- Admit Tickets
- Anticipation Guide
- Common Benchmarks
- Compare & Contrast
- Create a Multimedia Poster
- DBQ's
- Evaluation rubrics

- Exit Tickets- google form exit ticket
- Fist- to-Five or Thumb-Ometer
- Illustration
- Journals
- KWL Chart
- Learning Center Activities
- Newspaper Headline
- Outline
- Question Stems
- Quickwrite
- Quizzes- enzyme quiz, photosynthesis quiz, cellular respiration quiz
- Red Light, Green Light
- Self- assessments
- Socratic Seminar
- Study Guide
- Surveys
- Teacher Observation Checklist
- Think, Pair, Share- large sticky posters
- Think, Write, Pair, Share
- Top 10 List
- Unit review/Test prep- Campbell and Reece chapter 8,9,10 study guides
- Unit tests- Unit 3 Personal Progress Check from AP Classroom
- Web-Based Assessments- google form quizzes
- Written Reports- CER's for lab activities

Primary Resources & Materials

- Campbell and Reece, AP Biology 11th Edition (2018)- Chapters 8,9,10

Ancillary Resources

- Pearson Education Test Prep Series for AP Biology (2017)
- AP Biology Investigative Labs- Investigation 5: Photosynthesis
- AP Biology Investigative Labs- Investigation 6: Respiration
- Campbell and Reece chapters 8,9,10 study guide worksheets
- Foglia powerpoints and review guides (www.explorebiology.com)
- PHET Interactive Simulations

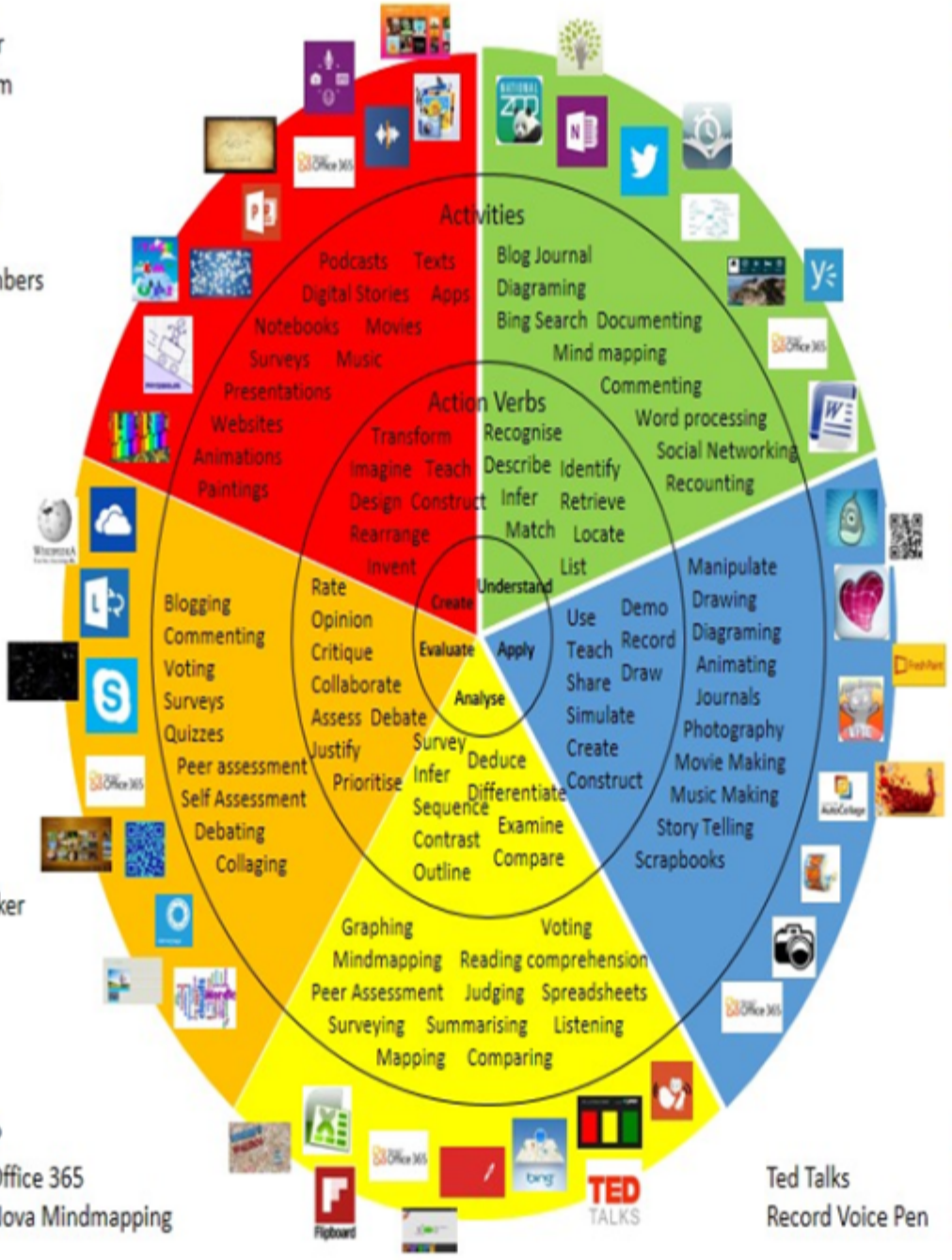
Technology Infusion

- Smart TV - (Enzymes slideshow/ Photosynthesis and cellular respiration presentations)
- Chrome Books for Projects/ Research/ Analysis
- Youtube - Amoeba sisters videos, Mr. Anderson videos, Crash course videos
- Khan Academy videos and quizzes
- Microsoft Powerpoint
- Google Drive
- Prezi
- Ted Talks
- Ted- ED
- Microsoft Excel: graphs, charts, calculations, equations

Win 8.1 Apps/Tools Pedagogy Wheel

Podcasts
Photostory 3
Kid Story Builder
Music Maker Jam
Paint A Story
Office 365
MS PowerPoint
Stack 'Em Up
NqSquared Numbers
Physamajig
Xylophone 8

Wikipedia
Skydrive
Lync
SkyMap
Skype
Office 365
Puzzle Touch
Easy QR
Memorylage
Life Moments
Word Cloud Maker



Where's Waldo?
MS Excel Office 365
Flipboard Nova Mindmapping

Ted Talks
Record Voice Pen

Originally taken from http://www.coetail.com/vzimmer/files/2013/02/iPadagogy-Wheel.001.jpg
And adapted for Windows 8.1 devices by Charlotte Beckhurst @CharBeckhurst

Alignment to 21st Century Skills & Technology

9.2.12.CAP.1	Analyze unemployment rates for workers with different levels of education and how the economic, social, and political conditions of a time period are affected by a recession.
9.2.12.CAP.2	Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.
9.2.12.CAP.3	Investigate how continuing education contributes to one's career and personal growth.
9.2.12.CAP.4	Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.
9.4.2.CT.1	Gather information about an issue, such as climate change, and collaboratively brainstorm ways to solve the problem (e.g., K-2-ETS1-1, 6.3.2.GeoGI.2).
9.2.12.CAP.5	Assess and modify a personal plan to support current interests and post-secondary plans.
9.4.2.CT.2	Identify possible approaches and resources to execute a plan (e.g., 1.2.2.CR1b, 8.2.2.ED.3).
9.4.2.CT.3	Use a variety of types of thinking to solve problems (e.g., inductive, deductive).
9.2.12.CAP.6	Identify transferable skills in career choices and design alternative career plans based on those skills.
9.4.2.DC.3	Explain how to be safe online and follow safe practices when using the internet (e.g., 8.1.2.NI.3, 8.1.2.NI.4).
9.4.2.DC.4	Compare information that should be kept private to information that might be made public.
9.4.2.DC.5	Explain what a digital footprint is and how it is created.

21st Century Skills/Interdisciplinary Themes

- Communication and Collaboration
- Creativity and Innovation
- Critical thinking and Problem Solving
- ICT (Information, Communications and Technology) Literacy
- Information Literacy
- Life and Career Skills
- Media Literacy

21st Century Skills

- Civic Literacy
- Environmental Literacy
- Global Awareness

- Health Literacy

Differentiation

Differentiations:

- Small group instruction
- Small group assignments
- Extra time to complete assignments
- Pairing oral instruction with visuals
- Repeat directions
- Use manipulatives
- Center-based instruction
- Token economy
- Study guides
- Teacher reads assessments allowed
- Scheduled breaks
- Rephrase written directions
- Multisensory approaches
- Additional time
- Preview vocabulary
- Preview content & concepts
- Story guides
- Behavior management plan
- Highlight text
- Student(s) work with assigned partner
- Visual presentation
- Assistive technology
- Auditory presentations
- Large print edition
- Dictation to scribe
- Small group setting

Hi-Prep Differentiations:

- Alternative formative and summative assessments
- Choice boards
- Games and tournaments
- Group investigations
- Guided Reading
- Independent research and projects
- Interest groups
- Learning contracts
- Leveled rubrics
- Literature circles
- Multiple intelligence options
- Multiple texts
- Personal agendas
- Project-based learning
- Problem-based learning
- Stations/centers
- Think-Tac-Toes
- Tiered activities/assignments

- Tiered products
- Varying organizers for instructions

Lo-Prep Differentiations

- Choice of books or activities
- Cubing activities
- Exploration by interest
- Flexible grouping
- Goal setting with students
- Jigsaw
- Mini workshops to re-teach or extend skills
- Open-ended activities
- Think-Pair-Share
- Reading buddies
- Varied journal prompts
- Varied supplemental materials

Special Education Learning (IEP's & 504's)

- printed copy of board work/notes provided
- additional time for skill mastery
- assistive technology
- behavior management plan
- Center-Based Instruction
- check work frequently for understanding
- computer or electronic device utilizes
- extended time on tests/ quizzes
- have student repeat directions to check for understanding
- highlighted text visual presentation
- modified assignment format
- modified test content
- modified test format
- modified test length
- multi-sensory presentation
- multiple test sessions
- preferential seating

- preview of content, concepts, and vocabulary
- Provide modifications as dictated in the student's IEP/504 plan
- reduced/shortened reading assignments
- Reduced/shortened written assignments
- secure attention before giving instruction/directions
- shortened assignments
- student working with an assigned partner
- teacher initiated weekly assignment sheet
- Use open book, study guides, test prototypes

English Language Learning (ELL)

- teaching key aspects of a topic. Eliminate nonessential information
- using videos, illustrations, pictures, and drawings to explain or clarif
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student’s learning;
- allowing students to correct errors (looking for understanding)
- allowing the use of note cards or open-book during testing
- decreasing the amount of workpresented or required
- having peers take notes or providing a copy of the teacher’s notes
- modifying tests to reflect selected objectives
- providing study guides
- reducing or omitting lengthy outside reading assignments
- reducing the number of answer choices on a multiple choice test
- tutoring by peers
- using computer word processing spell check and grammar check features
- using true/false, matching, or fill in the blank tests in lieu of essay tests

At Risk

- allowing students to correct errors (looking for understanding)
- teaching key aspects of a topic. Eliminate nonessential information
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student’s learning
- allowing students to select from given choices
- collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test.
- decreasing the amount of workpresented or required

- marking students' correct and acceptable work, not the mistakes
- modifying tests to reflect selected objectives
- providing study guides
- tutoring by peers
- using authentic assessments with real-life problem-solving
- using videos, illustrations, pictures, and drawings to explain or clarify

Talented and Gifted Learning (T&G)

- Advanced problem-solving
- Allow students to work at a faster pace
- Cluster grouping
- Create a blog or social media page about their unit
- Create a plan to solve an issue presented in the class or in a text
- Debate issues with research to support arguments
- Flexible skill grouping within a class or across grade level for rigor
- Higher order, critical & creative thinking skills, and discovery
- Multi-disciplinary unit and/or project
- Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities
- Utilize exploratory connections to higher-grade concepts
- Utilize project-based learning for greater depth of knowledge

Sample Lesson

Unit Name: Unit 3: Cellular Energetics

NJSLS: Attached

Interdisciplinary Connection: Art (sketching or building models)

Statement of Objective: SWDAT use models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter.

Anticipatory Set/Do Now: Review inputs and outputs of photosynthesis and respiration

Learning Activity: In teams, students create a visual representation (e.g., diagram with annotation) to explain the interdependent relationships of cellular respiration and photosynthesis and how the processes of cellular respiration and photosynthesis support life on Earth. Visual representations are displayed in the classroom for peer review and revision and to generate questions for further investigation.

Student Assessment/CFU's: Google form- questions on interdependence of cellular respiration and photosynthesis

Materials: Smart TV for anticipatory set, chrome books for exit ticket, poster board, coloring supplies

21st Century Themes and Skills: Health and Environmental Literacy

Differentiation/Modifications: Visual Representation, extra time for task completion,

Integration of Technology: Smart TV for anticipatory set, Google classroom for exit ticket

HS-LS1-5	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
HS-LS1-7	Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.