

# Year 1, Unit 9 HL Topic 8 Metabolism, Cell Respiration and Photosynthesis

Content Area: **Science**  
Course(s): **IB Biology, HL**  
Time Period: **Second Marking period**  
Length: **3 Weeks**  
Status: **Published**

## Unit Overview

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Students will learn the importance of energy acquisition through different methods. Cellular respiration through anaerobic and aerobic methods as well as photosynthesis will be addressed.

## STAGE 1- DESIRED RESULTS

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8.1 Developments in scientific research follow improvements in computing—developments in bioinformatics, such as the interrogation of databases, have facilitated research into metabolic pathways.

8.2 Paradigm shift—the chemiosmotic theory led to a paradigm shift in the field of bioenergetics.

8.3 Developments in scientific research follow improvements in apparatus—sources of  $^{14}\text{C}$  and autoradiography enabled Calvin to elucidate the pathways of carbon fixation.

## Standards

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**2020 New Jersey Student Learning Standards- Science**

## Science and Engineering Practices

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- Asking Questions and Defining Problems
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Planning and Carrying Out Information

## Cross Cutting Concepts

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- Cause and Effect
- Energy and Matter
- Patterns
- Stability and Change
- Structure and Functions
- Systems and System Models

## **Disciplinary Core Ideas**

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### **Life Sciences**

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- LS1A: Structure and Functions
- LS1B: Growth and Development of Organisms
- LS1C: Organization for Matter and Energy Flow in Organisms

### **Engineering. Technology. and Applications of Science**

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- ETS1B: Developing Possible Solutions

### **Essential Questions**

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8.1 How are metabolic reactions regulated in response to the cell's needs?

8.2 How is energy converted to a usable form in cell respiration?

8.3 How is light energy converted into chemical energy?

### **Enduring Understanding**

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Students will have a lasting understanding of the importance of enzymes to the function of all living organisms, both plants and animals. Students will learn the detailed mechanisms of how energy is produced and used in both plants and animals. The relationship of interdependence of both plants and animals will be lasting based on the essential production and use of oxygen.

## Students will know...

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### 8.1

- Metabolic pathways consist of chains and cycles of enzyme-catalysed reactions.
- Enzymes lower the activation energy of the chemical reactions that they catalyze.
- Enzyme inhibitors can be competitive or non-competitive.
- Metabolic pathways can be controlled by end-product inhibition.

### 8.2

- Cell respiration involves the oxidation and reduction of electron carriers.
- Phosphorylation of molecules makes them less stable.
- In glycolysis, glucose is converted to pyruvate in the cytoplasm.
- Glycolysis gives a small net gain of ATP without the use of oxygen.
- In aerobic cell respiration pyruvate is decarboxylated and oxidized, and converted into acetyl compound and attached to coenzyme A to form acetyl coenzyme A in the link reaction.
- In the Krebs cycle, the oxidation of acetyl groups is coupled to the reduction of hydrogen carriers, liberating carbon dioxide.
- Energy released by oxidation reactions is carried to the cristae of the mitochondria by reduced NAD and FAD.
- Transfer of electrons between carriers in the electron transport chain in the membrane of the cristae is coupled to proton pumping.
- In chemiosmosis protons diffuse through ATP synthase to generate ATP.
- Oxygen is needed to bind with the free protons to maintain the hydrogen gradient, resulting in the formation of water.
- The structure of the mitochondrion is adapted to the function it performs.

### 8.3

- Light-dependent reactions take place in the thylakoid membranes and the space inside them.
- Light-independent reactions take place in the stroma.
- Reduced NADP and ATP are produced in the light-dependent reactions.
- Absorption of light by photosystems generates excited electrons.
- Photolysis of water generates electrons for use in the light-dependent reactions.
- Transfer of excited electrons occurs between carriers in thylakoid membranes.
- Excited electrons from Photosystem II are used to contribute to generate a proton gradient.
- ATP synthase in thylakoids generates ATP using the proton gradient.
- Excited electrons from Photosystem I are used to reduce NADP.
- In the light-independent reactions a carboxylase catalyzes the carboxylation of ribulose biphosphate.
- Glycerate 3-phosphate is reduced to triose phosphate using reduced NADP and ATP.
- Triose phosphate is used to regenerate RuBP and produce carbohydrates.
- Ribulose biphosphate is reformed using ATP.
- The structure of the chloroplast is adapted to its function in photosynthesis.

## Misconceptions

Students often come in thinking that respiration is the act of breathing, whereas in Biology, respiration is the

process that brings oxygen to cells, which allows food molecules to dissassociate to form ATP.

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**Students will be able to...**

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8.1

- Analyze end-product inhibition of the pathway that converts threonine to isoleucine.
- Use databases to identify potential new anti-malarial drugs.

8.2

- Critique electron tomography used to produce images of active mitochondria.

8.3

- Explain Calvin's experiment to elucidate the carboxylation of RuBP.

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**STAGE 2- EVIDENCE OF LEARNING**

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**Formative Assessment**

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- Debriefing
- Hand Signals
- Journal Entry
- Observation
- Questions & Answers
- Quiz
- Web or Concept Map

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**Authentic Assessments**

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8.1

- Skill: Calculating and plotting rates of reaction from raw experimental results.
- Skill: Distinguishing different types of inhibition from graphs at specified substrate concentration.

## 8.2

- Skill: Analysis of diagrams of the pathways of aerobic respiration to deduce where decarboxylation and oxidation reactions occur.
- Skill: Annotation of a diagram of a mitochondrion to indicate the adaptations to its function.

## 8.3

- Skill: Annotation of a diagram to indicate the adaptations of a chloroplast to its function.

Laboratories will be used for assessment

Quizzes will be given.

## **Benchmark Assessments**

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Chapter tests will be given.

## **STAGE 3- LEARNING PLAN**

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### **Instructional Map**

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Helpful guidance to assist in implementation of the IB biology curriculum

## 8.1

- Enzyme inhibition should be studied using one specific example for competitive and non-competitive inhibition.

## 8.2

- The names of the intermediate compounds in glycolysis and the Krebs Cycle are not required.

## **Modification/Differentiation of Instruction**

### Differentiation Strategies for Special Education Students

- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Varied homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

### Differentiation Strategies for Gifted and Talented Students

- Increase the level of complexity
- Decrease scaffolding
- Variety of finished products
- Allow for greater independence
- Learning stations, interest groups
- Varied texts and supplementary materials
- Use of technology
- Flexibility in assignments
- Varied questioning strategies
- Encourage research
- Strategy and flexible groups based on formative assessment or student choice
- Acceleration within a unit of study
- Exposure to more advanced or complex concepts, abstractions, and materials
- Encourage students to move through content areas at their own pace

- After mastery of a unit, provide students with more advanced learning activities, not more of the same activity
- Present information using a thematic, broad-based, and integrative content, rather than just single-subject areas

### Differentiated Strategies for ELL Students

- Remove unnecessary materials, words, etc., that can distract from the content
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Gradually increase the level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials, including visuals
- Use technology, if available and appropriate
- Differentiate homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Allow students to work at their own pace
- Presenting ideas through auditory, visual, kinesthetic, & tactile means
- Role play
- Provide graphic organizers, highlighted materials
- Strategy and flexible groups based on formative assessment

### Differentiation Strategies for At Risk Students

- Remove unnecessary materials, words, etc., that can distract from the content
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Gradually increase the level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials
- Use technology, if available and appropriate

- Differentiate homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Presenting ideas through auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment

## **504 Plans**

Students can qualify for 504 plans if they have physical or mental impairments that affect or limit any of their abilities to:

- walk, breathe, eat, or sleep
- communicate, see, hear, or speak
- read, concentrate, think, or learn
- stand, bend, lift, or work

Examples of accommodations in 504 plans include:

- preferential seating
- extended time on tests and assignments
- reduced homework or classwork
- verbal, visual, or technology aids
- modified textbooks or audio-video materials
- behavior management support
- adjusted class schedules or grading
- verbal testing
- excused lateness, absence, or missed classwork
- pre-approved nurse's office visits and accompaniment to visits
- occupational or physical therapy

## **Modification Strategies**

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- Cooperative Grouping
- Oral Directions
- Peer Tutoring
- Preferential Seating
- Repeated Drill and Practice

## **Differentiation Strategies**

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### **High Preparation**

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- Group Investigations
- Independent Research / Project
- Varying Graphic Organizers

### **Low Preparation**

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- Flexible Grouping
- Use of Collaboration
- Varied Product Choice
- Varied Supplemental Materials
- Work Alone / Together

## **Horizontal Intergration- Interdisciplinary Connections**

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See Appendix

## **Vertical Integration- Discipline Mapping**

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Previous courses

6<sup>th</sup> grade – Diversity of life

7<sup>th</sup> grade – Populations and Ecosystems

8<sup>th</sup> grade – Human Systems Interactions and Heredity and Adaptations

9<sup>th</sup> grade – Honors Biology

10<sup>th</sup> grade – Honors Chemistry

Possible next courses

Honors Physics

Anatomy & Physiology

IB Physics

Zoology

Forensics

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### **Additional Materials**

Videos used through McGraw Hill, Crash Course and Howard Hughes Medical Institute.

Current Research articles supplied through Newsela.