IB Biology Y1 Unit 3: Molecular Biology: Cellular Energetics

Teacher(s)	IB Biology PLC	**Subject group and course**	Group 4/IB Biology Y1 SL		
Course part and topic	Unit 3: Cellular Energetics Topic 2.5, 2.7-2.9	**SL or HL/Year 1 or 2**	SL Y1	**Dates**	6 weeks
Unit description and texts		**DP assessment(s) for unit**			
Molecular biology explains living processes in terms of chemical reactions and substances involved. Enzymes help control metabolism by speeding up chemical reactions by lowering the activation energy of reactions. Photosynthesis and Cellular Respiration are processes by which organisms create energy by converting one form of energy to another or by the breakdown of materials. Protein synthesis provides the materials needed to build organisms. (Subtopics 2.5, 2.7-2.9, Pearson IB Biology Textbook)		• Unit Summative assessment • Projects/Practicals • Formative/Summative assessment quizzes per subtopic to check for understanding			

INQUIRY: Establishing the purpose of the unit

Unit Statement of Inquiry: Research is continuously being conducted to find novel applications for enzymes that will promote human health and wellness.

Essential Ideas/Inquiry Statements per Subtopic:
Enzymes control the metabolism of a cell.
Genetic information in DNA can be accurately copied and can be translated to make the proteins needed by the cell.
Cell respiration supplies energy for the functions of life.
Photosynthesis uses the energy in sunlight to produce the chemical energy needed for life.

Core Ideas: Enzymes/Cellular Energy: Photosynthesis, Respiration, Fermentation, DNA Replication (review nucleic acids structure and function), Protein Synthesis

Phenomenon: Industrial production of lactose free milk - enzymes have become more important to the production of items that are needed by populations around the world

Crosscutting Concepts-
Stability and Change/Patterns/Systems and Systems Models

ACTION: teaching and learning through inquiry

Content/skills/concepts—essential understandings **U = Understandings** **NOS = Nature of Science** **A = Applications** **S = Skills**	**Learning process** *Check the boxes for any pedagogical approaches used during the unit. Aim for a variety of approaches to help facilitate learning.*
Students will know the following content/Students will grasp the following concepts: 2.5: Enzymes Understandings ● Enzymes have an active site to which specific substrates bind. ● Enzyme catalysis involves molecular motion and the collision of substrates with the active site. ● Temperature, pH and substrate concentration affect the rate of activity of enzymes. ● Enzymes can be denatured. ● Immobilized enzymes are widely used in industry. 2.7: DNA replication, transcription, and translation (Protein Synthesis) Understandings ● The replication of DNA is semi-conservative and depends on complementary base pairing. ● Helicase unwinds the double helix and separates the two strands by breaking hydrogen bonds. ● DNA polymerase links nucleotides together to form a new strand, using the pre-existing strand as a template. ● Transcription is the synthesis of mRNA copied from the DNA base sequences by RNA polymerase. ● Translation is the synthesis of polypeptides on ribosomes. ● The amino acid sequence of polypeptides is determined by mRNA according to the genetic code. ● Codons of three bases on mRNA correspond to one amino acid in a polypeptide. ● Translation depends on complementary base pairing between codons on mRNA and anticodons on tRNA. 2.8: Cell Respiration ● Cell respiration is the controlled release of energy from organic compounds to produce ATP. ● ATP from cellular respiration is immediately available as a source of energy in the cell.	Learning experiences and strategies/planning for self-supporting learning: Lecture Socratic Seminar Small Group/Pair Work PowerPoint Lecture Notes Individual Presentations Group Presentations Student Lecture/Leading the class Interdisciplinary Learning Details: Modeling, Think/Pair/Share, CER, Writing Prompts, Videos, etc. Accommodations: ● *SWD/504 – Accommodations Provided* ● *ELL – Reading & Vocabulary Support* ● *Intervention Support* ● *Extensions – Enrichment Tasks and Project*

• Anaerobic cell respiration gives a small yield of ATP from glucose. • Aerobic cell respiration requires oxygen and gives a large yield of ATP from glucose. 2.9: Photosynthesis • Photosynthesis is the production of carbon compounds in cells using light energy. • Visible light has a range of wavelengths with violet the shortest wavelength and red the longest. • Chlorophyll absorbs red and blue light most effectively and reflects green light more than other colours. • Oxygen is produced in photosynthesis from the photolysis of water. • Energy is needed to produce carbohydrates and other carbon compounds from carbon dioxide. • Temperature, light intensity and carbon dioxide concentration are possible limiting factors on the rate of photosynthesis. Applications and Skills • Application: Methods of production of lactose-free milk and its advantages. • Skill: Design of experiments to test the effect of temperature, pH and substrate concentration on the activity of enzymes. • Skill: Experimental investigation of a factor affecting enzyme activity. (Practical 3) • Application: Use of Taq DNA polymerase to produce multiple copies of DNA rapidly by the polymerase chain reaction (PCR). • Application: Production of human insulin in bacteria as an example of the universality of the genetic code allowing gene transfer between species. • Skill: Use a table of the genetic code to deduce which codon(s) corresponds to which amino acid. • Skill: Analysis of Meselson and Stahl's results to obtain support for the theory of semi-conservative replication of DNA. • Skill: Use a table of mRNA codons and their corresponding amino acids to deduce the sequence of amino acids coded by a short mRNA strand of known base sequence. • Skill: Deducing the DNA base sequence for the mRNA strand. • Application: Use of anaerobic cell respiration in yeasts to produce ethanol and carbon dioxide in baking. • Application: Lactate production in humans when anaerobic respiration is used to maximize the power of muscle contractions. • Skill: Analysis of results from experiments involving measurement of respiration rates in germinating seeds or invertebrates using a respirometer	Guidance: ❖ Lactase can be immobilized in alginate beads and experiments can then be carried out in which the lactose in milk is hydrolysed. ❖ Students should be able to sketch graphs to show the expected effects of temperature, pH and substrate concentration on the activity of enzymes. They should be able to explain the patterns or trends apparent in these graphs. ❖ In diagrams of DNA structure, the helical shape does not need to be shown, but the two strands should be shown antiparallel. Adenine should be shown paired with thymine and guanine with cytosine, but the relative lengths of the purine and pyrimidine bases do not need to be recalled, nor the numbers of hydrogen bonds between the base pairs. ❖ The different types of DNA polymerase do not need to be distinguished. ❖ Details of the metabolic pathways of cell respiration are not needed but the substrates and final waste products should be known. ❖ There are many simple respirometers which could be used. Students are expected to know that an alkali is used to absorb CO2, so reductions in volume are due to oxygen use. Temperature should be

• Application: Changes to the Earth's atmosphere, oceans and rock deposition due to photosynthesis. • Skill: Drawing an absorption spectrum for chlorophyll and an action spectrum for photosynthesis. • Skill: Design of experiments to investigate the effect of limiting factors on photosynthesis. • Skill: Separation of photosynthetic pigments by chromatography. (Practical 4) NOS Experimental design—accurate, quantitative measurements in enzyme experiments require replicates to ensure reliability. (3.2) Obtaining evidence for scientific theories—Meselson and Stahl obtained evidence for the semi-conservative replication of DNA. (1.8) Assessing the ethics of scientific research—the use of invertebrates in respirometer experiments has ethical implications. (4.5) Experimental design—controlling relevant variables in photosynthesis experiments is essential. (3.1)	kept constant to avoid volume changes due to temperature fluctuations. ❖ Students should know that visible light has wavelengths between 400 and 700 nanometres, but they are not expected to recall the wavelengths of specific colours of light. ❖ Water free of dissolved carbon dioxide for photosynthesis experiments can be produced by boiling and cooling water. ❖ Paper chromatography can be used to separate photosynthetic pigments but thin layer chromatography gives better results.
Students will be assessed on classwork, discussions, group work, lab work and reflections using a variety of formats with a focus on the applications and skills provided in the syllabus. Practicals 3 and 4 will be completed during this Unit	**Formative assessment:** Quiz/Test Project/Model CER/Reflection Essay/Writing Assignment Lab Experiments

Students will be assessed per subtopic and then at the end of the unit (Topic) to ensure understanding using IB exam style questions, modeling, reflection, lab reports, and writing prompts	**Summative assessment:** Quiz/Test Project/Model CER/Reflection Essay/Writing Assignment Lab practicals
Students may be aware of many of the concepts within this unit, so building on prior knowledge using scaffolding techniques to aid students in a deeper understanding and extending learning to ensure that students can meet the goals set by the unit.	Differentiation: Affirm Identity - build self-esteem Value Prior Knowledge Scaffold Learning Extend Learning Details: Many concepts may be familiar to the students and others will need more scaffolding and extension.

Approaches to learning (ATL)

Check the boxes for any explicit approaches to learning connections made during the unit. For more information on ATL, please see the guide.

Thinking - Asking questions and defining problems
Social Communication- Constructing Explanations/Engaging in Argument from Evidence
Self-management - Carrying out Investigations
Research- Developing and using models

Language and learning *Check the boxes for any explicit language and learning connections made during the unit. For more information on the IB's approach to language and learning, please see the guide.*	**TOK connections** *Check the boxes for any explicit TOK connections made during the unit*	**CAS connections** *Check the boxes for any explicit CAS connections. If you check any of the boxes, provide a brief note in the "details" section explaining how students engaged in CAS for this unit.*
Activating Background Knowledge Scaffolding for new learning Acquisition of new learning through practice Demonstrating proficiency	Personal and Shared Knowledge Ways of Knowing Areas of Knowledge The Knowledge Framework Details: Development of some techniques benefits particular human populations more than others. For example, the development of lactose-free milk available in Europe and North America would have greater benefit in Africa/ Asia where lactose intolerance is more prevalent. The development of techniques requires financial investment. Should knowledge be shared when techniques developed in one part of the world are more applicable in another?	Creativity Activity Service Details: Modeling and active participation in the learning process. Creating materials to aid their fellow classmates in understanding a particular concept through peer interaction and team/group activities.

International Mindedness/Aims:

International Mindedness: (Research/Reflections/Writing)
Enzymes are extensively used in industry for the production of items from fruit juice to washing powder.

Aims: (Practicals/Activities/Student Reflections/CER Activities)
Aim 8: There are ethical implications in altering the genome of an organism in order to produce proteins for medical use in humans.
Aim 8: The ethics of the use of animals in experiments could be discussed in relation to respirometer experiments. Large-scale use of food plants for biofuels and the resulting impact on food prices has ethical implications.

Resources
Damon, A.; McGonegal, R.; Tosto, P.; Ward, W. *Standard level biology*; Pearson Education Limited: Harlow, Essex, 2014. Greenwood, T.; Pryor, K.; Bainbridge-Smith, L.; Allan, R. Environmental science: student workbook; Biozone International: Hamilton, New Zealand, 2013. Van de Lagemaat, R. www.inthinking.net: Andorra la Vella, Andorra, 2019. IB Biology Schoology Course

Stage 3: Reflection—considering the planning, process and impact of the inquiry

What worked well *List the portions of the unit (content, assessment, planning) that were successful*	**What didn't work well** *List the portions of the unit (content, assessment, planning) that were not as successful as hoped*	**Notes/changes/suggestions:** *List any notes, suggestions, or considerations for the future teaching of this unit*