Marietta City Schools

2024-2025 District Unit Planner

Teacher(s)	IB Biology Y1 Trotter PLC Logue/Logue	**Subject group and course**	Group 4/IB Biology MHS Y1 SGO		
Course part and topic	Unit 2: Molecular Biology: Structure and Function **A1.1**.1-1.1.6, **A1.2**.1-1.2.10, **B1.1**, **B1.2**.1-1.2.5 **HL A1.1**.7-1.1.8, **A1.2**.11-1.2.15, **B1.2.6-1.2.12**	**SL or HL/Year 1 or 2**	HL Y1	**Dates**	9 weeks S1
Unit description and texts		**DP assessment(s) for unit**			
Molecular biology explains living processes in terms of chemical reactions and substances involved. Molecules to Metabolism, Water, Carbohydrates and Lipids, Proteins, and the Structure of Nucleic Acids Sickle Cell Theme throughout the course New IB Biology Guide First Assessment 2025		Unit Formative and Summative assessment(s) – Practice Paper 1 and 2 IB style Questions ● Properties of Water Lab (A1.1) ● Protein Project (Database) (B1.2)			

Topic Abbreviations:
Themes: A = Unity & Diversity, B = Form & Function, C = Interaction & Interdependence, D = Continuity & Change
Level of Organization: 1 = Molecules, 2 = Cells, 3 = Organisms, 4 = Ecosystems

INQUIRY: Establishing the purpose of the unit

Statement of Inquiry:
Various Functions of a cell can be predicted through the complex structures of their molecules.

Phenomenon: Sickle cell disease is caused by mutations in the beta-globin (HBB) gene that lead to the production of an abnormal version of a subunit of hemoglobin — the protein responsible for carrying oxygen in red blood cells

Crosscutting Concepts
- Structure and Function
- Interactions
- Stability and Change
- Patterns

CORE IDEAS
- Properties of Water
- Organic Compounds
- Chemistry Basics

Macromolecules:
- Nucleic Acids
- Carbohydrates
- Lipids
- Proteins

SEP:
- Carrying out investigations
- Asking Questions and Defining Problems
- Developing & Using Models
- Engage in Argument from Evidence

ACTION: teaching and learning through inquiry

Content/skills/concepts—essential understandings **Themes: A = Unity & Diversity, B = Form & Function, C = Interaction & Interdependence, D = Continuity & Change**	**Learning process** *Check the boxes for any pedagogical approaches used*

Level of Organization: 1 = Molecules, 2 = Cells, 3 = Organisms, 4 = Ecosystems **GQ - Guiding Questions** **NOS - Nature of Science** **AOS - Application of Skills** **LQ - Linking Question**	*during the unit. Aim for a variety of approaches to help facilitate learning.*
A1.1, A1.2, B1.1, B1.2 Students will know the following content/Students will grasp the following concepts: **A1.1 Water (Unity and Diversity - Cells)** **GQ -** • What physical and chemical properties of water make it essential for life? • What are the challenges and opportunities of water as a habitat? **Guidance:** **A1.1.1—Water as the medium for life** Students should appreciate that the first cells originated in water and that water remains the medium in which most processes of life occur. **A1.1.2—Hydrogen bonds because of the polar covalent bonds within water molecules** Students should understand that polarity of covalent bonding within water molecules is due to unequal sharing of electrons and hydrogen bonding due to this polarity occurs between water molecules. Students should be able to represent two or more water molecules and hydrogen bonds between them with the notation shown below to indicate polarity. **A1.1.3—Cohesion of water molecules due to hydrogen bonding and consequences for organisms** Include transport of water under tension in xylem and the use of water surfaces as habitats due to the effect known as surface tension. **A1.1.4—Adhesion of water to materials that are polar or charged and impacts for organisms** Include capillary action in soil and in plant cell walls. **A1.1.5—Solvent properties of water linked to its role as a medium for metabolism and for transport in plants and animals** Emphasize that a wide variety of hydrophilic molecules dissolve in water and that most enzymes catalyze reactions in aqueous solution. Students should also understand that the functions of some molecules in cells depend on them being hydrophobic and insoluble. **A1.1.6—Physical properties of water and the consequences for animals in aquatic habitats** Include buoyancy, viscosity, thermal conductivity, and specific heat capacity. Contrast the physical properties of water with those of air and illustrate the consequences using examples of animals that live in	Learning experiences and strategies/planning for self-supporting learning: • Socratic Seminar • Small Group/Pair Work • PowerPoint Lecture Notes • Individual Presentations • Group Presentations • Student Lecture/Leading the class • Interdisciplinary Learning • Guided and Student Designed Labs and Explorations 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* **Assessment Objectives:** The assessment objectives for biology reflect

water and in air or on land, such as the black-throated loon (*Gavia arctica*) and the ringed seal (*Pusa hispida*).
Note: When students are referring to an organism in an examination, either the common name or the scientific name is acceptable.

Additional higher level
A1.1.7—Extraplanetary origin of water on Earth and reasons for its retention
The abundance of water over billions of years of Earth's history has allowed life to evolve. Limit hypotheses for the origin of water on Earth to asteroids and reasons for retention to gravity and temperatures low enough to condense water.

A1.1.8—Relationship between the search for extraterrestrial life and the presence of water
Include the idea of the "Goldilocks zone".

LQ -
• How do the various intermolecular forces of attraction affect biological systems?
• What biological processes only happen at or near surfaces?

A1.2 Nucleic Acids (Unity and Diversity - Molecules)

GQ -
- **How do the various intermolecular forces of attraction affect biological systems?**
- **What biological processes only happen at or near surfaces?**

Guidance:
A1.2.1—DNA as the genetic material of all living organisms
Some viruses use RNA as their genetic material but viruses are not considered to be living**.**

A1.2.2—Components of a nucleotide
In diagrams of nucleotides use circles, pentagons and rectangles to represent relative positions of phosphates, pentose sugars and bases.

A1.2.3—Sugar–phosphate bonding and the sugar–phosphate "backbone" of DNA and RNA
Sugar–phosphate bonding makes a continuous chain of covalently bonded atoms in each strand of DNA or RNA nucleotides, which forms a strong "backbone" in the molecule.

A1.2.4—Bases in each nucleic acid that form the basis of a code
Students should know the names of the nitrogenous bases.

A1.2.5—RNA as a polymer formed by condensation of nucleotide monomers
Students should be able to draw and recognize diagrams of the structure of single nucleotides and RNA polymers.

A1.2.6—DNA as a double helix made of two antiparallel strands of nucleotides with two strands linked by hydrogen bonding between complementary base pairs

those parts of the aims that will be formally assessed either internally or externally. It is the intention of this course that students can fulfil the following assessment objectives.

1. Demonstrate knowledge of:
   A. terminology, facts, and concepts
   B. skills, techniques, and methodologies.
2. Understand and apply knowledge of:
   A. terminology and concepts
   B. skills, techniques, and methodologies.
3. Analyze, evaluate, and synthesize:
   A. experimental procedures
   B. primary and secondary data
   C. trends, patterns, and predictions.
4. Demonstrate the application of skills necessary to carry out insightful and ethical investigations

In diagrams of DNA structure, students should draw the two strands antiparallel, but are not required to draw the helical shape. Students should show adenine (A) paired with thymine (T), and guanine (G) paired with cytosine (C). Students are not required to memorize the relative lengths of the purine and pyrimidine bases, or the numbers of hydrogen bonds.

A1.2.7—Differences between DNA and RNA
Include the number of strands present, the types of nitrogenous bases and the type of pentose sugar. Students should be able to sketch the difference between ribose and deoxyribose. Students should be familiar with examples of nucleic acids.

A1.2.8—Role of complementary base pairing in allowing genetic information to be replicated and expressed
Students should understand that complementarity is based on hydrogen bonding.

A1.2.9—Diversity of possible DNA base sequences and the limitless capacity of DNA for storing information
Explain that diversity by any length of DNA molecule and any base sequence is possible. Emphasize the enormous capacity of DNA for storing data with great economy.

A1.2.10—Conservation of the genetic code across all life forms as evidence of universal common ancestry
Students are not required to memorize any specific examples.

Additional higher level
A1.2.11—Directionality of RNA and DNA
Include 5' to 3' linkages in the sugar–phosphate backbone and their significance for replication, transcription and translation.

A1.2.12—Purine-to-pyrimidine bonding as a component of DNA helix stability
Adenine–thymine (A–T) and cytosine–guanine (C–G) pairs have equal length, so the DNA helix has the same three-dimensional structure, regardless of the base sequence.

A1.2.13—Structure of a nucleosome
Limit to a DNA molecule wrapped around a core of eight histone proteins held together by an additional histone protein attached to linker DNA. Application of skills: Students are required to use molecular visualization software to study the association between the proteins and DNA within a nucleosome.

Applications of Skills:
Visualization software of Nucleosome structure

A1.2.14—Evidence from the Hershey–Chase experiment for DNA as the genetic material
Syllabus content 37 Biology guideStudents should understand how the results of the experiment support the conclusion that DNA is the genetic material.
NOS: Students should appreciate that technological developments can open up new possibilities for experiments. When radioisotopes were made available to scientists as research tools, the Hershey–Chase experiment became possible.

A1.2.15—Chargaff's data on the relative amounts of pyrimidine and purine bases across diverse life forms
NOS: Students should understand how the "problem of induction" is addressed by the "certainty of falsification". In this case, Chargaff's data falsified the tetranucleotide hypothesis that there was a repeating sequence of the four bases in DNA.

LQ -

- **What makes RNA more likely to have been the first genetic material rather than DNA?**
- **How can polymerization result in emergent properties?**

B1.1 Carbohydrates and Lipids (Form and Function - Molecules)

GQ -

- **In what ways do variations in form allow diversity of function in carbohydrates and lipids?**
- **How do carbohydrates and lipids compare as energy storage compounds?**

Guidance:
B1.1.1—Chemical properties of a carbon atom allowing for the formation of diverse compounds upon which life is based
Students should understand the nature of a covalent bond. Students should also understand that a carbon atom can form up to four single bonds or a combination of single and double bonds with other carbon atoms or atoms of other non-metallic elements. Include among the diversity of carbon compounds examples of molecules with branched or unbranched chains and single or multiple rings.

NOS: Students should understand that scientific conventions are based on international agreement (SI metric unit prefixes "kilo", "centi", "milli", "micro" and "nano").

B1.1.2—Production of macromolecules by condensation reactions that link monomers to form a polymer
Students should be familiar with examples of polysaccharides, polypeptides and nucleic acids.

B1.1.3—Digestion of polymers into monomers by hydrolysis reactions
Water molecules are split to provide the -H and -OH groups that are incorporated to produce monomers, hence the name of this type of reaction.

B1.1.4—Form and function of monosaccharides
Students should be able to recognize pentoses and hexoses as monosaccharides from molecular diagrams showing them in the ring forms. Use glucose as an example of the link between the properties of a monosaccharide and how it is used, emphasizing solubility, transportability, chemical stability and the yield of energy from oxidation as properties.

B1.1.5—Polysaccharides as energy storage compounds
Include the compact nature of starch in plants and glycogen in animals due to coiling and branching during polymerization, the relative insolubility of these compounds due to large molecular size and the relative ease of adding or removing alpha-glucose monomers by condensation and hydrolysis to build or mobilize energy stores.

B1.1.6—Structure of cellulose related to its function as a structural polysaccharide in plants
Include the alternating orientation of beta-glucose monomers, giving straight chains that can be grouped in bundles and cross-linked with hydrogen bonds.

B1.1.7—Role of glycoproteins in cell–cell recognition
Include ABO antigens as an example**.**

B1.1.8—Hydrophobic properties of lipids
Lipids are substances in living organisms that dissolve in non-polar solvents but are only sparingly soluble in aqueous solvents. Lipids include fats, oils, waxes, and steroids.

B1.1.9—Formation of triglycerides and phospholipids by condensation reactions
One glycerol molecule can link three fatty acid molecules or two fatty acid molecules and one phosphate group.

B1.1.10—Difference between saturated, monounsaturated, and polyunsaturated fatty acids
Include the number of double carbon (C=C) bonds and how this affects melting point. Relate this to the prevalence of different types of fatty acids in oils and fats used for energy storage in plants and endotherms, respectively.

B1.1.11—Triglycerides in adipose tissues for energy storage and thermal insulation
Students should understand that the properties of triglycerides make them suited to long-term energy storage functions. Students should be able to relate the use of triglycerides as thermal insulators to body temperature and habitat.

B1.1.12—Formation of phospholipid bilayers as a consequence of the hydrophobic and hydrophilic regions
Students should use and understand the term “amphipathic”.

B1.1.13—Ability of non-polar steroids to pass through the phospholipid bilayer
Include estradiol and testosterone as examples. Students should be able to identify compounds as steroids from molecular diagrams.

LQ -

- **How can compounds synthesized by living organisms accumulate and become carbon sinks?**
- **What are the roles of oxidation and reduction in biological systems?**

B1.2 Proteins (Form and Function - Molecules)
GQ -

- **What is the relationship between amino acid sequence and the diversity in form and function of proteins?**
- **How are protein molecules affected by their chemical and physical environments?**

Guidance:

B1.2.1—Generalized structure of an amino acid
Students should be able to draw a diagram of a generalized amino acid showing the alpha carbon atom with amine group, carboxyl group, R-group and hydrogen attached.

B1.2.2—Condensation reactions forming dipeptides and longer chains of amino acids
Students should be able to write the word equation for this reaction and draw a generalized dipeptide after modelling the reaction with molecular models.

B1.2.3—Dietary requirements for amino acids
Essential amino acids cannot be synthesized and must be obtained from food. Non-essential amino acids can be made from other amino acids. Students are not required to give examples of essential and nonessential amino acids. Vegan diets require attention to ensure essential amino acids are consumed.

B1.2.4—Infinite variety of possible peptide chains
Include the ideas that 20 amino acids are coded for in the genetic code, that peptide chains can have any number of amino acids, from a few to thousands, and that amino acids can be in any order. Students should be familiar with examples of polypeptides.

B1.2.5—Effect of pH and temperature on protein structure
Include the term “denaturation.”

Additional higher level
B1.2.6—Chemical diversity in the R-groups of amino acids as a basis for the immense diversity in protein form and function
Students are not required to give specific examples of R-groups. However, students should understand that R-groups determine the properties of assembled polypeptides. Students should appreciate that Rgroups are hydrophobic or hydrophilic and that hydrophilic R-groups are polar or charged, acidic or basic.

B1.2.7—Impact of primary structure on the conformation of proteins
Students should understand that the sequence of amino acids and the precise position of each amino acid within a structure determines the three-dimensional shape of proteins. Proteins therefore have precise, predictable and repeatable structures, despite their complexity.

B1.2.8—Pleating and coiling of secondary structure of proteins
Include hydrogen bonding in regular positions to stabilize alpha helices and beta-pleated sheets.

B1.2.9—Dependence of tertiary structure on hydrogen bonds, ionic bonds, disulfide covalent bonds and hydrophobic interactions Students are not required to name examples of amino acids that participate in these types of bonding, apart from pairs of cysteines forming disulfide bonds. Students should understand that amine and carboxyl groups in R-groups can become positively or negatively charged by binding or dissociation of hydrogen ions and that they can then participate in ionic bonding.

B1.2.10—Effect of polar and non-polar amino acids on tertiary structure of proteins
In proteins that are soluble in water, hydrophobic amino acids are clustered in the core of globular proteins. Integral proteins have regions with hydrophobic amino acids, helping them to embed in membranes.

B1.2.11—Quaternary structure of non-conjugated and conjugated proteins Syllabus content 51 Biology guideInclude insulin and collagen as examples of non-conjugated proteins and haemoglobin as an example of a conjugated protein. **NOS:** Technology allows imaging of structures that would be impossible to observe with the unaided senses. For example, cryogenic electron microscopy has allowed imaging of single-protein molecules and their interactions with other molecules. **B1.2.12—Relationship of form and function in globular and fibrous proteins** Students should know the difference in shape between globular and fibrous proteins and understand that their shapes make them suitable for specific functions. Use insulin and collagen to exemplify how form and function are related. **LQ -** ● **How do abiotic factors influence the form of molecules?** ● **What determines whether a substance can pass through a biological membrane?**	
Students will be assessed daily with classwork, discussions, group work, and reflections using a variety of formats with a focus on the applications and skills provided in the syllabus.	**Possible Formative Assignments/Assessments:** Quiz/Test Project/Model CER/Reflection Essay/Writing Assignment Formative Lab Activity

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 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.	**Possible Summative Assignments/Assessments:** Quiz/Test Project/Model CER/Reflection Essay/Writing Assignment Summative Lab Practical

	Differentiation: Affirm Identity - build self-esteem Value Prior Knowledge Scaffold Learning Extend Learning Student Choice when possible 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 - Conducting Investigations
Research- Developing and using models

Language and learning	**TOK connections**	**CAS connections**
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.	*Check the boxes for any explicit TOK connections made during the unit*	*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 Potatoes have been genetically modified to reduce the level of amylose to produce a more effective adhesive. Proteomics and the production of proteins by cells cultured in fermenters offer many opportunities for the food, pharmaceutical and other industries.	Personal and Shared Knowledge Ways of Knowing Areas of Knowledge The Knowledge Framework Details: Claims about the "memory of water" have been categorized as pseudoscientific. What are the criteria that can be used to distinguish scientific claims from pseudoscientific claims? There are conflicting views as to the harms and benefits of fats in diets. How do we decide between competing views? The story of the elucidation of the structure of DNA illustrates that cooperation and collaboration among scientists exists alongside competition between research groups. To what extent is research in secret 'anti-scientific'? What is the relationship between shared and personal knowledge in the natural sciences?	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)
There are challenges for the increasing human population in sharing water resources equitably for drinking and irrigation, electricity generation and a range of industrial and domestic processes.
Variation in the prevalence of different health problems around the world could be discussed including obesity, dietary energy deficiency, kwashiorkor, anorexia nervosa and coronary heart disease.

Aims: (Labs/Activities/Student Reflections/CER Activities)
The course enables students, through the overarching theme of the NOS, to:

1. **develop conceptual understanding that allows connections to be made between different areas of the subject, and to other DP sciences subjects**
2. **acquire and apply a body of knowledge, methods, tools, and techniques that characterize science**
3. **develop the ability to analyze, evaluate and synthesize scientific information and claims**
4. **develop the ability to approach unfamiliar situations with creativity and resilience**
5. **design and model solutions to local and global problems in a scientific context**
6. **develop an appreciation of the possibilities and limitations of science**

7. **develop technology skills in a scientific context**
8. **develop the ability to communicate and collaborate effectively**
9. **develop awareness of the ethical, environmental, economic, cultural, and social impact of science.**

Resources				
• Textbook Pearson Biology for the IB Diploma Standard and Higher Level • IB Biology Guide First Assessment 2025 • Van de Lagemaat, R. www.inthinking.net: Andorra la Vella, Andorra, 2019. • IB Biology Schoology Course • Discovery Education Biology and Chemistry Resources				

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*