Marietta City Schools

2024–2025 District Unit Planner

IB Biology Y1 Unit 4: Genetics

Teacher(s)	IB Biology Y1 - Trotter PLC Logue/Trotter	**Subject group and course**	Group 4/IB Biology Y1 SL MHS Y1 SGO		
Course part and topic	Unit 4: Genetics D1.3, D2.1, D3.2	**SL or HL/Year 1 or 2**	SL Y1	**Dates**	7 weeks

Unit description and texts	**DP assessment(s) for unit**
● Every living organism inherits a blueprint for life from its parents. ● Chromosomes carry genes in a linear sequence that is shared by members of a species. ● The inheritance of genes follows patterns. ● Meiosis leads to independent assortment of chromosomes and unique composition of alleles in daughter cells. ● What might happen during meiosis if two genes are located next to each other on a chromosome? ● If three genes control a single feature how many different combinations are there of alleles, assuming 2 alleles for each gene? Sickle Cell Theme throughout the course New IB Biology Guide First Assessment 2025	● Unit Formative and Summative assessment(s) ● Data analysis: Human Genome project: base sequencing analysis **Applications of Skills:** ▪ Identify phases of mitosis and meiosis using diagrams, viewed with a microscope, and/or micrograph (D2.1) ▪ Distinction between continuous variables such as skin color and discrete variables such as ABO blood groups – apply measures of central tendency – mean, median, and mode (D3.2) ● Use Box and Whisker plots to display six aspects of data: outliers, minimum, , first quartile, median, third quartile, and maximum

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

International Baccalaureate
Baccalauréat International
Bachillerato Internacional

INQUIRY: Establishing the purpose of the unit

Statement of Inquiry:
Advancements in biotechnology supports complex research into the inheritance patterns and genetics of all living things.

Phenomenon:
The causes and effects of sickle cell anemia – A base substitution mutation drives significant phenotypical change in humans.

Crosscutting Concepts
- Structure and Function
- Systems and System models
- Patterns

CORE IDEAS
- Genes: Mutations/Variation
- Cell Division: Mitosis/Meiosis/ Cytokinesis
- Down Syndrome/Non-Disjunction
- Inheritance: Patterns
- Haploid/Diploid
- Phenotype/Genotype
- Phenylketonuria (PKU)
- Single Nucleotide Polymorphisms (SNPs)
- ABO Blood Groups
- Incomplete
- Codominance
- Sex determination
- Sex Linked Traits
- Continuous inheritance due to Polygenic inheritance or environmental factors

SEP:
- Asking Questions and Defining Problems
- Carry out Investigations
- Engage in Argument from Evidence

ACTION: teaching and learning through inquiry

Content/skills/concepts—essential understandings	Learning process
Themes: A = Unity & Diversity, B = Form & Function, C = Interaction & Interdependence, D = Continuity & Change **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**	*Check the boxes for any pedagogical approaches used during the unit. Aim for a variety of approaches to help facilitate learning.*
D1.3, D2.1, D3.2 Students will know the following content/Students will grasp the following concepts: **D1.3 Mutations and Gene Editing (Continuity and Change - Molecules)** **GQ -** ● **How do gene mutations occur?** ● **What are the consequences of gene mutation?** **Guidance:** **D1.3.1—Gene mutations as structural changes to genes at the molecular level** Distinguish between substitutions, insertions, and deletions. **D1.3.2—Consequences of base substitutions** Students should understand that single-nucleotide polymorphisms (SNPs) are the result of base substitution mutations and that because of the degeneracy of the genetic code they may or may not change a single amino acid in a polypeptide.	**Learning experiences and strategies/planning for self-supporting learning:** Labs and Hands On Activities 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*

D1.3.3—Consequences of insertions and deletions Include the likelihood of polypeptides ceasing to function, either through frameshift changes or through major insertions or deletions. Specific examples are not required. **D1.3.4—Causes of gene mutation** Students should understand that gene mutation can be caused by mutagens and by errors in DNA replication or repair. Include examples of chemical mutagens and mutagenic forms of radiation. **D1.3.5—Randomness in mutation** Students should understand that mutations can occur anywhere in the base sequences of a genome, although some bases have a higher probability of mutating than others. They should also understand that no natural mechanism is known for making a deliberate change to a particular base with the purpose of changing a trait. **D1.3.6—Consequences of mutation in germ cells and somatic cells** Include inheritance of mutated genes in germ cells and cancer in somatic cells. **D1.3.7—Mutation as a source of genetic variation** Students should appreciate that gene mutation is the original source of all genetic variation. Although most mutations are either harmful or neutral for an individual organism, in a species they are in the long term essential for evolution by natural selection. **NOS: Commercial genetic tests can yield information about potential future health and disease risk.** One possible impact is that, without expert interpretation, this information could be problematic. **LQ -** ● **How can natural selection lead to both a reduction in variation and an increase in biological diversity?** ● **How does variation in subunit composition of polymers contribute to function?** **D2.1 Cell and Nuclear Division (Continuity and Change - Cells)** **GQ -**	● *ELL – Reading & Vocabulary Support* ● *Intervention Support* ● *Extensions – Enrichment Tasks and Project* Guidance: ❖ Students should be able to recall one specific base substitution that causes glutamic acid to be substituted by valine as the sixth amino acid in the hemoglobin polypeptide. ❖ The number of genes in a species should not be referred to as genome size as this term is used for the total amount of DNA. At least one plant and one bacterium should be included in the comparison and at least one species with more genes and one with fewer genes than a human. ❖ The GenBank® database can be used to search for DNA base sequences. The cytochrome C gene sequence is available for many different organisms and is of particular interest because of its use in reclassifying organisms into three domains. ❖ Deletions, insertions, and frameshift mutations do not need to be included. ❖ The terms karyotype and karyogram have different meanings. Karyotype is a property of a cell—the number and type of chromosomes present in the nucleus, not a photograph or diagram of them. ❖ Genome size is the total length of DNA in

- **How can large numbers of genetically identical cells be produced?**
- **How do eukaryotes produce genetically varied cells that can develop into gametes?**

Guidance:

D2.1.1—Generation of new cells in living organisms by cell division

In all living organisms, a parent cell—often referred to as a mother cell—divides to produce two daughter cells.

D2.1.2—Cytokinesis as splitting of cytoplasm in a parent cell between daughter cells

Students should appreciate that in an animal cell a ring of contractile actin and myosin proteins pinches a cell membrane together to split the cytoplasm, whereas in a plant cell vesicles assemble sections of membrane and cell wall to achieve splitting.

D2.1.3—Equal and unequal cytokinesis

Include the idea that division of cytoplasm is usually, but not in all cases, equal and that both daughter cells must receive at least one mitochondrion and any other organelle that can only be made by dividing a pre-existing structure. Include oogenesis in humans and budding in yeast as examples of unequal cytokinesis.

D2.1.4—Roles of mitosis and meiosis in eukaryotes

Emphasize that nuclear division is needed before cell division to avoid production of anucleate cells.

Mitosis maintains the chromosome number and genome of cells, whereas meiosis halves the chromosome number and generates genetic diversity.

D2.1.5—DNA replication as a prerequisite for both mitosis and meiosis

Students should understand that, after replication, each chromosome consists of two elongated DNA molecules (chromatids) held together until anaphase.

D2.1.6—Condensation and movement of chromosomes as shared features of mitosis and meiosis

Include the role of histones in the condensation of DNA by supercoiling and the use of microtubules and microtubule motors to move chromosomes.

an organism. Examples of genome and chromosome number have been selected to allow points of interest to be raised.

- The two DNA molecules formed by DNA replication prior to cell division are sister chromatids until the splitting of the centromere at the start of anaphase. After this, they are individual chromosomes.
- Preparation of microscope slides showing meiosis is challenging and permanent slides should be available in case no cells in meiosis are visible in temporary mounts.
- Drawings of the stages of meiosis do not need to include chiasmata.
- The process of chiasmata formation need not be explained.
- Alleles carried on X chromosomes should be shown as superscript letters on an upper case X, such as Xh .
- The expected notation for ABO blood group alleles is:

Phenotype		*Genotype*	
	O		ii
	A		I^AI^A or I^Ai
	B		I^BI^B or I^Bi
	AB		I^AI^B

- Students should be able to deduce whether a man could be the father of a child from the pattern of bands on a DNA profile.
- Dolly can be used as an example of somatic-cell transfer.
- A plant species should be chosen for rooting experiments that forms roots

D2.1.7—Phases of mitosis Students should know the names of the phases and how the process as a whole produces two genetically identical daughter cells. **D2.1.8—Identification of phases of mitosis** **AOS: Students should do this using diagrams as well as with cells viewed with a microscope or in a micrograph.** **D2.1.9—Meiosis as a reduction division** Students should understand the terms "diploid" and "haploid" and how the two divisions of meiosis produce four haploid nuclei from one diploid nucleus. They should also understand the need for meiosis in a sexual life cycle. Students should be able to outline the two rounds of segregation in meiosis. **D2.1.10—Down syndrome and non-disjunction** Use Down syndrome as an example of an error in meiosis. **D2.1.11—Meiosis as a source of variation** Students should understand how meiosis generates genetic diversity by random orientation of bivalents and by crossing over. **LQ -** ● **What processes support the growth of organisms?** ● **How does the variation produced by sexual reproduction contribute to evolution?** **D3.2 Inheritance (Continuity and Change - Organisms)** **GQ -** ● **What patterns of inheritance exist in plants and animals?** ● **What is the molecular basis of inheritance patterns?** **Guidance:** **D3.2.1—Production of haploid gametes in parents and their fusion to form a diploid zygote as the means of inheritance**	readily in water or a solid medium. **Assessment Objectives:** The assessment objectives for biology reflect those parts of the aims that will be formally assessed either internally or externally. It is the intention of this course that students can fulfill 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

Students should understand that this pattern of inheritance is common to all eukaryotes with a sexual life cycle. They should also understand that a diploid cell has two copies of each autosomal gene. **D3.2.2—Methods for conducting genetic crosses in flowering plants** **Use the terms “P generation”, “F1 generation”, “F2 generation” and “Punnett grid”.** Students should understand that pollen contains male gametes and that female gametes are located in the ovary, so pollination is needed to carry out a cross. They should also understand that plants such as peas produce both male and female gametes on the same plant, allowing self-pollination and therefore self-fertilization. Mention that genetic crosses are widely used to breed new varieties of crop or ornamental plants. **D3.2.3—Genotype as the combination of alleles inherited by an organism** Students should use and understand the terms “homozygous” and “heterozygous”, and appreciate the distinction between genes and alleles. **D3.2.4—Phenotype as the observable traits of an organism resulting from genotype and environmental factors** Students should be able to suggest examples of traits in humans due to genotype only and due to environment only, and traits due to interaction between genotype and environment. **D3.2.5—Effects of dominant and recessive alleles on phenotype** Students should understand the reasons that both a homozygous-dominant genotype and a heterozygous genotype for a particular trait will produce the same phenotype. **D3.2.6—Phenotypic plasticity as the capacity to develop traits suited to the environment experienced by an organism, by varying patterns of gene expression** Phenotypic plasticity is not due to changes in genotype, and the changes in traits may be reversible during the lifetime of an individual. **D3.2.7—Phenylketonuria as an example of a human disease due to a recessive allele** Phenylketonuria (PKU) is a recessive genetic condition caused by mutation in an autosomal gene that codes for the enzyme needed to convert phenylalanine to tyrosine.	

D3.2.8—Single-nucleotide polymorphisms and multiple alleles in gene pools Students should understand that any number of alleles of a gene can exist in the gene pool but an individual only inherits two. **D3.2.9—ABO blood groups as an example of multiple alleles** Use IA, IB and i to denote the alleles. **D3.2.10—Incomplete dominance and codominance** Students should understand the differences between these patterns of inheritance at the phenotypic level. In codominance, heterozygotes have a dual phenotype. Include the AB blood type (IAIB) as an example. In incomplete dominance, heterozygotes have an intermediate phenotype. Include four o'clock flower or marvel of Peru (*Mirabilis jalapa*) as an example. ***Note: When students are referring to organisms in an examination, either the common name or the scientific name is acceptable.*** **D3.2.11—Sex determination in humans and inheritance of genes on sex chromosomes** Students should understand that the sex chromosome in sperm determines whether a zygote develops certain male-typical or female-typical physical characteristics and that far more genes are carried by the X chromosome than the Y chromosome. **D3.2.12—Hemophilia as an example of a sex-linked genetic disorder** Show alleles carried on X chromosomes as superscript letters on an uppercase X. **D3.2.13—Pedigree charts to deduce patterns of inheritance of genetic disorders** Students should understand the genetic basis for the prohibition of marriage between close relatives in many societies. **NOS: Scientists draw general conclusions by inductive reasoning when they base a theory on observations of some but not all cases. A pattern of inheritance may be deduced from parts of a pedigree chart and this theory may then allow genotypes of specific individuals in the pedigree to be deduced. Students should be able to distinguish between inductive and deductive reasoning.** **D3.2.14—Continuous variation due to polygenic inheritance and/or environmental factors**	

Use skin color in humans as an example. **AOS: Students should understand the distinction between continuous variables such as skin color and discrete variables such as ABO blood group. They should also be able to apply measures of central tendency such as mean, median and mode.** **D3.2.15—Box-and-whisker plots to represent data for a continuous variable such as student height** **AOS: Students should use a box-and-whisker plot to display six aspects of data: outliers, minimum, first quartile, median, third quartile and maximum. A data point is categorized as an outlier if it is more than 1.5 × IQR (interquartile range) above the third quartile or below the first quartile.** **LQ -** ● **What are the principles of effective sampling in biological research?** ● **What biological processes involve doubling and halving?**	
Students may 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.	**Formative assessment:** Quiz/Test Lab Analysis or Report Project/Model CER/Reflection Essay/Writing Assignment

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 Lab Analysis or Report Project/Model CER/Reflection Essay/Writing Assignment
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: There is a link between sickle cell anemia and the prevalence of malaria. How can we know whether there is a causal link in such cases or simply a correlation? Sequencing of the rice genome involved cooperation between biologists in 10 countries. In 1922 the number of chromosomes counted in a human cell was 48. This remained the established number for 30 years, even though a review of photographic evidence from the time clearly showed that there were 46. For what reasons do existing beliefs carry a certain inertia? Mendel's theories were not accepted by the scientific community for a long time. What factors would encourage the acceptance of new ideas by the scientific community? The use of DNA for securing convictions in legal cases is well established, yet even universally accepted theories are overturned in the light of new evidence in science. What criteria are necessary for assessing the reliability of evidence?	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) Sequencing of the human genome shows that all humans share most of their base sequences but also that there are many single nucleotide polymorphisms that contribute to human diversity Sequencing of the rice genome involved cooperation between biologists in 10 countries. **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 TBD – evaluation of resources ● 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 Additional Resources: Old Syllabus ● 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. ● Hodder Study and Revision Guide for the IB Diploma Hodder IA Internal Assessment for Biology

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*