

Year 1, Unit 3 Genetics

Content Area: **Science**
Course(s): **IB Biology, HL**
Time Period: **Second Marking period**
Length: **5 Weeks**
Status: **Published**

Unit Overview

Students will learn about the principles of inheritance and inheritance patterns. These will be used to analyze prevalence of genetic disorders.

STAGE 1- DESIRED RESULTS

- 3.1 Developments in scientific research follow improvements in technology—gene sequencers are used for the sequencing of genes.
- 3.2 Developments in research follow improvements in techniques—autoradiography was used to establish the length of DNA molecules in chromosomes.
- 3.3 Making careful observations—meiosis was discovered by microscope examination of dividing germ-line cells.
- 3.4 Making quantitative measurements with replicates to ensure reliability. Mendel's genetic crosses with pea plants generated numerical data.
- 3.5 Assessing risks associated with scientific research—scientists attempt to assess the risks associated with genetically modified crops or livestock.

Standards

2020 New Jersey Student Learning Standards- Science

Science and Engineering Practices

- Analyzing and Interpreting Data
- Asking Questions and Defining Problems
- Constructing Explanations and Designing Solutions

- Developing and Using Models
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information
- Planning and Carrying Out Information
- Using Mathematics and Computational Thinking

Cross Cutting Concepts

- Cause and Effect
- Energy and Matter
- Influence of Engineering, Technology, and Science on Society and the Natural World
- Interdependence of Science, Engineering, and Technology
- Patterns
- Scale, Proportion, and Quantity
- Stability and Change
- Structure and Functions
- Systems and System Models

Disciplinary Core Ideas

Life Sciences

- LS1A: Structure and Functions
- LS1B: Growth and Development of Organisms
- LS1D: Information Processing
- LS3A: Inheritance of Traits
- LS3B: Variation of traits

Essential Questions

3.1 How does every living organism inherit a blueprint for life from its parents?

3.2 How do chromosomes carry genes in a linear sequence that is shared by members of a species?

3.3 Why do alleles segregate during meiosis and how do they allow new combinations to be formed by the fusion of gametes?

3.4 Why does inheritance show different types of patterns?

3.5 How have biologists developed techniques for artificial manipulation of DNA, cells and organisms?

Enduring Understanding

Student will have a lasting understanding about the importance of transfer of genetic information and the consequences of mutations that can result from the transfer of genetic information.

Students will know...

3.1

- A gene is a heritable factor that consists of a length of DNA and influences a specific characteristic.
- A gene occupies a specific position on a chromosome.
- The various specific forms of a gene are alleles.
- Alleles differ from each other by one or only a few bases.
- New alleles are formed by mutation.
- The genome is the whole of the genetic information of an organism.
- The entire base sequence of human genes was sequenced in the Human Genome Project.

3.2

- Prokaryotes have one chromosome consisting of a circular DNA molecule.
- Some prokaryotes also have plasmids, but eukaryotes do not.
- Eukaryote chromosomes are linear DNA molecules associated with histone proteins.
- In a eukaryote species there are different chromosomes that carry different genes.
- Homologous chromosomes carry the same sequence of genes, but not necessarily the same alleles of those genes.
- Diploid nuclei have pairs of homologous chromosomes.
- Haploid nuclei have one chromosome of each pair.
- The number of chromosomes is a characteristic feature of members of a species.
- A karyogram shows the chromosomes of an organism in homologous pairs of decreasing length.
- Sex is determined by sex chromosomes and autosomes are chromosomes that do not determine sex.

3.3

- One diploid nucleus divides by meiosis to produce four haploid nuclei.
- The halving of the chromosome number allows a sexual life cycle with fusion of gametes.
- DNA is replicated before meiosis so that all chromosomes consist of two sister chromatids.
- The early stages of meiosis involve pairing of homologous chromosomes and crossing over followed by condensation.
- Orientation of pairs of homologous chromosomes prior to separation is random.
- Separation of pairs of homologous chromosomes in the first division of meiosis halves the chromosome number.

- Crossing over and random orientation promotes genetic variation.
- Fusion of gametes from different parents promotes genetic variation.

3.4

- Mendel discovered the principles of inheritance with experiments in which large numbers of pea plants were crossed.
- Gametes are haploid so contain only one allele of each gene.
- The two alleles of each gene separate into different haploid daughter nuclei during meiosis.
- Fusion of gametes results in diploid zygotes with two alleles of each gene that may be the same allele or different alleles.
- Dominant alleles mask the effects of recessive alleles, but co-dominant alleles have joint effects.
- Many genetic diseases in humans are due to recessive alleles of autosomal genes, although some genetic diseases are due to dominant or co-dominant alleles.
- Some genetic diseases are sex-linked. The pattern of inheritance is different with sex-linked genes due to their location on sex chromosomes.
- Many genetic diseases have been identified in humans, but most are very rare.
- Radiation and mutagenic chemicals increase the mutation rate and can cause genetic diseases and cancer.

3.5

- Gel electrophoresis is used to separate proteins or fragments of DNA according to size.
- PCR can be used to amplify small amounts of DNA.
- DNA profiling involves comparison of DNA.
- Genetic modification is carried out by gene transfer between species.
- Clones are groups of genetically identical organisms, derived from a single original parent cell.
- Many plant species and some animal species have natural methods of cloning.
- Animals can be cloned at the embryo stage by breaking up the embryo into more than one group of cells.
- Methods have been developed for cloning adult animals using differentiated cells.

Students will be able to...

3.1

- Deduce the causes of sickle cell anemia, including a base substitution mutation, a change to the base sequence of mRNA transcribed from it and a change to the sequence of a polypeptide in hemoglobin.
- Compare the number of genes in humans with other species.

3.2

- Examine Cairns' technique for measuring the length of DNA molecules by autoradiography.
- Compare genome size in T2 phage, *Escherichia coli*, *Drosophila melanogaster*, *Homo sapiens* and *Paris japonica*.
- Compare diploid chromosome numbers of *Homo sapiens*, *Pan troglodytes*, *Canis familiaris*, *Oryza*

sativa, *Parascaris equorum*.

- Create a karyograms to deduce sex and diagnose Downs Syndrome in humans.

3.3

- Assess the statement that non-disjunction can cause Downs Syndrome and other chromosome abnormalities.
- Critique studies showing age of parents influences chances of non-disjunction.
- Analyze descriptions of methods used to obtain cells for karyotype analysis e.g. chorionic villus sampling and amniocentesis and the associated risks.

3.4

- Analyze inheritance of ABO blood groups.
- Deduce red-green color blindness and hemophilia as examples of sex-linked inheritance.
- Explain inheritance of cystic fibrosis and Huntington's disease.
- Identify consequences of radiation after nuclear bombing of Hiroshima and accident at Chernobyl.

3.5

- Explain the use of DNA profiling in paternity and forensic investigations.
- Analyze gene transfer to bacteria using plasmids makes use of restriction endonucleases and DNA ligase.
- Application: Assessment of the potential risks and benefits associated with genetic modification of crops.
- Summarize the production of cloned embryos produced by somatic-cell nuclear transfer.

STAGE 2- EVIDENCE OF LEARNING

Formative Assessment

- 3- Minute Pause
- Exit Card / Ticket
- Observation
- One Minute Essay
- Questions & Answers
- Quiz

Authentic Assessments

3.1

- Skill: Use of a database to determine differences in the base sequence of a gene in two species.

3.2

- Skill: Use of databases to identify the locus of a human gene and its polypeptide product.

3.3

- Skill: Drawing diagrams to show the stages of meiosis resulting in the formation of four haploid cells.

3.4

- Skill: Construction of Punnett grids for predicting the outcomes of monohybrid genetic crosses.
- Skill: Comparison of predicted and actual outcomes of genetic crosses using real data.
- Skill: Analysis of pedigree charts to deduce the pattern of inheritance of genetic diseases.

3.5

- Skill: Design of an experiment to assess one factor affecting the rooting of stem-cuttings.
- Skill: Analysis of examples of DNA profiles.
- Skill: Analysis of data on risks to monarch butterflies of Bt crops.

Laboratories will be used for assessment

Quizzes will be given.

Benchmark Assessments

Chapter tests will be given.

STAGE 3- LEARNING PLAN

Instructional Map

Helpful guidance for implementing the IB Biology curriculum

3.1

- 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 frame shift mutations do not need to be included.

3.2

- 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 an organism. The 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 considered to be sister chromatids until the splitting of the centromere at the start of anaphase. After this, they are individual chromosomes.

3.3

- 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.

3.4

- Alleles carried on X chromosomes should be shown as superscript letters on an upper case X, such as X^h.
- The expected notation for ABO blood group alleles is:

<i>Phenotype</i>	<i>Genotype</i>
O	ii
A	A A or Ai
B	B B or Bi
AB	A B

3.5

- Students should be able to deduce whether or not 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 readily in water or a solid medium.

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

- Cooperative Grouping
- Oral Directions
- Peer Tutoring
- Preferential Seating
- Teacher Notes

Differentiation Strategies

Low Preparation

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

Horizontal Intergration- Interdisciplinary Connections

See Appendix

Vertical Integration- Discipline Mapping

Previous courses

6th grade – Diversity of life

7th grade – Populations and Ecosystems

8th grade – Human Systems Interactions and Heredity and Adaptations

9th grade – Honors Biology

10th grade – Honors Chemistry

Possible next courses

Honors Physics

Anatomy & Physiology

IB Physics

Zoology

Forensics

Additional Materials

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

Current Research articles supplied through Newsela.