Exceptions to Mendel's Laws (Non-Mendelian Genetics)

Content Area: **Science**
Course(s): **CP Genetics**
Time Period: **Marking Period 2**
Length: **3 weeks**
Status: **Published**

Course Pacing Guide

Unit	MP/Trimester	Weeks
• DNA and the Central Dogma- Structure and Replication	1	2
• DNA and the Central Dogma- Protein Synthesis	1	2
• Meiosis, Prenatal Screening, and Genetic Family History	1	3
• Mendelian Genetics	1	2
• Non-Mendelian Genetics	2	3
• Genetics of Cancer	2	2.5
• Modern Tools and Techniques	2	2.5
• Genetic Disease Eradication	2	1

Exceptions to Mendel's Laws (Non-Mendelian)

The following phenomena can disrupt Mendelian phenotypic ratios and have different effects on the actual phenotype:

- Lethal alleles: a phenotypic class dies very early in development.
    - In humans early acting lethal alleles will cause spontaneous miscarriage.
    - In certain breeds of dogs, especially the Mexican hairless dog, receiving two dominant alleles will result in spontaneous abortion.
- Multiple alleles: Many variants or degrees of a phenotype occur even though a person still one inherits one allele from each parent.
    - Examples: PKU, Cystic Fibrosis (all examples may not be mentioned)
- Incomplete dominance:
    - A heterozygote's phenotype is intermediate between those of the homozygotes.
        - Example: Familial hypercholesterolemia
- Epistasis: One gene masks or otherwise affects another's phenotype
- X-linked: the gene is carried on the X chromosome, but not the Y chromosome; as a result males show this phenotypic trait more so than females
    - Hemophilia
    - Colorblindness
- Maternal inheritance and mitochondrial genes: Genes that are only passed from the mother to both male and female offspring.
    - Features of mitochondrial DNA include no crossing over, no DNA repair, high exposure to oxygen free radicals, no histones, no introns, and maternal inheritance.
    - Genetic disorders in mitochondrial DNA are associated with defects in energy conversion and usually affect the nervous system, muscles, liver and kidneys.
- Penetrance: Some individuals with a particular genotype do not have the associated phenotype
    - Refers to the all-or-nothing expression of a genotype. Genetic and environmental factors can influence penetrance.
    - Polydactyly is incompletely penetrant. Some people who inherit the dominant allele have more than five digits on a hand or foot yet others who must have the allele based on their parents, have the normal number of fingers and toes.

- Expressivity: A genotype is associated with a phenotype of varying intensity o Refers to the severity or extent of the trait.

- Pleiotropy: The phenotype includes many symptoms, with different subsets in different individuals
    - This is the case for porphyria variegate, an autosomal dominant, pleiotropic, error of metabolism.
- Phenocopy: An environmentally caused condition has symptoms and a reoccurrence pattern similar to those of a known inherited trait.
    - Limb birth defect caused by thalidomide, a drug given to pregnant women for morning sickness (teratogen) mimicked the inherited disorder called phocomelia.

Key Terms: phenocopy, pleiotropy, expressivity, penetrance, epistasis, codominance, incomplete dominance, cystic fibrosis, porphyria variegate, Marfan syndrome, X-linked traits

Enduring Understandings

The students will explore their own understanding how inheritance is governed by the information stored in discrete unit factors called genes. These genes alleles sometimes fail to display the clear-cut dominant and recessive traits observed by Mendel. Students will be able to identify these different modes of inheritance. Students will investigate traits and/or genetic disorders associated with these modes of inheritance.

*This unit is designed to be very flexible according to class ability. Not all of these ideas may be covered some years, while other years we may push into great detail

Essential Questions

- How are traits and genetic disorders associated with the following modes of inheritance: X-linked, incomplete dominance, codominance, epistasis

- How do lethal alleles affect the phenotypic ratios of the expected and observed results?
- How do certain traits and genetic disorders demonstrate pleiotropic affects?
- How do the ratios of each of the Non-Mendelian modes of inheritance differ than Mendelian genetics discussed in the previous chapter?

New Jersey Student Learning Standards (No CCS)

9-12.HS-LS1-1	Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.
9-12.HS-LS4-3	Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
9-12.HS-LS3-2	Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
9-12.HS-LS3-1	Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

Amistad Integration

Discuss the 23andMe-based study in which genomics has facilitated discovery of African American ancestory, and also provides insights into slave treatment/forced reproduction. This may or may not occur in this unit, but this may be covered at the appropriate time in the course.

Holocaust/Genocide Education

Students will have an ethics discussion about the concepts of hate-based discrimmination, and how genomics can play a role in reshaping the way we view each other. This may or may not occur in this unit, but this may be covered at the appropriate time in the course.

Interdisciplinary Connections

LA.RL.11-12.1	Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.
LA.RL.11-12.2	Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.
LA.RL.11-12.4	Determine the meaning of words and phrases as they are used in the text, including

	figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (e.g., Shakespeare as well as other authors.)
MA.S-CP.A.2	Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.
MA.S-CP.A.3	Understand the conditional probability of A given B as $P(A\ and\ B)/P(B)$, and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.
MA.S-CP.B.9	Use permutations and combinations to compute probabilities of compound events and solve problems.
MA.S-MD.B.6	Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).
MA.S-MD.B.7	Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).
SCI.HS-LS1-1	Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
SOC.6.1.12.A.16.b	Analyze government efforts to address intellectual property rights, personal privacy, and other ethical issues in science, medicine, and business that arise from the global use of new technologies.

Technology Standards

TECH.8.1.12.A.3	Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue.
TECH.8.1.12.A.CS1	Understand and use technology systems.
TECH.8.1.12.A.CS2	Select and use applications effectively and productively.
TECH.8.1.12.C.CS1	Interact, collaborate, and publish with peers, experts, or others by employing a variety of digital environments and media.
TECH.8.1.12.C.CS2	Communicate information and ideas to multiple audiences using a variety of media and formats.
TECH.8.1.12.C.CS4	Contribute to project teams to produce original works or solve problems.
TECH.8.1.12.E.CS2	Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
TECH.8.1.12.E.CS3	Evaluate and select information sources and digital tools based on the appropriateness for specific tasks.

21st Century Themes/Careers

CRP.K-12.CRP1.1	Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going

	beyond the minimum expectation and in participating in activities that serve the greater good.
CRP.K-12.CRP2.1	Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.
CRP.K-12.CRP4.1	Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.
CRP.K-12.CRP6.1	Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.
CRP.K-12.CRP7.1	Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.
CRP.K-12.CRP8.1	Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.
CRP.K-12.CRP11.1	Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.

Financial Literacy Integration

Students will address these standards through common health issues, such as funding allocation vs. disease commonality, healthcare costs vs. cost of new medicine, ethics of compassionate use in pharmaceuticals, and personalized medicine.

PFL.9.1.12.A.3	Analyze the relationship between various careers and personal earning goals.
PFL.9.1.12.A.6	Summarize the financial risks and benefits of entrepreneurship as a career choice.
PFL.9.1.12.B.1	Prioritize financial decisions by systematically considering alternatives and possible consequences.
PFL.9.1.12.G.1	Analyze risks and benefits in various financial situations.
PFL.9.1.12.G.3	Compare the cost of various types of insurance (e.g., life, homeowners, motor vehicle) for the same product or service, given different liability limits and risk factors.

Instructional Strategies & Learning Activities

- Use of whiteboard tables to draw ideas, concepts
- Group learning/accountability
- Small group lessons
- Large group checkpoint, firm-up sessions on key concepts
- Student-led learning and presentation design
- Interactive learning through feedback and presentation improvement
- Peer breakout groups for self-check, teaching
- Disease investigation to solidify concepts
- Careful crafting of a positive "them vs. me" classroom to encourage them to rely on each other over
- Reward positive classroom behavior with greater freedoms (e.g., music, work outside)
- Learning through inquiry model via case/clinical studies
- Collect and analyze data to develop explanations

Differentiated Instruction

Favored strategies:

- Inquiry/Problem-Based Learning
- Learning preferences integration (visual, auditory, kinesthetic)
- Meaningful Student Voice & Choice
- Relationship-Building & Team-Building
- Self-Directed Learning
- Mastery Learning (feedback toward goal)
- Grouping
- Socratic Seminar
- Jigsaws
- Concept Attainment
- Mentoring
- Assessment Design & Backwards Planning
- Flipping the classroom to concentrate on application during class meeting times

Formative Assessments

- Informal conversation
- Questioning techniques
- Progress feedback
- Small scale homeworks
- Academic goal check-ins (e.g., know this by then)
- Stimulus activities that provides progress data

Summative Assessment

- Student presentations and/or clinical studies
- End of unit
- Lab experiments/reports

Benchmark Assessments

- Unit tests and quizzes and/or projects

Alternate Assessments

None

Resources & Technology

- Students will access a wide variety of online resources, including the free open stax biology text (https://openstax.org/details/books/biology-2e). Online resources include, but are not limited to NCBI, OMIM, Sequence alignment tools, GWAS studies, etc.. Students will investigate recent technological advances in genome sequencing, gene editing, and gene therapy mechanisms.
- Students will use teacher slide presentation notes; copy will be given to students (paper copy and/or digital copy)
- Lab experiment associated with these topics will be completed

BOE Approved Texts

Closure

Includes:

- Sequence It - create timelines of major events discussed
- Low-Stakes Quizzes - Give a short quiz using technologies like Kahoot or a Google form.
- Ask a question. Give students ten seconds to confer with peers before you call on a random student to answer. Repeat.
- Have kids orally describe a concept, procedure, or skill in terms so simple that a child in first grade would get it.
- Direct kids to raise their hands if they can answer your questions.
- Have students confer with each other, and have each group summarize a main concept, or ask a question.

ELL

Includes:

- Alternate Responses
- Teacher Modeling
- Simplified Written and Verbal Instructions
- E-Dictionaires
- Google Translate

Special Education

List is not inclusive but may (as the IEP document indicates):

- Shorten assignments to focus on mastery of key concepts.
- Reduce visual distractions in the classroom (mobiles, etc.).
- Provide a computer for written work.
- Seat the student close to the teacher or a positive role model.
- Provide an unobstructed view of the chalkboard, teacher, movie screen, etc.
- Keep extra supplies of classroom materials (pencils, books) on hand.
- Maintain adequate space between desks.
- Give directions in small steps and in as few words as possible.
- Number and sequence the steps in a task.
- Have student repeat the directions for a task.
- Provide visual aids.
- Go over directions orally.
- Provide a vocabulary list with definitions.
- Divide tests into small sections of similar questions or problems.
- Allow the student to complete an independent project as an alternative test.
- Grade spelling separately from content.
- Stand near the student when giving directions or presenting a lesson.
- Use a pass-fail or an alternative grading system when the student is assessed on his or her own growth.

504

Examples of accommodations in 504 plans can include but are not limited to:

- preferential seating
- extended time on tests and assignments
- reduced homework or classwork
- verbal, visual, or technology aids
- occupational or physical therapy
- scheduled weekly meetings at the student's request

At Risk

Examples may include:

- Use of mnemonics
- Have student restate information
- Provision of notes or outlines
- Concrete examples
- Assistance in maintaining uncluttered space
- Weekly home-school communication tools (notebook, daily log, phone calls or email messages)
- Peer or scribe note-taking
- Lab and math sheets with highlighted instructions
- Graph paper to assist in organizing or lining up math problems
- Use of manipulatives
- No penalty for spelling errors
- Follow a routine/schedule
- Teach time management skills
- Verbal and visual cues regarding directions and staying on task
- Adjusted assignment timelines
- Visual daily schedule
- Immediate feedback
- Work-in-progress check
- Pace long-term projects
- Preview test procedures
- Film or video supplements in place of reading text
- Pass/no pass option
- Cue/model expected behavior
- Use de-escalating strategies
- Use peer supports and mentoring
- Chart progress and maintain data

Gifted and Talented

Foster student interest in science, promote development of critical thinking and problem-solving skills, model and encourage transparency in thinking, and encourage risk-taking.