Unit 5: Heredity (Life Science)

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Department of Curriculum and Instruction

Belleville Public Schools

Curriculum Guide

AP Biology

Unit 5: Heredity

Belleville Board of Education

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Unit Overview

Unit 5 focuses on heredity and the biological concepts and processes involved in ensuring the continuity of life. Students learn that the storage and transmission of genetic information via chromosomes from one generation to the next occur through meiosis. Meiotic division ensures genetic diversity, which is crucial to the survival of a species. In this unit, students gain a deeper understanding of Mendelian genetics and learning how non-Mendelian genetics describes those patterns of inheritance that seem to violate Mendel's laws. This unit also teaches the role played by chromosomal inheritance, environmental factors, and nondisjunction on an individual's phenotype. In Unit 6, students move on to learn about gene expression and regulation.

Enduring Understanding

- **TOPIC 5.1 Meiosis-**Heritable information provides for continuity of life.
- **TOPIC 5.2 Meiosis and Genetic Diversity-**Heritable information provides for continuity of life.
- **TOPIC 5.3 Mendelian Genetics-**Organisms are linked by lines of descent from common ancestry
- **TOPIC 5.4 Non-Mendelian Genetics-**Heritable information provides for continuity of life.
- **TOPIC 5.5 Environmental Effects on Phenotype-**Naturally occurring diversity among and between components within biological systems affects interactions with the environment.
- **TOPIC 5.6 Chromosomal Inheritance-**Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

Essential Questions

- How is our understanding of evolution influenced by our knowledge of genetics?
- Why is it important that not all inherited characteristics get expressed in the next generation?
- How would Mendel's laws have been affected if he had studied a different type of plant?
- How does the diversity of a species affect inheritance?
- How do living systems store, retrieve, and transmit genetic information critical to life processes?
- How does the expression of genetic material control cell products which, in turn, determine the metabolism and nature of the cell?
- What is the relationship between changes in genotype and phenotype and evolution?

Exit Skills

By the end of AP Biology Unit 5, Heredity, the student should be able to:

- Explain how meiosis results in the transmission of chromosomes from one generation to the next.
- Describe similarities and/ or differences between the phases and outcomes of mitosis and meiosis.
- Explain how the process of meiosis generates genetic diversity.
- Explain how shared, conserved, fundamental processes and features support the concept of common ancestry for all organisms.
- Explain the inheritance of genes and traits as described by Mendel's laws.
- Explain deviations from Mendel's model of the inheritance of traits.
- Explain how the same genotype can result in multiple phenotypes under different environmental conditions.
- Explain how chromosomal inheritance generates genetic variation in sexual reproduction.

New Jersey Student Learning Standards (NJSLS-S)

NextGen Science Standards

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.
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.
HS-LS3-3	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
HS-LS4-1	Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
9-12.HS-LS3-1.1.1	Ask questions that arise from examining models or a theory to clarify relationships.
9-12.HS-LS4-1.1.1	students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale; thus requiring improved investigations and experiments. They use mathematical representations to identify certain patterns and analyze patterns of performance in order to reengineer and improve a designed system.
9-12.HS-LS3-1.2.1	students understand that empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. They suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They also propose causal relationships by examining what is known about smaller scale mechanisms within the system. They recognize changes in systems may have various causes that may not have equal effects.
9-12.HS-LS3-2.2.1	students understand that empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. They suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They also propose causal relationships by examining what is known about smaller scale mechanisms within the system. They recognize changes in systems may have various causes that may not have equal effects.
9-12.HS-LS3-3.3.1	Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).
9-12.HS-LS3-3.4.1	Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.
9-12.HS-LS3-2.7.1	Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence.
9-12.HS-LS4-1.8.1	Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).
9-12.HS-LS3-1.LS1.A.1	All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins.
9-12.HS-LS3-1.LS3.A.1	Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function.
9-12.HS-LS3-2.LS3.B.1	In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic

	variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited.
9-12.HS-LS3-3.LS3.B.1	Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.
9-12.HS-LS3-2.LS3.B.2	Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.
9-12.HS-LS4-1.LS4.A.1	Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.

Interdisciplinary Connections

LA.RST.9-10.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
LA.RST.9-10.2	Determine the central ideas, themes, or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
LA.RST.9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
LA.RST.9-10.7	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
LA.RST.9-10.8	Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
LA.RST.9-10.9	Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
LA.WHST.9-10.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant sufficient textual and non-textual evidence.
LA.WHST.9-10.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
LA.WHST.9-10.9	Draw evidence from informational texts to support analysis, reflection, and research.

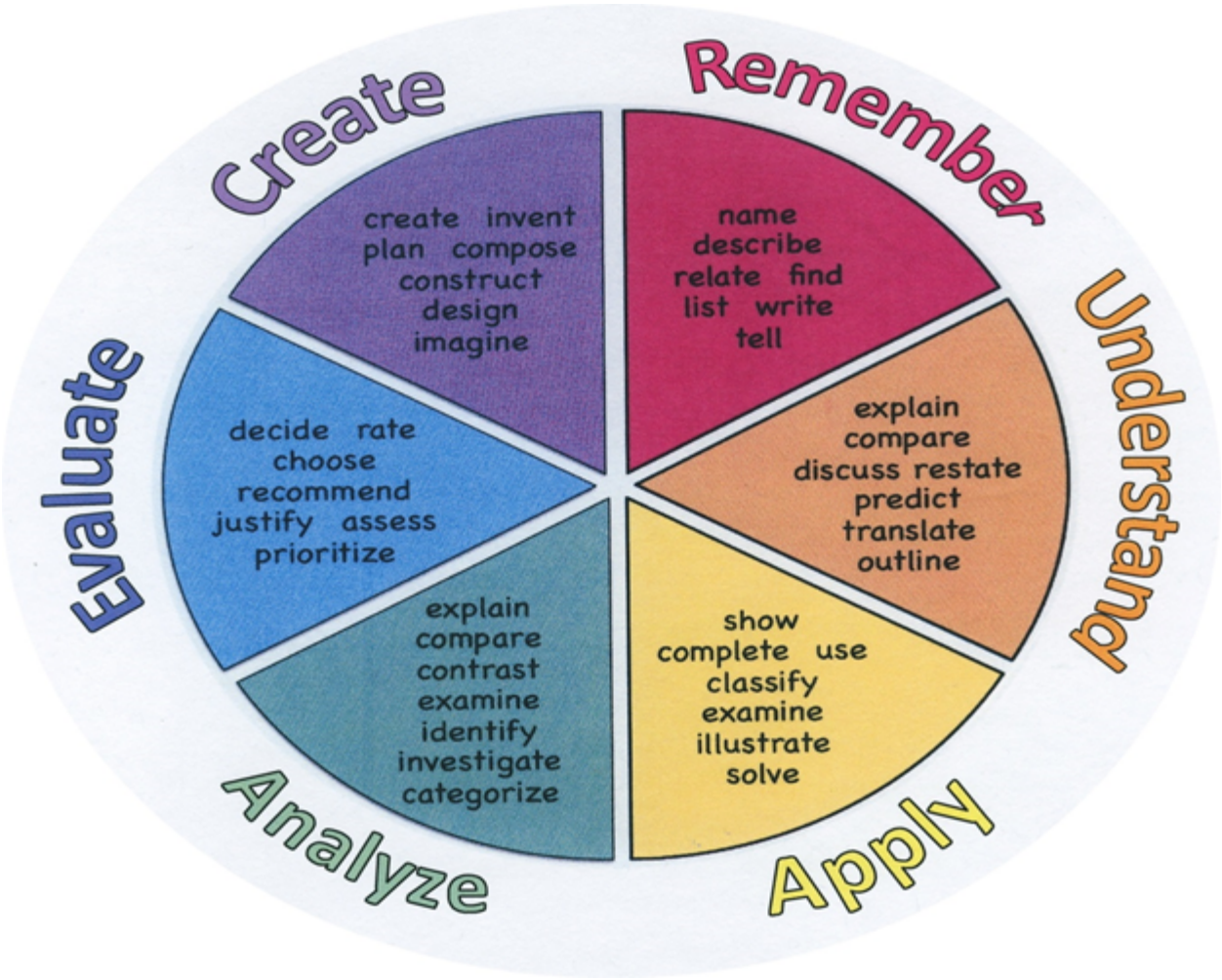
Learning Objectives

- SWDAT construct an explanation, using visual representations or narratives, as to how DNA in chromosomes is transmitted to the next generation via mitosis, or meiosis followed by fertilization
- SWDAT represent the connection between meiosis and increased genetic diversity necessary for evolution
- SWDAT evaluate evidence provided by data sets to support the claim that heritable information is passed from one generation to another through mitosis, or meiosis followed by fertilization.

- SWDAT construct a representation that connects the process of meiosis to the passage of traits from parent to offspring.
- SWDAT pose questions about the ethical, social, or medical issues surrounding human genetic disorders.
- SWDAT apply mathematical routines to determine Mendelian patterns of inheritance provided by data sets.
- SWDAT explain deviations from Mendel's model of the inheritance of traits.
- SWDAT explain how the inheritance patterns of many traits cannot be accounted for by Mendelian genetics.
- SWDAT describe representations of an appropriate example of inheritance patterns that cannot be explained by Mendel's model of the inheritance of traits.
- SWDAT construct explanations of the influence of environmental factors on the phenotype of an organism.
- SWDAT use evidence to justify a claim that a variety of phenotypic responses to a single environmental factor can result from different genotypes within the population.

Action Verbs: Below are examples of action verbs associated with each level of the Revised Bloom's Taxonomy.

Remember	Understand	Apply	Analyze	Evaluate	Create
Choose	Classify	Choose	Categorize	Appraise	Combine
Describe	Defend	Dramatize	Classify	Judge	Compose
Define	Demonstrate	Explain	Compare	Criticize	Construct
Label	Distinguish	Generalize	Differentiate	Defend	Design
List	Explain	Judge	Distinguish	Compare	Develop
Locate	Express	Organize	Identify	Assess	Formulate
Match	Extend	Paint	Infer	Conclude	Hypothesize
Memorize	Give Examples	Prepare	Point out	Contrast	Invent
Name	Illustrate	Produce	Select	Critique	Make
Omit	Indicate	Select	Subdivide	Determine	Originate
Recite	Interrelate	Show	Survey	Grade	Organize
Select	Interpret	Sketch	Arrange	Justify	Plan
State	Infer	Solve	Breakdown	Measure	Produce
Count	Match	Use	Combine	Rank	Role Play
Draw	Paraphrase	Add	Detect	Rate	Drive
Outline	Represent	Calculate	Diagram	Support	Devise
Point	Restate	Change	Discriminate	Test	Generate
Quote	Rewrite	Classify	Illustrate		Integrate
Recall	Select	Complete	Outline		Prescribe
Recognize	Show	Compute	Point out		Propose
Repeat	Summarize	Discover	Separate		Reconstruct
Reproduce	Tell	Divide			Revise
	Translate	Examine			Rewrite
	Associate	Graph			Transform
	Compute	Interpolate			
	Convert	Manipulate			
	Discuss	Modify			
	Estimate	Operate			
	Extrapolate	Subtract			
	Generalize				
	Predict				



Suggested Activities & Best Practices

1. Students can construct simulated chromosomes with pop beads or pipe cleaners and manipulate them through the stages of meiosis. As students are modeling the process, they can make a sketch or take a photograph of each stage. They should begin with either a 2n = 4 or a 2n = 6 “cell” so that they can build their understanding using a simpler system before applying what they have learned to meiosis in humans.

2. Students use the projects they created in the instructional activity described above to explain how meiosis followed by fertilization increases genetic variation, whereas mitosis usually results in genetically identical daughter cells. Students should use the model to make predictions about the effect of genetic mutation on both processes.

3. Students can use genetic corn to apply the chi-square test to a dihybrid cross. First, students calculate the expected genotypic and phenotypic ratios using a Punnett square. They then formulate null hypotheses for the cross and perform a chi-square test. They conclude by stating whether they should reject or fail to reject the null hypothesis and justify their reasoning.

4. Students can read a case study about the genetics and evolution of skin color, then answer any questions that may accompany the case study. Alternately, teachers can provide appropriate questions and/or assignments to ensure that students understand the concepts addressed in the case study. Instead of answering the questions on paper, students can be divided into groups to debate possible answers to some or all of the questions. This activity can be augmented by having students read an article about the biology

of skin color.

5. Investigation activity using Wisconsin Fast Plants. “Who’s the Father?” is a quick but engaging way to review or to introduce Mendelian inheritance.

6. Students make predictions about expected phenotypic ratios in genetic crosses and then use the chi-square test to explain any deviations between the expected and observed ratios. Students should use provided data or experiments using Fast Plants (or Drosophila).

7. A Day in the Life. Students compose a short story, PowerPoint presentation, video, poem, song, or significant piece of art to describe a day in the life of a teenager afflicted with a single gene disorder or chromosomal abnormality. Students should include the science behind the disorder (i.e., causes and effects) and identify a social, medical, or ethical issues associated with human genetic disorders.

8. Students work in pairs to solve a daily genetics problem (e.g., monohybrid, dihybrid, test cross, co-dominance versus incomplete dominance, sex-linkage, crossing over, pedigrees). The first pair with a solution comes to the board and works the problem for peer review.

9. **AP Biology Investigation 7: Mitosis and Meiosis.** After exploring and modeling mitosis and meiosis, students conduct independent investigations to determine the effect(s) of biotic or abiotic factors on the rate of mitosis in plant roots.

Assessment Evidence - Checking for Understanding (CFU)

• Common Benchmarks (Benchmark)

• Unit tests- Unit 5 Personal Progress Check from AP Classroom (Summative)

• Quizzes-Meiosis vs Mitosis quiz, Mendelian Genetics quiz (Summative)

• Unit review/Test prep- Campbell and Reece chapter 13,14,15 study guides (Formative)

• Web-Based Assessments- google form quizzes (Summative)

• DBQ's (Formative)

• Written Reports- CER's for lab activities (Alternate)

• Surveys (Alternate)

- Admit Tickets

- Anticipation Guide
- Common Benchmarks
- Compare & Contrast
- Create a Multimedia Poster
- DBQ's
- Evaluation rubrics
- Exit Tickets- google form exit ticket
- Fist- to-Five or Thumb-Ometer
- Illustration
- Journals
- KWL Chart
- Learning Center Activities
- Newspaper Headline
- Outline
- Question Stems
- Quickwrite
- Quizzes-Meiosis vs Mitosis quiz, Mendelian Genetics quiz
- Red Light, Green Light
- Self- assessments
- Socratic Seminar
- Study Guide
- Surveys
- Teacher Observation Checklist
- Think, Pair, Share- large sticky posters
- Think, Write, Pair, Share
- Top 10 List
- Unit review/Test prep- Campbell and Reece chapter 13,14,15 study guides
- Unit tests- Unit 5 Personal Progress Check from AP Classroom
- Web-Based Assessments- google form quizzes
- Written Reports- CER's for lab activities

Primary Resources & Materials

- Campbell and Reece, AP Biology 11th Edition (2018)- Chapters 2,3,4,5

Ancillary Resources

- Pearson Education Test Prep Series for AP Biology (2017)
- AP Biology Investigative Labs- Investigation 7: Mitosis and Meiosis

- Campbell and Reece chapters 13,14,15 study guide worksheets
- Molecular model kits or alternative (e.g., foam balls and toothpicks)
- Foglia powerpoints and review guides (www.explorebiology.com)
- PHET Interactive Simulations

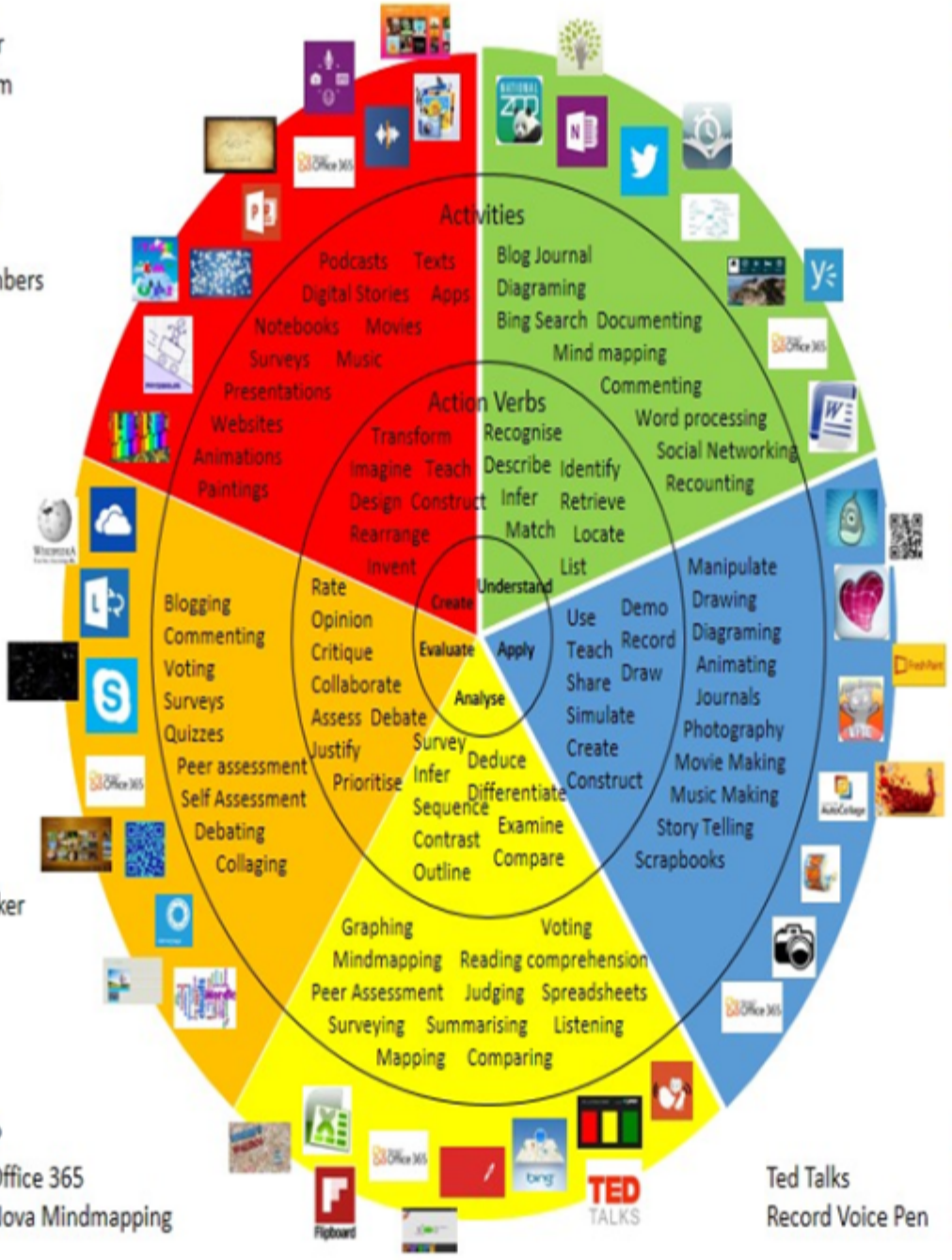
Technology Infusion

- Smart TV - (Meiosis, Mendelian Genetics, and Chromosomal Inheritance slideshow presentations)
- Chrome Books for Projects/ Research/ Analysis
- Youtube - Amoeba sisters videos, Mr. Anderson videos, Crash course videos
- Khan Academy videos and quizzes
- Microsoft Powerpoint
- Google Drive
- Prezi
- Ted Talks
- Ted- ED
- Microsoft Excel: graphs, charts, calculations, equations

Win 8.1 Apps/Tools Pedagogy Wheel

Podcasts
Photostory 3
Kid Story Builder
Music Maker Jam
Paint A Story
Office 365
MS PowerPoint
Stack 'Em Up
NqSquared Numbers
Physamajig
Xylophone 8

Wikipedia
Skydrive
Lync
SkyMap
Skype
Office 365
Puzzle Touch
Easy QR
Memorylage
Life Moments
Word Cloud Maker



Where's Waldo?
MS Excel Office 365
Flipboard Nova Mindmapping

Ted Talks
Record Voice Pen

Originally taken from http://www.coetail.com/vzimmer/files/2013/02/iPadagogy-Wheel.001.jpg
And adapted for Windows 8.1 devices by Charlotte Beckhurst @CharBeckhurst

Alignment to 21st Century Skills & Technology

CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP5	Consider the environmental, social and economic impacts of decisions.
CRP.K-12.CRP6	Demonstrate creativity and innovation.
CRP.K-12.CRP7	Employ valid and reliable research strategies.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP11	Use technology to enhance productivity.
CAEP.9.2.12.C.1	Review career goals and determine steps necessary for attainment.
CAEP.9.2.12.C.2	Modify Personalized Student Learning Plans to support declared career goals.
CAEP.9.2.12.C.3	Identify transferable career skills and design alternate career plans.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.1.12.C	Communication and Collaboration: Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.
TECH.8.1.12.D	Digital Citizenship: Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.
TECH.8.1.12.F	Critical thinking, problem solving, and decision making: Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.
TECH.8.2.12	Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.
TECH.8.2.12.E	Computational Thinking: Programming: Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.

21st Century Skills/Interdisciplinary Themes

- Communication and Collaboration
- Creativity and Innovation
- Critical thinking and Problem Solving
- ICT (Information, Communications and Technology) Literacy
- Information Literacy
- Life and Career Skills
- Media Literacy

21st Century Skills

- Civic Literacy
- Environmental Literacy
- Global Awareness
- Health Literacy

Differentiation

Differentiations:

- Small group instruction
- Small group assignments
- Extra time to complete assignments
- Pairing oral instruction with visuals
- Repeat directions
- Use manipulatives
- Center-based instruction
- Token economy
- Study guides
- Teacher reads assessments allowed
- Scheduled breaks
- Rephrase written directions
- Multisensory approaches
- Additional time
- Preview vocabulary
- Preview content & concepts
- Story guides
- Behavior management plan
- Highlight text
- Student(s) work with assigned partner
- Visual presentation
- Assistive technology
- Auditory presentations
- Large print edition
- Dictation to scribe
- Small group setting

Hi-Prep Differentiations:

- Alternative formative and summative assessments
- Choice boards
- Games and tournaments
- Group investigations
- Guided Reading
- Independent research and projects
- Interest groups
- Learning contracts
- Leveled rubrics
- Literature circles

- Multiple intelligence options
- Multiple texts
- Personal agendas
- Project-based learning
- Problem-based learning
- Stations/centers
- Think-Tac-Toes
- Tiered activities/assignments
- Tiered products
- Varying organizers for instructions

Lo-Prep Differentiations

- Choice of books or activities
- Cubing activities
- Exploration by interest
- Flexible grouping
- Goal setting with students
- Jigsaw
- Mini workshops to re-teach or extend skills
- Open-ended activities
- Think-Pair-Share
- Reading buddies
- Varied journal prompts
- Varied supplemental materials

Special Education Learning (IEP's & 504's)

- printed copy of board work/notes provided
- additional time for skill mastery
- assistive technology
- behavior management plan
- Center-Based Instruction
- check work frequently for understanding
- computer or electronic device utilizes
- extended time on tests/ quizzes
- have student repeat directions to check for understanding
- highlighted text visual presentation
- modified assignment format

- modified test content
- modified test format
- modified test length
- multi-sensory presentation
- multiple test sessions
- preferential seating
- preview of content, concepts, and vocabulary
- Provide modifications as dictated in the student's IEP/504 plan
- reduced/shortened reading assignments
- Reduced/shortened written assignments
- secure attention before giving instruction/directions
- shortened assignments
- student working with an assigned partner
- teacher initiated weekly assignment sheet
- Use open book, study guides, test prototypes

English Language Learning (ELL)

- teaching key aspects of a topic. Eliminate nonessential information
- using videos, illustrations, pictures, and drawings to explain or clarif
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning;
- allowing students to correct errors (looking for understanding)
- allowing the use of note cards or open-book during testing
- decreasing the amount of workpresented or required
- having peers take notes or providing a copy of the teacher's notes
- modifying tests to reflect selected objectives
- providing study guides
- reducing or omitting lengthy outside reading assignments
- reducing the number of answer choices on a multiple choice test
- tutoring by peers
- using computer word processing spell check and grammar check features
- using true/false, matching, or fill in the blank tests in lieu of essay tests

At Risk

- allowing students to correct errors (looking for understanding)
- teaching key aspects of a topic. Eliminate nonessential information

- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning
- allowing students to select from given choices
- collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test.
- decreasing the amount of workpresented or required
- marking students' correct and acceptable work, not the mistakes
- modifying tests to reflect selected objectives
- providing study guides
- tutoring by peers
- using authentic assessments with real-life problem-solving
- using videos, illustrations, pictures, and drawings to explain or clarify

Talented and Gifted Learning (T&G)

- Advanced problem-solving
- Allow students to work at a faster pace
- Cluster grouping
- Create a blog or social media page about their unit
- Create a plan to solve an issue presented in the class or in a text
- Debate issues with research to support arguments
- Flexible skill grouping within a class or across grade level for rigor
- Higher order, critical & creative thinking skills, and discovery
- Multi-disciplinary unit and/or project
- Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities
- Utilize exploratory connections to higher-grade concepts
- Utilize project-based learning for greater depth of knowledge

Sample Lesson

Unit Name: Unit 5: Heredity

NJSLS: Attached

Interdisciplinary Connection: Art (building models)

Statement of Objective: SWDAT construct an explanation, using visual models they have created, as to how DNA in chromosomes is transmitted to the next generation via mitosis, or meiosis followed by fertilization.

Anticipatory Set/Do Now: Mitosis vs. Meiosis video clip

Learning Activity: Students create a series of diagrams with annotations that compare, contrast, and analyze the

processes of mitosis and meiosis, focusing on the chromosome number of the resulting daughter cells.

Student Assessment/CFU's: Exit Ticket- Google form questions on the similarities and differences between mitosis and meiosis

Materials: Smart TV for anticipatory set, chromebooks for exit ticket, materials to build mitosis and meiosis models

21st Century Themes and Skills: Health and Environmental Literacy

Differentiation/Modifications: Visual Representation, extra time for task completion,

Integration of Technology: Smart TV for anticipatory set, google classroom for exit ticket

HS-LS1-4	Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
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.