Unit 7: Natural Selection (Life Science)

Content Area: **Science**
Course(s): **Biology AP**
Time Period: **FebMar**
Length: **20-23 days**
Status: **Published**

Title Section

Department of Curriculum and Instruction

Belleville Public Schools

Curriculum Guide

AP Biology

Unit 7: Natural Selection

Belleville Board of Education

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Board Approved: September 23, 2019

Unit Overview

The concepts in Unit 7 build on foundational content from previous units as students discover natural selection, a mechanism of evolution—the theory that populations that are better adapted to their environment will survive and reproduce. Thus, the evolution of a species involves a change in its genetic makeup over time. In this unit, students study the evidence for and mechanisms of evolutionary change. Students also learn what happens when a species does not adapt to a changing or volatile environment and about the Hardy-Weinberg equilibrium as a model for describing and predicting allele frequencies in nonevolving populations. Students will learn to calculate and draw conclusions about the evolution, or lack thereof, of a population from data related to allele frequencies.

Enduring Understanding

- **TOPIC 7.1 Introduction to Natural Selection-**Evolution is characterized by a change in the genetic makeup of a population over time and is supported by multiple lines of evidence.
- **TOPIC 7.2 Natural Selection-**Evolution is characterized by a change in the genetic makeup of a population over time and is supported by multiple lines of evidence.
- **TOPIC 7.3 Artificial Selection-**Evolution is characterized by a change in the genetic makeup of a population over time and is supported by multiple lines of evidence.
- **TOPIC 7.4 Population Genetics-**Evolution is characterized by a change in the genetic makeup of a population over time and is supported by multiple lines of evidence.
- **TOPIC 7.5 Hardy-Weinberg Equilibrium-**Evolution is characterized by a change in the genetic makeup of a population over time and is supported by multiple lines of evidence.
- **TOPIC 7.6 Evidence of Evolution-**Organisms are linked by lines of descent from common ancestry.
- **TOPIC 7.7 Common Ancestry-**Organisms are linked by lines of descent from common ancestry.

- **TOPIC 7.8 Continuing Evolution-**Life continues to evolve within a changing environment.
- **TOPIC 7.9 Phylogeny-**Life continues to evolve within a changing environment.
- **TOPIC 7.10 Speciation-**Life continues to evolve within a changing environment.
- **TOPIC 7.11 Extinction-**Life continues to evolve within a changing environment.
- **TOPIC 7.12 Variations in Populations-**Naturally occurring diversity among and between components within biological systems affects interactions with the environment.
- **TOPIC 7.13 Origin of Life on Earth-**Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

Essential Questions

- What conditions in a population make it more or less likely to evolve?
- How does species interaction encourage or slow changes in species?
- How does evolution by natural selection drive the diversity and unity of life?
- What scientific evidence from many disciplines, including mathematics, supports models about the origin of life on Earth and biological evolution?
- How can phylogenetic trees and cladograms be used to graphically model evolutionary history among species?

Exit Skills

By the end of AP Biology Unit 7, Natural Selection, the student should be able to:

- Describe the causes of natural selection.
- Explain how natural selection affects populations.
- Describe the importance of phenotypic variation in a population.
- Explain how humans can affect diversity within a population.
- Explain the relationship between changes in the environment and evolutionary changes in the population.
- Explain how random occurrences affect the genetic makeup of a population.
- Describe the role of random processes in the evolution of specific populations.
- Describe the change in the genetic makeup of a population over time.
- Describe the conditions under which allele and genotype frequencies will change in populations.
- Explain the impacts on the population if any of the conditions of Hardy-Weinberg are not met.
- Describe the types of data that provide evidence for evolution.
- Explain how morphological, biochemical, and geological data provide evidence that organisms have changed over time.
- Describe the fundamental molecular and cellular features shared across all domains of life, which provide evidence of

common ancestry.

- Describe structural and functional evidence on cellular and molecular levels that provides evidence for the common ancestry of all eukaryotes.
- Explain how evolution is an ongoing process in all living organisms.
- Describe the types of evidence that can be used to infer an evolutionary relationship.
- Explain how a phylogenetic tree and/or cladogram can be used to infer evolutionary relatedness.
- Describe the conditions under which new species may arise.
- Describe the rate of evolution and speciation under different ecological conditions.
- Explain the processes and mechanisms that drive speciation.
- Describe factors that lead to the extinction of a population.
- Explain how the risk of extinction is affected by changes in the environment.
- Explain species diversity in an ecosystem as a function of speciation and extinction rates.
- Explain how extinction can make new environments available for adaptive radiation.
- Explain how the genetic diversity of a species or population affects its ability to withstand environmental pressures.
- Describe the scientific evidence that provides support for models of the origin of life on Earth.

New Jersey Student Learning Standards (NJSLS-S)

NextGen Science Standards

HS-LS4-1	Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
HS-LS4-2	Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
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.
HS-LS4-4	Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
HS-LS4-5	Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
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-LS4-3.1.1	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-LS4-2.2.1	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-LS4-5.2.1	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-LS4-4.2.1	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-LS4-3.4.1	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-LS4-2.6.1	Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
9-12.HS-LS4-4.6.1	Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
9-12.HS-LS4-5.7.1	Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.
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-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.
9-12.HS-LS4-3.LS4.B.1	Natural selection occurs only if there is both
9-12.HS-LS4-2.LS4.B.1	Natural selection occurs only if there is both
9-12.HS-LS4-3.LS4.B.2	The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population.

9-12.HS-LS4-4.LS4.C.1	Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.
9-12.HS-LS4-3.LS4.C.1	Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.
9-12.HS-LS4-5.LS4.C.1	Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species.
9-12.HS-LS4-3.LS4.C.2	Adaptation also means that the distribution of traits in a population can change when conditions change.
9-12.HS-LS4-5.LS4.C.2	Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost.

Interdisciplinary Connections

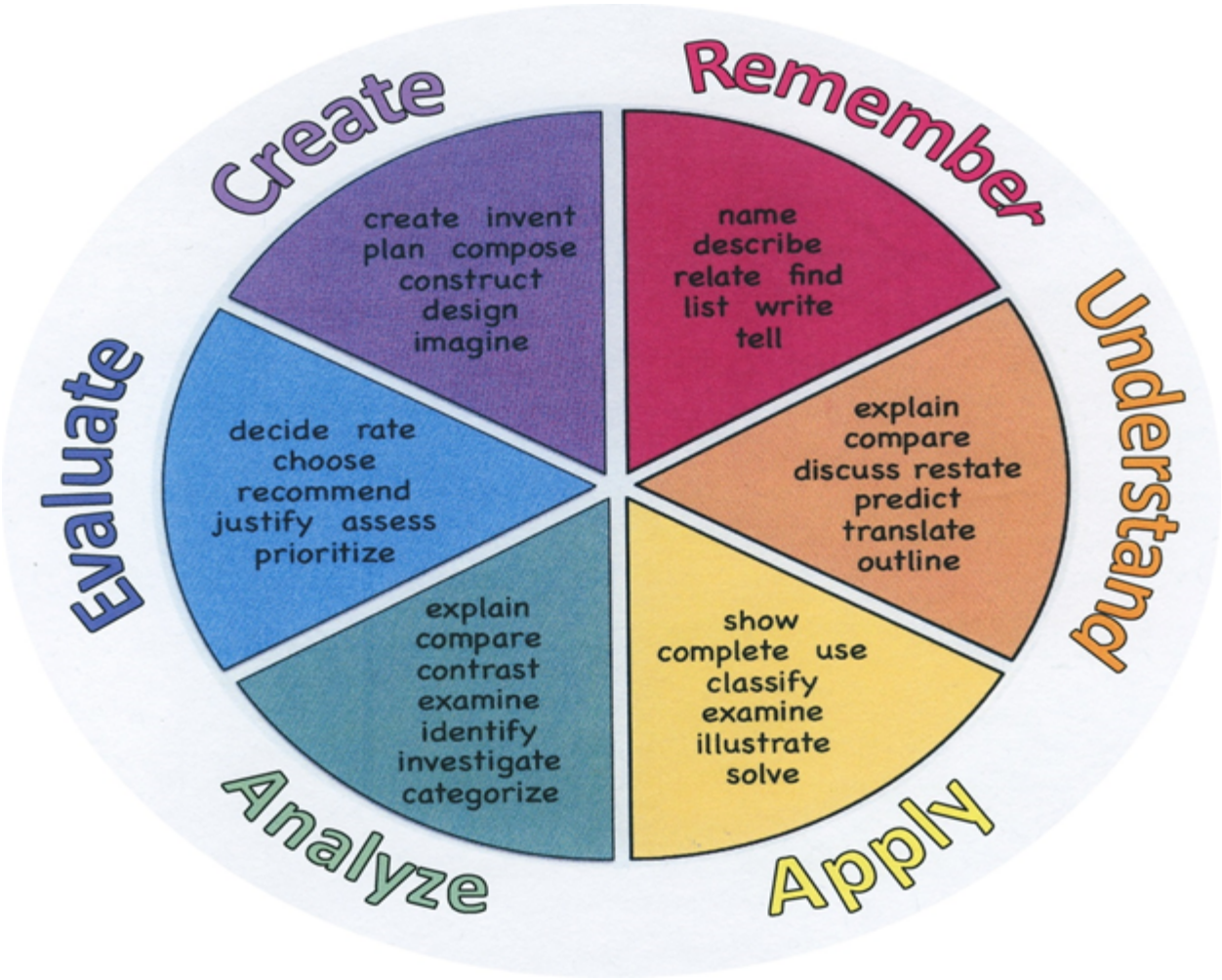
LA.RST.9-10.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
LA.RST.9-10.2	Determine the central ideas, themes, or conclusions of a text; trace the text's explanation or depiction 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 convert a data set from a table of numbers that reflect a change in the genetic makeup of a population over time and apply mathematical methods and conceptual understandings to investigate the cause(s) and effect(s) of this change.
- SWDAT evaluate evidence provided by data to qualitatively and quantitatively investigate the role of natural selection in evolution.
- SWDAT analyze data to support the claim that responses to information and communication of information affect natural selection.
- SWDAT apply mathematical methods to data from a real or simulated population to predict what will happen to the population in the future.
- SWDAT evaluate data-based evidence that describes evolutionary changes in the genetic makeup of a population over time.
- SWDAT connect evolutionary changes in a population over time to a change in the environment.
- SWDAT use data from mathematical models based on the Hardy-Weinberg equilibrium to analyze genetic drift and effects of selection in the evolution of specific populations.
- SWDAT justify data from mathematical models based on the Hardy-Weinberg equilibrium to analyze genetic drift and the effects of selection in the evolution of specific populations.
- SWDAT use theories and models to make scientific claims and/or predictions about the effects of variation within populations on survival and fitness.
- SWDAT make predictions about the effects of genetic drift, migration, and artificial selection on the genetic makeup of a population.
- SWDAT evaluate evidence provided by data from many scientific disciplines to support biological evolution.
- SWDAT refine evidence based on data from many scientific disciplines that support biological evolution.
- SWDAT design a plan to answer scientific questions regarding how organisms have changed over time using information from morphology, biochemistry, and geology.
- SWDAT connect scientific evidence from many scientific disciplines to support the modern concept of evolution.
- SWDAT construct and/or justify mathematical models, diagrams, or simulations that represent processes of biological evolution.
- SWDAT pose scientific questions about a group of organisms whose relatedness is described by a phylogenetic tree or cladogram in order to (1) identify shared characteristics, (2) make inferences about the evolutionary history of the group, and (3) identify character data that could extend or improve the phylogenetic tree.
- SWDAT construct explanations based on scientific evidence that homeostatic mechanisms reflect continuity due to common ancestry and/or divergence due to adaptation in different environments.
- SWDAT analyze data related to questions of speciation and extinction throughout the Earth’s history.
- SWDAT design a plan for collecting data to investigate the scientific claim that speciation and extinction have occurred throughout the Earth's history.
- SWDAT use data from a real or simulated population(s), based on graphs or models of types of selection, to predict what will happen to the population in the future.
- SWDAT justify the selection of data that addresses questions related to reproductive isolation and speciation.
- SWDAT describe speciation in an isolated population and connect it to change in gene frequency, change in environment, natural selection, and/or genetic drift.
- SWDAT describe a model that represents evolution within a population.
- SWDAT evaluate given data sets that illustrate evolution as an ongoing process.
- SWDAT describe a scientific hypothesis about the origin of life on Earth.
- SWDAT evaluate scientific questions based on hypotheses about the origin of life on Earth.
- SWDAT describe the reasons for revisions of scientific hypotheses about the origin of life on Earth.
- SWDAT evaluate scientific hypotheses about the origin of life on Earth.
- SWDAT evaluate the accuracy and legitimacy of data to answer scientific questions about the origin of life on Earth.
- SWDAT justify the selection of geological, physical, and chemical data that reveal early Earth conditions.

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 perform a brine shrimp lab, placing groups of brine shrimp eggs in petri dishes with various concentrations of salt in the water. They monitor the number of eggs and swimming shrimp in the petri dishes at regular time intervals over a period of two to three days. Students can calculate the hatching viability in each petri dish and then graph their data. Chi-square can be used to analyze the null hypothesis.

2. Students use one of the Rock Pocket Mouse activities available online to learn the principles of the Hardy-Weinberg theorem and to calculate allele frequencies in a population.

3. Ask the Expert: Show students a cartoon of an isolating mechanism that leads to speciation. Discuss with students what is happening in this cartoon and how it relates to speciation. Students should do research on other isolating mechanisms and draw their own cartoon to illustrate their learnings.

4. **AP Biology Investigation 2: Mathematical Modeling: Hardy-Weinberg:** Introduces students to application of the Hardy-Weinberg equation to study changes in allele frequencies in a population and to examine possible causes for these changes.

5. **AP Biology Investigation 1: Artificial Selection:** Using Wisconsin Fast Plants, students explore evolution by conducting an artificial selection investigation. Students then can apply principles to determine if extreme selection can change expression of a

quantitative trait.

6. Students read the two articles from Science about genetic variants/kidney disease/Trypanosoma. They then answer the following question either in writing or class discussion: How does the information apply to the study of population genetics and support the concept of continuing evolution by natural selection?

7. Provided with data from real or simulated populations, students apply the Hardy-Weinberg mathematical model to determine if selection is occurring. If it is determined that the populations are not in H-W equilibrium, students should describe possible reasons for the deviation.

8. Students work through the online PBS activity “Evolution and Time,” following the instructions to create a journal entry to evaluate and describe the geological ecosystem of a particular time period.

9. Using excerpts from The Beak of the Finch, students write a brief narrative explaining how evidence from many scientific disciplines supports the observations of Charles Darwin as well as Peter and Rosemary Grant regarding differences in beak sizes and, thus, supports evolution by natural selection. Then, in small groups, students share and discuss their explanations.

10. 'Caminalcules Phylogeny'- activity that introduces students to cladogram and phylogenetic tree construction. Provided with a group of organisms, students construct a phylogenetic tree or cladogram to reflect the evolutionary history of the group. Students then share the cladogram with peers for review and revision.

11. **AP Biology Investigation 3: Comparing DNA Sequences to Understand Evolutionary Relationships with BLAST:**. Students use BLAST to compare several genes from different organisms and then use the information to construct a cladogram to visualize evolutionary relatedness among species. This lab introduces students to methods of bioinformatics with many applications, including to better understand genetic disease.

12. Students conduct online research to identify examples of recent or ongoing speciation events and prepare a poster or PowerPoint slide(s) to share their speciation event with the class for discussion.

13. Back to the Birds. Students make predictions about what the data might reflect and what conclusions might be drawn about natural selection and evolution if researchers were to visit the Galapagos Islands today and reexamine beak sizes in finches.

14. Beginning with an extant, familiar species, students imagine its evolution to a new species and create a mini-poster showing their ideas. They should include at least five intermediate stages that reflect concepts of speciation explored in class. Students then share the posters with peers for review, discussion, and revision.

15. Provided with a list of terms, definitions, and descriptions of processes, students construct a concept map of conditions on the early Earth that support scientific hypotheses about the origin of life-forms.

Assessment Evidence - Checking for Understanding (CFU)

• Common Benchmarks (Benchmark)

• Unit tests- Unit 7 Personal Progress Check from AP Classroom (Summative)

• Quizzes-Hardy-Weinberg quiz, evidence of evolution quiz (Summative)

• Unit review/Test prep- Campbell and Reece chapter 22,23,24,25,26 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-Hardy-Weinberg quiz, evidence of evolution 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 22,23,24,25,26 study guides
- Unit tests- Unit 7 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 22,23,24,25,26

Ancillary Resources

- Pearson Education Test Prep Series for AP Biology (2017)
- AP Biology Investigative Labs- Investigation 1: Artificial Selection
- AP Biology Investigative Labs- Investigation 2: Mathematical Modeling: Hardy-Weinberg
- AP Biology Investigative Labs- Investigation 3: Comparing DNA Sequences to Understand Evolutionary Relationships with BLAST
- Campbell and Reece chapters 22,23,24,25,26 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

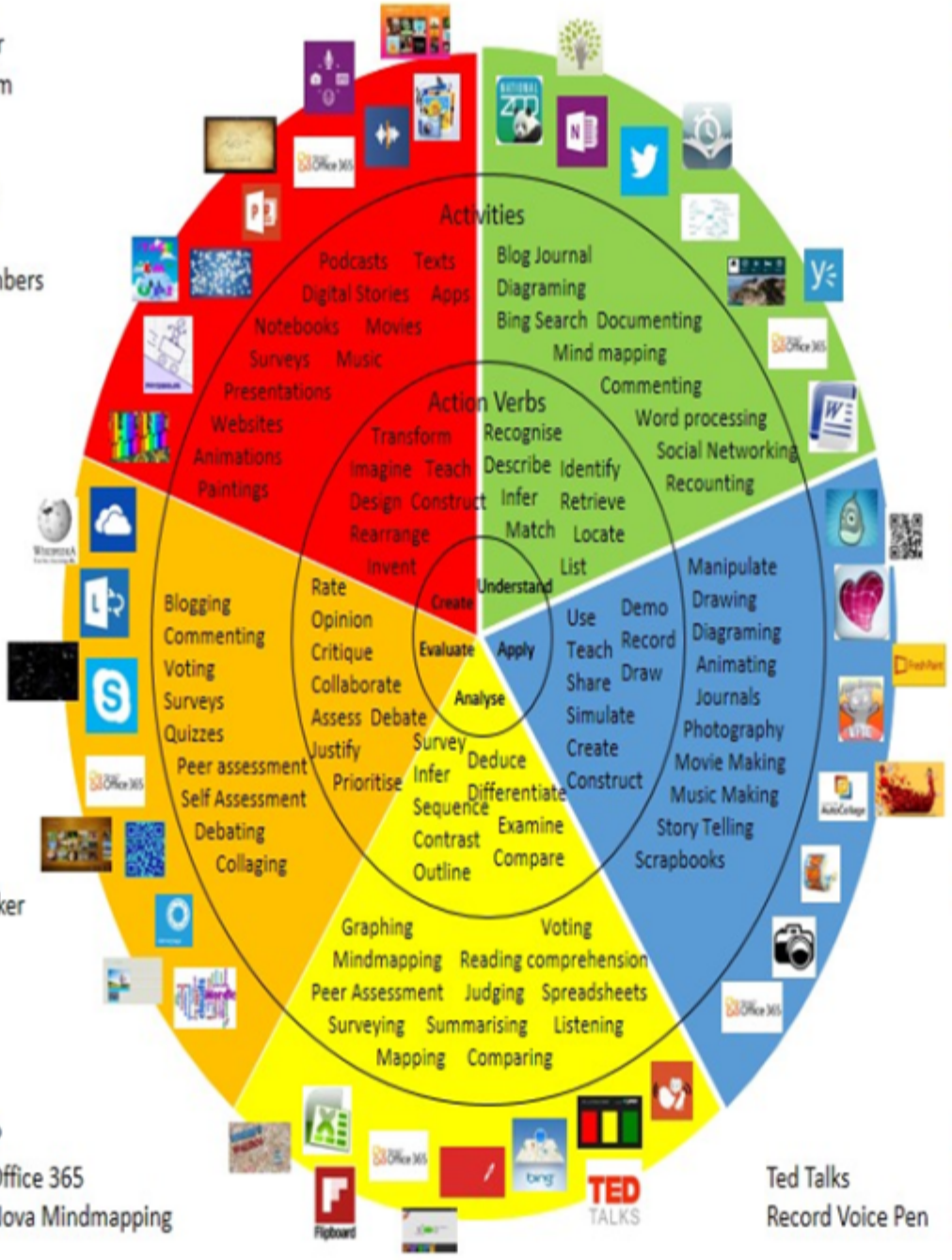
Technology Infusion

- Smart TV - (Natural/Artificial selection, Phylogeny, Evidence of Evolution, Origin of Life on Earth 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.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 7: Natural Selection

NJSLS: Attached

Interdisciplinary Connection: Art (building models)

Statement of Objective: SWDAT construct a model that represents processes of biological evolution.

Anticipatory Set/Do Now: Phylogeny introduction on SmartTV- Students will be given a small number of organisms and asked to organize them based on evolutionary relatedness. Discuss and review what methods students used to put organisms into certain categories.

Learning Activity: 'Caminalcules Phylogeny'- activity that introduces students to cladogram and phylogenetic tree construction. Provided with a group of organisms, students construct a phylogenetic tree or cladogram to reflect the

evolutionary history of the group. Students then share the cladogram with peers for review and revision.

Student Assessment/CFU's: Exit Ticket- Google form analyis questions on phylogenetic tree activity

Materials: Smart TV for anticipatory set, chromebooks for exit ticket, poster board, "caminicule" organisms

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-LS4-1	Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
HS-LS4-4	Construct an explanation based on evidence for how natural selection leads to adaptation of populations.