Raising Chickens, Changing Lives: A STEM PBL

Developer's Note of Introduction

Dear Educator,

Raising Chickens, Changing Lives: A STEM PBL was designed to provide you with the background knowledge, lessons, and curriculum needed to teach life science through the implementation of an urban chicken farm at your school site. Each lesson has been designed to be grade-level appropriate for high-school and has been correlated to the California Next Generation Science Standards and the California Common Core State Standards. Additionally, lessons and activities were designed with the 21st Century student outcomes in mind.

Students have a natural sense of curiosity about living things in the world around them. By hatching and raising chickens students can develop an understanding of biology through direct experience with living things, their life cycles and their habitats.

An additional goal of this STEM PBL is to help students develop life skills. Life skills help an individual live a productive and satisfying life and have the power to create a better quality of life. Within this curriculum your students will have the opportunity to develop life skills related to creativity, collaboration, communication, critical thinking, information literacy, initiative, leadership, and the use of technology.

I hope that Raising Chickens, Changing Lives: A STEM PBL is an enjoyable experience for both you and your students as well as a beneficial unit in your life science curriculum. Here are a few quotes from my students: The best part of learning about chickens and embryos was…

“Building a home for them”

“How they breathe”

“Being able to witness it all as I was learning”

“Raising the chickens and learning about different types of chickens and their eggs”

“Seeing them hatch”

California State Standards Alignment

Next Generation Science Standards

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

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. (LS1.A and LS3.A)

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. (LS3.B)

HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Common Core: English Language Arts

RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS3-1),(HS-LS3-2)

RST.11-12.9: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-LS3-1)

SL.11-12.5: Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-4)

SL. 9-10, 11-12.6: Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.

WHST.9-12.1: Write arguments focused on discipline-specific content. (HS-LS3-2)

WS 11-12.6: Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

WS 11-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when

appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Common Core: Mathematics

MP.2: Reason abstractly and quantitatively. (HS-LS3-2),(HS-LS3-3)

MP.4: Model with mathematics. (They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas.) (HS-LS1-4)

21st Century Student Outcomes

Learning & Innovation Skills:

Creativity, Critical Thinking, Communication, Collaboration

Information Literacy:

Access and Evaluate Information, Use and Manage Information

Life & Career Skills:

Flexibility & Adaptability, Initiative & Self Direction, Social & Cross-Cultural Skills, Productivity & Accountability, Leadership & Responsibility

CTE Building & Construction Trades

2.0 Communications

2.1 Recognize the elements of communication using a sender–receiver model.
2.2 Identify barriers to accurate and appropriate communication.
2.3 Interpret verbal and nonverbal communications and respond appropriately.
2.4 Demonstrate elements of written and electronic communication such as accurate spelling, grammar, and format.
2.5 Communicate information and ideas effectively to multiple audiences using a variety of media and formats.

4.0 Technology

4.1 Use electronic reference materials to gather information and produce products and services.
4.2 Employ Web-based communications responsibly and effectively to explore complex systems and issues.
4.3 Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources.
4.4 Discern the quality and value of information collected using digital technologies, and recognize bias and intent of the associated sources.

5.0 Problem Solving and Critical Thinking

5.1 Identify and ask significant questions that clarify various points of view to solve problems.
5.4 Interpret information and draw conclusions, based on the best analysis, to make informed decisions.

PBL Design Overview

STEM PBL Design Overview

Title:	**Raising Chickens, Changing Lives**	**Est. Start Date:**	**Duration: 7-10 weeks of curriculum, ongoing PBL unit**
Teacher:	**Kathleen Dennis**	**Grade Level: 9-12**	
Content Focus:	**Life Science**	**Other subject areas to be included: Engineering, Mathematics, Technology**	
Overall Idea: Summary of the issue, challenge, investigation, scenario, or problem	**Students will study the structure and function of DNA, mitosis and the growth and development of multicellular organisms, and the inheritance of traits through urban chicken farming.** **This STEM PBL is an integrated study of life science, engineering, mathematics, and technology with a focus on presenting and student communication skills.**		
The Project: What will students design, build, and/or present at the end of the PBL to demonstrate their expertise and solution/answer to the Driving Question?	**An education assortment of fertile eggs was purchased for this PBL from: https://www.mypetchicken.com/catalog/Fertile-Hatching-Eggs/Hatching-Eggs-for-Education-p911.aspx** **Students will begin the PBL by studying DNA, mitosis, and what chickens need to survive. When the eggs arrive they will research the types of eggs received (because it's a surprise!) and begin incubation. Students will monitor the daily conditions in the incubator and begin designing a coop for the chickens. When a winning coop has been selected students will construct it and it will become the chickens new home when they are fully feathered. Students will continue to learn with this PBL as they now have a small chicken farm to maintain and eggs to collect!**		
Essential Questions:	**What is mitosis?** **How are traits passed from parents to offspring?**	**Driving Questions:**	**Is it possible to design a self-sustaining chicken farm in an urban, high crime and poverty ridden neighborhood?** **How can chickens help us to understand cell division, the role of DNA and inheritance?**

		T+A	E		T+A	E
21st Century Skills and MPS to be explicitly taught	**Creativity**	x		**Flexibility & Adaptability**		x
	Critical Thinking		x	**Initiative & Self Direction**		x
	Communication	x		**Social & Cross-Cultural Skills**		x

<table>
<tr><td rowspan="3">and assessed (T+A) or that will be encouraged (E) by Project work but not taught or assessed:</td><td>Collaboration</td><td></td><td>x</td><td>Productivity & Accountability</td><td></td><td>x</td></tr>
<tr><td>Access & Evaluate Information</td><td>x</td><td></td><td>Leadership & Responsibility</td><td></td><td>x</td></tr>
<tr><td>Use & Manage Information</td><td>x</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Presentation Audience</td></tr>
<tr><td rowspan="6">Culminating Products and Performances</td><td rowspan="3">Group:</td><td colspan="2" rowspan="3">Chicken coop, models, Google Slides presentation</td><td>Class</td><td colspan="2">x</td></tr>
<tr><td>School</td><td colspan="2"></td></tr>
<tr><td>Community</td><td colspan="2"></td></tr>
<tr><td rowspan="3">Individual:</td><td colspan="2" rowspan="3">Incubation journals and graphs</td><td>Experts</td><td colspan="2">x</td></tr>
<tr><td>Web</td><td colspan="2"></td></tr>
<tr><td colspan="3">Other:</td></tr>
<tr><td colspan="7">Project Overview</td></tr>
<tr><td>Entry event to launch inquiry, engage students:

Outline or Conceptual Flow
Include assessment points and clearly identify opportunity(s) for students to inquire, research, and share their new knowledge with their peers.</td><td colspan="6">What comes first, the chicken or the egg? Without any access to technology students will work in small groups to make a claim with evidence and present their claim to the class. There are many theorized answers to this ancient question, but here is one that is widely accepted:

Explanation Video: https://www.youtube.com/watch?v=1a8pI65emDE

1. Students should know the structure and function of DNA.
a. All cells contain genetic information in the form of DNA molecules.
i. DNA is located in the nucleus of cells
ii. DNA is a double helix formed by base pairs attached to a sugar-phosphate backbone.
iii. DNA can replicate itself.
iv. DNA can be altered, genetically modified organisms
b. Genes are regions in the DNA that contain the instructions that code for the formation of proteins.
i. A gene is the basic physical and functional unit of heredity.
ii. Every person has two copies of each gene, one inherited from each parent.
iii. The entire human genome has been mapped by the Human Genome Project.</td></tr>
</table>

	2. Students should know how organisms grow and develop. **a.** In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. i. The major purpose of mitosis is for growth and to replace worn out cells. ii. There are 5 phases of mitosis, interphase, prophase, metaphase, anaphase, telophase. **b.** The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. i. Chromosomes are not visible in the cell's nucleus—not even under a microscope—when the cell is not dividing. ii. Each chromosome has a constriction point called the centromere, which divides the chromosome into two sections, or "arms." iii. Each chromosome is comprised of two chromatids after interphase. **c.** Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. **3. Students should know how traits are inherited.** a. Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. i. In humans, each cell normally contains 23 pairs of chromosomes, for a total of 46. b. The instructions for forming species' characteristics are carried in DNA. i. The genotype of an individual influences their phenotype ii. Mendelian Inheritance iii. Punnet squares can be used to predict an organism's genotype and phenotype. iv. Alleles are forms of the same gene with small differences in their sequence of DNA bases. These small differences contribute to each person's unique physical features. v. Genetic diseases may be inherited. c. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. i. Homeobox genes produce basic body parts in all animals. ii. Genes respond to environmental factors. iii. Some consequences of gene regulation are cancer, disease, aging, and obesity.

<table>
<tr><td></td><td colspan="5">d. 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.
i. 98% of DNA is Noncoding DNA</td></tr>
<tr><td rowspan="10">Assessments</td><td rowspan="5">Formative Assessments
(During Project)</td><td>Quizzes/Tests</td><td>x</td><td></td><td></td></tr>
<tr><td>Journaling/Learning Log</td><td></td><td></td><td></td></tr>
<tr><td>Preliminary Plans/Outlines</td><td>x</td><td></td><td></td></tr>
<tr><td>Rough Drafts</td><td></td><td></td><td></td></tr>
<tr><td>Other</td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">Summative Assessments
(End of Project, identify content areas to be covered)

NOTE: The end of PBL Summative Assessments do NOT replace The Project.</td><td>Written Product(s), with rubric</td><td></td><td>Other Products: Chicken Coop</td><td>x</td></tr>
<tr><td>Oral Presentation, with rubric</td><td>x</td><td>Peer Evaluation</td><td>x</td></tr>
<tr><td>Multiple Choice/Short Answer Test</td><td>x</td><td>Self-Evaluation</td><td></td></tr>
<tr><td>Essay Test</td><td></td><td>Other</td><td></td></tr>
<tr><td colspan="5"></td></tr>
<tr><td rowspan="4">Resources Needed</td><td colspan="2">On-site people, facilities</td><td colspan="2">Science teacher, construction teacher or teacher with constructions skills and time to implement</td></tr>
<tr><td colspan="2">Equipment</td><td colspan="2">Construction tools (saw, hammer, drills, etc.)</td></tr>
<tr><td colspan="2">Materials</td><td colspan="2">Wood, chicken wire, screws, various building materials for model coops, incubator, fertile chicken eggs, chicken food, wood shavings, 1:1 devices, Internet, paper, pencils, various art materials. Various materials and art supplies are needed during the 7 weeks of instruction, be sure to review the lesson ahead of time (especially for activities) to make sure you have all needed materials</td></tr>
<tr><td colspan="2">Community resources</td><td colspan="2">Master gardener, feed store, chicken farmer</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td></td><td></td><td>Journal/Learning Log</td><td>x</td><td>Focus Group</td><td></td></tr>
</table>

Reflection Methods	(Individual, Group, and/or Whole Class)	Whole-class Discussion	x	Fishbowl Discussion	
		Survey	x	Other: Inside /Outside Circle	x

Project Teaching and Learning Guide	
Knowledge and Skills Needed by Students (to successfully complete culminating projects and to do well on summative assessments)	
Student needs to be able to: **Clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristics traits passed from parents to offspring.**	**Student needs to be able to:** **Illustrate the role of cellular division and differentiation in producing and maintaining complex organisms.**
Student needs to be able to: **Provide evidence that inheritable genetic variations may result from: new genetic combinations through meiosis, viable errors occurring during replication, and/or mutations caused by environmental factors.**	**Student needs to be able to:** **Describe the necessary requirements for a successful egg incubation and the requirements for raising chickens.**
Student needs to be able to: **Design and build a chicken coop by breaking the problem down into smaller, more manageable engineering problems.**	**Student needs to be able to:**

Weekly Lesson Plans

*Please note that it is very difficult to have set weekly lesson plans in project based learning as learning takes it's own course. Problems may arise or you may find that you want or need to spend more or less time on a topic. Please use the lesson guide below as a template that you modify to the needs of your students and school site. Refer to Appendix A for the URL to access the direct links to the videos, activities, Google forms, and Kahoot Quizzes included in the lesson plans.

Below are the lesson plans needed to teach the specified Next Generation Science Standards and lessons specific to the incubation, hatching, and raising of the chickens are not included. However, many embryology resources and links to already developed curriculum are included on page 36 of this document. That along with Pinterest and a couple books from your local library should be more than enough!

*All lessons were designed to fit a 45 minute class period with a daily warm-up activity of the teachers choosing. Daily warm-up could assess prior knowledge of the intended objective, check for understanding, review of previously taught content, and/or be just for fun, such as a puzzle or riddle.

****WHEN USING GOOGLE TEMPLATES PLEASE MAKE A COPY FIRST!! This will create a working copy for yourself that you may then edit without affecting the original documents. Thank you!**

<table>
<tr><td>Week 1-3</td><td>DNA, genes, and chromosomes (Structure and Function of DNA & Inheritance of Traits)
Standard (DCI's)- 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. (LS1.A, LS3.A)

<table><tr><td>Day 1</td><td>Objective: What is DNA?
Lesson: Have students fill out form worksheet while going through the Khan Academy video. Encourage students to pause and discuss with each other.

Resources:
Khan Academy Video:
https://www.khanacademy.org/science/biology/dna-as-the-genetic-material/structure-of-dna/v/dna-deoxyribonucleic-acid

Google Form Worksheet:
https://docs.google.com/forms/d/1opY6TqEXODF6h1i-</td></tr></table></td></tr>
</table>

	Q8txgJiN6SQFHkC-NcgW8T4_1_Q/edit?usp=sharing
Day 2	**Objective: What is complementary base pairing?** **Lesson: Students are given a single strand of DNA from a living organism of their choice and must follow complementary base pairing rules to complete a double stranded bracelet.** **Resources:** Activity: Build a DNA bracelet: http://www.yourgenome.org/activities/sequence-bracelets
Day 3	**Objective: Where is DNA located?** **Lesson: Go through Journey Into DNA Flash media show with students and have them complete the Google form worksheet. After completing the worksheet have students use microscopes to look at various cells. Good examples would be human blood smear, human spermatozoa, human muscle, and human cerebrum. Be sure to have students locate the nucleus of the cell, note differences between the tissues, and point out that the red blood cell does not contain a nucleus.** **Resources:** Journey into DNA video, essay, and questions: http://www.pbslearningmedia.org/resource/tdc02.sci.life.gen.journeydna/journey-into-dna/ Google Form Worksheet: https://docs.google.com/forms/d/1F5s7iX_2ZWrbAB_0id3jF-S54j-3xSu0qCTJ6EdtTh8/edit?usp=sharing
Day 4	**Objective: Create an analogy for DNA** **Lesson: Review with students what the human genome is, have a short group discussion and then have students work individually to create a class slideshow of different analogies for DNA.** **Resources:** Human Genome definition and facts: **http://www.yourgenome.org/facts/what-is-a-genome** Group discussion: Scientists have likened the human genome to a parts list. Explain what they mean. Come up with your own analogy for DNA. DNA Analogy Slides Template: https://docs.google.com/presentation/d/1ExW9rLLJ0OgmY-

	NOQbLKEEbDJ6Cs_-aCt-XnxPp_1sA/edit?usp=sharing
Day 5	**Objective: What is the Human Genome Project?** **Lesson: Introduce the Human Genome Project with a short video and discussion questions, then have students explore the DNA sequencing process in the Flash media web activity. Have students record their discussion answers on the Google Form worksheet.** **Resources:** Human Genome video: https://www.pbslearningmedia.org/resource/tdc02.sci.life.gen.hgp/human-genome-project/#.WVq-DdUrLrc Sequence for Yourself Web Activity: https://www.pbslearningmedia.org/resource/tdc02.sci.life.gen.sequence/sequence-for-yourself/#.WV7FYtUrLrc Google Form Worksheet: https://docs.google.com/forms/d/1RQUnmolCjFop6BkNJ_RCtqrteyYkWuFWiEH419SKySM/edit?usp=sharing
Day 6	**Objective: How is DNA put together?** **Lesson: Let students review the structure and function of DNA in this fun edible activity where students build a candy model of a strand of DNA. Afterwards students CFU with an interactive challenge to build 3 unique strands of DNA and match them to their owners based on the given information.** **Resources:** Activity: Modeling DNA's structure with candy: http://www.pbslearningmedia.org/resource/tdc02.sci.life.repro.lp_dnastructure/modeling-dna-structure/ DNA schematics: http://www.apsnet.org/edcenter/K-12/TeachersGuide/PlantBiotechnology/Article%20Images/fig02.jpg http://rapguidetoevolution.co.uk/wp-content/uploads/2011/05/DNA-FINAL.png Building DNA Game: https://www.nobelprize.org/educational/medicine/dna_double_helix/dnahelix.html
Day 7	**Objective: Formative Assessment**

		Lesson: Kahoot! Quiz to CFU of Objectives: What is DNA?, What is complementary base pairing?, Where is DNA located?, and What is the Human Genome Project? **Resources:** Quiz Link: https://play.kahoot.it/#/k/0353b302-e6f7-4bf7-9496-61ecaf379ea0
	Day 8	**Objective: What are genes and chromosomes?** **Lesson: Have students review the information on genes and chromosomes and discuss what is a gene? What is a chromosome? Then have students work with a partner to explore chromosome pairs by making a karyotype and matching chromosomes. After letting students experience PTC paper and determine if they have the gene that allows them to taste have them calculate what percentage of the class is a "taster". On average 75% of people can taste and 25% cannot. Discuss the results with your class by making a graph.** **Resources:** Gene and chromosome information article: http://kidshealth.org/en/kids/what-is-gene.html Chromosome Karyotype Web Activity: http://learn.genetics.utah.edu/content/basics/karyotype/ PTC information and facts: http://learn.genetics.utah.edu/content/basics/ptc/
	Day 9	**Objective: What are master control genes?** **Lesson: Students take a deeper look at genes and their origins. Begin the lesson by posing a questions and giving students time to formulate an answer with evidence: If identical twins have the exact same DNA, then why are they not 100% exactly the same? After discussing have students watch the video on epigenetics. Then have students work with a partner to watch the two videos on gene control and homeobox genes and answer the comprehension questions on the Google Response Form.** **Resources:** What is epigenetics? video: https://www.youtube.com/watch?v=_aAhcNjmvhc&t=107s Gene Control video: http://www.pbslearningmedia.org/resource/tdc02.sci.life.cell.genecont

		rl/gene-control/ Homeobox gene video: http://www.pbslearningmedia.org/resource/tdc02.sci.life.gen.genetictoolkit/genetic-tool-kit/ Google Response Form: https://docs.google.com/forms/d/13vxqQl14q8LE7ZpwGIZr_nRcvJ95crK698vP8ZZbLSg/edit?usp=sharing
	Day 10	**Objective: What are Genetically Modified Organisms?** **Lesson: Split the class into 6 equal groups and assign each group one of the 3 What would you do scenarios from the GMO food information and facts webpage. Have them work together to decide what they would do and share with the class defending their stance with specific reasons. Then assign pairs of students to a GMO Animal and complete their slide in the class slideshow.** **Resources:** GMO food information and facts: http://learn.genetics.utah.edu/content/science/gmfoods/ Full Class GMO Animals Google Slides Presentation: 1. Enviropig 2. Web-Spinning Goats 3. Fast Growing Salmon 4. Less-Flatulent Cows 5. Sudden Death Mosquitos 6. Glittering Gold SeaHorses 7. Mostly Male Tilapia 8. Featherless Chicken 9. Glow-in-the-Dark Rabbit and Cat 10. Hypoallergenic Cat 11. Super Cows 12. Popeye Pigs Google Slides Template: https://docs.google.com/presentation/d/1I9j7-6GxCWVs3E10mFbnWTT9m_cR7AWMcieQTRKaWFc/edit?usp=sharing
	Day 11	**Objective: Should we create babies by design?** **Lesson: Have students work through whether they think in the future we should create designer babies. They will be presented with various pros and cons and asked the same question five**

		times. After going through the Flash web interactive students are asked write persuasively about their stance using the evidence provided. **Resources:** Lesson website: http://ca.pbslearningmedia.org/resource/tdc02.sci.life.gen.babiesbydesign/should-we-create-babies-by-design/ Flash web interactive poll: http://www.pbs.org/wgbh/evolution/humans/babies/ YouTube Video Tay Sachs: https://www.youtube.com/watch?v=RzEpkBU-ITA Worksheet: https://docs.google.com/document/d/1cqHqNZJsvISJX08Yo0zHnbc8KH-MGZsiywOzr9CPlu0/edit?usp=sharing
	Day 12	**Objective: What are traits and how are they inherited?** **Lesson: Pose an inheritance question to your students: How might it be possible for you to have red hair, but both your mom and dad have brown hair? After discussing, have students visit the three resources below, watch the videos, read the content, and fill out the Google Form Worksheet.** **Resources:** Inheritance basics: http://learn.genetics.utah.edu/content/basics/inheritance/ Ted Ed video on Mendel and Punnett squares: https://www.youtube.com/watch?v=Mehz7tCxjSE Monohybrid cross video: https://www.youtube.com/watch?v=i-0rSv6oxSY Google Form Worksheet: https://docs.google.com/forms/d/1GiqUKCxFr7oMWl0ONZ0VRUCXkq7r-YT24uWKz2153-M/edit?usp=sharing
	Day 13	**Objective: How do Punnett squares show probability of inheritance?** **Lesson: After learning the basics of inheritance let students explore making baby bunnies in this Punnett square game.**

<table>
<tr><td></td><td>
<table>
<tr><td></td><td>Resources:
Furry Family Web interactive Punnett square game:
http://vital.cs.ohiou.edu/steamwebsite/downloads/FurryFamily.swf

Optional extension STEM resource: interactive web activity to breed dragons 17 levels of heredity and breeding!:
https://concord.org/stem-resources/geniverse</td></tr>
<tr><td>Day 14</td><td>Objective: Extract real DNA from a strawberry!
Lesson: Follow the instructions to help students extract and isolate DNA from strawberries using simple, household ingredients.

Resources:
Activity: DNA extraction Lab:
https://www.stevespanglerscience.com/lab/experiments/strawberry-dna/

Alternate Online DNA extraction:
http://learn.genetics.utah.edu/content/labs/extraction/</td></tr>
<tr><td>Day 15</td><td>Objective: Formative Assessment
Lesson: Kahoot! Quiz to CFU of Objectives: What are genes and chromosomes?, What are Genetically Modified Organisms?, What are traits and how are they inherited?, and How do Punnett squares show probability of inheritance?

Resources:
Quiz Link:
https://play.kahoot.it/#/k/80edb370-9de4-489c-bed5-f46610823868</td></tr>
</table>
</td></tr>
<tr><td>English Extensions</td><td>Nature vs nurture persuasive writing
Pros/Cons and ethics of GMO’s
http://learn.genetics.utah.edu/content/science/pharming/</td></tr>
<tr><td>Week 4-5</td><td>Cell division: Mitosis (Growth and Development of Organisms)
Standard (DCI)- HS-LS1-4: Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. (LS1.B)

<table>
<tr><td>Day 1</td><td>Objective: What is mitosis?
Lesson: Introduce students to mitosis with the fun graphic</td></tr>
</table>
</td></tr>
</table>

		handout and let them work with a partner to study and color the images. Then have students watch the mitosis video and fill out the comprehension worksheet. **Resources:** Mitosis graphic handout: https://s-media-cache-ak0.pinimg.com/originals/9e/f0/82/9ef0824c0a0b09f4e4fcd23b1822104d.jpg Mitosis Video: https://www.youtube.com/watch?annotation_id=annotation_3739956411&feature=iv&src_vid=gwcwSZIfKlM&v=f-ldPgEfAHI Mitosis Worksheet: http://www.amoebasisters.com/uploads/2/1/9/0/21902384/video_recap_of_mitosis_by_amoeba_sisters.pdf
	Day 2	**Objective: Create a rubric for a stop-motion animation video of the process of mitosis.** **Lesson: Follow the tutorial to help students create a flat birds-eye view stop-motion animation of mitosis using WeVideo. Show students example videos and create a rubric together as a class using Rubistar. Let students ask questions about the project and let them decide what they should be graded on. Students may get creative and bring in their own supplies or you may choose to provide colored paper, dried beans, markers, string, foil, playdough, etc.** **Resources:** Tutorial: http://www.techmantraining.com/wevideo.html Example Videos: http://www.teachertube.com/video/mitosis-stop-motion-video-243544 https://www.youtube.com/results?search_query=mitosis+stop+motion+animation Rubistar Website: http://rubistar.4teachers.org/index.php WeVideo Website: https://www.wevideo.com/
	Day 3	**Objective: Create a stop-motion animation video of the process of mitosis.** **Lesson: Pass out the stop-motion planning guide and storyboard**

		to students. Have them brainstorm ideas before getting students into partners or groups to begin planning their videos. Then, introduce students to the importance of Storyboarding with the how to storyboard video. **Resources:** How to storyboard your animation video: https://www.youtube.com/watch?v=ji2nwkH2JRo Stop-Motion Planning Guide & Storyboard: https://docs.google.com/document/d/1vbFXOv9Iu0B0qFYesfNKdkGNlErH1QpeSKXQtU0BoCs/edit?usp=sharing Stop-motion planning guide and storyboard: https://docs.google.com/document/d/15AoxBpgN_URC07jCEPx3Sftn3BEe0Z0DvqDYJXjueC0/edit?usp=sharing WeVideo: https://www.wevideo.com/
	Day 4	**Objective: Create a stop-motion animation video of the process of mitosis.** **Lesson: Direct students to review the mitosis video from Day 1 and have them take the photos for Interphase and Prophase. Additional Khan Academy videos on interphase and mitosis have also been included for student review.** **Resources:** Day 1 mitosis video: https://www.youtube.com/watch?annotation_id=annotation_3739956411&feature=iv&src_vid=gwcwSZIfKlM&v=f-ldPgEfAHI Khan Academy Interphase video: https://www.khanacademy.org/test-prep/mcat/cells/cellular-division/v/interphase Khan Academy Mitosis video: https://www.khanacademy.org/test-prep/mcat/cells/cellular-division/v/mitosis WeVideo website: https://www.wevideo.com/
	Day 5	**Objective: Create a stop-motion animation video of the process of mitosis.**

		Lesson: Direct students to review the mitosis video from Day 1 and the Khan academy video and have them take the photos for Metaphase and Anaphase. **Resources:** Day 1 mitosis video: https://www.youtube.com/watch?annotation_id=annotation_3739956411&feature=iv&src_vid=gwcwSZIfKlM&v=f-ldPgEfAHI Khan Academy Mitosis video: https://www.khanacademy.org/test-prep/mcat/cells/cellular-division/v/mitosis WeVideo website: https://www.wevideo.com/
	Day 6	**Objective: Create a stop-motion animation video of the process of mitosis.** **Lesson: Direct students to review the mitosis video from Day 1 and the Khan Academy video, have them take the photos for Telophase and Cytokinesis and begin putting the clips together in WeVideo. Students will need to create accounts if they haven't already.** **Resources:** Day 1 mitosis video: https://www.youtube.com/watch?annotation_id=annotation_3739956411&feature=iv&src_vid=gwcwSZIfKlM&v=f-ldPgEfAHI Khan Academy Mitosis video: https://www.khanacademy.org/test-prep/mcat/cells/cellular-division/v/mitosis WeVideo website: https://www.wevideo.com/ WeVideo Academy tutorials: https://www.wevideo.com/academy
	Day 7	**Objective: Create a stop-motion animation video of the process of mitosis.** **Lesson: Have students put all clips in order, add music and transitions, and perform video edits.** **Resources:**

<table>
<tr><td></td><td>
<table>
<tr><td></td><td>WeVideo:
https://www.wevideo.com/

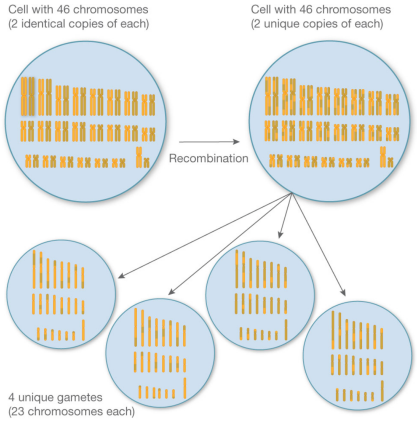
WeVideo Academy tutorials:
https://www.wevideo.com/academy</td></tr>
<tr><td>Day 8</td><td>Objective: Create a stop-motion animation video of the process of mitosis.
Lesson: Have students put all clips in order, add music and transition, and finish editing the video. Have students review the rubric they created.

Resources:
WeVideo:
https://www.wevideo.com/

WeVideo Academy tutorials:
https://www.wevideo.com/academy</td></tr>
<tr><td>Day 9</td><td>Objective: Formative Assessment
Lesson: Kahoot! Quiz to CFU of Objective: What is mitosis?

Resources:
Kahoot! Quiz on Mitosis:
https://play.kahoot.it/#/k/ad8bc977-bd59-4700-ab9c-05b5486670bb</td></tr>
<tr><td>Day 10</td><td>Objective: Give commendations and recommendations for peers work.
Lesson: Explain the difference between a commendation and a recommendation and the importance of both. Show student videos in class and have students complete commendation and recommendation form for each video.

Resources:
Commendation and Recommendation form:
https://docs.google.com/document/d/1Bam555bYfzEbLmlQMZdMGLUZ92vT3uNfNYLlZEaKy9Q/edit?usp=sharing</td></tr>
</table>
</td></tr>
<tr><td>Week 6</td><td>Cell division: Meiosis (Variation of Traits)
Standard (DCI)- 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. (LS3.B)</td></tr>
</table>

	Day 1	**Objective: What happens when I breed pigeons of different genotypes?** **Lesson: Breed pigeons for desired traits while learning the basic laws of inheritance. Choose pigeons with the right genotype, and breed them to yield offspring with a specified phenotype in 26 puzzles of increasing complexity.** **Resources:** Breeding Pigeons Game, Pigeonetics: http://learn.genetics.utah.edu/content/pigeons/pigeonetics/ Pigeonetics Teacher's Guide: http://teach.genetics.utah.edu/content/pigeons/PigeoneticsGameTeacherGuide.pdf
	Day 2	**Objective: What is Meiosis?** **Lesson: Introduce students to meiosis with the graphic handout and discuss to check for understanding. Then have students watch the meiosis video and fill out the comprehension worksheet.** **Resources:** Meiosis graphic handout: *Meiosis* When egg and sperm form, they go through a special type of cell division called meiosis. One purpose of meiosis is to reduce the number of chromosomes by half. The other is to create genetic diversity. Meiosis begins like mitosis: the cell copies each chromosome. But unlike in mitosis, homologous chromosome pairs line up and exchange pieces—a process called recombination. Remember, homologous chromosomes have the same genes but with slight differences. Recombination increases genetic diversity by putting pieces of chromosomes that came from mom together with pieces of chromosomes that came from dad. Next, the newly recombined homologous chromosomes are divided into two daughter cells. Then the sister chromatids are pulled apart into a total of four cells. Each of these cells has one copy each of 23 chromosomes, all with a unique combination of mom's and dad's genes.  Meiosis Video: https://www.youtube.com/watch?v=VzDMG7ke69g Meiosis Video Worksheet: http://www.amoebasisters.com/uploads/2/1/9/0/21902384/video_recap_of_meiosis_by_amoeba_sisters_final.pdf
	Day 3	**Objective: Create an analogy for mitosis and meiosis** **Lesson: Students will show that they understand the concepts of**

<table>
<tr><td></td><td>
<table>
<tr><td></td><td>mitosis and meiosis, as well as the difference between them by completing the interactive Google worksheet.

Resources:
Analogy for mitosis and meiosis worksheet:
https://docs.google.com/drawings/d/1Y8s_GNaO3eYVhEozyZTdRzanbFw2HgXqZM0HJx7gOvE/edit?usp=sharing</td></tr>
<tr><td>Day 4</td><td>Objective: How does sunscreen work?
Lesson: Follow the 2 day lesson plans provided to carry out this hands-on experiment investigating how sunscreen works. Use the resources for more learning at the end for background knowledge.

Resources:
Does Sunscreen Protect my DNA Lab:
http://teach.genetics.utah.edu/content/dna/sunscreenstudent.pdf</td></tr>
<tr><td>Day 5</td><td>Objective: How does sunscreen work?
Lesson: Follow the 2 day lesson plans provided to carry out this hands-on experiment investigating how sunscreen works.

Resources:
Does Sunscreen Protect my DNA Lab:
http://teach.genetics.utah.edu/content/dna/sunscreenstudent.pdf</td></tr>
</table>
</td></tr>
<tr><td>Week 7</td><td>Mutation (Variation of Traits)
Standard (DCI)- 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. (LS3.B)

<table>
<tr><td>Day 1</td><td>Objective: What is Mutation?
Lesson: Watch the video as a class, jigsaw the 5 literature sections to small groups of students, and have students create posters to present their section to the class.

Resources:
http://learn.genetics.utah.edu/content/basics/mutation/</td></tr>
<tr><td>Day 2</td><td>Objective: What is mutation?
Lesson: Finish jigsaw assignment and present posters to classmates.</td></tr>
</table>
</td></tr>
</table>

		Resources: http://learn.genetics.utah.edu/content/basics/mutation/
	Day 3	**Objective: What are some possible outcomes of mutation?** **Lesson: Have students research some of the possible outcomes of DNA mutation with the resources below.** **Resources:** http://learn.genetics.utah.edu/content/basics/outcomes/ Cancer http://ed.ted.com/lessons/how-do-cancer-cells-behave-differently-from-healthy-ones-george-zaidan
	Day 4	**Objective: Create an educational genetic disorder brochure** **Lesson: Introduce genetic disorder brochure project, create a project rubric with students, and assign disorders.** **Resources:** http://mrscienceut.net/GeneticDisorderBrochureProject.pdf
	Day 5	**Objective: Create an educational genetic disorder brochure** **Lesson: Work on genetic disorder brochure and give commendations and recommendations to classmates.** **Resources:** Genetic Disorder Brochure: http://mrscienceut.net/GeneticDisorderBrochureProject.pdf

Project Curriculum Resources

Below are various academic content resources to help the teacher design and modify the curriculum to the needs of his/her students. The material below may also be helpful for the teacher to gain background information on a particular topic. Refer to Appendix A for the URL to access the direct links to these resources online.

Genetics Resources:

URL Hyperlink	Description
*https://ghr.nlm.nih.gov/primer	Basics of human genetics and the effects of genetic variation on human health

*http://learn.genetics.utah.edu/content/basics/	Everything you need to know about genetics basics and some activities for class
http://curriculumforexcellencescience.weebly.com/dna-and-inheritance.html	Videos and activities to supplement curriculum for teaching DNA and inheritance
https://www.khanacademy.org/science/biology	Khan Academy courses on cell division, classical and molecular genetics, DNA as the genetic material, Central Dogma (RNA to DNA to protein), gene regulation
http://ed.ted.com/search?utf8=✓&qs=dna	TedEd lessons on DNA
https://www.hhmi.org/biointeractive/genetics	100's of genetics resources including short films, animations, click & learn interactives, and classroom activities
http://ngss.nsta.org/classroom-resources-results.aspx?CoreIdea=5	Classroom resources from the National Science Teachers Association for 6-12 grade on heredity
https://www.exploratorium.edu/snacks/subject/genetics	Short activities "snacks" from the Exploratorium in San Francisco on genetics
https://www.exploratorium.edu/imaging-station/activities/classroom/genetic_crosses/ca_genetic_crosses.php	Punnet square classroom investigation with Drosophila Melanogaster, the fruit fly
https://www.pinterest.com/explore/mitosis/	Pinterest page for mitosis, lots of ideas and always being updated
https://www.nobelprize.org/educational/medicine/dna_double_helix/dnahelix.html	DNA complementary base pairing game for students
https://www.genome.gov/10000464/online-genetics-education-resources/	Huge compilation of online genetics education resources from the National Human Genome Research Institute
http://www.sumanasinc.com/webcontent/animations/biology.html	Animated tutorials with quizzes on various basic biology topics, including mitosis,

	meiosis, alleles, DNA, and genetic crosses
https://ca.pbslearningmedia.org/search/?q=&selected_facets=supplemental_curriculum_hierarchy_nodes%3A8380&selected_facets=grades_exact%3A6&selected_facets=grades_exact%3A7&selected_facets=grades_exact%3A8&selected_facets=grades_exact%3A9&selected_facets=grades_exact%3A10&selected_facets=grades_exact%3A11&selected_facets=grades_exact%3A12&selected_facets=	Lots of resources from PBS learning media for teaching genetics and heredity 6-12th grade
https://concord.org/	The Concord Consortium, tons of interactive STEM resources and they are FREE!

Embryology Resources:

URL Hyperlink	Description
https://poultry4hyouth.ces.ncsu.edu/embryology/	Tons of resources for teaching embryology including videos, how to guides, and links to curriculum
*http://edis.ifas.ufl.edu/pdffiles/4H/4H36800.pdf	An Intracurricular Guide to Chicken Embryology: 15 lessons and math integration
*http://www.sedgwick.k-state.edu/4-h-youth/documents/CHICK%20EMBRYOLOGY%20LESSON%20PLAN.pdf	Chick embryology curriculum for hatching eggs in the classroom
https://www.youtube.com/playlist?list=PL5V9GXQlS0_ussQHLwE08gPYYewEE7iSO	Youtube playlist of 12 videos on chick embryology
http://www.uspoultry.org/t_resources/index.cfm	Teacher resources from the US Poultry and Egg Association on poultry, eggs, agriculture, and food safety