Unit 5: Feed the World

Content Area: **Science**
Course(s):
Time Period: **Marking Period 2**
Length: **4 weeks**
Status: **Published**

Summary

This unit explores the challenge of feeding the world in the 21st century. Students will explore different farming practices, the boom in modern agriculture known as the green revolution, the impacts of modern industrial and animal farming, and learn about the advances and setbacks associated with modern pesticides. Students will model over fishing and explore the phenomena known as tragedy of the commons. Planning for the future, sustainability and problem solving are strong themes that run throughout the unit.

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CS.9-12.8.2.12.ETW.1	Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product.
CS.9-12.8.2.12.ETW.2	Synthesize and analyze data collected to monitor the effects of a technological product or system on the environment.
CS.9-12.8.2.12.ETW.3	Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation, and propose an innovative sustainable solution.
CS.9-12.8.2.12.ITH.3	Analyze the impact that globalization, social media, and access to open source technologies has had on innovation and on a society's economy, politics, and culture.
LA.RI.11-12.3	Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.
LA.RI.11-12.7	Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.
LA.RI.11-12.9	Analyze and reflect on (e.g., practical knowledge, historical/cultural context, and background knowledge) documents of historical and literary significance for their themes, purposes and rhetorical features, including primary source documents relevant to U.S. and/or global history.
LA.SL.11-12.1.D	Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.
LA.SL.11-12.4	Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.
MA.S-IC.A.1	Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
MA.S-IC.A.2	Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation.
MA.S-IC.B.3	Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
MA.S-IC.B.6	Evaluate reports based on data.

MA.S-ID.A.1	Represent data with plots on the real number line (dot plots, histograms, and box plots).
SCI.HS.ESS3.C	Human Impacts on Earth Systems
SCI.HS.ESS3.D	Global Climate Change
SCI.HS.ETS1.B	Developing Possible Solutions
SCI.HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity.
SCI.HS-ESS3-6	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity (i.e., climate change).
SCI.HS-LS4-6	Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
SCI.HS-LS2-5	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
SCI.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.
SCI.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.
SCI.HS-LS1-5	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).
TECH.9.4.12.IML.5	Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a, 7.1.AL.PRSNT.2).
TECH.9.4.12.IML.8	Evaluate media sources for point of view, bias, and motivations (e.g., NJSLSA.R6, 7.1.AL.IPRET.6).
	Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
	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.
	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.
	As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.
	Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
	All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere.

Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.

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.

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When evaluating solutions, it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.

Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.

As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.

The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells.

The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.

Systems of specialized cells within organisms help them perform the essential functions of life.

A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.

Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

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.

Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved.

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.

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, which carry out most of the work of cells.

Essential Questions and Enduring Understandings

Essential Questions:

In what ways has the development of agriculture impacted the direction and influence of human civilization and its impact on Earth?

What changing conditions have necessitated major agricultural changes throughout the course of human history?

How have modern agricultural techniques both helped and hindered the quality of life for the average human in different parts of the world?

How have human changes to the planet impacted our ability to provide sufficient food to our growing population?

ENduring Understandings:

Rapidly growing human population has only been possible through agricultural development.

We are quickly approaching the limits of our ability to grow enough food for our population, and modern techniques create local and global changes that will make food production even more difficult in the future.

Objectives

Students will be able to define key terms: agriculture, Green Revolution, polyculture, crop rotation,

shelterbelts, contour plowing, bioaccumulation, biomagnification, persistent pesticides, organophosphates, Pesticide Treadmill, DDT (dichlorodiphenyltrichloroethane), carabamates, monoculture, subsistence agriculture.

Students will know the difference between broad vs. narrow spectrum pesticides.

Students will know how traditional agricultural techniques create long term sustainability and maintain biodiversity.

Students will know Integrated Pest Management and sustainable farming practices. Explain the technology, fishing methods and techniques associated with commercial fishing.

Students will know the effects of DDT on organisms in each trophic level

Students will know that the world's oceans are not limitless and unless something is done, the collapse of the oceanic food chain is a reality for this generation.

Students will know the global issues that have resulted from the transition to modern agriculture during the Green Revolution.

Students will be skilled at identifying reasons why certain diets are produced more efficiently than others and why a crop-based diet is much more efficient than a meat-based one.

Students will be skilled at identifying the impacts of high-input, modern agricultural systems.

Students will be skilled at detailing the environmental issues associated with high input agriculture, monocultures, and the use of broad-spectrum pesticides.

Students will be skilled at identifying the impacts of high-input, modern agricultural systems.

Learning Plan

Complete homework assignments that include vocabulary and reading comprehension, research on different pesticides and their uses and effects, personal statements about opinions of issues discussed in class, and

journal entries.

Answer questions about farming agriculture and pesticides after watching a video that describes the modern agricultural revolution.

Demonstrate over-fishing in a tragedy of a commons activity involving M&M's with a case study on the collapse of the Georges Bank Fishery.

Research and create a comparative analysis of the major pesticide types and their varying impact on biodiversity: organophosphates, carbamates and chlorinated hydrocarbons

Read a chapter from Rachel Carson's Silent Spring and reflect on her accomplishments.

Participate in a Pesticide Treadmill Lab demonstrating the Evolution of the Super bug and answer discussion questions.

Create a PowerPoint/research report on an assigned topic related to pesticide use and magnification in food chains.

View PowerPoint presentation: Pesticides in the Environment – Bioaccumulation and Biomagnification.

Lab: The Pesticide Treadmill: The birth of the Superbug.

Food Resources Research Project: Choose any crop and research the processes and impacts of its production from seed to supermarket.

Assessment

Formative Assessments:

- Worksheets
- Do Nows
- Exit Tickets
- Class Discussions

Quizzes:

- Tradtional vs Modern Agricultural Techniques
- Pesticide Families and Biomagnification

Bench Marks:

Midterm and Final Exam

Alternative:

- Video worksheet: modern vs traditional agriculture techniques
- Pesticide Families Research Assignment
- Tragedy of the Commons fishing game and worksheet
- GM Crops Study Guide
- Pesticide Use/ Monocultures Discussion
- Agriculture and Pesticides Review
- Food resources research project

Summative:

Unit Tests:

- Agriculture, Pesticides and Overfishing

Materials

Raven & Berg Evnironment Textbooks (ISBN: 978-1-119-39341-2)

Guided note packets (teacher developed)

Technology (student & teacher laptops, SmartBoard)

PowerPoints

Workshets/notes

Youtube/Netflix

Silent Spring text

GM Crops Case Study and Articles for analysis

Tragedy of the Commons Game: goldfish snacks, straws, cups, plates, worksheet

Suggested Strategies for Modification

https://docs.google.com/spreadsheets/d/1P8BzKodtBsbWi4rQ0tunGWhZkCOg52IvbNO7yy-TFJI/edit?usp=sharing