

### NGSS Unit Plan

<b>Title of Unit</b>	Environmental Footprint	<b>Subject/Grade</b>	Biology 9th grade
<b>Curricular Theme(s)</b>	<i>Biology</i>	<b>Time Frame</b>	6 Weeks to One Quarter or Advisory
<b>Essential Questions to be Addressed</b>	Designing and Evaluating Solutions: <ul style="list-style-type: none"> <li>How can humans reduce their environmental footprints?</li> <li>How do the food choices we make impact the ecosystem?</li> </ul>		

### Background Information and Context

#### NGSS Performance Expectations:

- HS-LS2-7.** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- HS-LS1-5.** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
- HS-LS1-7.** Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. [conceptual understanding of inputs and outputs of cellular respiration and not the identification of specific processes in cellular respiration]
- HS-LS1-6 (optional).** Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
- HS-LS2-1.** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-2.** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- HS-ETS1-2.** Design solutions to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

#### Applicable Common Core Standards (CCSS ELA and CCSS Math)

*Items in italics are not prerequisite to the successful accomplishment of a given Performance Expectation but may be otherwise connected to it.*

#### ELA/Literacy

##### **HS-LS1-5:**

- 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-LS1-7:

- **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-LS2-1 and HS-LS2-2:

- **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.
- **WHST.9-12.2.** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

### HS-LS2-7:

- **RST.9-10.8.** Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
- **RST.11-12.7.** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- **RST.11-12.8.** Evaluate the hypothesis, data, analyses, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- **WHST.9-12.7.** 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.

### Mathematics

### HS-LS1-5 and HS-LS1-7:

- **MP.4.** Model with Mathematics.
- **HSF-IF.C.7.** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
- **HSF-BF.A.1.** Write a function that describes a relationship between two quantities.

### HS-LS2-1 and HS-LS2-2:

- **MP.2.** Reason abstractly and quantitatively.
- **MP.4.** Model with Mathematics.
- **HSN-Q.A.1.** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- **HSN-Q.A.2.** Define appropriate quantities for the purpose of descriptive modeling.
- **HSN-Q.A.3.** Choose a level of accuracy appropriate to the limitations on measurement when reporting quantities.

### HS-LS2-7:

- **MP.2.** Reason abstractly and quantitatively.

- *HSN-Q.A.2.* Define appropriate quantities for the purpose of descriptive modeling.
- *HSN-Q.A.3.* Choose a level of accuracy appropriate to the limitations on measurement when reporting quantities.

### HS-ETS1-2:

- **MP.4.** Model with Mathematics.

### Optional: *HS-LS1-6:*

- **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.
- **WHST.9-12.2.** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
- **WHST.9-12.5.** Develop and strengthen writing as needed by planning, revising, editing, rewriting or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- **WHST.9-12.9.** Draw evidence from informational texts to support analysis, reflection, and research.

## Prior Understandings

- Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
- Plants acquire their materials for growth chiefly from air and water.
- Plants and some microorganisms use the energy from light to make sugars (food) from carbon dioxide in the atmosphere through the process of photosynthesis, which also releases oxygen.
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules to support growth or to release energy.

## Community Connections: Sustainability Initiative

Nature/Food connections: Design and evaluate a nutrition plan for an adult that supports a sustainable local food system.\*

- Community Health Centers <http://www.unityhealthcare.org/>
- Food and Friends <http://www.foodandfriends.org/site/pp.asp?c=ckLSI8NNIdJ2G&b=7565475>
- Latin American Youth Center <http://www.layc-dc.org/>
- Neighbors Consejo <http://www.neighborsconsejo.org/>
- Mary's Center <http://www.maryscenter.org/>
- Washington Youth Garden\* <http://www.washingtonyouthgarden.org/>
- Rocklands Farm\* <http://www.rocklandsfarmmd.com/education.html>

- Local grocery stores (Whole Foods, Giant, corner stores, etc.). Visit to compare food prices, variety and availability
- GIS mapping\*
  - <http://www.ers.usda.gov/data-products/food-access-research-atlas/go-to-the-atlas.aspx> (type washington DC)
  - DC Atlas Plus\* <http://atlasplus.dcgis.dc.gov/> (e.g. in: DGIS layers, select “business and economic development” then select “grocery store locations” or “farmers markets”)
- Partnerships with community colleges and universities
  - [http://www.udc.edu/college\\_of\\_urban\\_agriculture\\_and\\_environmental\\_studies/center\\_for\\_urban\\_agriculture\\_gardening\\_educat](http://www.udc.edu/college_of_urban_agriculture_and_environmental_studies/center_for_urban_agriculture_gardening_educat)
  - [http://www.udc.edu/college\\_urban\\_agriculture\\_and\\_environmental\\_studies/welcome](http://www.udc.edu/college_urban_agriculture_and_environmental_studies/welcome)
- Registered dietitians/nutritionists <http://www.eatright.org/About/Content.aspx?id=7531>
- Pennsylvania Association for Sustainable Agriculture <http://www.pasafarming.org/>
- Partnerships with middle schools

\* These sites were visited during the Environmental Literacy Summer Institute.

### Common Misconceptions

- Students may believe that only animals perform cellular respiration and plants only have photosynthesis.
- Photosynthesis is a process where CO<sub>2</sub> is changed into oxygen.
- Plants exhale oxygen.
- Plants also need nourishment to function.
- Plants obtain their nutrients, or “food,” from the soil instead of manufacturing organic compounds through photosynthesis. *(Please note/clarify: Minerals and N (in the form of NH<sub>3</sub>+) are obtained from the soil.)*

### Disciplinary Core Ideas: (Students will know...)

#### LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- 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.

#### LS4.D: Biodiversity and Humans

- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary to HS-LS2-7)*
- Humans depend on the living world for the resources and other benefits provide 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. (secondary to HS-LS2-7)

### LS1.C: Organization for Matter and Energy Flow in Organisms

- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.
- As matter and energy flow through different organizational level of living systems, chemical elements are recombined in different ways to form different products.
- 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.

### LS2.A: Interdependent Relationships in Ecosystems

- 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.
- 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.

### ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a arrange of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary to HS-LS2-7)

### ETS1.C: Optimizing the Design Solution

- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.

**LS1-6:** 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. As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.

*\*Reasoning: If students have examples of plants that create different molecules that are needed for human nutritional health, this can support arguments for why biodiversity is essential for life.\** e.g., <http://www.savvyvegetarian.com/articles/get-enough-protein-veg-diet.php>

### Science and Engineering Practices: (Students will...)

#### Developing and Using Models

- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5, HS-LS1-7)

#### Using Mathematics and Computational Thinking

- Use math and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)
- Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)

#### Scientific Knowledge Is Open to Revision in Light of New Evidence

- Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2)

#### Constructing Explanations and Designing Solutions

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7, HS-ETS1-2)
- Construct and revise 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. (HS-LS1-6)

### Crosscutting Concepts: (Students will connect...)

#### Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-7)

#### Energy and Matter

- 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. (HS-LS1-5, HS-LS1-6)
- Energy cannot be created or destroyed - it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7)

#### Scale, Proportion and Quality

- The significance of a phenomenon is dependent on the scale, proportion, and quantity

at which is occurs. (HS-LS2-1)

- Using the concept of orders of magnitude allows one to understand how a model at once scale relates to a model at another scale. (HS-LS2-2)

### Performance Task

#### Performance Task Description

*Note: The performance task should include elements from the three dimensions from the NGSS (both knowing and doing).*

**[INSERT DESCRIPTION]**

<b>Goal</b>	Design and evaluate a nutrition plan for a healthy adult that supports a sustainable local food system.
<b>Role</b>	Choices: A. Nutritionist for one of the following groups: Athletes, vegan, vegetarian, people with diabetes, cancer patients, people with high blood pressure and high cholesterol, people infected with HIV/AIDS, people with different income levels/food budgets, people who don't take time to exercise or cook, people living in a certain part of the world or with certain food preferences, people living in food deserts (community resource #9) B. Students advocating for sustainable nutrition plan for school lunches C. Community Educators/Health Advocates D. Nutrition/environmental consultants called in to advise on the menu at a local fast food restaurant to reduce the environmental footprint
<b>Audience</b>	Choices: A. Community health center, local organization needing nutrition expertise for a group of people with specific dietary needs and requirements B. Letter to the "Let's Move Campaign" (e.g., recommend additions to the Presidential Challenge to add a focus on sustainable food sources), Op-ed in the newspaper, School District level manager in charge of purchasing food for school lunches, PTA C. Students educate members of the community on how to eat in a way that reduces their environmental footprint. D. Students organize a campaign to McDonald's, Wendy's or another nearby fast food restaurant to persuade them to reduce their environmental impact (by changing their menu or where they obtain food sources to local/sustainable).
<b>Situation</b>	Will vary depending upon teacher/student choice of roles/audience (e.g. Create a nutritional plan based on a certain set of conditions that will help sustain the ecosystem.) The adult will be a/an:

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	<ul style="list-style-type: none"> <li>• Athlete</li> <li>• Vegetarian</li> <li>• Vegan</li> <li>• Diabetic</li> <li>• Cancer patient</li> <li>• HIV/AIDS patient</li> </ul>
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<b>Performance</b>	<p>This project has 4 separate components:</p> <ol style="list-style-type: none"> <li>A nutritional plan (individual/group/restaurant menus or plans that will be compiled into a class binder)</li> <li>A report explaining how the nutrition plan creates a sustainable world. Justification must include information about carrying capacity, biodiversity and the ecosystem and environmental impact of the nutritional plan. The report must also explain how products of photosynthesis (HS-LS1-6) create the major nutrients necessary for living and why biodiversity is important to meet the nutritional needs of humans. <i>[For example, through photosynthesis, the leaves of a tomato will create glucose and other sugars whereas the leaves of a bean plant will create glucose and another set of sugars. Humans need a variety (for biodiversity see HS-LS2-2) of plants in order to get well - balanced nutrition.]</i></li> <li>An educational presentation to the client, community organization, or restaurant. Acceptable products would include: a public service announcement (PSA), brochure/pamphlet, PowerPoint/Prezi, or poster/infographic</li> <li>Project Journal</li> </ol>
<b>Other Evidence</b>	<ul style="list-style-type: none"> <li>• Warm-Ups and Exit Tickets</li> <li>• Diagrams and/or models of photosynthesis and cellular respiration</li> <li>• Shorter written assignments, such as <i>Compare and Contrast</i></li> <li>• Lab reports</li> <li>• Quizzes</li> <li>• Mini-Presentations such as “Each One Teach One”</li> <li>• Peer feedback</li> </ul>

Grouping Strategies	Materials and Equipment Required
For the performance task (and depending on class size), students can work in groups of two, but no more than three.	<ul style="list-style-type: none"> <li>• Computer with Internet access</li> <li>• Access to a sample nutrition plan</li> <li>• Access to videos and resources regarding nutrition</li> <li>• Project journal</li> </ul>



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### Comments

Instructions for teachers:

- Review the **"Entry Document"** with students at the beginning of the unit.
- Have students create a list of information they need to know. Much of the list of "need to know" information will come from unknown vocabulary that has been intentionally embedded into the entry document.
- Discuss the Rubrics as well and connect each Rubric to its part of the Performance Task when timely.
- Students should revisit their "need to know" document as a task list to help them keep track of their progress through the unit.

### Extension Activities

- Health Advocacy: Students will host a health fair, inviting different members of the community to attend. Students will share their nutrition plans and educate individuals on the importance of healthy eating and biodiversity and ways to adjust eating habits to reduce their environmental footprint.
- Each One Teach One: Create a partnership between high school and middle school students for high school students to educate middle school students on biodiversity, environmental footprints and nutrition.

### Sample "Entry Document" for the Performance Task

In this sample entry letter, the student assumes the role of an expert on nutrition (dietician or nutritionist) and the audience is a local community health center, such as Unity Health Care. The students are being recruited by the health center to help create nutritional plans for a variety of clients who have specific dietary needs and challenges.

Other student/audience roles can be substituted (see Performance Task GRASP on page 7 for a list of options).

Dear *Nutritionist*,

We are writing to ask for your help and expertise in developing nutritional plans for several of our patients (your clients) who have specific dietary needs and challenges. We want them to make smart dietary choices based on their personal lifestyles. We also want these plans to be sustainable and assist our patients in reducing their environmental footprints.

Your client will have one of the following lifestyles: an active lifestyle (student athlete), special dietary requirements (vegan, vegetarian) or a health condition (cancer, diabetes, HIV/AIDS, high blood pressure, high cholesterol). To help you get started, we will provide you with some background information about the patients and their lifestyles. These client cards outline and describe the individual dietary needs of your client.

To be considered for this contract, we are requesting the following deliverables:

1. A nutritional plan for your clients that based on their particular demographic characteristics and lifestyle. The nutritional plan should have example meals for 1-3 days with a **brief** explanation on how each meal meets the nutrition and dietary guidelines of your client.
2. A written report in which you explain how your meal plan will help to sustain the ecosystem. You should focus on the environmental impact of your food choices. For example, what food choices should people make to reduce their carbon footprint, increase biodiversity, and restore ecosystem stability? Your report must include information about carrying capacity, biodiversity and impact on the ecosystem. We are also interested in understanding what foods are able to provide humans with essential amino acids and nutrients and how those plants/food sources are able to produce those nutrients starting with photosynthesis.
3. A formal presentation describing your client's situation, the menu that was developed and how the menu allows your client to reduce his/her environmental footprint. *Also, please be aware that your audience and client are not likely to be trained scientists or health professionals. Therefore, when you make your presentation, you must explain all science concepts in a way the community can understand.*
4. A project journal to provide evidence to back up the arguments you develop in your

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presentation, written report and nutritional menu/plan. This project journal should catalog your learning and the notes and resources used in your research.

We recommend you begin by reading the profile of your client. Also, keep in mind that our funders are connected to specific farms. Therefore, you must choose at least 3 items from the following list of foods/ingredients when constructing your menus: [*Teachers select food choices from Appendix B.*]

We look forward to reviewing and publishing your nutritional plans and to your presentations and suggestions on ways your client can adjust their diet to reduce their environmental footprint.

Sincerely,

*(GreenDC) Health Care*

Deadlines: *(GreenDC) Health Care* must receive:

- A preview (draft) of your nutritional plan by \_\_\_\_\_.
- Final nutritional plans are due on \_\_\_\_\_.
- The written report is due on \_\_\_\_\_.
- Presentations are scheduled for \_\_\_\_\_.

You may submit requests for additional \_\_\_\_\_.

### Performance Task Rubrics

**Key:** 4 = Exemplary      3 = Proficient      2 = Developing      1 = Novice

#### Nutritional Plan

**Student task:** Create a nutritional plan for your client that is based on his/her demographic characteristics and personal lifestyle.

<b>A.</b>	<b>Menu for 1-3 days</b>
4	Menu includes 1-3 days of meals with strong, thoughtful revisions based on classroom concepts
3	Menu includes 1-3 days of food with revisions based on classroom concepts
2	Menu is missing days and/or lacks revisions based on classroom concepts
1	Menu is missing substantial portions and does not includes revisions based on classroom concepts
<b>B.</b>	<b>Nutritional content for each food item</b>
4	Breakdown of nutritional content (calories, carbohydrates, protein, fat, other) is included for each food item
3	Breakdown of nutritional content (calories, carbohydrates, protein, fat, other) is included for most food items
2	Breakdown of nutritional content (calories, carbohydrates, protein, fat, other) is included for some food items
1	Breakdown of nutritional content (calories, carbohydrates, protein, fat, other) is not included for each food item
<b>C.</b>	<b>Statement about meeting nutritional needs of client</b>
4	Statement clearly and thoughtfully describes how menu meets the nutritional needs of client based on demographics and personal lifestyle
3	Statement describes how menu meets the nutritional needs of client based on demographics and personal lifestyle
2	Statement somewhat describes how menu meets the nutritional needs of client
1	Statement does not describe how menu meets the nutritional needs of client

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D.	Quality and accuracy of nutritional plan
4	Final nutritional plan is clear and easy to follow, visually appealing and accurate
3	Final nutritional plan is mostly easy to follow, visually appealing and accurate
2	Final nutritional plan is somewhat easy to follow, visually appealing and accurate
1	Final nutritional plan is confusing, visually unappealing and inaccurate

DRAFT



**Key:** 4 = Exemplary (A) 3 = Proficient (B) 2 = Developing (C) 1 = Novice (D/F)

### Written Report

**Student task:** Explain how your meal plan meets your client's needs while sustaining the ecosystem and reducing the environmental footprint.

A.	Photosynthesis, the production of molecules and nutrients and biodiversity
4	Complete, clear and accurate explanation of how plants provide a variety of molecules and nutrients through photosynthesis and the connection between biodiversity in an ecosystem and good nutrition.
3	Explanation of how plants provide a variety of molecules and nutrients through photosynthesis and the effects of biodiversity in a person's diet and on the ecosystem is mostly clear and accurate.
2	Explanation of how plants provide a variety of molecules and nutrients through photosynthesis and the effects of biodiversity in a person's diet and on the ecosystem is somewhat clear and accurate or incomplete.
1	No connection is made between photosynthesis, plants as food sources and the effects of biodiversity on diet or the ecosystem.
B.	Cellular respiration and energy transfer
4	Explanation of how organisms obtain energy from food includes nuance and complexity of any or all of the following: the 10% rule, the cyclical connection between photosynthesis and cellular respiration, and the ability of producers to do both photosynthesis and cellular respiration.
3	Explanation of how organisms obtain energy from food includes a complete description of how energy moves through an ecosystem at the macro level (from the sun to producers and consumers, etc) and an accurate description of energy transfer at the micro level (cellular respiration).
2	Explanation of how organisms get energy from food includes either cellular respiration or a description of how energy is transferred from the sun to other organisms in an ecosystem, but not both.
1	Statements made about how energy is transferred from the sun into plants and then into cells is incomplete or inaccurate.

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C.	Carrying capacity, biodiversity and environmental impact.
4	The menu is changed a way that creates a more sustainable ecosystem and reasoning behind the change are accurately explained, using carrying capacity, biodiversity and human activity.
3	The menu is changed a way that creates a more sustainable ecosystem and reasoning behind the change are mostly explained, using carrying capacity, biodiversity and human activity.
2	The menu is changed a way that creates a more sustainable ecosystem and reasoning behind the change are somewhat explained, using carrying capacity, biodiversity and human activity.
1	The menu is not changed in a way that creates a more sustainable ecosystem and reasoning behind the changes to the menu are missing.

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### Presentation

**Student task:** Give an oral presentation describing your client's situation, his/her nutritional needs, the meal plan you developed and how your menu effectively reduces your client's environmental footprint.

Criteria	1	2	3	4	Rating
<b>Content</b>	Most of the content is not meaningful, relevant or on topic	About 50% of the content is meaningful and relevant	Most of the presentation content is meaningful, relevant and on topic	All content is clearly related and on topic	
<b>Delivery</b>	Long pauses and grasping for words in almost every sentence	Pauses and grasping for words in about 50% of sentences	Occasional pauses and grasping for words	Delivery is smooth; No pauses or grasping for words	
<b>Grammar</b>	Errors in most sentences	Errors in about 50% of sentences	Occasional (1-3) errors	No errors	
<b>Eye Contact</b>	Looked away most of the time	Looked at the audience about 50% of the time	Looked at the audience most of the time	Looked continually at the audience	
<b>Professional</b>	Distracted by peers, laughing or unfocused during most of presentation	Distracted by peers, laughing or not focused about 50% of time	Occasionally (1-3 times) distracted, laughing or unfocused	Remained focused and poised throughout presentation	

### Project Journal

**Student task:** Keep a project journal to document your learning, notes and resources used in your research. Use the notes from this journal when creating your menu, writing your report and planning your presentation.

*Project Journals will be assessed for overall quality, completeness, accuracy, effort and communication of your thoughts and work in all lessons. Use your journal to ask unique questions, create illustrations to clarify key concepts, record observations, generate problem-solving descriptions, jot down ideas for projects or experiments, etc.*

Criteria	1	2	3	Rating
Quality of writing	Ideas lack organization or neatness; Uses little scientific vocabulary; Notes are incomplete	Ideas are somewhat organized and neat; Occasional use of scientific vocabulary; Notes are minimally complete	Ideas are organized, neat, thoughtful; Consistent use of scientific vocabulary; Detailed, descriptive, complete notes	
Labs and science concepts	Some steps of lab identified correctly; Explanations of science concepts are not accurate or clear	Most steps of labs are identified correctly; Mostly accurate explanations of science concepts	All steps of labs identified correctly; Accurate explanations of science concepts	
Diagrams & illustrations to communicate ideas	Not accurate or missing; Missing quite a few labels; Not neat or relevant	Mostly accurate but not complete; Some labels; Somewhat neat and relevant	Accurate and complete; All diagrams are labeled, neat and relevant	
Understanding of information	Explanations not accurate or missing key information; Questions not relative or showing much thought	Mostly accurate explanations; Questions relevant and applicable, but do not show much creativity	Accurate scientific explanations; Questions generated are unique, relevant and thoughtful	
Extended thinking	Few examples of creative, individual thinking; Did not meet the minimum requirements of project	Some creative examples of individual work and ideas; Met most of the requirements of project	Many examples of individual and creative thinking of information; Meets all requirements of project	

### Recommended Instructional Progression

We recommend teaching the content in this unit in the following order:

- Step 1: Entry Document and Rubrics
- Step 2: Photosynthesis and Macromolecules
- Step 3: Cellular Respiration and Energy Transfer
- Step 4: Carrying Capacity, Biodiversity, Environmental Impact

### Additional Resources

#### Appendix A: Client Cards

#### Appendix B: Recommended Food Options

##### Examples

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>• Salmon (overexploitation and pollution)</li> <li>• Avocados (drought, climate change, and habitat destruction)</li> <li>• Fruit, Nuts, Honey (disappearance of bees)</li> <li>• Alfalfa and indirectly-grazing organisms (disappearance of bees and pollinators)</li> <li>• Bananas (risk of fungus from monoculture)</li> <li>• Corn, Wheat in farms with poor farming practices (soil depletion)</li> <li>• Sugar Cane (import and transportation costs)</li> <li>• Beef and Pork price increase (diseases such as Pork virus, drought in California)</li> </ul> | <ul style="list-style-type: none"> <li>• Chicken (avian flu may be due to overpopulation enabling the spread of disease)</li> <li>• Quinoa (impact of a surge in US demand on farmers and farmland in other parts of the world)</li> <li>• Soy (illustrate the risk of monoculture vs. polyculture)</li> </ul> <p>NOTE: to include invasive species, you might suggest that students include bull frogs (an invasive species) on their menu to help rebuild an ecosystem.</p> |
|---|---|

#### Appendix C: Ideas for Field Trips or Classroom Visitors that Teach Students about Ecosystem Solutions (should coincide with Appendix C).

- Beekeeper
- Farmers markets/ Farmers
- Vegan bakeries/ Bakers
- Fishers
- Aquatic Recreation Education Center (AREC)
- Washington Youth Garden illustrates *Three Sisters* form of farming that uses beans (and their associated root bacteria) for nitrogen fixation and other strategies  
<http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1039&context=nebanthro>



- Note: There are four key nutrients that plants need to survive in addition to CO<sub>2</sub> and H<sub>2</sub>O (K, S, N, P) <http://soils.wisc.edu/facstaff/barak/soilscience326/listofel.htm>

### Appendix D: Resource for Calculations/Research

- Carbon footprint calculator to estimate land needed to produce certain foods, Energy calculator connected to 10% rule <http://www.nature.org/greenliving/carboncalculator/>
- Authentic data sets <http://faostat.fao.org/>
- Narratives on ecosystem impact <http://foodfirst.org/>, <http://www.iatp.org/>
- Complex look at sustainable diet <http://www.news.cornell.edu/stories/2007/10/diet-little-meat-more-efficient-many-vegetarian-diets>
- Other Resources
  - <http://nypost.com/2014/06/18/meat-poultry-and-fish-prices-spike-to-all-time-high/>
  - <http://www.pork.org/News/3904/NationalPorkBoardStatementOnPEDV.aspx>
  - <http://www.cdc.gov/flu/avian/>
  - <http://www.cnn.com/2013/10/23/health/meat-recall/>
  - <http://www.fda.gov/Food/default.htm>
- Teacher Resources:
  - <http://www.grain.org/>
  - [https://www.google.com/search?q=food+climate+research+network&sourceid=ie7&rls=com.microsoft:en-US:IE-SearchBox&ie=&oe=&gws\\_rd=ssl](https://www.google.com/search?q=food+climate+research+network&sourceid=ie7&rls=com.microsoft:en-US:IE-SearchBox&ie=&oe=&gws_rd=ssl)
  - <http://ase.tufts.edu/gdae/>

### Learning Plan/Instructional Sequence

## OVERVIEW

### Unit 3: Ecosystems

Part 1: Photosynthesis, Nutrition, & the Need for Biodiversity

Part 2: Cellular Respiration & Energy Transfer

Part 3: Ecosystem Usage, Stability & Human Impact

*\* NOTE: The majority of time should be spent on Part 3 of this unit.*

### Part 1 – Photosynthesis, Nutrition, and the Need for Biodiversity

**ENGAGE:** Lesson 1: Introduction to the Unit

### Narrative:

#### Lesson Objective & Rationale

This is a project-based unit of study that will take an entire quarter. On Day 1, introduce the culminating project **Entry Letter** and **Rubric**. The entry letter intentionally contains vocabulary students will not know. Students can use that vocabulary to create a list of information they “need to know,” which serves as an outline for the unit. This introductory lesson is also an opportunity to engage students wanting to study the core concepts in the unit, such as nutrition, land usage needed to sustain farming, and sustainability, among others.

**Objective:** Students will be able to explain that they will study where food comes from/originates (photosynthesis, cellular respiration, & energy transfer) in order to create a menu to show a specific audience how to change their diet in a way that helps to reduce human impact and create a more sustainable ecosystem.

#### Suggested Plan

This sample lesson engages students through a discussion of photos and video highlighting challenges with nutrition and the environment.

*Clarification of Teacher and Student Roles for this Sample Lesson:*

**Teacher’s Role:** Throughout the lesson, the teacher is facilitating a gallery walk, multiple discussions, and reading, as students work

**Students’ Role:** Students will engage in a gallery walk, discussion, whole class reading, and in small groups to analyze the entry assignment by creating a list of “need to knows.”

### **Engage:**

Gallery Walk of the following images:

<ul style="list-style-type: none"> <li>• Children with bloated bellies from protein deficiency</li> <li>• Person with eye problems due to Vitamin A deficiency</li> <li>• Person with gout (vitamin C deficiency)</li> <li>• Person with goiter (iodine deficiency)</li> <li>• Body builder (increased protein intake)</li> </ul>	<ul style="list-style-type: none"> <li>• Rainforest destruction (for farming land)</li> <li>• Dust bowl (shows soil exhaustion)</li> <li>• Damaged ocean habitat (due to human pollution)</li> <li>• Organic farming (showing diverse plantings)</li> <li>• Any other images that fuel student interest in nutrition and ecosystem impact</li> </ul>
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### Explore:

Hand out, read, and discuss the entry letter document and rubrics for the performance assessment. Students create a list of what they will “need to know” in order to successfully address the Performance Task.

### Explain:

Students work in small groups (no more than 4 students) to discuss the entry letter document and create a list of “need to knows” (example: if students don’t know what the term ‘ecosystem’ means in the entry letter, then that will be one of the things they need to know/learn in this unit).  
*Logistics:* It is most convenient if students create the “need to know” list in a GoogleDoc shared with all members of their group and with the teacher.

### Elaborate:

Students and teacher will review the rubrics connected to the performance task. Students will have an opportunity to ask the teacher about the rubric and deadline.

### Evaluate (Evidence of Student Learning):

Students view and compare each other’s “Need to Know” list. Teacher should review students’ “need to know” lists.

**ENGAGE/EXPLORE:** Lesson 2: Introduce and Engage Students in the role/processes of Photosynthesis (HS-LS1-5)

**DCI:** LS1.C: The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.

### Scientific Practices:

### Crosscutting Concept:

### Narrative:

#### Lesson Objective & Rationale

After introducing the unit project in Lesson 1, the next step is for students to develop an understanding of photosynthesis in order to explain where our food comes from. In this lesson a demonstration using BTB and elodea will be used to build students’ conceptual understanding of photosynthesis chemical activities.

**Objective:** Students will be able to write the reactions for photosynthesis and understand the products made by this process (glucose, oxygen) by performing a demonstration.

### Suggested Plan

This sample lesson uses a demonstration to emphasize inputs and outputs of photosynthesis.

#### *Clarification of Teacher and Student Roles:*

**Teacher Role:** Begin and close the lesson with a demo. Teachers give a brief mini lesson through modeling the formula of photosynthesis with pictures.

**Student Role:** Students will engage in a demo and discuss their observations. They will also practice constructing, writing and describing the chemical reactions of photosynthesis.

### Engage:

Lab groups are given beakers with water and BTB mixed together and straws. Teacher explains to students why the water is blue (it contains a chemical called BTB), but should not explain what BTB does. Students should blow gently through the straws once they are put into the BTB solution until the the solution turns to a yellow/green color. At this point, ask half the groups to cover the top of their beaker with aluminum foil or saran wrap. The other half should be given a portion of elodea to put into the solution.

### Explore

Teacher should pose the question, “Why did the water turn yellow/green?” to the class. Students should make a prediction.

### Explain

### Elaborate

### Evaluate (Evidence of Student Learning):

**EXPLAIN:** Lesson 3: Photosynthesis

**DCI:**

**Scientific Practices:** Developing and Using Models

**Crosscutting Concept:**

### Narrative:

Lesson Objective & Rationale

Explain photosynthesis

### Suggested Plan

Students model photosynthesis

*Clarification of Teacher and Student Roles:*

**Teacher Role**

**Student Role**

**Engage**

**Explore**

**Explain**

**Elaborate**

**Evaluate (Evidence of Student Learning):**

**ELABORATE:** Lesson 4: Specific Nutrients Made during Photosynthesis and the Biodiversity of Plants Needed for Good Nutrition (HS-LS1-6)

**DCI:** LS1.C. 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. (LS4.D: Biodiversity and Humans)

**Scientific Practices:**

**Crosscutting Concept:**

### Narrative:

Lesson Objective & Rationale

Elaborate on the specific nutrients made in Photosynthesis and why biodiversity among plants is needed.

### Suggested Plan

Answer the question: "How are plants able to make all nutrients we need (simple and complex carbohydrates, proteins, etc)?"

*Clarification of Teacher and Student Roles:*

**Teacher Role**

**Student Role**

**Engage**

**Explore**

**Explain**

**Elaborate**

**Evaluate** (Evidence of Student Learning):

**EVALUATE:** Lesson 5: Photosynthesis and Biodiversity (HS.LS1.5 and HS.LS1.6)

**DCI:** ETS1.B: 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.

**Scientific Practices:**

**Crosscutting Concept:**

### Narrative:

#### Lesson Objective & Rationale

### Suggested Plan

Students create a one-day menu and describe the nutrient content of the foods plus where the food came from.

*Clarification of Teacher and Student Roles:*

**Teacher Role**

**Student Role**

**Engage**

**Explore**

**Explain**

**Elaborate**

**Evaluate** (Evidence of Student Learning):

## ***Part 2 – Cellular Respiration and Energy Transfer***

**ENGAGE/EXPLORE:** Lesson 6: Introduce /Explore Cell Respiration and Energy Transfer (HS-LS1-7)

**DCI: LS1.C.** 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.



**Scientific Practices:** Developing and Using Models

**Crosscutting Concept:**

### Narrative:

#### Lesson Objective & Rationale

We know food groups and where they came from, now how do we unlock energy from food.

#### Suggested Plan

Students will...

*Clarification of Teacher and Student Roles:*

**Teacher Role**

**Student Role**

**Engage**

**Explore**

**Explain**

**Elaborate**

**Evaluate** (Evidence of Student Learning):

**EXPLAIN:** Lesson 7: Cellular Respiration (HS-LS1-7)

**DCI: LS1.C.** 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.

**Scientific Practices:** Developing and Using Models

**Crosscutting Concept:**

### Narrative:

#### Lesson Objective & Rationale

#### Suggested Plan

Students model Cellular Respiration

*Clarification of Teacher and Student Roles:*

**Teacher Role**

**Student Role**

**Engage**

**Explore**

**Explain**

**Elaborate**

**Evaluate** (Evidence of Student Learning):

**ELABORATE:** Lesson 8: 10% Rule of Energy Transfer (HS-LS1-7)

**DCI: LS1.C.** As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another.

**Scientific Practices:** Developing and Using Models

**Crosscutting Concept:**

### Narrative:

#### Lesson Objective & Rationale

#### Suggested Plan

Students will...

*Clarification of Teacher and Student Roles:*

**Teacher Role**

**Student Role**

**Engage**

**Explore**

**Explain**

**Elaborate**

**Evaluate** (Evidence of Student Learning):

**ELABORATE:** Lesson 9: Connect Photosynthesis and Cellular Respiration

**DCI: LS1.C.** As matter and energy flow through different organizational level of living systems, chemical elements are recombined in different ways to form different products.

**Scientific Practices:** Developing and Using Models

**Crosscutting Concept:**

### Narrative:

#### Lesson Objective & Rationale

#### Suggested Plan

Students will Model Photosynthesis and Cell Respiration CO<sub>2</sub> cycle

*Clarification of Teacher and Student Roles:*

**Teacher Role**

**Student Role**

**Engage**

**Explore**

**Explain**

**Elaborate**

**Evaluate** (Evidence of Student Learning):

**EVALUATE:** Lesson 10: Evaluate (HS.LS1.5-7)

**DCI:**

**Scientific Practices:**

**Crosscutting Concept:**

### Narrative:

#### Lesson Objective & Rationale

#### Suggested Plan

Students revise/add to their nutrition plan to describe calorie content of the food.

*Clarification of Teacher and Student Roles:*

### Teacher Role

### Student Role

Engage

Explore

Explain

Elaborate

Evaluate (Evidence of Student Learning):

## Part 3 – Ecosystem Usage, Stability, and Human Impact (EMPHASIS)

**ENGAGE:** Lesson 11: Ecosystem Usage, Stability and Human Impact (HS.LS1.5-7)

*What is your environmental footprint?*

**DCI: LS4.D.** Humans depend on the living world for the resources and other benefits provide by biodiversity.

**Scientific Practices:**

**Crosscutting Concept:**

### Narrative:

**EXPLORE:** Lesson 12: Ecosystems (HS.LS2.1-2)

*What would happen to Earth/local ecosystems if every person ate a similar menu?*

**DCI: LS2.A.** Interdependent Relationships in Ecosystems: 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.

**Scientific Practices:** Using Mathematics and Computational Thinking

**Crosscutting Concept:**

### Narrative:

### COMMON PRACTICE WITH A VIRTUAL ACTIVITY

**EXPLAIN:** Lesson 13: *What would happen to Earth/local ecosystems if every person ate a similar menu?*

**DCI: LS2.A.** (cont.): 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.

**Scientific Practices:** Using Mathematics and Computational Thinking

**Crosscutting Concept:**

### Narrative:

**ELABORATE:** Lesson 14: *How can you change your menu to make ecosystems stable/ reduce human impact, so that your great, great grandchildren also have good nutrition?*

**DCI:** Students will apply **LS2A** above to begin drafting the report required for the unit.

**ETS1.B.** 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.

**Scientific Practices:** Using Mathematics and Computational Thinking

**Crosscutting Concept:**

### Narrative:

SPECIFIC EXAMPLES OF PLANTS/ FOOD

**EXPLORE/EXPLAIN:** Lesson 15: *When can ecosystems bounce back from change and when can they not bounce back?*

**DCI: LS2.A.** 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.

**Scientific Practices:**

**Crosscutting Concept:**

### Narrative:

**ELABORATE/EXPLAIN:** Lesson 16: *What environmental impacts have resulted from human farming?*

**DCI: LS2.C.** 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.

*(Clarification statement: For the sake of time, the detailed lessons prioritize habitat destruction, pollution, climate change, which all tie to carbon footprint. Invasive species may fit if students choose bull frogs for example in their menu.)*

**Scientific Practices:**

**Crosscutting Concept:**

### Narrative:

**ELABORATE:** Lesson 17: *What human activities are helping to restore eco-systems and how much ecosystem damage be reversed?*

**DCI: LS4.D.** Biodiversity: 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.

(secondary to HS-LS2-7)



## Environmental Literacy Unit Plan

Grade: HS Biology

Title: *Environmental Footprint*

Authors: Binni Chadda, Friendship Collegiate;

Elizabeth Dunn, Friendship Tech Prep; Jacqueline

Fernandez, LAYCCA; Alexandra Fuentes, Cesar Chavez

Beekeeper, Farmers markets, vegan bakeries, farmers, fishers bakers, Aquatic Resources Education Center (AREC)

**Scientific Practices:**

**Crosscutting Concept:**

**Narrative:**

**ELABORATE:** Lesson 18: Optimizing the Design Solution (ETS1.C)

**DCI:** Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.

**Scientific Practices:** Using Mathematics and Computational Thinking

**Crosscutting Concept:**

**Narrative:**

**EVALUATE:** Lesson 19

**DCI: ETS1.B.** 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.

**Scientific Practices:** Using Mathematics and Computational Thinking

**Crosscutting Concept:**

**Narrative:**

### Universal Access

### Supporting English Language Learners

Reading, Writing, or Speaking Activity	Supports for <i>Emerging</i> Learners	Supports for <i>Expanding</i> Learners	Supports for <i>Bridging</i> Learners



### Supporting Struggling Learners

Activity	Supports for Students who need <u>Minor</u> Support	Supports for Students who Need <u>Intensive</u> Support

### Supporting Advanced Learners

Activity	Extensions for Advanced Students

### Connecting to the Core: NGSS Aligned Performance Tasks

**ELA Connections** (*Reading, Writing or Speaking Activities*) listed in Learning and Instructional Sequence

#### **HS-LS2-7:**

- RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
- RST.11-12.8. Evaluate the hypothesis, data, analyses, and conclusions in science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

**Math Connections** (*listed in Learning and Instructional Sequence*)

#### **HS-LS2-1 and HS.LS2-2:**

- MP.2. Reason abstractly and quantitatively
- MP.4. Model with Mathematics.
- HSN-Q.A.1. Reason quantitatively and use units to solve problems. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- HSN-Q.A.3. Reason quantitatively and use units to solve problems. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

#### **HS-ETS1-2:**

- MP.4. Model with Mathematics.