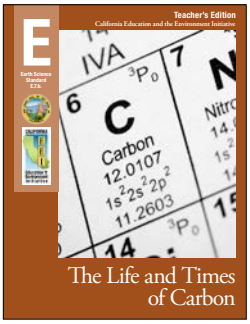
TEACH COMMON CORE STANDARDS
WITH THE EEI CURRICULUM

Created with your needs in mind, this document shows the correlation between the EEI Curriculum and the California Common Core State Standards. By teaching the EEI unit lessons in your classroom, you will be simultaneously addressing the Common Core standards depicted in this guide.

E.7.b.—The Life and Times of Carbon



In this unit students explore the diverse forms of carbon humans depend on and read an article about carbon-based fuels. They play a game that moves them through the carbon cycle, and then they discuss the concepts of carbon flow and carbon reservoirs in the global carbon cycle. Students analyze the flow of carbon between the different reservoirs. They then identify the environmental and socio-economic factors involved in decisions about using carbon-based fuels.

	RST.9–10.1	RST.9–10.2	RST.9–10.4	RST.9–10.5	RST.9–10.6	RST.9–10.8	RST.9–10.10	RST.11–12.2	RST.11–12.7	WHST.9–10.2	WHST.9–10.4	WHST.9–10.8	SL.9–10.1	SL.9–10.2	SL.9–10.4	SL.11–12.1
California Connections	✓	✓	✓	✓	✓	✓	✓			✓						
1		✓	✓	✓			✓	✓		✓		✓	✓			✓
2		✓	✓						✓	✓	✓		✓			
3			✓							✓	✓		✓	✓		
4			✓				✓			✓	✓		✓			
5			✓				✓			✓	✓		✓		✓	
Traditional Assessment										✓	✓					
Alternative Assessment				✓			✓			✓						

COMMON CORE STANDARDS

Note: *For your reference, the list of California Common Core State Standards abbreviations is on the following page.*

Using the EEI-Common Core Correlation Matrix

The matrix on the front page identifies a number of Common Core standards that are supported by this EEI unit. However, the check marks in the matrix do not necessarily signify that the Common Core standards checked will be taught to mastery by using this EEI unit alone. Teachers are encouraged to select which Common Core standards they wish to emphasize, rather than teaching to every indicated standard. By spending more time on selected standards, students will move toward greater Common Core proficiency in comprehension, critical thinking and making reasoned arguments from evidence. Teaching this EEI unit will provide opportunities for teachers to implement the shift in instructional practice necessary for full Common Core implementation.

California Common Core State Standards Abbreviations

- **CCCSS:** California Common Core State Standards
- **RST:** Reading Standards for Literacy in Science and Technical Subjects
- **SL:** Speaking and Listening Standards
- **WHST:** Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects

Note: *Since each Common Core standard includes a breadth of skills, in this correlation, the portion of the standard description that is featured in the Common Core standards applications is cited, using "…" to indicate omitted phrases. For a list of the complete standard descriptions, please see the Common Core Reference Pages located on pages 16–17 of this document.*

A Note about Common Core Speaking and Listening Standards

Throughout this unit, students participate in various learning structures and groups to analyze, discuss, and synthesize data, which supports the skill in Speaking and Listening Standard 1 "Participate effectively in a range of collaborative discussions (one-on-one, groups…) with diverse partners." With prior instruction on collaborative discussions, these various groupings and the materials students examine lend themselves to prime discussion material for collaborative discussions. Learning structures with tasks for pairs and groups are in the following lessons:

- **Lesson 1:** Whole class, groups of 6, pairs
- **Lesson 2:** Whole class, groups of 4
- **Lesson 3:** Whole class, groups of 5
- **Lesson 4:** Whole class, pairs
- **Lesson 5:** Whole class, groups of 4

National Geographic Resources

No maps or posters are used with this unit.

Unit Assessment Options

Assessments	Common Core Standards Applications
Traditional Assessment	
Part 1 includes 15 multiple-choice questions, and six matching definitions problems. Part 2 includes 15 short answer/essay questions, where students demonstrate their understanding of the global carbon cycle.	**WHST.9–10.2:** Write informative/explanatory texts, including…scientific…processes. **WHST.9–10.4:** Produce clear and coherent writing… appropriate to task…
Alternative Assessment	
Students complete an illustration and construct a written response to a task.	**RST.9–10.5:** Analyze the structure of the relationships among concepts in a text… **RST.9–10.10:** …read and comprehend science…texts… independently and proficiently. **WHST.9–10.2:** Write informative/explanatory texts, including the narration of historical events, scientific…processes. a) Introduce a topic and organize ideas, concepts, and information… b) Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information… c) Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. d) Use precise language and domain-specific vocabulary… f) Provide a concluding statement or section that follows from and supports the information or explanation…

Lesson 1: Carbon: The Building Block of Life

Students brainstorm materials they think contain carbon. To explore the diverse forms of carbon we depend on, students read an article about carbon-based fuels, ***California Connections: The Promise of Biofuels: Hype or a Real Solution***? and visit stations displaying carbon-containing materials.

Use this correlation in conjunction with the **Procedures** located on pages 46–47 of the Teacher's Edition. Only procedure steps with a Common Core correlation are included in the table below.

Student Tasks	Common Core Standards Applications
Vocabulary Development: For depth of understanding, vocabulary may be featured within the context of the unit instead of or in addition to the beginning of the lesson.	**RST.9–10.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context…
Step 2: Students complete a reading in ***California Connections: The Promise of Biofuels: Hype or a Real Solution?*** (Student Edition, pages 2–5), and summarize the article. As a class, students add forms of carbon to the **Where's the Carbon?** list. ***Suggestion:*** *In addition to reading* ***California Connections*** *for content, students should look at several key elements on how the writing is structured. This can be done while they're reading or during a second reading of the material. Students who have been familiarized with this process can identify these structural elements as they read by themselves and then they can be discussed as a class.* Refer to the **Reading *California Connections* Using a Common Core Reading and Writing Focus** on pages 11–15 to view specific suggestions for integrating Common Core standards while reading this selection not only for content, but for text structure as well. ***Suggestion:*** *Students would benefit from a collaborative class discussion before summarizing the article.*	**RST.9–10.2:** Determine the central ideas…trace the text's explanation or depiction of a complex process, phenomenon, or concept… **RST.9–10.10:** …read and comprehend science…texts…independently and proficiently.
Step 3: Students read **Collecting Carbon** (Student Workbook, pages 4–7). Students discuss the difference between the words "biotic" and "abiotic" and discuss the difference between the two.	**RST.9–10.4:** Determine the meaning of…key terms, and other domain-specific words and phrases… **RST.9–10.5:** Analyze the structure of the relationships among concepts in a text, including relationships among key terms…
Step 5: In groups of six, students rotate through a series of **Carbon Study Stations**, and copy the chemical formula for each item in Column B of **Collecting Carbon**, using the **Carbon Items Labels** associated with each item at each station. ***Tip:*** *To preserve the colored workbooks for use each year, use one of these strategies:* ■ *Make black and white copies for students to write on while looking at the color copy.* ■ *Use a sheet protector over the color copy.* ■ *Laminate the color photos and cut into strips that students place over their black and white copy.*	**RST.9–10.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases… **WHST.9–10.2d:** Use precise language and domain-specific vocabulary to…convey a style appropriate to the discipline and context… **WHST.9–10.8:** Gather relevant information from multiple authoritative print and digital sources…

Student Tasks	Common Core Standards Applications
Step 5 (Continued): ■ *Do together as a class with the teacher holding the page and writing on sheet protector.*	
Step 6: Student work in pairs to complete Part 2 of **Collecting Carbon** by brainstorming how carbon is used in different forms in nature and by people. They make notes in Column C of the chart. Then in Part 3, students use the information they have gained to work individually to develop a summary statement that explains the importance of carbon to living organisms. ***Suggestion:*** *After the brainstorming session, allow students to use other resources (on-line, research materials, etc.) to add to their list.*	**RST.9–10.2:** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process…or concept; provide an accurate summary of the text. **RST.11–12.2:** Determine the central ideas…of a text; summarize… information presented in a text by paraphrasing them in simpler but still accurate terms. **SL.9–10.1:** Initiate and participate effectively in a range of collaborative discussions…building on others' ideas and expressing their own clearly… c) Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas…and conclusions. **WHST.9–10.2:** Write informative/ explanatory texts… c) Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. d) Use precise language and domain-specific vocabulary… f) Provide a concluding statement or section that follows from and supports the information or explanation…
Steps 7 and 8: As a class, students identify items that are biotic versus abiotic, connecting the idea that carbon is in a variety of everyday items. They then discuss the link between the atmosphere and the ocean. The lesson concludes with "biogeochemistry" being defined. The ideas generated by these questions lend themselves to an in-depth collaborative conversation. With prior training in collaborative conversations, student leaders could facilitate the discussion, encouraging students to extend the connections they make related to the carbon cycle.	**SL.9–10.1:** Initiate and participate effectively in a range of collaborative discussions…building on others' ideas and expressing their own clearly… c) Propel conversations by posing and responding to questions…or challenge…conclusions. d) Respond thoughtfully to diverse perspectives… **SL.11–12.1d:** …synthesize comments, claims, and evidence…

Lesson 2: We Live in a Carbon-ated World

Students are introduced to the concepts of carbon flow and carbon reservoirs in the global carbon cycle. After learning about each reservoir, students identify the natural processes that move carbon between reservoirs in the global carbon cycle.


Lesson 2

We Live in a Carbon-ated World

This lesson focuses on carbon "reservoirs" and the natural systems and processes that move carbon between reservoirs, resulting in the global carbon cycle. Working in small groups, students read and organize a set of cards that describe how natural processes in four major carbon reservoirs (the atmosphere; rocks, soils and sediments; terrestrial plants; and the ocean) take up and store carbon.

Students discover that some reservoirs store more carbon than others and that the amount of carbon in each reservoir can change over geologic time. They learn that natural processes and human activities affect the amount of carbon dioxide (CO_2) in the atmosphere.

Learning Objectives

Key Vocabulary

Use this correlation in conjunction with the **Procedures** located on pages 76–78 of the Teacher's Edition. Only procedure steps with a Common Core correlation are included in the table below.

Student Tasks	Common Core Standards Applications
Vocabulary Development: For depth of understanding, vocabulary may be featured within the context of the unit instead of or in addition to the beginning of the lesson.	**RST.9–10.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context…
Step 1: Students view **San Luis Reservoir, California** (Visual Aid #1), and build a definition for "reservoir."	**RST.9–10.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases…
Step 2: In groups of four, students read and organize a set of **Carbon Reservoir Cards** (Teachers Masters, pages 3-4) to illustrate all four major reservoirs of the carbon cycle.	**RST.9–10.2:** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process…or concept… **RST.9–10.4:** Determine the meaning of symbols, key terms… **RST.11–12.7:** Integrate and evaluate multiple sources of information presented in diverse formats… **SL.9–10.1:** Initiate and participate effectively in a range of collaborative discussions…
Step 3: Students view **Carbon Reservoirs** (Visual Aid #2) and identify each of the four carbon reservoirs. Students then turn to **Moving Through the Global Carbon Cycle** (Student Workbook, pages 8–9) and answer question #1. Next, students discuss the relationship between the atmosphere and terrestrial plants.	**RST.11–12.7:** Integrate and evaluate multiple sources of information presented in diverse formats… **SL.9–10.1:** …participate…in a range of collaborative discussions…
Step 4: While viewing **Global Carbon Cycle, Carbon Reservoirs, Photosynthesis**, and **Respiration and Decomposition** (Visual Aids #2, #4, and #5) students continue the discussion of the four natural processes involved in the movement of carbon between reservoirs.	**SL.9–10.1:** …participate…in a range of collaborative discussions…

Student Tasks	Common Core Standards Applications
Steps 6–9: Students view **Biological Pump, Solubility Pump, Weathering, Sedimentation**, and **Subduction and Volcanic Eruptions** (Visual Aids #6, #7, #8, #9, and #10) and discuss natural processes that move carbon between reservoirs in the global carbon cycle. ***Suggestion:*** *Have each of the Visual Aids posted in different sections of the rooms. Create 5 equal groups and have each group visit each visual aid and write their responses on a stick note. After students visit each station, compare and contrast the groups' responses.*	**SL.9–10.1:** …participate…in a range of collaborative discussions…
Step 10: Students work in their groups to answer questions 2 and 3 on **Moving Through the Global Carbon Cycle**. Students then work independently to answer questions 4 and 5.	**SL.9–10.1:** …participate…in a range of collaborative discussions… **WHST.9–10.2:** Write informative/ explanatory texts… c) Use varied transitions and sentence structures… d) Use precise language and domain-specific vocabulary… f) Provide a concluding statement… **WHST.9–10.4:** Produce clear and coherent writing…appropriate to task…

Lesson 3: Carbon Cycling: Waste Not, Want Not

Students examine the flow of carbon and energy by playing a board game involving processes that result in carbon flow between different reservoirs of the global carbon cycle. They record the game's progress on individual logs for a class discussion.


Lesson 3

Carbon Cycling: Waste Not, Want Not

Use this correlation in conjunction with the **Procedures** located on pages 98–100 of the Teacher's Edition. Only procedure steps with a Common Core correlation are included in the table below.

Student Tasks	Common Core Standards Applications
Vocabulary Development: For depth of understanding, vocabulary may be featured within the context of the unit instead of or in addition to the beginning of the lesson.	**RST.9–10.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases…
Steps 2–4: In groups of five, students use the **Carbon Flow Game Board** and **Carbon Flow Game Set**, to play a game. They discuss and record their answers on the **Carbon Flow Observation Log** (Student Workbook, pages 10–11).	**SL.9–10.2:** Integrate multiple sources of information presented in diverse media or formats…
Steps 5 and 6: Students report their "Carbon Game" results, and the teacher records the results on the **Carbon Flow Summary Chart**. Students then discuss each scenario encountered in the game. ***Suggestion:*** *Have students diagram the carbon flow from the game into a scientific schematic.*	**SL.9–10.1:** …participate…in a range of collaborative discussions…
Step 7: While viewing **How Much Is a Metric Ton?** (Visual Aid #13), students answer questions and discuss how much carbon dioxide is contributed to the system by human activities.	**SL.9–10.1:** …participate…in a range of collaborative discussions…
Step 8: Students complete **Going With the Flow** (Student Workbook, pages 12–16).	**WHST.9–10.2:** Write informative/explanatory texts… c) Use varied transitions and sentence structures… d) Use precise language and domain-specific vocabulary… f) Provide a concluding statement… **WHST.9–10.4:** Produce clear and coherent writing…appropriate to task…

Lesson 4: It Started with Fire

Students read a story about how one-third of the world's population uses solid fuels, such as wood and dung, as their primary energy source for cooking and heating. Students also examine the energy efficiency and carbon footprint of using different fuels.


Lesson 4

It Started with Fire

Use this correlation in conjunction with the **Procedures** located on pages 122–123 of the Teacher's Edition. Only procedure steps with a Common Core correlation are included in the table below.

Student Tasks	Common Core Standards Applications
Vocabulary Development: For depth of understanding, vocabulary may be featured within the context of the unit instead of or in addition to the beginning of the lesson.	**RST.9–10.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context…
Step 1: While viewing **Earth at Night** and **Collecting Firewood** (Visual Aids #14 and #15), students answer questions and discuss energy usage differences between developed and developing countries.	**SL.9–10.1:** …participate…in a range of collaborative discussions…
Step 2: Individually, students read **Pasture Patties, Meadow Muffins, Cow Pies, and Buffalo Chips** (Student Edition, pages 6–7), and then work with a partner to discuss the questions at the end of the reading. Students answer the question "Which do you think is older, dung or wood?"	**RST.9–10.10:** …read and comprehend science…texts…independently and proficiently.
Steps 3–6: Students are asked questions based on their reading, paired discussions, and prior knowledge. They share their prior knowledge about the effects of increased amounts of carbon dioxide in the atmosphere. ***Suggestion:*** *Increase the Common Core elements in the discussion by encouraging students to build on each other's ideas, cite evidence from the text, pose questions that probe reasoning and evidence in the text and in each others comments.*	**SL.9–10.1c:** Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas…and conclusions.
Step 7: Students work in pairs to complete **Accounting for Changing Levels of Atmospheric Carbon Dioxide** (Student Workbook, pages 17–20).	**SL.9–10.1:** …participate…in a range of collaborative discussions… **WHST.9–10.2:** Write informative/explanatory texts… **WHST.9–10.4:** Produce clear and coherent writing…appropriate to task…

Lesson 5: Biofuels in the News

Students read news clips to identify the environmental, economic, social, and political factors people consider when making decisions about using carbon-based fuels. As their understanding of "carbon neutral" fuel options improves, their decisions about fuel options may change, too.

Use this correlation in conjunction with the **Procedures** located on pages 138–140 of the Teacher's Edition. Only procedure steps with a Common Core correlation are included in the table below.

Student Tasks	Common Core Standards Applications
Vocabulary Development: For depth of understanding, vocabulary may be featured within the context of the unit instead of or in addition to the beginning of the lesson.	**RST.9–10.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases…
Step 3: As the teacher fills in the **Sample Decision Chart**, students discuss the factors that affect their decision to purchase clothes.	**SL.9–10.1:** …participate…in a range of collaborative discussions…
Steps 4 and 5: Students work in small groups to explore factors that influence how people make decisions about our energy needs and new energy technology. In groups of four, students read the **Biofuel News Clip** (Student Edition, pages 8–10), and use **Examining Decision Factors** (Student Workbook, pages 21–24) to identify the type of trade-offs each news clip is presenting. They prepare and present a one-minute report on a chosen news clip. ***Suggestion:*** *Have students use multimedia to present their news clip analysis. Discuss with students how news presented orally (radio, for example) differs from information presented in a multimedia format (Television, for example). If time allows, have students present the news clips in both formats and discuss the impacts on the listeners/viewers.*	**RST.9–10.10:** …read and comprehend science…texts…independently and proficiently. **SL.9–10.1:** …participate…in a range of collaborative discussions… **SL.9–10.4:** Present information, findings, and supporting evidence clearly, concisely, and logically…
Steps 6 and 7: Students summarize and discuss what they learned from the progression of news clips. For each category of factors, students discuss the trade-offs regarding corn ethanol.	**SL.9–10.1:** …participate…in a range of collaborative discussions…
Step 8: Students turn to **Carbon Footprint of Corn-Based Biofuel** (Student Workbook, pages 25–26) to read and analyze an article. ***Suggestion:*** *Have students cite textual evidence when analyzing the article.*	**RST.9–10.10:** …read and comprehend science…texts…independently and proficiently. **WHST.9–10.2:** Write informative/explanatory texts… **WHST.9–10.4:** Produce clear and coherent writing…appropriate to task…

Unit Assessment

Refer to the introduction pages at the front of this document for information regarding the Traditional and Alternative Assessments for this unit and their Common Core correlations.

Reading *California Connections* using a Common Core Reading and Writing Focus

Reading

Science teachers can further enhance the teaching of Common Core Reading Literacy Standards by noting the suggestions below and in the following pages while reading the ***California Connections*** selection for content. Explicitly teach students to pay attention to the structure of the text by noting the following:

- Note how the author cites evidence to support main points; note any gaps or inconsistencies. **(RST.9–10.1** and **RST.11–12.1)**
- Note how the author sets up the central ideas or conclusions; trace the text's explanation or depiction of a process or concept; summarize concepts, processes, and information by paraphrasing the text and the text as a whole. **(RST.9–10.2** and **RST.11–12.2)**
- Note how the author explains multi-step procedures. **(RST.9–10.3** and **RST.11–12.3)**
- Note how the author explains the meaning of key terms, symbols, domain specific words, and phrases. **(RST.9–10.4** and **RST.11–12.4)**
- Analyze the structure of the relationships among concepts in a text, and the relationships among key terms, including categories or hierarchies. **(RST.9–10.5** and **RST.11–12.5)**
- Analyze the author's purpose in providing an explanation, or describing a procedure, and how this defines the question the author seeks to address; identify important unresolved issues. **(RST.9–10.6** and **RST.11–12.6)**
- Note how the information in the ***California Connections*** text integrates with information provided throughout the unit in diverse formats, including tables, charts, maps, and quantitative data. **(RST.9–10.7** and **RST.11–12.7)**
- Assess the extent to which the reasoning and evidence in a text support the author's claim; evaluate the analysis and conclusions in the text. **(RST.9–10.8** and **RST.11–12.8)**
- When other documents are included, compare and contrast findings presented in this text to those in other sources, noting when the findings support or contradict previous explanations. **(RST.9–10.9** and **RST.11–12.9)**
- Note comprehension strategies for understanding science text. **(RST.9–10.10** and **RST.11–12.10)**

Note: *Standard descriptions are paraphrased, using terminology that applies to reading a* ***California Connections*** *selection.*

Writing

Many ***California Connections*** selections can be used as a model for future student writing tasks applying the Writing Literacy Standards by noting how the author structures the text, organizes the ideas, and provides well-chosen relevant and sufficient facts, extended definitions, concrete details, quotations, or other information and examples.

Using the *California Connections* Selection

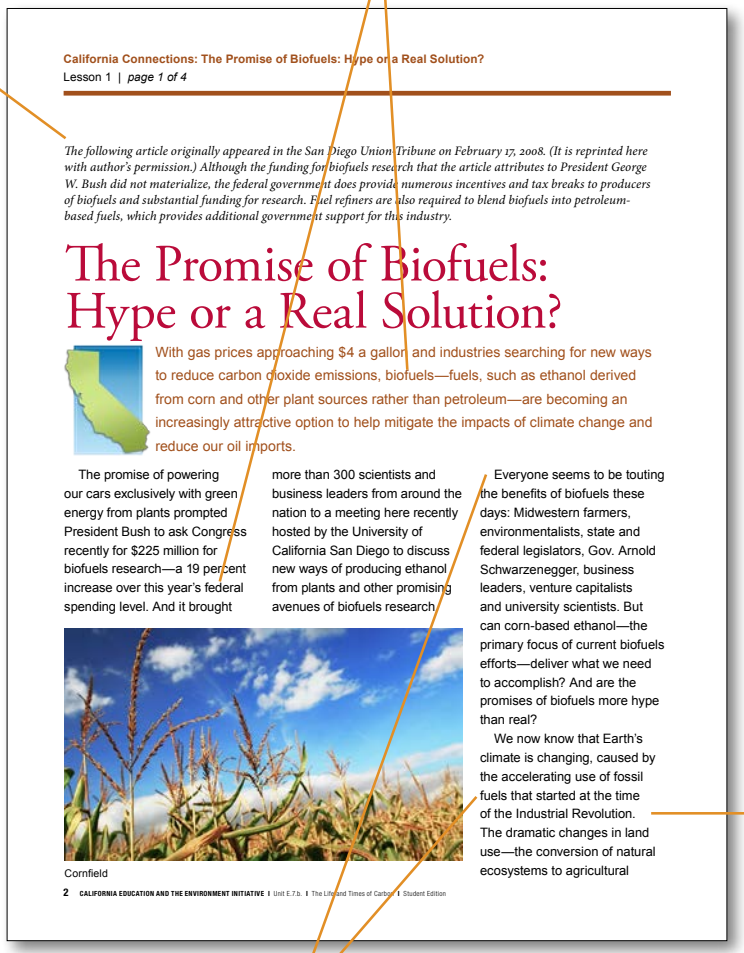
The following pages note specific places where the ***California Connections*** selection provides examples for specific Writing Literacy Standards for Science and Technical subjects, using this selection as a writing model. They also provide suggestions for teaching students to analyze text structure using the Reading Literacy Standards for Science and Technical subjects. Teachers can incorporate more suggestions from the list above.

RST.9–10.8: Assess the extent to which the reasoning and evidence in a text support the author's claim…

- *Are these claims supported in the text?*

RST.9–10.6: Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Suggestion: *Have students evaluate the source of this article and decide how the author answers the questions identified in the title.*



California Connections: The Promise of Biofuels: Hype or a Real Solution?
Lesson 1 | *page 1 of 4*

The following article originally appeared in the San Diego Union-Tribune on February 17, 2008. (It is reprinted here with author's permission.) Although the funding for biofuels research that the article attributes to President George W. Bush did not materialize, the federal government does provide numerous incentives and tax breaks to producers of biofuels and substantial funding for research. Fuel refiners are also required to blend biofuels into petroleum-based fuels, which provides additional government support for this industry.

The Promise of Biofuels: Hype or a Real Solution?

With gas prices approaching $4 a gallon and industries searching for new ways to reduce carbon dioxide emissions, biofuels—fuels, such as ethanol derived from corn and other plant sources rather than petroleum—are becoming an increasingly attractive option to help mitigate the impacts of climate change and reduce our oil imports.

The promise of powering our cars exclusively with green energy from plants prompted President Bush to ask Congress recently for $225 million for biofuels research—a 19 percent increase over this year's federal spending level. And it brought more than 300 scientists and business leaders from around the nation to a meeting here recently hosted by the University of California San Diego to discuss new ways of producing ethanol from plants and other promising avenues of biofuels research.

Everyone seems to be touting the benefits of biofuels these days: Midwestern farmers, environmentalists, state and federal legislators, Gov. Arnold Schwarzenegger, business leaders, venture capitalists and university scientists. But can corn-based ethanol—the primary focus of current biofuels efforts—deliver what we need to accomplish? And are the promises of biofuels more hype than real?

We now know that Earth's climate is changing, caused by the accelerating use of fossil fuels that started at the time of the Industrial Revolution. The dramatic changes in land use—the conversion of natural ecosystems to agricultural

Cornfield

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RST.9–10.1: Cite specific textual evidence to support analysis of science…texts, attending to the precise details of explanations or descriptions.

Suggestion: *While reading, have students summarize sections of the material, citing evidence from the text.*

RST.9–10.10: …read and comprehend science/technical texts… independently and proficiently.

Suggestion: *Throughout the reading, note comprehension strategies for understanding the text.*

RST.9–10.6: Analyze the author's purpose in providing an explanation…

Suggestion: *Ask what the author's purpose is for including this explanation.*

RST.9–10.2: …trace the text's explanation…of a… concept…

RST.9–10.5: Analyze the structure of the relationships among concepts in a text…

Suggestion: *This sentence sets up the structure of this text. Have students trace its development while reading.*

WHST.9–10.2b: Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details…or other information and examples…

WHST.9–10.2c: Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

RST.9–10.4: Determine the meaning of symbols, key terms, and other domain-specific words…

- *Biofuels*
- *Tariff*
- *Biomass*

California Connections: The Promise of Biofuels: Hype or a Real Solution?
Lesson 1 | *page 2 of 4*

fields—that accompanied the growth of human population also contributed substantially by releasing carbon stored in the vegetation and in the soils. These activities caused an increase in atmospheric carbon dioxide that has not been seen in the past 400,000 years. This increase is responsible for the so-called greenhouse effect, the warming of the land and the oceans with resulting changes in wind, rain and storm patterns. The evidence supporting this interpretation is both overwhelming and unequivocal.

Biofuels can help mitigate this global climate change phenomenon because they are made from plants and algae that absorbed carbon dioxide in the process of photosynthesis. When we burn fossil fuels, we add carbon dioxide to the atmosphere, but burning biofuels releases carbon dioxide that was taken out of the atmosphere by plants or algae a few days, weeks or years earlier. So, we create a carbon cycle, helping to prevent further buildup of carbon dioxide in the atmosphere. The United States has a strong biofuels industry based largely on ethanol derived from corn grain and made possible by the high price of petroleum, generous farm subsidies and a stiff tariff on imports of sugar and ethanol.

Unfortunately, all biofuels are not created equal when we look at the extent to which they mitigate greenhouse gas buildup. The reason is that growing plants and converting plant material into biofuel also takes energy. And at the moment that energy comes mostly from electricity generated by fossil fuels. So much energy is required to produce the two main biofuels now being utilized in the United States—ethanol made from cornstarch and biodiesel made from canola and soybeans—that the net effect of their use on greenhouse gases is negative rather than positive.

The reasons are complex: corn and canola require a lot of nitrogen fertilizer to grow, and making nitrogen fertilizers is very energy intensive. Furthermore, whenever nitrogen fertilizer is used soil bacteria cause nitrous oxide to be released into the atmosphere. In the case of corn ethanol, distilling the ethanol requires energy. We can't make ethanol pipelines because ethanol is corrosive, so ethanol has to be transported in trains and trucks. For these and other reasons, the greenhouse gas balance—greenhouse gases removed from the atmosphere minus greenhouse gases

Ethanol factory

released—is unfavorable for corn ethanol. In Europe, opposition to biofuels derived from food crops is already developing because they contributed to the recent rise in food prices. When fuel is derived from crops, food prices rise. Also, when croplands are converted for growing biofuel crops, a rise in food prices is unavoidable.

Fortunately, new technological developments are on the horizon. Ethanol can also be made from cellulose, the large linear molecule of plants consisting entirely of glucose that is the most abundant natural material in the world. Cellulose is the main ingredient in wood and in the new so-called biomass crops, such as *Miscanthus* (a large perennial grass) that do not require much nitrogen fertilizer

CALIFORNIA EDUCATION AND THE ENVIRONMENT INITIATIVE | Unit E.7.b. | The Life and Times of Carbon | Student Edition 3

RST.9–10.1: Cite specific textual evidence to support analysis of science…texts, attending the precise details of explanations or descriptions.

Suggestion: *While reading, have students summarize sections of the material, citing evidence from the text.*

WHST.9–10.2b: Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details…or other information and examples…

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and can have yields of 15 tons of biomass per acre when grown on good soils. The University of California at Berkeley has major research projects funded by the State of California and British Petroleum to develop the processes that convert cellulosic biomass into biofuels.

Scientists reported at our biofuels conference that sugar can also be fermented directly into gasoline-like molecules, such as alkanes, that do not need to be distilled. This would require us to create new superbugs. Remember the superbugs that ate oil spills? Our new superbugs would produce oil-like molecules for transportation.

Also, oil can be produced by microalgae living in shallow ponds using the nutrients in municipal wastewater. With such plant and algal sources and with new industrial processes and fermentations, we could have a true greenhouse gas neutral transportation system that prevents further buildup of carbon dioxide and the two other greenhouse gases released as a result of agricultural practices—methane and nitrous oxide—into the atmosphere. Indeed, the other greenhouse gases have to be counted as well. Jeff Severinghaus, of UCSD's Scripps Institution of Oceanography, reported at the meeting that for those crops that require nitrogen fertilizers, such as corn, canola and switchgrass, the release of nitrous oxide by soil bacteria may negate the positive effect of carbon dioxide absorption by photosynthesis.

So, when can we implement those solutions that promise to reduce greenhouse gases? Major technological breakthroughs are still needed to make these biofuels a reality. For one, the new crops need to be bred and selected—domesticated—for high biomass production. We still need to find the best genes and create the most efficient bacteria that would carry out these novel fermentations to produce alkanes rather than ethanol. We also need to develop more economical methods for the large-scale cultivation of algae and ways of extracting the new fuel molecules. Unfortunately, research on plants, algae and microbes has been woefully underfunded for decades as the nation focused its research dollars on human health and diseases.

By the end of the conference many in the audience realized that stark choices are being forced upon us: Fuel or tortillas, beef or biodiesel, which shall it be? When our lawmakers and the public at large understand that such choices are on our doorstep, then this funding trend could be reversed. Hopeful signs are the president's proposed budget already mentioned and a recent report by the National Research Council urging much greater funding for plant genetics, the basis of all crop improvement for food, fuel or fiber.

Algal bloom in pond

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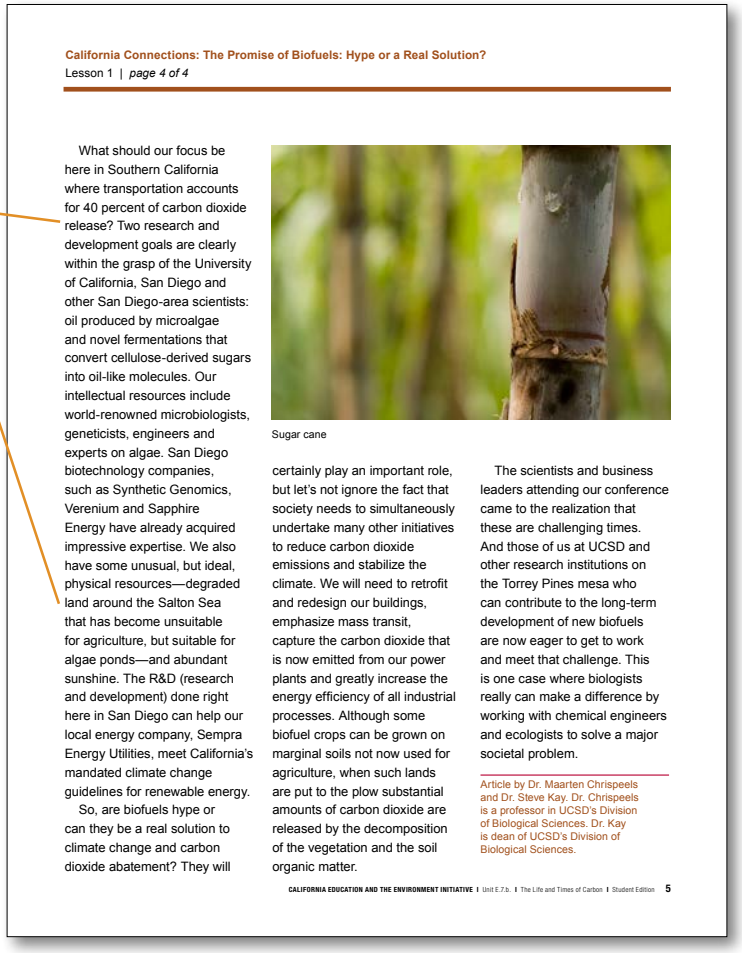
RST.9–10.4: Determine the meaning of symbols, key terms, and other domain-specific words…

- *Cellulosic*
- *Alkanes*
- *Fermentation*

WHST.9–10.2b: Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details…or other information and examples…



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What should our focus be here in Southern California where transportation accounts for 40 percent of carbon dioxide release? Two research and development goals are clearly within the grasp of the University of California, San Diego and other San Diego-area scientists: oil produced by microalgae and novel fermentations that convert cellulose-derived sugars into oil-like molecules. Our intellectual resources include world-renowned microbiologists, geneticists, engineers and experts on algae. San Diego biotechnology companies, such as Synthetic Genomics, Verenium and Sapphire Energy have already acquired impressive expertise. We also have some unusual, but ideal, physical resources—degraded land around the Salton Sea that has become unsuitable for agriculture, but suitable for algae ponds—and abundant sunshine. The R&D (research and development) done right here in San Diego can help our local energy company, Sempra Energy Utilities, meet California's mandated climate change guidelines for renewable energy.

So, are biofuels hype or can they be a real solution to climate change and carbon dioxide abatement? They will certainly play an important role, but let's not ignore the fact that society needs to simultaneously undertake many other initiatives to reduce carbon dioxide emissions and stabilize the climate. We will need to retrofit and redesign our buildings, emphasize mass transit, capture the carbon dioxide that is now emitted from our power plants and greatly increase the energy efficiency of all industrial processes. Although some biofuel crops can be grown on marginal soils not now used for agriculture, when such lands are put to the plow substantial amounts of carbon dioxide are released by the decomposition of the vegetation and the soil organic matter.

Sugar cane

The scientists and business leaders attending our conference came to the realization that these are challenging times. And those of us at UCSD and other research institutions on the Torrey Pines mesa who can contribute to the long-term development of new biofuels are now eager to get to work and meet that challenge. This is one case where biologists really can make a difference by working with chemical engineers and ecologists to solve a major societal problem.

Article by Dr. Maarten Chrispeels and Dr. Steve Kay. Dr. Chrispeels is a professor in UCSD's Division of Biological Sciences. Dr. Kay is dean of UCSD's Division of Biological Sciences.

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RST.9–10.6: Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Suggestion: *Revisit the question asked in the title and have students decide if the questions was adequately addressed. Have students cite text to support their position.*

California Common Core State Standards Descriptions for Grades 9–10

Speaking and Listening Standards

- **SL.9–10.1:** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grades 9–10 topics, texts, and issues,* building on others' ideas and expressing their own clearly and persuasively.
  - c) Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.
  - d) Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.
- **SL.9–10.2:** Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.
- **SL.9–10.4:** Present information, findings, and supporting evidence clearly, concisely, and logically **(using appropriate eye contact, adequate volume, and clear pronunciation)** such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose **(e.g., argument, narrative, informative, response to literature presentations),** audience, and task. **CA**

Reading Standards for Literacy in Science and Technical Subjects

- **RST.9–10.1:** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
- **RST.9–10.2:** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- **RST.9–10.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.
- **RST.9–10.5:** Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
- **RST.9–10.6:** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
- **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.9–10.10:** By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects

- **WHST.9–10.2:** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
  - a) Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
  - b) Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
  - c) Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
  - d) Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
  - f) Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

- **WHST.9–10.4:** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- **WHST.9–10.8:** Gather relevant information from multiple authoritative print and digital sources **(primary and secondary),** using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. **CA**

California Common Core State Standards Descriptions for Grades 11–12

Speaking and Listening Standards

- **SL.11–12.1:** Initiate and participate effectively in a range of collaborative discussions (one-on- one, in groups, and teacher-led) with diverse partners on *grades 11–12 topics, texts, and issues,* building on others' ideas and expressing their own clearly and persuasively.

  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.

Reading Standards for Literacy in Science and Technical Subjects

- **RST.11–12.2:** Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- **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.