Kelly Byrne **Bull** and Juliann **Dupuis**

The Role of Young Adult Nonfiction in an Interdisciplinary Approach to Teaching Genetics

Sometimes the students labeled "reluctant readers" are only reluctant to read the steady diet of fiction offered to them in English class. Increasingly, English teachers are looking to expand the kinds of texts they teach in order to better meet students' diverse interests and abilities. To meet students' interests, English teachers can include quality titles of young adult (YA) nonfiction that engage those readers who thrive by learning more about a multitude of subjects. In fact, *Reading Next* (Biancarosa & Snow, 2006) identifies elements of effective adolescent literacy programs, calling for "language arts teachers using content area texts and content area teachers providing instruction and practice in reading and writing skills specific to their subject area" (p. 4). Such calls speak directly to English teachers, encouraging them to participate in interdisciplinary teams to benefit student learning.

Adolescent Literacy: A Position Statement (IRA, 2012) also encourages content area teachers to collaborate, stating that adolescents deserve "content area teachers who provide instruction in the multiple literacy strategies" and "deserve access to and instruction with multimodal, multiple texts" (p. 2). The use of literacy strategies, namely the focus of English teachers on providing materials concentrated on a particular area of study, can only help to create meaningful content area learning from text that has been a continuous "barrier to both science learning and reading comprehension" (Romance & Vitale, 2011, p. 1).

With these position statements in mind and acknowledging how the Common Core State Standards (CCSS) (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) call for an increased use of nonfiction in English classrooms, we look to an interdisciplinary teaming of English and biology to answer these literacy calls and build student learning. We—an English educator and a science educator—believe that YA nonfiction is a powerful tool in an interdisciplinary approach for teaching content in both English and biology classrooms.

Sheehy and Clemmons (2012) assert that "the future of YAL must include its integration into all content areas through engaging projects that challenge students to integrate literacy, critical thinking, content, and technology" (p. 226). Supporting this stance, Au (2013) acknowledges that "by high school, many students of diverse backgrounds are reading and writing far below grade-level expectations. These students need the boost provided when all teachers emphasize the importance of literacy and teach accordingly" (p. 537). In addition, Romance and Vitale (2011) supported previously reported findings with conclusions from a multi-year study that content area learning in science was effective as a means for improving student reading and comprehension. The authors provide implications that suggest that a curricular approach to integrating literacy within in-depth science instruction has the potential to increase student academic

achievement both directly and through transfer. This article aims to illustrate how English and biology teachers can utilize YA nonfiction texts to provide an interdisciplinary approach to teach genetics via the theory of evolution.

In high schools across the country, students often take courses in English and biology at the same time, providing an opportunity for these content area teachers to collaborate. In such collaborations, "sharing books with our colleagues can initiate rich discussions about the role young adult literature can play in fostering adolescents' literacy and content knowledge"(Bull, Dulaney, North-Coleman, Kaplan, & Stover, 2013, p. 121). Both English and biology teachers benefit when their students employ literacy skills, are involved in meaning making with complex texts, and increase their comprehension. The purpose of this article is to illustrate how YA nonfiction texts (in both print and digital format) can be utilized in an interdisciplinary approach, teaming English and biology teachers, to strengthen students' understandings of genetics. This kind of collaboration can improve student comprehension of science content while meeting the English language arts standards identified in the CCSS: a win-win situation for both teachers and their students.

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A Rationale for Interdisciplinary Instruction

This article, while intended for the use of all teachers, may be most helpful to those teachers who are new to the idea of interdisciplinary teaching. The ideas are meant to help scaffold the process of teaching across the curriculum and can be adjusted for the use in all content area classrooms. It is our hope that the reader is able to find ideas that will spark an interest or will inspire collaboration between colleagues.

We understand that oftentimes educators find themselves struggling with the amount of information they must cover within their content areas, leaving little time or space in their curriculum to collaborate with others. This lack of collaboration is not only due to the immense pressure felt by teachers to prepare students for state testing, but also the deficit in the amount of time there is to meet with other teachers, especially those teaching other subject areas, due to the different teaching schedules.

While these barriers can seem overwhelming and discouraging, they are not absolute and can be overcome by encouraging leadership to incorporate some common planning times into the schedule throughout the week or during professional development days. The collaborative planning will only work to enhance the connections students will make between subject areas and their relation to real-life encounters. With the implementation of the Common Core Standards, teachers of all content areas are responsible for teaching core disciplinary ideas and concepts. The integration of these concepts in all subject areas is of benefit to both teachers and students: students are better able to see and make tangible connections between subjects; teachers are able to build on one another's ideas, making them more focused, engaging, and confident. This integration provides the perfect opportunity for teachers to work on curriculum mapping , encouraging those who teach the same subjects to collaborate and discuss where and how they teach certain topics. Those teachers who teach different subjects can also discuss their timelines and where certain subjects may fit together well, thus promoting the idea of teaming across content areas.

High school teachers typically teach the same content and books across grade levels and ability levels. With this continuity, it would be possible to integrate another text focusing on a specific area of study about another subject—in this case, genetics. Whether or not the students have the same biology teacher is irrelevant, because at some point during the year, students taking biology will encounter genetics in their curriculum. The overlap in the English classroom can only help to bolster an understanding of these concepts.

Teachers of both subjects will need to find a common planning time to discuss any questions or concerns either of them may have. A good time to do this is during inservice days. Often, there is some time set aside in the day for individuals to work on planning and/or collaboration. If this is not the case, then asking for some time from administrators is reason-

able. While the content in each course overlaps, there is still freedom for each teacher to make the content their own and teach using preferred methodologies.

A Rationale for the English–Biology Collaboration

The interdisciplinary study we offer in this article employs YA nonfiction in meaningful ways that can benefit all stakeholders: English teachers, biology teachers, and the adolescents they teach. English teachers can benefit from this interdisciplinary approach in three ways. First, the new NCTE/NCATE Standards for Initial Preparation of Teachers of Secondary English Language Arts, Grades 7–12 was approved in October 2012 and has important implications for both preservice and practicing teachers.

Specifically, element six of Standard Three calls for teachers to "plan instruction which, when appropriate, reflects curriculum integration and incorporates interdisciplinary teaching methods and materials" (NCATE, 2012). Knowing that adolescents often struggle with and are rarely encouraged to see how subjects have cross-curricular connections, English teachers can look for ways to make such connections more transparent and relevant. Second, the Common Core English Language Arts Standards (2010) call for increased emphasis on informational text and its range, quality, and complexity. YA nonfiction texts that center on genetics content hit these marks. Third, a key text that we offer in this article is a work of graphic nonfiction, a relatively new genre that appeals to YA readers who are interested in learning content (nonfiction) through a highly visual format (graphic novel). What English teacher *isn't* interested in test-driving this graphic-nonfiction vehicle that is sure to engage reluctant readers?

Biology teachers can benefit from this approach, too. Incorporating YA nonfiction texts that will supplement and enrich units of study is a goal of this approach. These YA nonfiction texts are not meant to replace biology textbooks, but to be used as supplemental texts that offer accurate information on specific topics in great depth and detail. Our approach offers literacy-building activities that align with both the CCSS (2010) and the newly published *Next Generation Science Standards* (Achieve, 2013). It is our hope that these instructional activities that align with national standards will encourage biology teachers to incorporate these YA nonfiction selections into their units of study.

Science and Literacy

The marrying of the two concepts, science and literacy, into one cohesive package is integral to growing our students into responsible and informed citizens who are able to make educated decisions and engage with policymakers regarding important scientific issues (Dougherty, 2009). The ability to integrate ideas and subject matter should not be a foreign concept, but rather one that is commonplace; it is our job as educators to make this explicit connection for our students. Reading is seemingly a neglected part of the science curriculum, as textbooks are used most often to provide homework (Wellington & Osborne, 2001). The missing connection between reading and science is unfortunate, given that most scientists today spend much time reading and acquiring knowledge (Wellington & Osborne, 2001). It is the job of the science teacher, therefore, to make this connection for students and teach them how to read "actively, critically, and efficiently" (Wellington & Osborne, 2001, p. 41).

Young adult nonfiction (aka trade books) for the science classroom offers teachers current, accurate texts that are rich in the depth and detail on focused topics that textbooks cannot match.

Young adult nonfiction (aka trade books) for the science classroom offers teachers current, accurate texts that are rich in the depth and detail on focused topics that textbooks cannot match. NSTA asserts that "reading science trade books is the perfect way for students to build literacy skills while learning science content" (National Science Teachers Association, 2013). Recent studies support the view that students learn effectively when scientific concepts are studied through the use of trade books. Authors of these studies have noted that students who read trade books in the science classroom have increased knowledge and vocabulary acquisition (Fang & Wei, 2010), improved motivation and engagement (Jensen & Moore, 2008),

and improved standardized test scores (Greenleaf et al., 2011). Such findings are difficult to overlook when teachers consider how to improve engagement and achievement in their own classrooms.

Although these studies document student gains in the science classroom, they do not address how an interdisciplinary study of YA nonfiction might improve student learning. Additionally, "recent pedagogical scholarship is aimed at making students active readers of fiction, but there is less discussion of teaching nonfiction genres" (Lamb, 2010, p. 43). Our article seeks to address both of these concerns. Because the study of science is vast and our space is limited, we chose to focus on one particular unit of study commonly found in a biology class—genetics.

To assist educators with incorporating these nonfiction texts into their classrooms, we offer reading strategies and multimodal activities designed to improve student comprehension.

What follows here are selections of YA nonfiction that can be used to teach genetics through the theory of evolution and to build literacy skills. These texts can be incorporated into English and biology classrooms to deepen students' content knowledge and improve students' integration of knowledge and ideas. To assist educators with incorporating these nonfiction texts into their classrooms, we offer reading strategies and multimodal activities designed to improve student comprehension.

YA Nonfiction Genetics Texts & Teaching Strategies

In the English Classroom: Graphic Nonfiction

Graphic nonfiction is a relatively new genre that has not received much scholarly attention. This is unfortunate because graphic nonfiction affords both teachers and students valuable literacy opportunities, particularly with the majority of states adopting the Common Core State Standards. Graphic novels "by their very nature, draw the reader into the story because the reader has to construct the story by actively integrating visual and verbal components. This is both a highly creative and interactive process, which makes learning more meaningful" (Jaffe, 2012). Teaching *The Stuff of Life: A Graphic Guide to Genetics and DNA* (Schultz, Cannon, & Cannon, 2009) can draw readers into the story, meet numerous Common Core State Standards for English Language Arts, and strengthen and deepen content knowledge in biology class.

The Stuff of Life: A Graphic Guide to Genetics and DNA (Schultz et al., 2009) is an award-winning selection of graphic nonfiction written for young adults. Recommended by *School Library Journal* and *Booklist*, *The Stuff of Life* is also a Young Adult Library Services Association (YALSA) 2009 Great Graphic Novel and a 2010 Quick Pick for Reluctant YA Readers. Using an entertaining format, *The Stuff of Life* explains genetics in a multimodal way, illustrating complex concepts and processes with artwork and highly accessible text. Students are sure to enjoy the "back story" of this book: Bloort, an alien from another planet, has traveled to earth to study human genetics and is reporting back to his leader. Bloort's information helps his leader determine that evolutionary processes that lead to genetic diversity are a strength for species survival and that his species could benefit greatly from such diversity.

Literacy activities designed to engage learners with meaning making throughout their reading of *The Stuff of Life* are included in Table 1. These activities are designed to engage readers with understanding key ideas and details, analyzing craft and structure, and integrating knowledge and ideas as called for in the Common Core State Standards for English Language Arts and Literacy in History/Social Studies, Science, and Technical Subjects (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Because *The Stuff of Life* works well across content areas, reading it in English class can assist students in analyzing multimodal text. As graphic nonfiction that is "housed" within a narrative framework, this text provides ample opportunity for readers to develop higher-level thinking. To further analyze *The Stuff of Life*, we believe that interdisciplinary study can take place in the biology classroom, enabling students to develop deeper understanding of genetics.

Table 1 illustrates how this interdisciplinary study can take place and aligns the learning activities with both the Common Core State Standards and the Next Generation of Science Standards. Before-reading activities are designed to build background knowledge

Table 1. How interdisciplinary units satisfy mandates of the CCSS and NGSS

***The Stuff of Life*: Interdisciplinary Teaching**	
In the English Classroom	Follow-Up Discussion in the Biology Classroom
Introduction	
Activities 1. View the book trailer: http://us.macmillan.com/the-stuffoflife-1/MarkSchultz (**CCSL-2:** Integrate multiple sources of information presented in diverse media or formats). 2. Preview the text by listening to NPR's story on *The Stuff of Life*: http://www.npr.org/templates/story/story.php?storyId = 100056967 3. Create a panel-type comic USING CHOGGER (http://chogger.com/creator) to explain a process familiar to you **(CCW-6:** Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others). **Questions:** How does Bloort explain DNA? What is it? What can it do? What metaphors does he use for DNA? (**CCRL-4**: Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the cumulative impact of specific word choices on meaning and tone.) At the end of the introduction, readers learn that Bloort has shared enough intriguing info with his leader to be allowed to continue his presentation. Why does the leader want to learn more? How will this info possibly affect Bloort's planet? **(CCRI-3:** Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are introduced and developed, and the connections that are drawn between them.)	1. Life on earth did begin with asexual reproduction, Bloort tells his leader. However, species evolved through sexual reproduction. What advantages are there to sexual reproduction in terms of genetics? **LS2.D:** Social Interactions and Group Behavior 2. Who were some of the "founding fathers" of human genetics? What were their discoveries? **LS3**: Heredity: Inheritance and Variation of Traits
Ch 1 How the System Works: The Molecular Story	
Questions: 1. Bloort explains that "the language of genetic science is very specific and specialized—it needs to convey concepts that are sometimes hard to visualize. It takes some study to make sense of it" (p. 27). Explain the analogy that Bloort uses to explain how DNA works. 2. How is RNA a "much less cautious, much more promiscuous cousin" to DNA? (p. 35) (**CCRL-4**: Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the cumulative impact of specific word choices on meaning and tone.)	1. There are a few sidebars that chronicle DNA from a Human Perspective in this chapter. Explain the contributions of the people highlighted here. 2. View Anatomy of a Cell (http://www.biology4kids.com/files/cell_main.html) **LS1.A:** Structure and Function **LS1.B**: Growth and Development of Organisms **LS1.C:** Organization for Matter and Energy Flow in Organisms **LS1.D:** Information Processing

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Ch 2 How the System Works: Sex and the Cellular Life	
Activity: With a partner, explain how the dialog format allows for in-depth detail of information to be conveyed. What is the purpose of having the ruler ask Bloort questions? (**CCRI-6:** Assess how point of view or purpose shapes the content and style of a text; AND **CCR Anchor Standard 2:** Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.)	1. Provide a few examples of how chromosome complexities create varieties within a particular species of organism. 2. Construct an "Alike but Different" graphic organizer for mitosis and meiosis. (Briefly describe the cell cycle process known as mitosis. Briefly describe the cell cycle process known as meiosis.) 3. View Mitosis (http://micro.magnet.fsu.edu/micro/gallery/mitosis/mitosis.html)
Ch 3: How the System Works: Everyone Gets an Inheritance	
Activity: Transform pictures into text that explains a process. Explain in writing how X [choose a process] occurs. Students must use pictures and text from the story to make sense of and explain the process in their own words. (**CCW2:** Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.)	1. How did Mendel come to understand laws of genetics? 2. Illustrate the probability of an offspring's having a particular genotype by using Punnet Squares. 3. The leader surmises that phenotype expression is more 'unruly' than genotype. Explain why. 4. View Learn Genetics (http://learn.genetics.utah.edu/)
Ch 4: Applying All That Stuff: For the Greater Good	
Choose 5 terms that you feel should have been included in the glossary because they are important. For each, write a definition and create an illustration. Write a sentence for each word, incorporating context clues to assist readers with determining meaning. Teachers should collect this work, and use these words, definitions, and illustrations to: • construct a bulletin board for word study; • create a review game where students must match the word/definition with the correct picture; • direct students to find these words used in context (articles on the Web; in this graphic novel; in the biology textbook). The leader is very interested in gene therapy because he wonders if it might be a solution to the genetic problems his species faces. Use the following words in a paragraph to explain how gene therapy works: identify, manipulate, splice, microbes, insert. (**CCS Reading Anchor 2:** Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.)	1. Explain the significance of the Human Genome Project. 2. View Control of the Cell http://www.nobelprize.org/educational/medicine/2001/ **LS2.D: Social Interactions and Group Behavior**

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Ch 5: Applying All That Stuff: Into the Future through the Past	
Explain the two theories concerning Neanderthals presented in this chapter. (**CCRI-8:** Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning.) From Bloort's lessons on genetics, what does the ruler decide is best for his planet? What changes will this mean for life on Glargal? (**CCSS Reading Anchor 3**: Analyze how and why individuals, events, and ideas develop and interact over the course of a text.) Construct a Glogster: graphic blog. This is a creative, interactive tech tool that utilizes both print and nonprint media. Mix Web, Images, Text, Music, and Video to express your understanding of X (choose a process). (**CCSL-5:** Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.)	1. Variations in the human species are significant. They reflect the fact that humans migrated from a single point of origin to establish genetically differentiated populations around the globe" (p. 123). How do we know this? Interpret the family tree on p 125. **Core Idea LS4:** Biological Evolution: Unity and Diversity **LS4.A:** Evidence of Common Ancestry and Diversity 2. View Evolution http://evolution.berkeley.edu/evolibrary/article/evo_01 **LS4.B**: Natural Selection **LS4.C:** Adaptation **LS4.D:** Biodiversity and Humans Create a panel-type comic USING CHOGGER (http://chogger.com/creator) to explain Y process in science. (**CCSW 6:** Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.)

and familiarize students with the genre of graphic nonfiction. They include multimodal resources to assist students with understanding content by viewing, listening, and creating. During-reading activities are designed to clarify concepts for students. They include examining the narrative framework of this story, completing chapter-specific reading guide questions, and creating illustrations to convey a scientific process. After-reading activities are designed to review and synthesis content presented in the book. They include focusing on key vocabulary, illustrating scientific concepts, and using multimedia resources to provide evidence of their understanding. Because biology is traditionally taught in ninth or tenth grade, we have aligned activities with the Grades 9–10 Complexity Band of the CCSS.

In all, the narrative structure of *The Stuff of Life* lends itself to a traditional literary analysis. The graphic aspect of the story illustrates clearly complex scientific concepts and processes. Together, the structure and illustration offer both English and biology teachers a wealth of teachable lessons to develop students' critical thinking, writing, and analysis while meeting curricular objectives and aligning with the CCSS.

In the Biology Classroom: Two Websites

Adolescents are "engaging more and more in reading and writing mediated by technology" (Conradi, Jang, Bryant, Craft, & McKenna, 2013, p. 567). Incorporating such multimedia into our instruction can engage and motivate learners as they deepen their content knowledge. Here are a few such websites.

The American Museum of Natural History—Darwin website: Found at http://www.amnh.org/exhibitions/past-exhibitions/darwin, this website has a vast amount of information about Darwin's life history, spanning from his childhood through all of his contributions to the understandings of evolution. One of our most well-known scientists, Charles Darwin is responsible for the theory of evolution. With his detailed notes and observations of finches from the Galapagos Islands, he became the authority on the adaptation of traits—the process whereby living species evolve in response to their environment.

The American Museum of Natural History website is broken into many different focus areas from which teachers can choose. An example that focuses on one particular portion of Darwin's history, entitled *The Idea Takes Shape,* is particularly helpful. Table 2 con-

Table 2. Reading guide for American Museum of Natural History website on Darwin

Sequence of Reading Activities	Activities	Alignment with Disciplinary Core Ideas and Common Core State Standards
Before	Post the following quote on the board ". . . barriers of every kind seem to separate regions in a greater degree than proportionally to the difference of climates on each side. Thus, great chains of mountains, spaces of sea between islands and continents, even great rivers and deserts." Ask students to think about and discuss what Charles Darwin meant by this. (He is emphasizing the importance of physical barriers—"spaces of sea between islands" like the Galpagos—in the origin of new species.) Ask students to define natural selection and how it relates to the quote.	**LS3:** Heredity: Inheritance and Variation of Traits across Generations—focuses on the flow of genetic information between generations. This idea explains the mechanisms of genetic inheritance and describes the environmental and genetic causes of gene mutation and the alteration of gene expression. **LS3B:** Variation of Traits **CCSS Speaking and Listening Anchor 1:** Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
During	Complete an analysis of directed activities relating to text (DARTs; see Figure 1). Students create tables using information from the information provided in the webpage. The headings are constructed by the student based on themes that may emerge. When tables are complete, ask students to make connections between their ideas either in graphic (concept map) form or written.	**LS4:** Biological Evolution: Unity and Diversity—explores "changes in the traits of populations of organisms over time" and the factors that account for species' unity and diversity alike. **LS4.A:** Evidence of Common Ancestry and Diversity **CCSS Reading Anchor 7:** Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively as well as in words.
After	Small-group and class discussion. Ask students how Darwin arrived at his final conclusion that natural selection was the cause of variation in organisms. Ask students to make connections to the scientific method. (Darwin gathered data from the islands, read other pieces of literature, formed a hypothesis about the origin of different species, continued to make comparisons between organisms (studying his specimens and others more local), arrived at current conclusion that "More animals were born than could survive. They constantly struggled against one another for food or room to grow, he thought. That meant any plant or animal with a competitive edge--drought tolerance, a thicker-than-average coat—could live longer and leave more offspring than its fellows. The presence of such adaptations controlled, in effect, which individuals would represent the species in the next generation.")	**LS3:** Heredity: Inheritance and Variation of Traits across Generations—focuses on the flow of genetic information between generations. This idea explains the mechanisms of genetic inheritance and describes the environmental and genetic causes of gene mutation and the alteration of gene expression. **LS3.A:** Inheritance of Traits **LS3.B:** Variation of Traits **LS4:** Biological Evolution: Unity and Diversity—explores "changes in the traits of populations of organisms over time" and the factors that account for species' unity and diversity alike. **LS4.B:** Natural Selection **LS4.C:** Adaptation **CCSS Reading Anchor 2:** Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

Types of organism	Location	Other species known to exist elsewhere
Finches	Galapagos (different versions found on all the islands)	
Mockingbird	Galapagos (2 of the 3 from different islands)	
Lesser Rhea	South America	Larger Rhea (common to an adjacent region)
Toxodon fossil	Uruguay (and 200 miles away)	

Figure 1. Example of analysis DART

tains a reading guide for this website, offering before-, during-, and after-reading activities that are aligned with Disciplinary Core Ideas. This reading guide is tailored to assist students in deepening their content knowledge through literacy activities (including "Directed Activities Relating to Text" or DART; see Figure 1). The goal of using this particular website would be to explore the essential question: *How does variation between individuals of the same species allow for survival?* Learning objectives for students would include: 1) explaining how barriers lead to changes in organisms, and 2) making connections between information in a text with scientific concepts.

Understanding Evolution, University of California, Berkeley, found at http://evolution.berkeley.edu/, has an immense amount of information focusing on Darwin, but also on the concept of evolution in general. The section used as an example is titled *Misconceptions about Natural Selection and Adaptation*. While there are many concepts to focus on regarding evolution, it is important that students' common misconceptions be addressed. In this section, incorrect information is dispelled, and students are provided with correct information regarding concepts commonly misunderstood.

Table 3 is a reading guide for this website offering before-, during-, and after-reading activities that are aligned with Disciplinary Core Ideas and the CCSS. It is tailored to assist students in deepening their content knowledge through literacy activities. A main focus or essential guiding question for this lesson would be: *How does genetics play a role in the evolution of species?* Learning objectives for students would include: 1) explaining the role that heritable traits have on natural selection, and 2) generalizing that organisms change due to the shift in environmental factors focusing on the need for survival.

The split-sentence DART in Figure 2 can be used with students in two ways:

1. Hand out the two lists in different envelopes and have students arrange the first list so all phrases can be seen, then take a phrase out of the second envelope and try and match it to one of the phrases already displayed.
2. Provide students with both lists of phrases, either on a piece of paper or on the board. Have students match a phrase on the left with a word/phrase on the right (Wellington & Osborne, 2001).

Given the push for the incorporation of digital text and media sources by the CCSS, the two websites we have highlighted will prove helpful and beneficial to students who are studying the topic of genetics. When websites such as these are used in conjunction with the textbook, students are provided with multiple modes and layers of learning. This learning is greatly beneficial to the diversity of learners we so often have in our classrooms who could benefit from expanding their book knowledge and engaging in other methods of instruction. Although we have offered a few suggested uses for the websites, there is a vast array of activities that could be constructed using the information provided there. We encourage teachers to adjust their activities according to students' needs and interests and to seek out other websites to supplement their book work.

Conclusion

Using YA nonfiction and websites as resources for teaching genetics and other science concepts provides

Table 3. Reading guide for UC Berkeley site on evolution

Sequence of Reading Activities	Activities	Alignment with Disciplinary Core Ideas and Common Core State Standards
Before	Use a split sentence DART to determine student levels of understanding before reading information on evolution. (See Figure 2.)	**LS4:** Biological Evolution: Unity and Diversity—explores "changes in the traits of populations of organisms over time" and the factors that account for species' unity and diversity alike. **LS4.B:** Natural Selection **LS4.C:** Adaptation **CCSS Reading Anchor 5:** Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text relate to each other and the whole.
During	Students construct a Frayer Model (Frayer, Frederick, & Klausmeier, 1969) using the concept of Natural Selection as the central focus and building upon it throughout the reading. (See Figure 3.)	**LS3:** Heredity: Inheritance. and Variation of Traits across Generations—focuses on the flow of genetic information between generations. This idea explains the mechanisms of genetic inheritance and describes the environmental and genetic causes of gene mutation and the alteration of gene expression. **LS3.A:** Inheritance of Traits **LS3.B:** Variation of Traits **LS4:** Biological Evolution: Unity and Diversity—explores "changes in the traits of populations of organisms over time" and the factors that account for species' unity and diversity alike. **LS4.B** Natural Selection **CCSS Reading Anchor 7:** Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.
After	After students read the webpage, ask them to reevaluate the phrase pairings from the *before* activity (Fig. 2). Ask students to identify which phrases are misconceptions, then discuss what the correct phrases should be and why. (Incorrect phrases: Natural selection is a process that perfects organisms; all adaptations can be used to explain natural selection; the only mechanism of evolution is natural selection.)	**LS4:** Biological Evolution: Unity and Diversity—explores "changes in the traits of populations of organisms over time" and the factors that account for species' unity and diversity alike. **LS4.B** Natural Selection **LS4.C** Adaptation **CCSS Reading Anchor 1:** Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

students with supplemental texts that are rich in detail and description. Reading such texts enriches their understanding, especially when teachers utilize content area literacy strategies such as those mentioned in the article. In particular, we find graphic nonfiction to be an especially powerful tool for communicating complex ideas in an accessible multimodal way for students. *The Stuff of Life* is an important text that lends itself well to interdisciplinary study, prompting students to think critically about both the form and content of the text. Our before-, during-, and after-reading activities prompted students to interact with texts by working collaboratively and utilizing technology to construct their understandings of genetics. Such

Phrase List A	Phrase List B
• Selection is dependent on • Natural Selection is a process • All adaptations • Feathers are • The only mechanism of evolution is • Mutation, migration, and genetic drift are • An exaptation	• natural selection • heritable traits • mechanisms of evolution • performs a function not produced by natural selection for its current use • can be used to explain natural selection • that perfects organisms • availability of genetic variation

Figure 2. A split-sentence DART

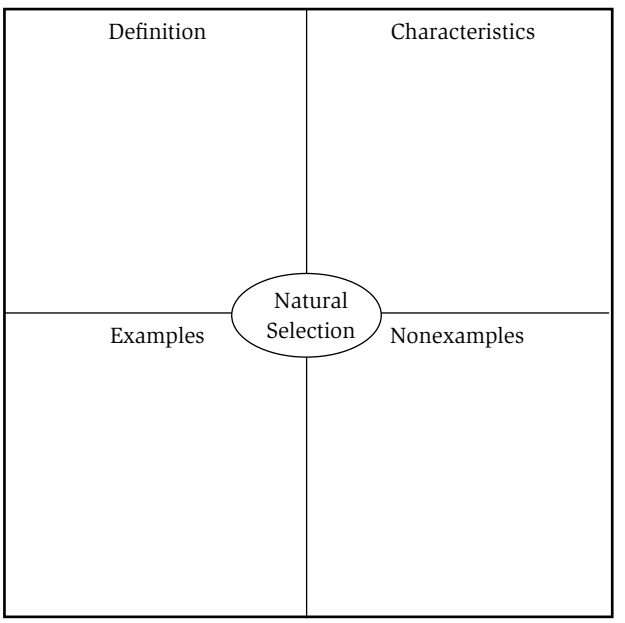

Figure 3. Frayer model for vocabulary development

instruction integrates the new Science Framework with the Common Core State Standards, ensuring our students work toward mastering twenty-first-century learning goals—goals that will prove to be beneficial beyond the walls of high school and support them in pursuing careers where they will be expected to work with information in multiple formats and interact with others in a respectful and productive environment.

We hope that this article intrigues readers enough to consider using these concrete strategies for interdisciplinary collaborations between English and biology teachers. Twenty-first-century learning, we believe, calls for methods and materials to engage learners in critical thinking and active learning across disciplines. For additional YA nonfiction texts that may work well for other English–biology collaborations, consider those in Tables 4 and 5.

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Table 4. Additional genetics & evolution texts to consider

Trade Books

- **Charles Darwin's* On the Origin of Species*: A Graphic Adaptation* (graphic novel)
- **Darwin: A Graphic Biography* (graphic novel)
- **Evolution: The Story of Life on Earth* (graphic novel)
- *EVO Teachers' Guide: Ten Questions Everyone Should Ask about Evolution*
- *The Usborne Introduction to Genes & DNA*
- *Garden Genetics: Teaching with Edible Plants*
- *Kingfisher Knowledge: Genes and DNA*

Websites:

- Learn Genetics: http://learn.genetics.utah.edu/
- Control the Cell Cycle Game: http://www.nobelprize.org/educational/medicine/2001/index.html
- About Darwin: http://www.pbs.org/wgbh/evolution/index.html
- Evolution Lessons: http://www.pbs.org/wgbh/evolution/educators/lessons/index.html
- Resources from the National Academies: http://www.nas.edu/evolution/
- Evolution on the Front Line: http://www.aaas.org/news/press_room/evolution/
- PBS Video Series: Evolution—A Journey into Where We're from and Where We're Going: http://www.pbs.org/wgbh/evolution/
- NSTA Recommends 36 books on evolution: http://www.nsta.org/publications/evolution.aspx

Table 5. YA nonfiction texts for additional English–Biology collaborations

Mary Roach	• *Gulp: Adventures on the Alimentary Canal* • *Stiff: The Curious Lives of Human Cadavers* • *Bonk: The Curious Coupling of Sex and Science* • *Packing for Mars: The Curious Science of Life in the Void* • *Spook: Science Tackles the Afterlife*
Sy Montgomery	• *Temple Grandin: How the Girl Who Loved Cows Embraced Autism and Changed the World* • *The Good Good Pig: The Extraordinary Life of Christopher Hogwood* • *Numerous award-winning titles from the Scientists in the Field series*
Phillip Hoose	• *Moonbird: A Year on the Wind with the Great Survivor B95* • *The Race to Save the Lord God Bird*
Jay Hosler	• *Evolution: The Story of Life on Earth* • *Clan Apis* • *The Sandwalk Adventures: An Adventure in Evolution Told in Five Chapters*
Christopher Willis	• *The Darwinian Tourist: Viewing the World through Evolutionary Eyes* • *The Spark of Life: Darwin and the Primeval Soup* • *Children of Prometheus: The Accelerating Pace of Human Evolution*

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