Includes CCSS Call-Outs

Teacher's Guide

Using Science Fiction/ Speculative Fiction to Support a Science Curriculum

Penguin Random House
ACADEMIC RESOURCES

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CONTENTS

WHY USE SCIENCE FICTION/SPECULATIVE FICTION TO SUPPORT A SCIENCE CURRICULUM?

If you think back to what first got you interested in science, what do you remember? Many people point to the first time they saw *Star Wars* in the theater, or read *Jurassic Park*. Maybe you have a similar story. Perhaps you became interested in medicine because of a television show like *House* or *ER*—or even earlier, when you first read *The Magic School Bus*.

In the social sciences, narratives are routinely used to engage students and provide a framework that makes content meaningful and relevant, and there is a growing body of research that suggests that the use of narrative in science may have similar positive effects. In the article "A Theoretical Framework for Narrative Explanation in Science," researchers note: "More narration might go some way toward altering the image of science as impersonal, atemporal, and ahistorical, characteristics that appear off-putting at least for some people"(Norris, et al.).*

The purpose of this guide is to provide some concrete examples of ways that science teachers can begin to incorporate science-based narrative fiction into their classrooms. Speculative fiction is not meant to be a replacement or alternative to the empirical study of science and use of expository texts; rather, speculative fiction can be a powerful supplement to pique student curiosity in and promote engagement with the sciences. Reading science fiction gives students the opportunity to explore scientific theories and concepts in a creative context, and imagine where science may one day lead us. That curiosity has the potential to do more than just get students interested in studying science; it could also be the spark that ignites future inquiry and fuels discovery.

ABOUT THIS GUIDE

The content in this guide is aligned with the Common Core Standards in Science and Technical Subjects and Writing: History, Social Studies, Science, and Technical Subjects, as well as Anchor Standards in Reading, Speaking and Listening, and Language.

The guide is broken up into three sections, with books divided into grade levels 6–8, 9–10, and 11–12, based on the complexity of the text and the explicitness of the novels. There is a brief introduction to each text and a series of questions that link each book's content to scientific concepts and topics. After each section, an additional list of titles with plots involving similar content and themes is provided as a resource for further exploration or differentiation.

* Norris, S. P., Guilbert, S. M., Smith, M. L., Hakimelahi, S. and Phillips, L. M. (2005), A theoretical framework for narrative explanation in science. Sci. Ed., 89: 535–563. doi: 10.1002/sce.20063

NOTE TO THE TEACHER

In writing a work of speculative fiction, an author must create a world that is internally consistent. This means that, although a writer is not limited by the scientific "reality" of the actual world we live in, the fictional world he or she creates must function according to a discernible set of laws. These laws usually operate within our understanding of chemistry, physics, and biology. When reading a work of speculative fiction, students should be able to identify the scientific laws and principles that govern the text. As an illustration of this concept, you may be interested in PBS Digital Media's episode of *It's Okay to Be Smart* examining the science behind the television series *Game of Thrones* (*http://tinyurl.com/mnf39wz*)

"Imagination is more important than knowledge. For knowledge is limited to all we now know and understand, while imagination embraces the entire world, and all there ever will be to know and understand."
—Albert Einstein

The following is a list of terms used for genres of speculative fiction. The titles in this guide span these genres:

SPECULATIVE FICTION: an umbrella term that encompasses most genres of non-realistic fiction or fiction with fantastical elements.

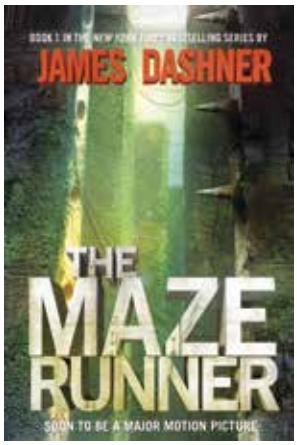
SCIENCE FICTION: fiction with a futuristic setting, often in outer space, and usually involving technology that does not yet exist but still operates within scientific laws and theories as they are currently understood. *Star Wars* and *Star Trek* are examples of this genre.

DYSTOPIA: a genre of speculative fiction that has seen a surge in popularity in recent years. Dystopias are broken utopias—worlds where things have gone terribly wrong in some fundamental way. Dystopian societies are typically the result of a totalitarian regime, environmental disaster, or the misuse of technology. *1984* and *Brave New World* are classic dystopian novels, while *The Hunger Games* is a more recent addition to the genre.

STEAMPUNK: an extremely popular genre of speculative fiction that is characterized by the inclusion of steam-powered versions of modern technology within Victorian/early-twentieth-century settings. The video game *Bioshock Infinite* is an example of steampunk.

CYBERPUNK: a story set in the near future that is concerned with technology and, often, rebellion or challenges to the social order. The movies *Blade Runner* and *The Matrix* are examples of the cyberpunk genre.

SLIPSTREAM: a category of work that bridges genres, often combining some elements of speculative fiction in a work that would otherwise be classified as realistic fiction.



MAZE RUNNER
(Maze Runner, Book One)
by James Dashner
Delacorte Press • TR
978-0-385-73795-1
374pp. • $9.99
Audiobook available from Listening Library as a CD and audio download

The Maze Runner *by James Dashner*

GRADES 6–8

Set in a futuristic world that has been devastated by solar flares and a subsequent outbreak of disease, *The Maze Runner* tells the story of a teenage boy named Thomas, who is trapped in a maze with a group of other boys and one girl. As they struggle to survive, they realize that there is more to the maze than meets the eye; they are actually variables in a giant experiment, and the survival of the entire planet may depend on whether they are able to recover their missing memories, crack the code, and escape the maze.

DISCUSSION QUESTIONS AND ACTIVITIES

1. How are simple machines used in this text? Build a model of one of the simple machines referenced in the book.
2. On page 28, Dashner writes, "The enormous stone wall to the right of them seemed to defy every known law of physics as it slid along the ground, throwing dust and sparks as it moved, rock against rock." What physical law(s) does this description seem to defy? What could be allowing the stone to move in this way?
3. Look at the descriptions of beetle blades found on pages 65 and 124. How would a machine like this work? In a group, design or build a model of a prototype for this type of machine.
4. Based on the description in the book (see pages 118–119, 126–129), what technologies would have been used to create Grievers? How much of this technology currently exists?
5. Explain the process called "The Changing" (pages 142, 149). Is there a scientific explanation for this process?
6. On page 220, Dashner writes, "At dinner Minho had told him an old story— one of the bizarre and random things he remembered from before—about a woman trapped in a maze. She escaped by never taking her right hand off the walls of the maze, sliding it along as she walked. In doing so, she was forced to turn right at every turn, and the simple laws of physics and geometry ensured that she eventually found the exit." Explain how the laws of physics helped her find her way out the maze in this story.
7. Explain how Minho uses scientific observation to discover the pattern of the maze's movement. Explain how scientific observation helps Thomas realize that the world of the maze has been fabricated.
8. What roles do variables play in scientific experiments? Why would Thomas say that the boys are variables (page 301)?
9. What does Thomas realize about the significance of the boys' names? What scientific discoveries are the boys' namesakes credited with?

10. Explain the experiment that the boys and Teresa have been a part of. Is it a well-designed experiment?
11. At the end of the book, Dashner reveals that the devastation on Earth was caused by a series of solar flares and a subsequent outbreak of disease. Explain the science of solar flares. What sort of devastation would they cause if they were to hit the earth?
12. Why would a damaged ecosystem result in the spread of disease?

LAB CONNECTIONS

The Scientific Method, Simple Machines, Code Breaking

CORRELATES TO COMMON CORE STANDARDS

SCIENCE & TECHNICAL SUBJECTS: Key Ideas & Details RST.6-8.1, 6-8.2; Craft & Structure RST.6-8.4, 6-8.5, 6-8.6; Integration of Knowledge & Ideas RST.6-8.8, 6-8.9; Writing Text Types and Purposes WHST.6-8.2a-f; Production & Distribution of Writing WHST.6-8.4, 6-8.5, 6-8.5; Research to Build & Present Knowledge WHST.6-8.7, 6-8.8, 6-8.9; Range of Writing WHST 6-8.10

ANCHOR STANDARDS: Reading Key Ideas & Details CCRA.R.1, CCRA.R.2; Integration of Knowledge & Ideas CCRA.R.9; WRITING: Text Types & Purposes CCRA.W.2, Production & Distribution of Writing CCRA.W.4, W.5, W.6; Research to Build & Present Knowledge CCRA.W.7, W.8, W.9; LANGUAGE: Vocabulary Acquisition & Use CCRA.L.4, L.6; Speaking & Listening Comprehension & Collaboration CCRA.SL.1; Presentation of Knowledge & Ideas CCRA.SL.4

OTHER TITLES OF INTEREST

The Scorch Trials by James Dashner
The Death Cure by James Dashner
The Kill Order by James Dashner
The 5th Wave by Rick Yancey
The Infinite Sea by Rick Yancey

FILM CONNECTION

The Maze Runner (2014) directed by Wes Ball

ALLIANCE
The Paladin Prophecy Book 2
by Mark Frost
Random House Books for Young Readers • HC • 978-0-375-87046-0
352pp. • $17.99
Audiobook available from Listening Library as a CD and audio download

Alliance: The Paladin Prophecy *by Mark Frost*

GRADES 6–8

Because it delves into one of the most controversial applications of genetics—the genetic engineering or modifying of human beings—this novel is a perfect choice as a supplement to engage students in the study of genetics. The National Institutes of Health and the National Library of Medicine have compiled an excellent resource section on genetics for teachers (*http://tinyurl.com/l2a7kuw*), including virtual labs and experiments that you can use in your classroom.

DISCUSSION QUESTIONS AND ACTIVITIES

1. On page 17, Will theorizes that he and his friends have powers "As a result of genetic manipulation performed on us during in vitro fertilization. As a secret medical/scientific program called the Paladin Prophecy." Explain the process of in vitro fertilization. How does genetic manipulation or modification work? Has it been done on humans?
2. On page 113, Frost writes about an astrolabe. Explain how an astrolabe works. Using instructions from St. John's College in Cambridge (*http://tinyurl.com/lynzdsz*), build your own astrolabe and practice using it.
3. Explain how electron microscopes and advanced cyclotrons work. Why would Ajay say that they are "more than suitable" for genetic work and gene splicing (pages 207–208)?
4. Explain what causes a sonic boom (page 235).
5. How do scientists determine the age of a bone or other organic artifact? How do they extract samples of DNA or other genetic material from the artifact (page 242)?
6. What is eugenics? How does evolution relate to eugenics? How are eugenics and evolution used in the Paladin Prophecy?
7. How do genetic hybrids and genetically modified crops increase agricultural yields (page 280)? Why are some people concerned about genetically modified foods? Do you think their concern is warranted?
8. What was the Manhattan Project (page 282)? How do atomic weapons work?
9. Genetic manipulation plays a large part in the plot of *Alliance*. Do you think genetically modifying human beings is a good idea or a bad idea? Does the technology to genetically engineer humans currently exist?
10. What is gene therapy? How is it different from the type of genetic engineering done in *Alliance*? How is it similar?

LAB CONNECTIONS

Genetics, Astronomy

CORRELATES TO COMMON CORE STANDARDS

SCIENCE & TECHNICAL SUBJECTS: Key Ideas & Details RST.6-8.1, 6-8.2; Craft & Structure RST.6-8.4, 6-8.5, 6-8.6; Integration of Knowledge & Ideas RST.6-8.8, 6-8.9; Writing Text Types and Purposes WHST.6-8.1 a-f, 6-8.2a-f; Production & Distribution of Writing WHST.6-8.4, 6-8.5, 6-8.5; Research to Build & Present Knowledge WHST.6-8.7, 6-8.8, 6-8.9; Range of Writing WHST 6-8.10

ANCHOR STANDARDS: Reading Key Ideas & Details CCRA.R.1, CCRA.R.2; Integration of Knowledge & Ideas CCRA.R.9; WRITING: Text Types & Purposes CCRA.W.1, W.2; Production & Distribution of Writing CCRA.W.4, W.5, W.6; Research to Build & Present Knowledge CCRA.W.7, W.8, W.9; LANGUAGE: Vocabulary Acquisition & Use CCRA.L.4, L.6; Speaking & Listening Comprehension & Collaboration CCRA. SL.1; Presentation of Knowledge & Ideas CCRA.SL.4

OTHER TITLES OF INTEREST

The Paladin Prophecy by Mark Frost
Red Rising by Pierce Brown
Friday by Robert A. Heinlein
Supernaturalist by Eoin Colfer

FILM CONNECTION

Gattaca (1997) directed by Andrew Niccol

FAIR COIN
by E. C. Myers
Pyr • HC • 978-1-61614-609-2
287pp. • $16.95

Fair Coin *by E. C. Myers*

GRADES 9–10

This novel delves into the realm of theoretical science and quantum physics, subjects that high school students usually find fascinating. Although the concepts referenced in the text are complex, *Fair Coin* provides a context for discussing these theories and their potential applications that students should find engaging.

DISCUSSION QUESTIONS AND ACTIVITIES:

1. On page 130, Jena mentions the idea of a temporal paradox—a concept that relates to the theoretical possibility of time travel. Explain the concept of a temporal paradox. Are there any theories that suggest ways to deal with this paradox?
2. In discussing the possibilities of a parallel universe, Jena says, "Multiple worlds isn't science fiction, it's a legitimate theory"(page 132). She goes on to explain that this theory is a part of quantum mechanics. Explain the scientific theory of parallel universes, or a multiverse.

3. What physical theory does Schrödinger's cat illustrate? Why is this theory difficult to prove or disprove? How does it relate to the theoretical physics at the core of the novel's plot?
4. What is Fair Coin theory? How does it relate to quantum physics? Conduct your own fair coin experiment and record the results (note to teachers: Columbia has published an excellent guide to this activity; visit *http://tinyurl.com/l2c79* for more information).
5. Research string theory. What are the core ideas of this theory (page 133)? Do you think string theory plays any part in the novel's plot? Explain your answer.
6. On page 137, Ephraim jokes that he's not radioactive, to which Jena replies, "How do you know? Do you have a Geiger counter?" What causes radioactivity? How does a Geiger counter work?
7. What is a doppelganger? How do doppelgangers relate to the theory of a multiverse?
8. Explain the mechanism that the characters in this book use to travel between parallel universes. Theoretically, would an object like the "fair coin" be possible? Explain your answer.
9. On page 184, Zoe remarks, "There's a popular saying, that 'any sufficiently advanced technology is indistinguishable from magic'"(page 184). Think of a piece of technology that you find particularly "magical" and explain the science that allows it to operate.
10. How is the term "analog" used in this novel? Research the etymology of the word. When was it first used? What was it describing? How is the term used in other branches of science?

LAB CONNECTIONS

Quantum Physics

CORRELATES TO COMMON CORE STANDARDS

SCIENCE & TECHNICAL SUBJECTS: Key Ideas & Details RST.9-10.1, 9-10.2; Craft & Structure RST.9-10.4, 9-10.5, 9-10.6; Integration of Knowledge & Ideas RST.9-10.8, 9-10.9; Writing Text Types and Purposes WHST.9-10.2a-f; Production & Distribution of Writing WHST.9-10.4, 9-10.5, 9-10.5; Research to Build & Present Knowledge WHST.9-10.7, 9-10.8, 9-10.9; Range of Writing WHST 9-10.10

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OTHER TITLES OF INTEREST:

Quantum Coin by E. C. Myers
The Dispossessed by Ursula Le Guin
The Practice Effect by David Brin
The Gods Themselves by Isaac Asimov
Timeline by Michael Crichton
The Number of the Beast by Robert Heinlein

FILM CONNECTION

A Brief History of Time (1991) directed by Errol Morris

DARK EDEN
A Novel
by Chris Beckett
Broadway Books • TR
978-0-8041-3868-0
448pp. • $15.00
Available from Books on Tape/Penguin Random House Audio as an audio download

Dark Eden *by Chris Beckett*

GRADES 9–10

Set generations after a pair of astronauts, a man and a woman, were stranded on an alien planet, *Dark Eden* tells the story of the original survivors' descendants and the society, called "Family," that they have created. The clash between the novel's young protagonist, John Redlantern, who wants to cross the mountains and seek new land, and the Family leaders, who are still awaiting rescue from Earth and fear leaving the original landing spot, leads to the conflict at the novel's climax. This book raises questions related to the study of biology and chemistry.

DISCUSSION QUESTIONS AND ACTIVITIES:

1. Based on the way Eden is described in the book, what technology would have to exist in order to send a manned spacecraft to a planet this far away? (See pages 68, 83–84, and 130–131 for oral histories of the original landing.) What unique challenges does space travel outside of our galaxy present to engineers? How far do you think we are from developing this technology?
2. The planet Eden does not have a sun as a source of light or heat. What makes the planet habitable?
3. What elements are required for an atmosphere that supports human life? Form a hypothesis that gives a scientific explanation for the presence of these elements on Eden.
4. The original colonists of Eden had to begin reproducing incestuously or face extinction (pages 85–87). What are the genetic consequences of incestuous reproduction (or inbreeding)? Do these consequences increase or decrease with subsequent generations? Find specific examples of some of these complications in the descriptions of the inhabitants of Eden.
5. The inhabitants of Eden do not have traditional watches or calendars. Why not? What do they use to count or mark time? Why does this make sense from a scientific perspective?
6. Examine the description of the trees on page 48. In the absence of photosynthesis, what do the trees use as a source of energy? How does this provide a source of light and heat to the inhabitants of Eden?

7. Based on the descriptions of the trees, their sap, and the edible crystals of stumpcandy (pages 48–51), can you hypothesize about what chemical elements and processes might be at work on Eden?
8. How are the animals on Eden similar to animals on Earth? How are they different? What adaptations have they made to allow them to live without sunlight? Choose a specific animal and explain its biology in depth, comparing and contrasting it with a counterpart on Earth.
9. Examine the various sources of light on Eden. What is the difference between bioluminescence, phosphorescence, luminescence, and photoluminescence? Based on the descriptions found in the text, which processes are operating on Eden? Explain your answer.
10. Examine an ecosystem on Earth that functions in the absence of sunlight. What adaptations allow organisms to exist in this environment? How is this ecosystem similar to the world of Eden? How is it different? Would you be willing to colonize a planet like Eden? Explain your answer.

LAB CONNECTIONS

Genetics, Bioluminescence, Photoluminescence, Phosphorescence, and Adaptation

CORRELATES TO COMMON CORE STANDARDS

SCIENCE & TECHNICAL SUBJECTS: Key Ideas & Details RST.9-10.1, 9-10.2; Craft & Structure RST.9-10.4, 9-10.5, 9-10.6; Integration of Knowledge & Ideas RST.9-10.8, 9-10.9; Writing Text Types and Purposes WHST.9-10.2a-f; Production & Distribution of Writing WHST.9-10.4, 9-10.5, 9-10.5; Research to Build & Present Knowledge WHST.9-10.7, 9-10.8, 9-10.9; Range of Writing WHST 9-10.10

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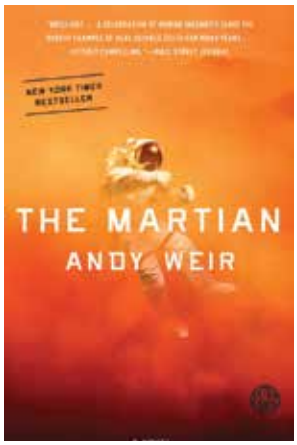
OTHER TITLES OF INTEREST

Mother of Eden (forthcoming, Spring 2015) by Chris Beckett
The Sparrow by Mary Doria Russell
Red Mars by Kim Stanley Robinson
The Moon is a Harsh Mistress by Robert Heinlein
The Martian Chronicles by Ray Bradbury

FILM CONNECTION

Avatar (2009) directed by James Cameron



THE MARTIAN
A Novel
by Andy Weir
Broadway Books • TR
978-0-553-41802-6
400pp. • $15.00

The Martian *by Andy Weir*

GRADES 9–10

Set in the not-so-distant future, *The Martian* tells the story of astronaut Mark Watney, who is stranded on Mars after a mission failure leads his crew and NASA to assume he is dead. Using his background in botany and engineering, Watney must find a way to survive until he can contact NASA and they can arrange a rescue mission. Once NASA realizes that Watney is, in fact, alive, a race begins to save his life. *Students may also be interested in Andy Weir's essay at Salon.com: "How Science Made Me a Writer."* (*http://tinyurl.com/ljdcskr*)

DISCUSSION QUESTIONS AND ACTIVITIES:

1. In the first chapter of the book, Weir describes the mission that stranded Mark Watney on Mars. Examine the technology mentioned in this chapter. What has kept us from carrying out manned space flights to Mars? Describe the requirements of this type of mission. How close are we to having the technology to send astronauts to Mars?
2. Explain the mechanism that Watney uses to keep track of time. Why does it make sense to mark time in Sols rather than days? How long is one Sol?
3. Examine the calculations that Watney uses to determine the amount of resources it will take in order for him to survive. Do you agree with his calculations? Explain your answer.
4. Examine the chemical process that Watney uses to create water from hydrogen and oxygen (pages 24–27). What makes this process especially dangerous? What mistake does Watney make in his calculations (pages 45–47)?
5. Research the various sources of energy Watney uses over the course of the novel (for example: solar cells, radioisotope thermoelectric generators, ion engines, rechargeable batteries). What are the risks and benefits associated with the various sources of energy?
6. Because of Watney's creative modification of equipment in order to survive (for example, see pages 258–259 and 300-301), Weir's novel has drawn comparisons to the true story of the *Apollo 13* mission. Research the technology and engineering that was used in the Apollo 13 mission and rescue. As a project, develop a workable plan (or model) that uses components of an existing device for a completely new function (the website *Instructables* may give you some ideas). View this brief scene from *Apollo 13* for inspiration (*http://tinyurl.com/A13clip*)
7. Explain the challenges that Watney faces in attempting to develop agriculture on Mars. Why are bacteria a necessary component of soil used for agriculture? How does Watney solve the initial problems that he encounters?
8. You may be familiar with the Academy Award-winning film *Gravity*, which is also a story about an astronaut's attempt to survive and return to Earth after a mission

failure. Read one of the articles examining the science in the film (such as this one from the *The Washington Post: http://tinyurl.com/WP-Gravity*). Choose a moment in *The Martian* that you found particularly compelling or interesting and conduct similar research about the science that is referenced in the section. Based on your research, do you think the aspect of Watney's story that you selected could really happen?

9. Throughout the novel, Mark Watney finds numerous ways to modify and utilize the crew's EVA suits. Research the engineering of EVA suits. What purposes do they serve? What materials are they made of? What unique challenges did scientists face when they designed EVA suits? How have they changed with technological advances? You may wish to begin your exploration at NASA's interactive spacesuit page at: *http://tinyurl.com/os2ldp9*.
10. Explain the physics behind the failure of the Iris launch (pages 187–191).
11. Explain the physics behind Mark Watney's mistake that caused Pathfinder to lose power (pages 224–228).
12. In order to navigate on Mars, Watney builds a homemade sextant (288). Explain how a sextant functions, then build your own sextant and test it to see if it works.
13. Explain how Mark Watney figures out that there is a dust storm on Mars. How does he use observation to figure out the direction and speed of the storm? Why is this information critical?
14. Explain the chemical process that Watney uses to turn water into rocket fuel (pages 335–336).
15. Explain the laws of physics involved in Watney's final launch and connection with the rescue team.

LAB CONNECTIONS

Chemical Reactions, Engineering, and Physics

CORRELATES TO COMMON CORE STANDARDS

SCIENCE & TECHNICAL SUBJECTS: Key Ideas & Details RST.9-10.1, 9-10.2; Craft & Structure RST.9-10.4, 9-10.5, 9-10.6; Integration of Knowledge & Ideas RST.9-10.8, 9-10.9; Writing Text Types and Purposes WHST.9-10.2a-f; Production & Distribution of Writing WHST.9-10.4, 9-10.5, 9-10.5; Research to Build & Present Knowledge WHST.9-10.7, 9-10.8, 9-10.9; Range of Writing WHST 9-10.10

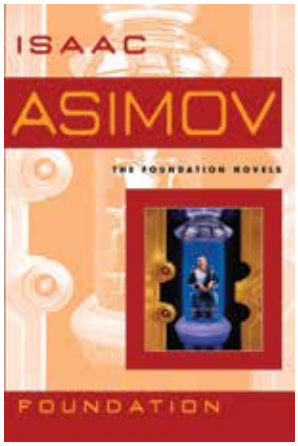
ANCHOR STANDARDS: Reading Key Ideas & Details CCRA.R.1, CCRA.R.2; Integration of Knowledge & Ideas CCRA.R.9; WRITING: Text Types & Purposes CCRA.W.2; Production & Distribution of Writing CCRA.W.4, W.5, W.6; Research to Build & Present Knowledge CCRA.W.7, W.8, W.9; LANGUAGE: Vocabulary Acquisition & Use CCRA.L.4, L.6; Speaking & Listening Comprehension & Collaboration CCRA. SL.1; Presentation of Knowledge & Ideas CCRA.SL.4

OTHER TITLES OF INTEREST

An Astronaut's Guide to Life on Earth by Chris Hadfield
Postcards from Mars by Jim Bell
Tunnel in the Sky by Robert Heinlein
Red Mars by Kim Stanley Robinson

FILM CONNECTION

Apollo 13 (1995) directed by Ron Howard
Gravity (2013) directed by Alfonso Cuarón



FOUNDATION
by Isaac Asimov
Spectra • TR • 978-0-553-38257-0
272pp. • $15.00
Available from Books on Tape/Penguin Random House Audio as an audio download

Foundation *by Isaac Asimov* — GRADES 9–10

Isaac Asimov's *Foundation* sets the stage for a series that is widely regarded as a masterpiece of the genre. Set in the distant future, Asimov's novel introduces a power struggle of epic proportions, as rival factions seek to control the planets that form the Galactic Empire. In Asimov's vision, nuclear power becomes the key to military and political control, and the scientists that oversee nuclear technology hold the key to the stability of the galaxy.

DISCUSSION QUESTIONS AND ACTIVITIES:

1. *Foundation* was originally published in 1951, close to the dawn of the era of space exploration and well before much of the technology that we consider commonplace today had been invented. What aspects of the future predicted in *Foundation* are accurate? What aspects are inaccurate?
2. According to the *Encyclopedia Galactica*, Hari Seldon's father was a "hydroponic tobacco grower"(page 1). Explain the process of hydroponics. What are the advantages and disadvantages of hydroponic farming? Do you predict that tobacco will continue to be an important crop in the future? Explain your answer.
3. Define the term "axiom" as it is used in the following sentence: "Seldon found the field little more than a set of vague axioms: he left it a profound statistical science" (page 1).
4. Read this description of deep space travel: "He had steeled himself just a little for the Jump through hyperspace, a phenomenon one did not experience in simple interplanetary trips. The Jump remained, and would probably continue to remain forever, the only practical method of travelling between the stars. Travel through ordinary space could proceed at a rate no more rapid than that of ordinary light (a bit of scientific knowledge that belonged among the items known since the forgotten dawn of human history), and that would have meant years of travel between even the nearest of inhabited systems. Through hyperspace, that unimaginable region that was neither space nor time, matter nor energy, something nor nothing, one could traverse the length of the Galaxy in the interval between two neighboring instants of

time"(page 4). This passage references Einstein's theory of special relativity (*http://tinyurl.com/86cs5j8*). Moving faster than the speed of light remains in the realm of science fiction, but could it ever be possible in real life? Research the scientific basis for ideas about the possibility of intergalactic travel, such as Asimov's hyperspace travel.

5. The starships in *Foundation* possess simulated gravity (pages 7 and 12), a technology that is widely used in television shows like *Star Trek* and *Firefly*. Explain the way that gravity works on our planet. How close are we to having the technology necessary to create a gravitational field? Why would this be important? Theoretically, should it be possible?
6. Energy is central to the plot of *Foundation*, with much of the political intrigue linked to control of nuclear power. Find all of the sources of energy mentioned in the text (one example can be found on page 14). How many of the sources of energy mentioned in the text currently exist? Which ones do you think are likely to continue to be used by humans for thousands of years? Are there any emerging technologies that Asimov did not mention in his text? What do you think the best source of energy for the future will be?
7. Explain Asimov's science of psychohistory. Does anything similar to psychohistory exist? Do you think it could? Consider the implications that data mining could have on the development of a system like Seldon's.
8. During his interrogation, Dr. Seldon remarks, "Scientific truth is beyond loyalty and disloyalty" (page 26). Do you agree or disagree with his statement? Explain your answer.
9. On page 38, Asimov explains how Seldon's office is spy-proof. Based on the descriptions in this section, explain the physics behind technology that could create "spy beams" and a "spy-proof" office. Does this technology currently exist? Is it being used?
10. Explain why the lack of metals creates a problem for the planet Terminus (pages 53–55). Why would nuclear power be seen as a solution?
11. Read Lord Dorwin's description of the scientific method (as he sees it) on page 65. Is he describing the actual scientific method? Explain.
12. Explain the role that nuclear power plays in the novel. What technologies are made possible by nuclear energy, and what are their applications for industrial and military purposes? Why is access to nuclear power limited? What are the results of these limitations?
13. In the novel, scientists evolve into religious figures and science becomes a primary religion. Discuss the intersection between science and religion. Do you think it is feasible that science may eventually replace religious faith, or can the two coexist?

LAB CONNECTIONS

Sources of Energy, Gravity

CORRELATES TO COMMON CORE STANDARDS

SCIENCE & TECHNICAL SUBJECTS: Key Ideas & Details RST.9-10.1, 9-10.2; Craft & Structure RST.9-10.4, 9-10.5, 9-10.6; Integration of Knowledge & Ideas RST.9-10.8, 9-10.9; Writing Text Types and Purposes WHST.9-10.1a-f, 9-10.2a-f; Production & Distribution of Writing WHST.9-10.4, 9-10.5, 9-10.5; Research to Build & Present Knowledge WHST.9-10.7, 9-10.8, 9-10.9; Range of Writing WHST 9-10.10

ANCHOR STANDARDS: Reading Key Ideas & Details CCRA.R.1, CCRA.R.2; Integration of Knowledge & Ideas CCRA.R.9; WRITING: Text Types & Purposes CCRA.W.1, W.2; Production & Distribution of Writing CCRA.W.4, W.5, W.6; Research to Build & Present Knowledge CCRA.W.7, W.8, W.9; LANGUAGE: Vocabulary Acquisition & Use CCRA.L.4, L.6; Speaking & Listening Comprehension & Collaboration CCRA. SL.1; Presentation of Knowledge & Ideas CCRA.SL.4

OTHER TITLES OF INTEREST

Prelude to Foundation by Isaac Asimov
Foundation and Empire by Isaac Asimov
Second Foundation by Isaac Asimov
Foundation's Edge by Isaac Asimov
Foundation and Earth by Isaac Asimov
Forward the Foundation by Isaac Asimov

FILM CONNECTION

Star Trek (2009) directed by J. J. Abrams

READY PLAYER ONE
A Novel
by Ernest Cline
Broadway Books • TR
978-0-307-88744-3
384pp.• $14.00
Available from Books on Tape/Penguin Random House Audio as a CD and audio download

Ready Player One *by Ernest Cline*

GRADES 11–12

This is another novel set in the not-too-distant future: the year 2044. *Ready Player One* provides a fascinating glimpse into the potential of advanced virtual reality technology. In fact, the author, Ernest Cline, recently spoke with *Forbes* magazine about current breakthroughs in technology and the directions they could take us. (The article can be found at: *http://tinyurl.com/ForbesRP1*) The story of a young man's quest to win an "Easter egg hunt" in virtual reality, this novel is fast-paced and fun to read. This is the only novel in the guide that features computer science—a field that is particularly appealing to today's high school students.

DISCUSSION QUESTIONS AND ACTIVITIES

1. Describe the extent and impact of global climate change in the novel. What caused the global energy crisis? How has it impacted society? Do you think it is possible that we will see a global energy crisis of this magnitude by 2044? Support your answer with data.
2. On page 25, Wade Watts explains how he creates a mechanism for recharging his device using "a rack of old car batteries and a modified exercise bike." Based on principles of physics, explain how this mechanism could work.
3. Watts describes preparing to play OASIS on page 26 and gives further details about the system on page 58. Explain how the technology involved in the components of the system work (for example, haptic technology, retina scans). How much of this technology currently exists?

4. OASIS stands for "Ontologically Anthropocentric Sensory Immersive Simulation." Examine the etymology of each of the words in the system's name. What do they tell you about the functions of the system? Examine names from other fields of science. How are scientific names generated? What can the etymology of a scientific name tell you about an organism or object?
5. Explain the code that allows for the creation of avatars. What allows them to interact with each other?
6. Since OASIS is free to access, how is the virtual world in *Ready Player One* monetized? Do you think this model makes sense? Explain your answer. Rebecca Skloot's book *The Immortal Life of Henrietta Lacks* raises questions about the ownership of biological materials. Can similar questions be raised about the ownership of virtual commodities? Debate these questions as a class.
7. In computer programming, what are "Easter eggs?" What is involved in programming an Easter egg into a game, application, program, or site?
8. Once Wade begins to advance in the online egg hunt, he acquires more advanced equipment to use in OASIS. Read the descriptions of the technology on pages 191–193. How much of this technology currently exists in some form? Explain how it works.
9. What would be difficult about creating a system as expansive and immersive as OASIS? Do you think such a system will ever be created? Would people be willing to exchange real experiences for virtual experiences? Explain your answer.
10. In addition to providing a source of recreation, OASIS also provides access to education. How could virtual reality or other similar technology revolutionize the classroom experience? What steps have we already taken to promote "virtual classrooms" or distance learning? Do you think this type of learning will eventually replace the traditional classroom?

LAB CONNECTIONS

Computer Programming, Engineering

CORRELATES TO COMMON CORE STANDARDS

SCIENCE & TECHNICAL SUBJECTS: Key Ideas & Details RST.11-12.1, 11-12.2; Craft & Structure RST.11-12.4, 11-12.6; Integration of Knowledge & Ideas RST.11-12.8, 11-12.9; Writing Text Types and Purposes WHST.11-12.1a-f, 11-12.2a-f; Production & Distribution of Writing WHST.11-12.4, 11-12.5, 11-12.5; Research to Build & Present Knowledge WHST.11-12.7, 11-12.8, 11-12.9; Range of Writing WHST 11-12.10

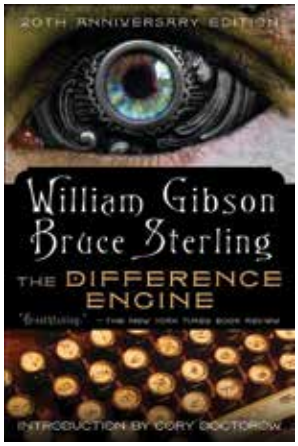
ANCHOR STANDARDS: Reading Key Ideas & Details CCRA.R.1, CCRA.R.2; Integration of Knowledge & Ideas CCRA.R.9; WRITING: Text Types & Purposes CCRA.W.1, W.2; Production & Distribution of Writing CCRA.W.4, W.5, W.6; Research to Build & Present Knowledge CCRA.W.7, W.8, W.9; LANGUAGE: Vocabulary Acquisition & Use CCRA.L.4, L.6; Speaking & Listening Comprehension & Collaboration CCRA. SL.1; Presentation of Knowledge & Ideas CCRA.SL.4

OTHER TITLES OF INTEREST

Neuromancer by William Gibson
Heavy Weather by Bruce Sterling
The Diamond Age by Neal Stephenson
Otherland: City of Golden Shadow by Tad Williams

FILM CONNECTION

The Matrix (1999) directed by the Wachowski brothers
Tron (1982) directed by Steven Lisberger



THE DIFFERENCE ENGINE
Written by William Gibson
Contribution by Bruce Sterling
Spectra • TR • 978-0-440-42362-1
512pp. • $16.00

The Difference Engine *by William Gibson and Bruce Sterling* GRADES 11–12

Often considered one of the definitive novels in the extremely popular steampunk genre, *The Difference Engine* provides an alternate history that imagines what the world would be like if Charles Babbage had succeeded in building a working prototype of his Analytical Engine, bringing England into the computer age in the 1800s. The novel blends Victorian mystery and suspense with a rich historical view of scientific discovery and reverence for the art and science of engineering. As Cory Doctorow states in his introduction to the novel, "At its root, steampunk venerates the artisan, celebrates an abundance of technology, and still damns the factory that destroyed the former's livelihood to create the latter" (page IX). This novel both celebrates the beauty and brilliance of the machines that created the industrial and computer revolutions, and questions the impact of those machines on society.

DISCUSSION QUESTIONS AND ACTIVITIES

1. Research Charles Babbage. Why is he considered the father of computing? Explain the design and function of both his Difference Engine and his Analytical Engine. How is the architecture of Babbage's invention similar to the basic architecture of modern computers? Explain the mechanism used to program the first computers. How has this technology evolved?
2. The novel features a number of steam-powered machines. Examine thermodynamics as a source of energy. (Note to teachers: there are numerous labs available to help students explore the laws of thermodynamics and its potential as a source of energy, including an introductory unit published by the U.S. Department of Energy at: *http://tinyurl.com/DOE-Thermo*)
3. One of the most exciting aspects of steampunk is that it encourages students to play with technology and mechanical engineering and to use their knowledge to create objects that display both form and function. In the introduction to

The Difference Engine, Cory Doctorow notes that 3-D printers and opportunities for collaboration provided by the Internet allow budding engineers the means to "produce wonderments that simultaneously embody light-speed technological change and enduring artisanship" (page X). Design your own invention that embodies both technology and artisanship.

4. The novel features a number of actual scientists as characters including Charles Lyell, Charles Darwin, Gideon Mantell, Michael Faraday, Isambard Brunel, Thomas Huxley, George and Frédéric Cuvier, William Buckland, and Bishop Berkeley. Research one of the scientists mentioned in the novel. What contributions did he make to science? How did his ideas or discoveries impact future inquiry and discovery? Design an experiment based on some aspect of the work of the scientist you selected.
5. One of the fictional machines in the novel is the kinotrope (see pages 41–46, 55, 75, and 127), which allows programmers to create a visualization using mechanical cubes rather than digital pixels. How would a machine like this operate? Explain the engineering and programming that would be required to create this type of visual output.
6. In discussing the mechanics required to build a flying machine, Godwin remarks, "We now understand certain matters having to do with the behavior of air in motion, the principles of atmospheric resistance. New principles, little-known as yet" (page 92). Explain the scientific principles and discoveries that made the field of aviation possible.
7. Pages 139–142 contain a debate related to dinosaur fossils and the implications those fossils raise regarding the appearance and behavior of dinosaurs—a debate that still resonates today. How has the field of paleontology evolved since the first discovery of fossils? How has our understanding of dinosaurs changed?
8. While riding the Metropolitan (the world's first underground railway), Sybil muses, "It was a queer business, the underground, when you thought about it, racketing along at such speeds, through the darkness under London, where the navies had come upon lead water-pipes of the Romans, and coins, mosaics, and archways, elephant's teeth a thousand years old"(page 57). Consider the incredible feat of engineering involved in building an underground transport system and explain the physics and technology that allowed engineers to build the Metropolitan and later, the Underground.
9. The novel features an ongoing debate over Catastrophism vs. Uniformitarianism. Explain both sides of the debate. What is your position? Explain the evidence that you find the most compelling.
10. The term "luddite" has come to refer to any person opposed to new technology. (For more information, please visit: *http://tinyurl.com/mcuako4*) Historically speaking, who were the Luddites? Examine the tension between people opposed to or fearful of technology and those committed to scientific inquiry and technological innovation. Can this tension be resolved?

LAB CONNECTIONS

Physics, Engineering, and Thermodynamics

CORRELATES TO COMMON CORE STANDARDS

Science & Technical Subjects: Key Ideas & Details RST.11-12.1, 11-12.2; Craft & Structure RST.11-12.4, 11-12.6; Integration of Knowledge & Ideas RST.11-12.8, 11-12.9; Writing Text Types and Purposes WHST.11-12.1a-f, 11-12.2a-f; Production & Distribution of Writing WHST.11-12.4, 11-12.5, 11-12.5; Research to Build & Present Knowledge WHST.11-12.7, 11-12.8, 11-12.9; Range of Writing WHST 11-12.10

Anchor Standards: Reading Key Ideas & Details CCRA.R.1, CCRA.R.2; Integration of Knowledge & Ideas CCRA.R.9; Writing: Text Types & Purposes CCRA.W.1, W.2; Production & Distribution of Writing CCRA.W.4, W.5, W.6; Research to Build & Present Knowledge CCRA.W.7, W.8, W.9; Language: Vocabulary Acquisition & Use CCRA.L.4, L.6; Speaking & Listening Comprehension & Collaboration CCRA.SL.1; Presentation of Knowledge & Ideas CCRA.SL.4

OTHER TITLES OF INTEREST

The Warlord of the Air by Michael Moorcock
The Anubis Gates by Tim Powers
The Time Machine by H. G. Wells
The Eyre Affair by Jasper Fforde

FILM CONNECTION

Creation (2009) directed by John Amiel

ORYX AND CRAKE
by Margaret Atwood
Anchor • TR • 978-0-385-72167-7
400pp. • $15.950
Available from Books on Tape/Penguin Random House Audio as a CD and audio download

Oryx and Crake *by Margaret Atwood* — GRADES 11–12

Oryx and Crake is the first novel in Atwood's acclaimed MaddAddam trilogy (*Oryx and Crake, Year of the Flood, MaddAddam*). While the novel is set in a post-apocalyptic world, a significant portion of *Oryx and Crake* is backstory, illustrating the friendship between two teen boys, the sensitive Jimmy and the brilliant Glenn, or Crake, and the events leading up to Crake's decision to genetically engineer a virus in order to destroy the human population and re-inhabit the Earth with his own genetically engineered perfect humans, called "Crakers"—a species who will be biologically incapable of committing the types of acts of violence, selfishness, and environmental destruction that humans have carried out. Unbeknownst to Jimmy, Crake has given him immunity against the pandemic disease, with the intent of leaving him as the sole surviving human and caretaker of the Crakers, a responsibility that is both a gift and a curse.

Atwood's vision of the future is terrifyingly realistic, and stands as a warning to readers about the dangers of environmental destruction and the potential consequences of unchecked and profit-driven genetic experimentation.

DISCUSSION QUESTIONS AND ACTIVITIES

1. Explain the mission of OrganInc Farms (pages 22–24). What is ironic about the farm's name? Based on Atwood's description, what do you think a "genographer" does? How close are we to developing and implementing technology that can replicate human organs?
2. Explain the events of the section titled "Bonfire" (pages 15–21). What happened to the sheep and cows that were set on fire? Who do you think was responsible? What was his or her motive? Explain the process involved in creating an agent of biological warfare. How do the CorpSeCorps agents combat and contain hostile bioforms?
3. Genetic engineering plays a significant role in Atwood's novel. Jimmy remembers receiving his pet rakunk: "There's been a lot of fooling around in those days: create-an-animal was so much fun, said the guys doing it; it made you feel like God" (page 51). Do we currently have the technology to create hybrid animals like rakunks or wolvogs? Is this sort of technology and experimentation a good idea? Defend your answer with thoughtful research about the benefits or perils of creating new hybrid species.
4. Crake gets his nickname from the online game MaddAddam: "*Adam named the living animals, MaddAddam names the dead ones"* (page 80). Jimmy has a MaddAddam nickname as well ("Thickney"), as does Oryx. Research extinction. How quickly are animals becoming extinct? If you were to choose the name of an extinct animal for yourself, what would you choose? Explain the reason for your choice.
5. Explain the role that pandemic disease plays in the novel. What factors contribute to a disease or virus becoming a pandemic? What made Crake's genetically modified virus a perfect vehicle for a pandemic?
6. Thoroughly reconstruct Crake's carefully thought out reasons for giving the Crakers each of their physical and behavioral characteristics. What genetic characteristics did he import from other animals? What purpose does each genetic alteration serve? What steps did he take to ensure that the Crakers would be peaceful and cooperative? Why do you think his attempts to eradicate the impulse to believe in a god failed? (Note to teachers: you may want to direct students to research on the biology of religious belief (*http://tinyurl.com/anekfw)*) or go to the site: *http://tinyurl.com/DOE-ThermoGuide.* If you were to create a race of "perfect" human beings, which specific genetic characteristics would you borrow from animals, and what purpose would each genetic alteration serve?
7. From a scientific perspective, how close are we to being able to genetically engineer human beings? How close are we to determining the ethical standards that should govern the genetic alteration of humans?
8. One of the most interesting genetic modifications that Crake performs on the Crakers is giving them the ability to purr. Examine the science behind the healing mechanism of purring.

9. At the end of the novel, Jimmy is dangerously ill from an antibiotic-resistant infection. Explain the process that leads to antibiotic resistance. Why would the world of *Oryx and Crake* be at particular risk for antibiotic-resistant strains of bacteria?
10. Although it is set in the relatively near future, the novel makes several references to the impact of climate change and the subsequent changes to the food chain. Examine the role that environmental destruction plays in the novel.
11. What is significant about the name of the Watson-Crick Institute? Why is this compound an appropriate place for Crake to work and study?
12. Some of the hybrid animals in the novel (ex: wolvogs, bobkittens) have become invasive species. Explain the problem of invasive species. How do they enter ecosystems? Why are they so disruptive and destructive? Present a case study of a real-world invasive species.
13. Is Crake a villain or a hero? Did he use science to save the world or destroy it? Defend your answer.

CORRELATES TO COMMON CORE STANDARDS

SCIENCE & TECHNICAL SUBJECTS: Key Ideas & Details RST.11-12.1, 11-12.2; Craft & Structure RST.11-12.4, 11-12.6; Integration of Knowledge & Ideas RST.11-12.8, 11-12.9; Writing Text Types and Purposes WHST.11-12.1a-f, 11-12.2a-f; Production & Distribution of Writing WHST.11-12.4, 11-12.5, 11-12.5; Research to Build & Present Knowledge WHST.11-12.7, 11-12.8, 11-12.9; Range of Writing WHST 11-12.10

ANCHOR STANDARDS: Reading Key Ideas & Details CCRA.R.1, CCRA.R.2; Integration of Knowledge & Ideas CCRA.R.9; WRITING: Text Types & Purposes CCRA.W.1, W.2; Production & Distribution of Writing CCRA.W.4, W.5, W.6; Research to Build & Present Knowledge CCRA.W.7, W.8, W.9; LANGUAGE: Vocabulary Acquisition & Use CCRA.L.4, L.6; Speaking & Listening Comprehension & Collaboration CCRA. SL.1; Presentation of Knowledge & Ideas CCRA.SL.4

OTHER TITLES OF INTEREST

Year of the Flood by Margaret Atwood
MaddAddam by Margaret Atwood
The Handmaid's Tale by Margaret Atwood
In Other Worlds: SF and the Human Imagination by Margaret Atwood
The Stand by Stephen King
Earth Abides by George R. Stewart

FILM CONNECTION

Contagion (2011) directed by Steven Soderbergh

NOTES

ABOUT THIS GUIDE'S WRITER

AMY JURSKIS is the author of a number of teaching guides, including *The Immortal Life of Henrietta Lacks* by Rebecca Skloot and *In the Garden of Beasts* by Erik Larson. She holds a B.A. in English from the University of Georgia and a MAT from Agnes Scott College. She currently serves as a chairperson of curriculum and English teacher at Oxbridge Academy of the Palm Beaches.

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