

# THE SCIENCE BEHIND THE STORIES

Vol. I—ORIGINS:  
Tales of Human Evolution

Chad Rohrbacher and Randall Hayes



# THE SCIENCE BEHIND THE STORY

by

Chad Rohrbacher and Randall Hayes

***Vol. I***

***Origins: Tales of Human Evolution***



E-QUALITY PRESS

THE SCIENCE BEHIND THE STORY, Volume I

An E-QUALITY PRESS production / June 2013  
UUID# FE8301F0-71A4-11E2-BCFD-0800200C9A66

ALL RIGHTS RESERVED

Copyright © 2013 Chad Rohrbacher and Randall Hayes  
Cover Art, "A Mother-Daughter Portrait,"  
copyright © 2011 by Eric T. Reynolds  
Cover design and book formatting by:



E-QUALITY PRESS

No part of this book may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage and retrieval system, without permission in writing from the publisher.

For information address: E-QUALITY PRESS,  
[www.e-qualitypress.com](http://www.e-qualitypress.com)

---

The name E-QUALITY PRESS and its logo, consisting of the letters "EQP" over an open book with power cord, are registered trademarks of E-QUALITY PRESS.  
[www.e-qualitypress.com](http://www.e-qualitypress.com)

---

PRODUCED IN THE UNITED STATES OF AMERICA

## **Acknowledgments**

The authors would like to offer special thanks to Beacon, a center for the study of evolution. We would also like to thank Eric T. Reynolds and Hadley Rille books who so graciously allowed us to use the text on which the manual is based. Rick Fisher at E-Quality Press also deserves thanks for his fine attention to detail and cogent observations concerning the text.

This work was supported by the National Science Foundation under Cooperative Agreement No. DBI-0939454. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

## CONTENTS

[Introduction, by Chad Rohrbacher](#)  
[Introduction Part Two, by Randall Hayes](#)

[What Do I \*Do\* with Fiction in a Science Class?](#)  
[Reading for Understanding and Meaning](#)  
[Annotation Quiz](#)  
[Basic Story Questions](#)  
[Basic Discussion Questions Template](#)

[“Patterns of the Fall” by Gerri Leen \(3,000,000 years ago\)](#)  
[Synopsis](#)  
[Vocabulary Words](#)  
[Main Characters](#)  
[Discussion Questions](#)  
[Search Terms & Key Concepts in Evolutionary Science](#)  
[Research/Discussion Questions](#)  
[Links & Resources](#)  
[Assignments](#)

[“The Dawn of Reason” by Lezli Robyn \(175,000 years ago\)](#)  
[Synopsis](#)  
[Vocabulary Words](#)  
[Main Characters](#)  
[Discussion Questions](#)  
[Search Terms & Key Concepts in Evolutionary Science](#)  
[Research/Discussion Questions](#)  
[Links & Resources](#)  
[Assignments](#)

[“Fire in the Sky, Frost in the Land” by Z.S. Adani \(71,000 years ago\)](#)  
[Synopsis](#)  
[Vocabulary Words](#)  
[Main Characters](#)  
[Discussion Questions](#)  
[Search Terms & Key Concepts in Evolutionary Science](#)  
[Research/Discussion Questions](#)  
[Links & Resources](#)  
[Assignments](#)

["The Ugly Ones" by Max Habilis \(41,000 years ago\)](#)

[Synopsis](#)

[Vocabulary Words](#)

[Main Characters](#)

[Discussion Questions](#)

[Search Terms & Key Concepts in Evolutionary Science](#)

[Research/Discussion Questions](#)

[Links & Resources](#)

[Assignments](#)

["The Pull of the World and the Push of the Sky" by Camille Alexa \(31,000 years ago\)](#)

[Synopsis](#)

[Vocabulary Words](#)

[Main Characters](#)

[Discussion Questions](#)

[Search Terms & Key Concepts in Evolutionary Science](#)

[Research/Discussion Questions](#)

[Links & Resources](#)

[Assignments](#)

["Arrows of Apollo" by Jenny Blackford \(2,500 years ago\)](#)

[Synopsis](#)

[Vocabulary Words](#)

[Main Characters](#)

[Discussion Questions](#)

[Search Terms & Key Concepts in Evolutionary Science](#)

[Research/Discussion Questions](#)

[Links & Resources](#)

[Assignments](#)

["Seven Views of Olduvai Gorge" by Mike Resnick \(throughout the span of human existence\)](#)

[Synopsis](#)

[Vocabulary Terms](#)

[Main Characters](#)

[Discussion Questions](#)

[Search Terms & Key Concepts in Evolutionary Science](#)

[Interlude 1: The Rock: Page 159](#)

[Interlude 2: Chain Link: Page 170](#)

[Interlude 3: The Knife: Page 179](#)

[Interlude 4: Metal Stylus: Page 186](#)

[Interlude 5: Jewelry: Page 196](#)

[Interlude 6: The Bullet: Page 207](#)

[Interlude 7: Exobiologist's Materials: Page 215](#)

[What \*Else\* Can I Do with Fiction in a Science Class?](#)

[Checklist for Effective Writing Assignments](#)

[Other Tips](#)  
[Sample Rubrics](#)  
[Peer Review Activities](#)  
[Other In-Class Writing Activities](#)  
[Teaching Strategies](#)  
[The Final Project](#)

[References](#)

## Introduction

by **Chad Rohrbacher**

**A**S A CENTER FOR THE STUDY of Evolution in Action funded by the National Science Foundation, BEACON is more than a single research laboratory struggling with a single problem. It is a community of hundreds of researchers and educators from many different fields, all applying the tools of evolutionary science to different problems, from hyena biology to robotics and artificial intelligence. As a collection of specialists forced to communicate with one another outside our specialties, and as scientists studying phenomena that after 150 years are still controversial to the public, we understand how important it is to tell exciting stories about our work, to engage the imagination, to draw people in so that they will invest the time to understand the details of our work.

When Dr. Hayes first approached me with his proposal for BEACON, I immediately said yes. Let me rephrase, he didn't even finish his sentence before I said yes. The idea of using science fiction to assist students with evolutionary biology ideas, concepts, and theories was extremely exciting.

As Dr. Hayes says below, BEACON is an interdisciplinary group. I have personally been a proponent of interdisciplinary study since I was in the residential learning community, Chapman, at Bowling Green State University. Interdisciplinary learning allows students opportunities to understand, view, and make connections with material in unique and exciting ways.

We decided to use *ORIGINS: Tales of Human Evolution* edited by Eric T. Reynolds because of its breadth and depth of stories. From Gerri Leen imagining what it was like 3,500,000 years ago in her story "Patterns of the Fall" to Hugo Award winner Mike Resnick's story "Seven Views of Olduvai Gorge," which is set in a futuristic Earth, each story brings a wealth of current scientific knowledge and combines it with a unique voice that's aimed at getting people interested in evolution. While science fiction may stretch the theories of science, exploring the "what if" scenarios in depth, this text seemed to stay as closely aligned to the science as possible.

We believe students often see science as boring, something to be memorized and parroted back on tests; however, science is instead extremely creative. It always starts in the scientist's imagination as a simple question: *What if?* And from that question a hypothesis and tests are born. Writers also ask *What if*, leading them to explore a

multitude of answers through all the complex conventions of fiction. Students will be able to explore theories and the tests that scientists have used to test them and see that science come to life in the stories chosen here.

This guide is for those who teach evolutionary biology, to assist them in using more creativity in their classrooms. It includes advice on how to get students to read the material *critically*, possible in-class and out of class assignments, and rubrics to help with the grading of any writing assignments. Further, for every story we have a synopsis, content questions, discussion questions, vocabulary building opportunities, and connections to the science.

We hope this guide is both useful and engaging for you and your students.

## Introduction Part Two

by **Randall Hayes**

**W**HY DO HUMANS RESPOND so strongly to stories?

Science fiction, perhaps even more so than other fiction, plays with big questions. When all the details of life are deliberately made different, the big questions are the only ones that still resonate.

The *Research Questions*, which go into considerably more detail than the *Discussion Questions*, are chosen from these eternal themes of human experience, for precisely the reason that everyone can relate to them. We have chosen to engage rather than inform, or at least to allow students to inform themselves, with a bit of guidance. There are two good reasons for this. First, being lectured to is, for many people, boring. Let *them* find their own answers. This will require some time, and some monitoring, but it will be well worth the effort.

Second, many of the individual points in these stories are at least controversial, and possibly made up from whole cloth. They are fiction, after all. Authors don't know everything, even about the full scientific consensus at the time the story was written, let alone what the scientific consensus will be by the time the story is read, after new discoveries have been made. Moreover, science fiction authors often deliberately change the facts to make them more interesting, or for the sake of a joke. Use this. Students love to hunt for "mistakes."

Recognizing that these stories could be used with high school students, who are legally minors, and college students, who are not (and whose instructors therefore have more flexibility), we have also deliberately chosen to include questions on *all* of the concepts presented in the stories. This includes violence, sexual situations, and those concepts that may fall within the science/religion debate. We recognize that artists love to make people uncomfortable. We leave the decisions about what to include in the classroom up to individual teachers, where they belong. You know your own students and their families better than we do; you know where their comfort zones (and yours) are. Our aim is to support you in whatever you choose to explore with your students.

We recommend that each student be assigned a small number of the Research questions, overlapping only partially with every other student's set of questions. A

teacher can print them out and have the students draw randomly, roll dice, or allow the students to choose their questions.

*Search Terms & Key Concepts from Evolutionary Science.* Most modern students would much rather search the Internet than a textbook, even one with a glossary and an index. A problem with keyword searches of the Internet is that one has to know *which keywords to use*. The words used in the stories themselves are not particularly helpful as keywords. Evolutionists from different academic specialties (mostly biology, but also psychology, economics, sociology, and other fields) have spent over a hundred years building up a specialized vocabulary that might as well be a foreign language. In fact, much of it is based on Latin and Greek, which *are* foreign languages to students who haven't studied the historical roots of English. Thus we offer lists of concepts that students can use to guide their searches as they attempt to answer the discussion questions. Websites come and go, and a simple list of links would be outdated almost immediately. However, these concepts have so far stood the test of time, and keyword searches related to these concepts should turn up good information. Obviously, not every website is a reliable source, and you as the instructor should do some searches and be familiar with the top sites, so that you can advise your students about unreliable websites.

Despite the limitations of website-link lists, we also include a few carefully chosen *Resources* with each story, particularly to documentaries that may be suitable for in-class or out-of-class viewing and nonfiction science books written for a popular audience. A few resources, listed here, will be useful with almost all of the stories.

- *Joseph Campbell and the Power of Myth*. Although they were done in the 1980s, these Bill Moyers interviews on DVD are an excellent introduction to any discussion of the evolution of human psychology. Specific episodes are mentioned with some of the stories.
- *VSI: Variation Selection Inheritance*, a podcast on all aspects of evolution, whether biological, cultural, or technological. This not-quite-weekly Internet radio show by Randall Hayes (yes, the same one) features interviews, book and movie reviews, and personal commentary. There is also an attached blog, a Facebook page, and a Twitter feed. These public outreach efforts are currently funded by the National Science Foundation through the BEACON Center for the Study of Evolution in Action (the same group who funded the development of this curriculum guide). Individual episodes are mentioned with the stories where relevant, but new ones are added continually. Blog posts and Facebook updates are too numerous to mention individually but are *searchable*.
- <http://variationselectioninheritance.podbean.com>
- <http://www.facebook.com/vsibeaconpodcast>
- <http://www.twitter.com/VSIBeacon>

The *Assignments* might be given out to small groups of students the same year. Keep in mind, however, that teachers get bored, too, and this boredom can be communicated to the class unconsciously. We instead suggest that a subset of the assignments for each story be given to the entire class, rotating between years to keep the book fresh for the teacher as well as for the students. The order of that rotation we obviously leave up to the individual teacher.

As you employ the ideas shared in the manual, we would love to hear about your experiences. What worked? What didn't? What are your students saying? Any surprises? What would you like to see in the next volume? Please share your insights at [vsi.beacon@gmail.com](mailto:vsi.beacon@gmail.com).

## What Do I Do with Fiction in a Science Class?

### Reading for Understanding and Meaning

**N**ATIONAL RESEARCH COUNCIL (2007) is concerned with American students underperforming in science compared to students in other countries, and we believe reading comprehension is a major factor in that discrepancy. Both those who write science texts and those who write science fiction generally share some common difficulties, including heavy vocabulary demands and the ability to pull meaning from the text. Students need to be able to discern or infer what is important. In scientific texts this may be inferring “conclusions drawn between propositions” and/or discerning between “prior topic knowledge and the current text” (Marr & Gormley, 1982). The reader of creative texts also must infer meaning through setting, plot, character action, dialogue, etc. It is our contention that working on reading comprehension in general will assist students with both modes of textual comprehension.

Many students spend a great deal of time reading; many instructors do not put an emphasis on reading comprehension (Shaw, 1999). In part this is because instructors believe students already have the skills, or instructors don't believe they can teach them skills (Sherfield, 2005). Further complicating this process, students can get easily overwhelmed by text-based material (Lei et al., 2010). Taking a small amount of class time reviewing and building the strategies described below can pay huge dividends. This is especially true since critical thinking and reading skills need active reading (White, 2004).

Teaching specific reading strategies have proven to be effective with scientific and narrative texts (Gunn, 2008; McDaniel et al., 2009). While there are a number of reading comprehension strategies and studies examining the effectiveness of those theories, for our purposes we wanted to keep it simple. We loosely base our suggestions on the **TKED** method. This method posits that students should start by identifying the **T**hesis, then **K**ey points, followed by **E**xamples, and finally **D**etails. In both scientific and creative texts, these general concepts can be applied fairly easily.

For example, being able to identify the thesis, key ideas, examples, and details is self-

explanatory. In stories one would look for the overall meaning or theme, secondary ideas presented, and textual examples and details that would support those ideas. Two things that are not “required” by TKED are defining and understanding difficult words, concepts, and references in context and reacting to the text by making comments, questions, connections to other writers, pop culture, other scientific texts, etc. in the margins.

The annotation quiz (a sample seen below) gives you an opportunity to easily see if students understand main concepts. We highly recommend that these quizzes be “open book”. Open book quizzes will be most useful to you, the instructor. You will be able to ask specific questions like “the thesis is” or “on page three paragraph 4 what is the key idea” or even “what is meant by the word ‘x’?” If students have spent time reading and annotating the text, they should be able to do extremely well on every quiz. If you find a majority of your class struggling with a concept, you can back up and review.

The second purpose of these quizzes is for you to gauge students’ ability to make meaning out of the text. “What does the author mean by. . . ?” or “How might this relate to. . . ?” or “Why is what the author saying here significant?” Further, we hope the format addresses the factual questions (questions that can be answered explicitly by facts contained in the text), inferential questions (questions that can be answered through analysis and interpretation of specific parts of the text), and universal questions (questions that are open-ended and deal with ideas raised in the text they are intended to provoke a discussion of an abstract idea or issue.)

Active reading is like every other skill that must be nurtured and developed, no matter the age or how long a person has been doing it. This is especially true for the current students, used to the clipped reading of websites. Indeed, playing tennis or piano, or even driving a car, needs a certain skill set, and practice, to be proficient. And that is our goal: to get students proficient in reading. Then students will be able to critically read and think about the texts, which as professors is our ultimate goal.

## Annotation Quiz

**O**VER THE COURSE of the semester you will be required to read and annotate essays. This is the deliberate process of reading, comprehending, thinking, and questioning the material. You will be reading more on how to complete this process in the first couple of weeks of the semester.

You will be asked to:

1. Identify and highlight the thesis and the main points of the essay.
2. Circle and define any unknown words, references, people, etc.

3. React to the text. Comment, question, make connections to other writers, pop culture, scientific texts, etc in the margins.

Name: \_\_\_\_\_

Points: \_\_\_\_\_

Essay being annotated: \_\_\_\_\_

Main Ideas:

1. \_\_\_\_\_  
\_\_\_\_\_

2. \_\_\_\_\_  
\_\_\_\_\_

3. \_\_\_\_\_  
\_\_\_\_\_

4. \_\_\_\_\_  
\_\_\_\_\_

5. \_\_\_\_\_  
\_\_\_\_\_

Keywords:

1. \_\_\_\_\_  
\_\_\_\_\_

2. \_\_\_\_\_  
\_\_\_\_\_

3. \_\_\_\_\_  
\_\_\_\_\_

4. \_\_\_\_\_  
\_\_\_\_\_

5. \_\_\_\_\_  
\_\_\_\_\_

Bonus:

\_\_\_\_\_  
\_\_\_\_\_

## **Basic Story Questions**

1. Who is the main character or protagonist?
2. What is his/her goal? What does she/he want?
3. Who is the antagonist? Why does he/she want to stop the protagonist (this could be internal, i.e., self, or external, e.g., a person or nature)?
4. What is the setting?
  - a. Time period?
  - b. Place?
5. What is the plot? What happens?
6. What is the climax?
7. Does the main character get what she/he wants?
8. What does the character learn?
9. Who are the minor characters?
10. What is the point of view? Why this view versus a different one?

## **Basic Discussion Questions Template**

1. This story makes significant contributions to the idea of sociological evolution. What might some be? Take one and develop it.
2. In what ways do (characters) present (characteristic)? Is this scientifically accurate as best as we can understand it? Why or why not? Use research to support your claim.
3. What is the sociological structure of this society? What are the main roles of the sexes?
4. Who is the narrator? Why this person versus someone else?
5. What is the most significant aspect of science in this story that the author is trying to impart?
6. Evaluate the story's success at staying true to what is known in science.

7. Synthesize evolutionary psychology sources with the story to highlight one major theory it explores.
8. In this story (action) happens. Why? Why does this scene grab the reader's imagination more than any other?
9. What was one thing that confused you in this story?
10. How is nature portrayed?
11. Why does (the story) end in this way?
12. What might the "moral" of the tale be, if any? Why is it significant?
13. What values are highlighted in (event/story)? What are the most important values for those characters during that time period? What values have supplanted those earlier ones? Why? Is the evolution of these values truly beneficial? Show why or why not.
14. What does this story say about current times, people, social structures, etc?
15. Describe the changes (character) experiences physically and mentally.
  - a. How do other characters respond to those changes?
  - b. Why might the other characters feel threatened by these changes or differences?
  - c. What literary techniques does the author use to illustrate these changes?
16. What are some behaviors you found shocking? Why? What is different now?
17. How does the author portray the relationship between reason, religion, and truth?
18. How does the author challenge our modern perceptions of adaptation, gender roles, alienation, and human/animal relationships?
19. Describe the kind of world (character) inhabits
  - a. Physical
  - b. Social
  - c. Psychological
  - d. Anything else?

20. How does (the story) reflect the time period the author was exploring?
21. What do you think will be the next steps in human evolution? Why?
22. Does (story) have a conventional conclusion, or a surprise ending? How does that contribute to the end of the story? In what ways does the historical context influence this story?
23. Is political evolution highlighted in any of the stories? To what effect?
24. What kinds of observations does (author) make in the story? How do characters depicted in later time periods observe and understand the world? From our most recent understanding, given our access to technology, books, etc., are these fair assumptions?
25. What is (character's) job? Why does the tribe need him? What other functions might it serve? How is this like what we see in the animal kingdom?
26. Often sci-fi stories explore how possible transformations in societal relationships are shaped by technological advances. What are some of the ways relationships are changed by technology? For better or worse? Why?
27. How do you react to/embrace/reject creativity in (story)? Why?
28. In what ways are animals portrayed in the story? How do these portrayals comment on contemporary attitudes toward them?
29. How are our opinions and beliefs tied to social, technological, psychological, and cultural systems?
30. Do social values and societies constrain technology, or does technology drive changes in values and society?

## **“Patterns of the Fall” by Gerri Leen**

**(3,000,000 years ago)**

### **Synopsis**

**“P**ATTERNS OF THE FALL” follows LittleBlack, a young female, through the process of family life with parents, finding a mate, and creating a family of her own. Within the confines of her “tribe”, the reader is introduced to seeing how they ate, what the social structure and family dynamic might have been like, and how they navigated the world around them.

The story opens with LittleBlack’s impression of the group and the courting of her soon to be mate, TallMale. LittleBlack’s mother assists LittleBlack through her first pregnancy, a son she calls StrangeEyes. Jumper, the youngest of LittleBlack’s sisters, whom LittleBlack never cared for, soon becomes integral to LittleBlack’s family by helping with the raising of StrangeEyes. When a volcano threatens to erupt, the tribe is both curious and concerned, none more than TallMale. As the volcano gets worse, so does LittleBlack’s mother’s condition. She is weak and coughs a lot; both symptoms portend death. Animals run from the volcano as it wracks the ground and spews ash into the air; Mother dies, perhaps in part due to the ash. Soon Father follows Mother and passes away. Through a difficult foraging season, TallMale goes searching but leaves Jumper and LittleBlack alone with StrangeEyes. When hyenas attack StrangeEyes, Jumper throws rocks at them to lead them away, sacrificing herself for the babe. LittleBlack gives birth to her second child, a daughter, RainEnd. The volcano threatens again, but the family unit is intact as they face the challenges together.

### **Vocabulary Words**

1. family dynamic
2. vocalization
3. survival of the fittest
4. interpersonal communication

5. social structure
6. monogamy
7. perch
8. alpha
9. unwary

## **Main Characters**

LittleBlack

Female Protagonist

TallMale

LittleBlack's mate

Mother

LittleBlack's mother

Jumper

LittleBlack's youngest sister

Father

LittleBlack's father

StrangeEyes

LittleBlack's son

RainEyes

LittleBlack's daughter

## **Discussion Questions**

1. How would you describe (character)
2. What are some of the tools they used?
3. What are some of the natural predators?
4. How would you describe the family dynamic?
5. What is the social structure of the Tribe?
6. How was information transferred between members of tribe and family? Was this an

effective way?

7. What were some of the emotions the author portrayed in the story? Do you think those are “fair” depictions? Why or why not?
8. What are some of the symbols in the story and why might those be significant? (Black rain and death, rain and birth, character names, etc.)
9. How does the family unit deal with death?
10. What causes such commotion? How do they make sense of it? Communicate about it.

## **Search Terms & Key Concepts in Evolutionary Science**

structure vs. function correlations

trade-offs

bipedal locomotion

ballistic movements

inclusive fitness

reciprocal altruism

kinship

cooperative breeding

cooperative provisioning

theory of mind

mirror neurons

language

facial gestures

body language

emotion

tripartite brain

limbic system

life history / life cycle

development as an evolutionary process, or evo-devo neoteny

seasonal breeding

endurance predator

ambush predator

scavenger

extinction

## Research/Discussion Questions

Forensics is the science of traces left behind by humans.

1. What can we tell from a set of footprints?

Jumper teaches herself to throw stones accurately.

1. What physical traits are necessary to throw things?
2. What traits are incompatible with the ability to throw things?

Jumper could not outrun the hyenas.

1. Could you, personally, outrun a hyena? Can anyone alive today outrun a hyena?
2. What about other predators? Are action movies and video games where humans battle animals hand-to-hand in single combat accurate? Why are movies and video games designed the way they are?

In this story, Australopithecines had fur.

1. Is this accurate, according to current evidence? Are there humans alive today who have fur?
2. Why do scientists suppose our ancestors lost their fur? Why are there so many different and competing explanations?

Science Fiction as a literary genre has particularly open and nonjudgmental attitudes towards sex.

1. What is the modern human “breeding season?” Do we have one?
2. Do other primates have sex for pleasure, outside of their breeding seasons?
3. Were LittleBlack and TallMale having sex for pleasure? What about Father and Mother? Is this realistic, based on current evidence?
4. Are modern humans monogamous? How many other primates are monogamous? How many other mammals are monogamous? Is Australopithecine monogamy realistic, based on current evidence?
5. Why is childbirth so much more difficult and painful for modern humans than for other mammals, even other primates? How does this compare with other historical explanations for the difficulty?

6. When did these differences in physical structure arise in our history? Do we know?
7. LittleBlack was already pregnant again before StrangeEyes could even walk. How realistic was this, based on current evidence? How soon can modern humans get pregnant again after a birth? What physiological variables control the ability to get pregnant?

Cognitive scientists and evolutionary psychologists have pointed towards a “theory of mind” being an important piece of our social behavior. In other words, the ability to imagine what another person is thinking is an incredibly useful social tool.

1. Would LittleBlack have had mirror neurons?
2. How did LittleBlack learn to throw rocks?
3. Could LittleBlack lie? What is a lie, neurally speaking?
4. There are modern humans who supposedly do not have a “theory of mind.” Who are these people?
5. Would these people be good models for the behavior of earlier species? Why or why not?
6. When did laughter arise as an emotional behavior?
7. Do other primates laugh? Other mammals?
8. When did grief or sadness arise as an emotional behavior? Do other primates grieve the loss of loved ones? Other mammals?
9. In this story, adult Australopithecines don’t cry. They howl or whine when they are upset and need to be soothed.
  - a. Did baby Australopithecines cry, with tears, the way modern humans do?
  - b. Do other modern primates cry tears, either as babies or as adults?
  - c. What is the purpose of crying?
10. Australopithecines are extinct. Why?

## **Links & Resources**

1. NOVA: Becoming Human, a documentary produced by station WGBH in Boston

Susan Savage-Rumbaugh's TED talk on bonobos, particularly the comparative "walking skeletons" video

[http://www.ted.com/talks/susan\\_savage\\_rumbaugh\\_on\\_apes\\_that\\_write.html](http://www.ted.com/talks/susan_savage_rumbaugh_on_apes_that_write.html)

Howard Hughes Medical Institute's 2011 series of four Holiday Lectures on Science. Stones, Bones, & Genes

<http://www.hhmi.org/biointeractive/evolution/lectures.html>

VSI, episodes 32 and 33 on hyenas and field biology in Africa.

## **Assignments**

1. Have students create a chart comparing primate growth patterns from their own research. It should look something like those at this website, from the Centers for Disease Control, but using multiple species.  
<http://www.cdc.gov/growthcharts/>
2. Have students create scatter plots of average time between births vs. body size across primate species, or mammal species in general. Do cooperative breeders gain in fertility over what one would expect based on body size?
3. Have students count the number of times one character imagines another's inner state for the purposes of predicting future behavior. As an extension, have them keep a journal of the number of times they do this themselves in an hour, or a day.
4. Have students view animals hunting and fighting on video and make lists of named "moves," or "maneuvers" that *real* animals use. They will be familiar with the concept from playing MMORPGs or other video games. What is the overlap between fantasy and reality? Why do game designers choose the moves they use?

## “The Dawn of Reason” by Lezli Robyn

(175,000 years ago)

### Synopsis

**T**HE HUNTER AND HIS FAMILY flee from two formidable antagonists: a blizzard that brings starvation and the Others who take their homes and land. When the Hunter comes across a living legend, The Mountain That Walks, an old Mammoth that protects its herd, he feels instant respect. As starvation looms, the Hunter and the other humans he’s encountered communicate to bring a beast down so they will survive. Through determination and teamwork, the humans bring down the great Mammoth and survive.

### Vocabulary Words

1. bisected
2. resolutely
3. sobriquet
4. sustenance
5. lethargy
6. futile
7. belied
8. demeanor
9. matriarchal

### Main Characters

Hunter

Protagonist

Mate

Hunter's mate

Baby

Hunter's infant

Mammoth

The Mountain Who Walks; leader of herd

Tribe

Group of humans Hunter meets

Others

Group that ran Tribe off from lands

## **Discussion Questions**

1. What are some of the tools used by the tribe?
2. How does the tribe communicate?
3. How does the tribe interact with nature and why is that important?
4. When describing the Others, how are they presented? What was probably meant? Are they another species or simply another tribe of modern humans, with a different language and culture? What clues are there in the description?
5. Why do you think Robyn titled the manuscript "The Dawn of Reason"? Based on the definition of "reasoning," do you believe she captured it well? Why or why not?
6. The Hunter shows empathy for the Mammoth through the story. Why? Is his empathy more than that of his fellow tribe members? Why or why not? What is the significance of that?
7. What were some of the tools that were more popularly used during this time period? Does that fit with what the scientific record shows?
8. What would make the Hunter drop his weapon? Does this depict reasoning?
9. At this time, were humanoids drawing to communicate? Why is this such a milestone? What are implications? What did this mean to the brain's development?

## **Search Terms & Key Concepts in Evolutionary Science**

cooperative hunting  
    wolf pack tactics  
    stabbing spear, throwing spear, atlatl  
gathering/foraging  
pregnancy sickness  
language  
    gestural communication  
    comparative anatomy of the larynx  
symbolic communication  
stone tools  
    flint knapping  
paleolithic vs. neolithic periods

## **Research/Discussion Questions**

Evolutionary scientists have proposed that humans could not have evolved our huge brains without a diet based at least partially on meat.

1. Why? What necessary elements would meat provide that other foods would not?
2. What physical or anatomical adaptations do modern humans have for eating meat?
3. Do other primates have any of these adaptations?
4. Why does this story (and most of the others in this volume) focus on the hunting of big game, rather than on the hunting or trapping of small game, or the gathering of plant materials “to add nutrients to their diet”? Which would be a more reliable source of calories?

The Hunter uses a stone axe, a slashing weapon, to hunt large game.

1. Is this realistic, given current knowledge?
2. How would you hunt a four-ton mammoth without modern weaponry?

This story dramatizes possibly the very first time a group of humans hunted as a group.

1. Is this realistic, given current knowledge of hunting in other primates, like chimps?

2. When did speech arise in human history?
3. What kinds of evidence bear on this question?

There is a standoff between the Hunter and The Mountain That Walked.

1. Are these behaviors consistent with the behaviors of a modern African bull elephant?

## **Links & Resources**

1. The BBC series *Inside Nature's Giants*: particularly the episode, "Elephant"
2. Disney Nature's documentary *Chimpanzee*, which shows chimp's hunting tactics
3. VSI Episode 20: Stones, Bones and Genes review and Episode 39: Chimpanzee review
4. Mastersgames.com, for hunting-strategy board games
5. Boardgamegeek.com, for hunting-strategy board games

## **Assignments**

1. Have students make their own stone tools. Supplies are available from many online outlets. There are even instructional videos online at YouTube and other such sites.
2. Have students research edible wild plants that grow in your area. Invite a local expert (often called a *forager*) to come to your class. *Under the forager's direction*, gather some plants (being careful to avoid pesticides and poisonous plants) and have an in-class tasting. Make sure to get parental permission first, as "wild foods" are an area of anxiety for some urban dwellers.
3. Have students research modern elephant anatomy and behavior as a window into past mammoth and mastodon behaviors. Organize a debate around the concept of "Rewilding Pleistocene Megafauna," with teams composed of randomly chosen members defending the various positions.
4. Have students research traditional checkers-type board games such as *Fox & Hounds*. Then have them design a mammoth-hunting game that takes into account the relative physical power and intelligence of humans and elephants. After some discussion and play-testing, compare the students' game(s) with a modern board game such as *Mammoth Hunters* or *Carcassone: Hunters and Gatherers*. These modern games are expensive, but there many game clubs at universities who maintain "game libraries," or sometimes game shop owners can be convinced to do

classroom demonstrations.

## “Fire in the Sky, Frost in the Land” by Z.S. Adani

(71,000 years ago)

### Synopsis

**B**EFORE THE GREAT ICE HITS, Unter must get his tribe to the new hunting grounds; however, a volcano eruption changes everything. While the return to the old hunting grounds is difficult, they make it with some ingenuity and good luck. As winter moves in, the tribe’s fortunes look bleak. But when they see another tribe hiding in a cavern, they have reason for optimism. The two groups ultimately share knowledge for shelter; the future for the new tribe looks bright.

### Vocabulary Words

1. pelt
2. acquisition
3. trod
4. quarry
5. gravid
6. sated
7. trekked
8. pantomimed
9. calamity

### Main Characters

Unter  
    Protagonist

Tian  
    Unter's right hand man

Iro  
    Fire keeper

Elders  
    Group's council

Rivo  
    Rival hunter

Ona  
    Unter's mate

Ruta  
    Twisted Foot Girl

Leye  
    Pregnant and first to lose baby in birth

Chitters  
    Chimps

Beno  
    Cave Dweller Father of Ona's 2nd child

### **Discussion Questions**

1. Who is the protagonist?
2. What stops them from reaching their winter hunting grounds?
3. What does Unter make that is original?
4. What does Ruta create?
5. What happens in the long tooth fight?
6. When Unter first sees cave dwellers, what happens?
7. What does Rivo want to do to the cave dwellers?
8. What makes them one tribe?

9. What kind of characteristics does Rivo exude?
10. What are chitters?
11. Why is the tribe desperate after Leye's experience?
12. Why does Unter reject the idea of just taking the cave?
13. Why does Ona leave Unter?
14. Why doesn't Unter do anything?
15. Why do they not like eating chitters?
16. Which tribe got the best trade? Why?

## **Search Terms & Key Concepts in Evolutionary Science**

D.S. Wilson and "ugly adaptations"

abortifacients

plant alkaloids

teratogens

energy or parental investment

male vs. female mating strategies

showoff males

egalitarianism

monogamy vs. polygamy

endogamy vs. exogamy

bride exchange

## **Research/Discussion Questions**

When did names like "Unter," as opposed to literal descriptions like "LittleBlack" or titles like "the Hunter" from the previous stories, arise, based on current evidence?

Several of the women of Unter's tribe miscarried their pregnancies. Others died while pregnant, without miscarrying.

1. How might miscarriage itself be an adaptation, or a survival trait? If it is, what factors might we expect to end a pregnancy?
2. How is the modern obesity epidemic rooted in physical adaptations to earlier times?

What physical traits, behaviors, and cultural practices would have been extremely useful to Unter's tribe, but less useful or even harmful to humans living in our modern environment?

Rival males like Unter and Rivo tolerate one another in the same hunting territory.

1. How unusual is this behavior in the animal kingdom? Count examples of species that use this cooperative hunting strategy.
2. If the cave tribe didn't like their chief hunter, why did they follow his lead? Why do any humans, at any time, allow themselves to be oppressed by a single tyrant or a small minority? Clearly, as a group, they could have killed him in his sleep if they chose to do so.

Humans are generally but not completely monogamous.

Unter offers the cave dwellers technology (the bow) in exchange for use of the cave.

1. Is this realistic, given that historical hunter-gatherers generally traded or raided women? Why might a modern author choose to change this detail?
2. Ona left Unter for another man, Beno, and then returned. What was her stated reason for these choices? What other reasons might she have had?

## **Links & Resources**

MARGIE Profet's two books, *Pregnancy Sickness: using your body's natural defenses to protect your baby-to-be* and *Protecting Your Baby-to-Be: preventing birth defects in the first trimester*.

## **Assignments**

1. Have students research the effects of nutrition, body fat percentage, or obesity on reproduction. Relate these to the different evolutionary "strategies" males and females have for maximizing their fitness. Have them generate hypotheses first, such as, "Underweight girls will mature sexually later than normal weight girls," or "Overweight girls will mature sexually earlier than normal weight girls," or "Female reproduction should be more sensitive to body weight than male reproduction." *This is a difficult step for many students*, as their normal practice is to phrase things as vaguely as possible to avoid being wrong, but it is essential to the scientific method. *Indeed, the ability to be happily wrong may be the fundamental attitude of a scientific worldview.*

2. As a critical thinking exercise, have students examine the website of *The Shangri-La Diet* (sethroberts.net). Is the idea behind this diet theoretically correct, based on current ideas about hunter/gatherer diets? Is the evidence for the effectiveness of this diet based on rigorous scientific studies? Can a hypothesis be correct without controlled experiments to support it?
3. Have students fill out food journals, tracking what they eat and where it came from. Then compare these journals to the recommendations of various diets (marketing fad-based ones, etc.) to see which ones the students are most closely following.
4. Have students create a “Hunter/Gatherer” diet plan, complete with brochures, book covers, and audio or video commercials. It might be a modern plan for losing weight, or an ancient plan for gaining weight. Be playful, but scientifically responsible concerning calorie counts and other nutrition information.
5. Have students research the work of Margie Profet and others on pregnancy sickness as an adaptation to a plant-based diet.
6. Examine the ironic history of thalidomide, which caused severe birth defects even as it was being used to treat the nausea of “morning sickness” as a symptom, rather than as an adaptation. What other common “symptoms” might also be unpleasant adaptations to disease?
7. Have students research the development of the bow through modern times as an example of technological evolution. Invite a modern sport archer or bow hunter to class for an outdoor demonstration and/or archery lesson.

## “The Ugly Ones” by Max Habilis

(41,000 years ago)

### Synopsis

**I**MMEDIATELY AFTER BIRTHING her child, Scout helplessly watches a midwife/mystic take the baby away, suggesting it was stillborn. This tribe of modern humans believed the baby was killed by the “invisible smoke” emanating from the other tribe’s camp. Scout’s sadness and longing for a child commits her to staking out the Neanderthal’s dwellings and marking them with pigment so the males of her tribe could easily find and slaughter their distant cousins. After marking the cave, she views the Neanderthals in what seems to be a ceremony. It was a birth of a child. Scout recognizes that they feel emotions, are empathetic, and even more kind to one another in some ways than her own tribe.

### Vocabulary Words

1. eradicate
2. Neanderthal
3. protruded
4. niche
5. vulnerable

### Main Characters

Scout  
    Protagonist  
The Elder

Midwife / Shaman

Ugly Ones

Tribe of Neanderthals

Ugly One Chief

Performs ceremony

Ugly One Young Female

Has child

Ugly One Young Male

Female's mate; has limp

### **Discussion Questions**

1. Who is Scout?
2. What happens to her early on? Why?
3. What is the explanation given by the Elder for Scout's misfortune?
4. Where do the Ugly Ones live?
5. How does Scout mark the caves? Was there widespread use of pigmentation during that time?
6. What make Scout's tribe so wary of the Ugly Ones?
7. What were the beliefs of the two tribes concerning "religion"?
8. Why do you think the Ugly Ones are more settled while Scout's tribe is more nomadic?
9. What kinds of beliefs did the Ugly Ones depict? Values? Emotions? Significance?
10. What do you make of the two tribes' religious beliefs or ceremonies? Do you think there are similarities today? Why or why not?

### **Search Terms & Key Concepts in Evolutionary Science**

inclusive fitness

kinship

reciprocal altruism

coalitional violence

sexual selection  
koinophilia

mate preference

emotions as both cause and effect in human behavior  
theory of mind  
empathy

blame and betrayal

language  
Broca's area, Wernicke's area  
FOXP2 gene  
critical period  
pidgin, Creole

life history / life cycle  
neoteny  
human body growth rate

adaptation  
adaptations for warfare  
pregnancy sickness as an adaptation

extinction

## **Research/Discussion Questions**

Scout's people have a claim about their reasons for destroying the Neanderthal tribe.

1. Is this claim a hypothesis or a superstition?
2. Generate as many reasonable hypotheses as you can for the cause of Scout's baby's death.
3. Why do modern tribes of humans *claim* they go to war? Are these reasons different than the reasons for individual murders? "Tribes" can be defined loosely, from criminal gangs to nations.
4. Why do modern tribes of humans *actually* go to war? What triggers emotions like hatred at the level of an entire tribe, as opposed to an individual human?
5. Why does war come and go? What triggers wars? In other words, why are we not in a constant state of war? Why are we not in a constant state of peace?
6. When did humans begin to kill one another with weapons? How far back does this behavior go in the fossil record?

Neanderthals were physically stronger than modern humans, and yet Scout recalls previous occasions where Neanderthal tribes were wiped out. Why were they losing these conflicts with our ancestors?

1. Just how strong were Neanderthals? How much could they lift? How do we know this?
2. Why are modern humans so weak, comparatively? What possible advantage could smaller muscles give us?
3. Neanderthals' brains were as big as ours, though shaped differently. According to current evidence, what do these differences mean for Neanderthal behavior?

Scout's people consider the Neanderthals ugly.

1. What features contribute to ugliness in every modern human culture?
2. Why do modern groups of humans, all of the same species, consider people outside their own ethnic groups to be ugly?

Scout hates the Ugly Ones, but is sent not to kill them, but to mark their cave so that the men can kill them.

1. Which gender commits most of the violence in modern times? What percentage of combat soldiers is female? Why is that, when modern weapons like guns and fighter jets require little physical strength to operate?
2. Was this different in earlier historical cultures? Is it realistic that Scout is carrying out a combat reconnaissance mission? Why might the tribe choose to send a woman? Why might an author choose to send a woman?
3. Why are there so many female warriors in pop culture? (*Buffy the Vampire Slayer*, Brienne of Tarth in HBO's *Game of Thrones*, *Birdy the Mighty* and the majority of Japanese anime, the Amazons of Greek myth, etc.).

In this story, Scout claims the Neanderthals can't talk, that they only make "bellowing sounds."

1. Is this accurate, according to current evidence? How do we know?
2. Is modern human language innate, trained, or some combination of the two? Are there examples of modern humans who cannot talk at all?
3. What nonhuman animals have been taught to talk?
4. If we cloned a Neanderthal, could we teach him or her language?

In this story, Neanderthals laugh, but it doesn't sound like "human" laughter.

1. When did laughter arise as an emotional behavior?
2. Do other primates laugh? Other mammals?

Scout notices the Neanderthals taking care of their wounded.

1. What evidence do we have for this level of empathy among Neanderthals?
2. When did grief or sadness arise as an emotional behavior?
3. Do other primates grieve the loss of loved ones? Other mammals? Non-mammals? When did grief arise on the evolutionary tree?

### **Links & Resources**

1. PBS NOVA 3-part documentary *Becoming Human*
2. Any of several documentaries on Otze the Iceman
3. *Joseph Campbell and the Power of Myth*, particularly the episode "The First Storytellers."
4. WNYC's *RadioLab*, particularly the episode "Laughter," season 4, episode 1.
5. Robert Provine's papers on the evolution of laughter

### **Assignments**

1. Have students research the structure of the birth canal across primates, and the effects of this structure on childbirth mortality across the family for both mothers and babies. They might even produce physical models of the female pelvic bones of various species for demonstration purposes.
2. Have students research differences in childbirth mortality across modern societies, where the physical characteristics of women are presumably almost identical. What causes these differences?
3. An assumption for the political argument in favor of equal rights for women is that there are no inherent differences between male and female behavior in humans. Organize a debate about this issue. Have students research their positions, which might be randomly assigned in order to push the students outside of their own prejudices. Keep in mind that within the study of argument there is a clear

separation between the truth of a claim (such as, “There are no inherent or genetic differences between male and female behavior”) and the relevance of a claim used to support a conclusion (for example, “Women should have equal rights *because they are the same as men*”). In other words, are inherent differences a good reason to deny equal rights to women, regardless of their truth?

**“The Pull of the World and the Push of the Sky” by  
Camille Alexa**

**(31,000 years ago)**

**Synopsis**

**G**UNH IS SMART, FUNNY, creative, and inventive. Some of his big ideas don't work out, but others are (for lack of a better word) game changers. Moogh, his brother, is stronger and faster, but not quite as smart. Moogh has his heart set on Enkha, a favorite woman of the tribe. As Gunh heads north he sees glaciers melting and in the ice what we can assume as the skeletal remains of a pterodactyl. His greatest idea is to “fix” the remains so that he can use it to fly. His tribe assists him in the quest and climactically he does indeed float on air in his makeshift flying “machine”.

**Vocabulary Words**

1. perennial
2. inhibited
3. travois
4. verdant
5. vantage
6. discernable
7. pendulum
8. carapaces
9. loped

10. steppe

## **Main Characters**

Gunh

Moogh's brother

Moogh

Gunh's only brother

Enkha

The woman both brothers swooned over

## **Discussion Questions**

1. How does Moogh feel about his brother?
2. How is Gunh viewed by his tribe?
3. What are some of the inventions Gunh creates?
4. Who is the good talker? In comparison, how does Gunh communicate with his brother?
5. What does Enkha say she will do if Gunh's plan succeeds?
6. Why does he pray to the hunting bird and what do you think the significance of this type of prayer is to early humans?
7. In terms of the time period, do you think the creative inventiveness depicted is fair? Why or why not?
8. Does Enkha's strong verbal communication play a part in her attraction both to the tribe and to Gunh and Moogh?
9. Why do you think the tribe helps Gunh in his plan?
10. How realistic is the scenario of finding a thawing Pteranodon (or other pterosaur) and using it as a hang glider? Why or why not? What other motives might the author have had for including those elements?
11. Does a story have to be factually correct in order to be morally or emotionally true to life? Give examples for "Yes" (stories that derive their power from details of everyday life) and examples for "No."

## **Search Terms & Key Concepts in Evolutionary Science**

inclusive fitness

sibling rivalry

convergent evolution

language

profanity and the cingulate gyrus

facial expressions

honest signaling

baby sign

religion

animism

shaman

pagan

polytheism

monotheism

## **Research/Discussion Questions**

What species is this tribe?

1. What clues does the author give us?
2. Are they consistent with current knowledge? Are they consistent with the earlier stories?

What is interfering with Moogh's sense of smell?

1. Is it surprising (or realistic) for a tribe of people who live outside all the time to have this problem?
2. Why are they not "perfectly adapted" to their environment? Is this an assumption of evolutionary science?

Gunh says one thing with his hands, and another contradictory thing with his face.

1. Can other animals lie like this? How old is this ability? What is its purpose?
2. How many muscles are found in the human face? Is this more or less than other animals, particularly primates?

Gunh says something like, "The ladies love a funny man."

1. How would a sense of humor help a male, in terms of mating? What genetic traits might be reflected by a good sense of humor?
2. What other animals have adaptations that seem to work against survival but for mating?
3. How is Gunh a typical male, in terms of his behavior? How is he atypical, or different from Moogh and the other males?
4. How is Enkha an atypical female? Do their examples mean that the generalizations about male and female behaviors are simply wrong? Compare to the generalizations about violence in males and females from the previous story.

Religions, like related species, can be classified as members of families that share features and are distinguished by differences.

1. What class of religion does this tribe have? What practices or beliefs does it have in common with modern religions? What practices or beliefs separate it from modern religions?
2. When Moogh mentions the “Fire-cursed flowers,” what does he mean? Does this imply that “Fire” is a god to him? Is he asking the Fire to curse the flowers, or merely expressing frustration? How is profanity different from ordinary speech, in terms of brain structure?
3. When Gunh asks the huntbird to guide him, is he praying to it in the same way that Harmonia will pray to her gods in the next story? Will he sacrifice something to the huntbird?
4. How might we relate religious beliefs and practices to the “theory of mind” mentioned in earlier stories?
5. What evidence is there for religious practice or belief in other human species? Other primates? Other mammals?
6. How would we compare this tribe’s religion to those in earlier stories?

Most of the tribe is fluent in sign language, but only a few like Enkha are good at “mouth speech.”

1. What evidence do we have for the hypothesis that sign language came first?
2. What evidence do we have against it?

Are Gunh and Enkha geniuses?

1. Can they be geniuses if they are not modern humans (*Homo sapiens*)?

2. Are there exceptionally intelligent members of other species? Find examples, if possible.

This is the first story containing a mention of cave art.

1. Is this realistic, based on current evidence?
2. Why were the paintings placed only in caves?
3. Or were they? What if they were everywhere, like graffiti, and just washed away, so that only the protected cave paintings survived? How would one go about answering this question?
4. Could cave art, like humor, have been a mating adaptation? What underlying genetic traits could be accurately reflected by an ability to draw pretty pictures?

## **Links & Resources**

1. *Joseph Campbell and the Power of Myth*, particularly the episode “The First Storytellers.”

Andrew Halloran’s book *The Song of the Ape*.

## **Assignments**

1. To follow up on Gunh’s facial joke, have students research the work of Paul Ekman on human facial expressions, including the involuntary micro-expressions, which can be used to read emotions independently of spoken language.
2. Have students research allergies, casting a wide net to include controversial work like that of Margie Profet on allergies as adaptations, and fringe theories like homeopathy. Focus particularly on what separates true science from pseudoscience. How does one separate real applications of the scientific method from the long words often associated with it?
3. Have students research the development of modern sign languages such as Signed English or American Sign Language. Give each a short poem or famous quote from someone they admire to translate into ASL and perform for the rest of the class. Compare their performances to those of apes taught to sign, such as Washoe, Nym Chimpsky, or Koko the gorilla.
4. Have students research the Baby Sign movement, in which infants as young as six months have been taught to sign, or have a baby-signing family bring their infant in to class to demonstrate and discuss. Is this type of communication more similar to

the ape-sign training methods than the linguistic translations above?

5. Have students research exceptional animals such as Alex the parrot or Chaser the Border collie (who apparently knows and responds to over a thousand words!) vs. earlier, scientifically debunked examples such as Clever Hans the counting horse. Are these examples relevant to the current controversy about apes learning language?
6. Have students look at Neolithic cave paintings in art books. Allow them to reproduce some of them in chalk on a sidewalk or wall, and then comment on the skill and intelligence that they required. Allow students to judge the best paintings and keep track of their agreement. Then repeat the exercise with famous works of abstract art. Do students agree more or less about the abstract works? What features do they use to judge them? Could these more abstract works be “objectively” valued in a mating competition?
7. The story does not mention any hunting magic, but we suspect that is one thing the cave paintings may have been used for. Have students design a fictional ritual that Gunh, Moogh, and Enkha’s tribe might have used in connection with their cave paintings.
8. Campbell also describes rituals as a way of dealing with the emotional aftermath of killing, such as guilt. Most modern students eat “anonymous” meat, which they had no hand in killing or preparing, and for which they probably feel no guilt. With particularly empathic students, it might be interesting to have them design a ritual to appease their own feelings of guilt.

## **“Arrows of Apollo” by Jenny Blackford**

**(2,500 years ago)**

### **Synopsis**

**T**HE PLAGUE ROCKS ATHENS. This story follows Harmonia, one of Pauson’s most trusted and well-liked servants, and her perspective on the war with Sparta, the plague, and the subsequent effects of the devastation. As the war grips the country tighter, taking most of the city’s men, many inside the city’s walls grow even more fearful. Overcrowding and limited supplies are making the city unbearable. Further, there are rumors the Spartans infected the city since they live in the same conditions yet are not sick. People are scared.

Pauson’s son, Aristogeiton, is infected by the plague. Harmonia is charged with taking care of him. She goes about this duty with care. Meanwhile Pauson’s mistress, Ismenia, is awash in worry and grief. Harmonia sees them both as good people and likes the boy. Indeed, Aristogeiton returns the affection. Then Harmonia’s twin sister comes down with the illness and Harmonia is frantic. As Pauson brings more doctors in from the city, the word from outside his home’s walls is bleaker. Pauson makes sacrifices to Apollo and he listens to the last doctor who comes to his home, taking stool, urine, and phlegm samples. While not all die, the doctor tells him, many who are infected with this plague will. Even if you have immunity there will be long-term health effects. Inside his house, Pauson’s son dies, his mistress dies, and even Harmonia’s twin sister dies. While Harmonia catches the plague, and is crippled by it, she survives and lives to see her master take on a new young mistress.

### **Vocabulary Words**

1. herms
2. Hekatombaion
3. fetid
4. nubile

5. triremes
6. agora
7. miasma
8. frieze

## **Main Characters**

Harmonia

Pauson's trusted slave.

Eukarpia

Harmonia's twin sister

Pauson

Head of household, or "master," and Aristogeiton's father

Ismenia

Pauson's mistress

Aristogeiton

Pauson's ill son.

Kalonike

Pauson's sister.

Kteme

An old slave and wet-nurse to Harmonia.

The Doctor

## **Discussion Questions**

1. There are multiple depictions of evolution here, such as the plague itself, the Spartans who were resistant, the Athenians who were immune, etc. What do you think are some of the reasons, implications, and significances of these depictions?
2. Do you see other types of evolution besides the purely physical at play? For example, the early doctors had no idea what was going on, but later they started taking samples to make a diagnosis.
3. Is the author trying to make any connections of science to religion? If so, how? Are they significant? Agree or disagree?
4. If the sickness was so contagious, why did they willingly put themselves in harm's

way? Would you? On a related note, Pauson exclaimed that the city outside his home's walls was degenerating. Did he have an ethical or moral obligation to help them? Why or why not? Would you?

5. What was the significance of the slaves in the story? What roles did they play? What about Pauson's mistresses?
6. Why is Apollo Far-Shooter responsible for both causing the plague and taking it away? Compare and contrast this with your own religion. Are modern gods simultaneously both good and evil?
7. Pauson promises to sacrifice animals to the gods in return for health, wealth, and good things. How is this the same as the way people related to "spirits" in the previous stories? How is it different?
8. Would this story have been more effective if it had not used a dead religion, but a historical episode from a living religion such as Christianity? What advantages and disadvantages does using a dead religion grant the author?

## **Search Terms & Key Concepts in Evolutionary Science**

Raptio

Game Theory

- Kin-based altruism
- Multi-level selection
- Egalitarianism
- Hierarchy
- Deception

Mating

Parenting

Emerging infections

Genetic disease resistance vs. immunity

- Allele frequency
- Hardy-Weinberg equilibrium

Religion

- Shamans, priests,
- Theory of mind

Language

- Representation
- Symbolic communication
- Linguistics

## Research/Discussion Questions

The Greeks are often credited with inventing democracy.

1. Is Greek society more or less equal than other agricultural societies from the same time period, in terms of economic class? In terms of gender? Give examples.
2. Is Greek society more or less equal than the hunter/gatherers from the previous stories, in terms of economic class? In terms of gender? Give examples.
3. How old is the practice of slavery, according to current evidence? Compare and contrast slavery to the practices of raiding other groups to capture women and children for adoption purposes.

Pausanias has both male and female slaves, but they are treated differently. The males are hired out for labor, while the household is run by his wife and the female slaves.

1. Is Pausanias using his female slaves as a harem, as “supplementary mates?” Why or why not? Are other Greeks at this time (male or female) doing so? What advantages and disadvantages would this mating strategy have?
2. Why would Pausanias choose a female slave to take care of his children, as opposed to a male slave, or as opposed to his own wife or sister? What advantages and dangers are inherent in this parenting strategy?
3. The story does not mention this, but the Greeks and other ancient historical societies routinely *castrated* male slaves to create household *eunuchs*. Considering an evolutionary point of view, why would they perform this particular surgery on male slaves, but not on female slaves?

Harmonia mentions reading from the *Iliad*.

1. When and where was writing invented? Would the artistic representations in earlier stories be considered writing?
2. If we consider writing as a biological or cultural adaptation, what problems did writing evolve to solve?
3. What happens to stories when they are written down? How might this process be compared to the formation of biological fossils?

The denizens of the city of Athens speak many different languages. Languages can be classified in the same “family tree” way that related species can, as members of families that share features and are distinguished by differences.

1. Are some of the languages spoken in this story more closely related than others?

2. Given the tree-like relationships between languages, is it fair to say that some languages are more advanced than others?

This story is the first to mention child abuse, which is a very common theme in modern literature.

1. Does this imply that child abuse did not happen in earlier cultures, or that it was less common?
2. Given that child abuse should lower a parent's fitness, how could abuse of your own children evolve? How could abuse of unrelated children evolve?

The Athenians are terrified of plagues, and have much experience with them. There was plenty of death in the previous stories, but none of them mentioned contagious disease as a serious, recurring problem.

1. Is this realistic, based on current evidence? Was there ever a time without plagues or epidemics?
2. Where do contagious diseases come from, meaning where do we get the viruses, bacteria, or fungi that cause them?

This is the first story to mention an organized religion. In science fiction, religion is often equated with superstition, but research shows the relationship between science and religion to be much more complicated and far more interesting.

1. How old is organized religion, with priests and laws, as opposed to a more individualized relationship with a shaman?
2. If we hypothesize that religion is a biological adaptation, what problems is it designed (or evolved) to solve?

Religions can be classified in the same "family tree" way that related species can, as members of families that share features and are distinguished by differences.

1. What class of religion does this culture have?
2. Are some religions more advanced than others? More complex? How would we compare this to differing amounts of biological complexity?

## **[Links & Resources](#)**

1. *Joseph Campbell and the Power of Myth*, particularly the episodes "Love and the Goddess" and "Sacrifice and Bliss."

2. *The Alphabet vs. the Goddess*, by Leonard Shlain, on the history of religion, war, and women's rights.
3. VSI Episode 2: The Man from Earth review and Episode 51 with Cathy Russell, who is working to craft a scientific creation story.
4. *Darwin's Cathedral: Evolution, Religion and the Nature of Society*, by David Sloan Wilson, on religion as an adaptation to the problems of living in large groups, as well as *The Neighborhood Project: Using Evolution to Improve My City, One Block at a Time*, summarized in this radio interview:  
<http://www.onbeing.org/program/evolving-city/4720>
5. *Secrets of the Dead: Mystery of the Black Death* documentary (1 hour, website also has lesson plans on inherited immunity)  
[http://www.pbs.org/wnet/secrets/previous\\_seasons/case\\_plague/index.html](http://www.pbs.org/wnet/secrets/previous_seasons/case_plague/index.html)
6. *Guns, Germs, and Steel* by Jared Diamond, either the book or the documentary series (6 hours, website also has lesson plans)  
<http://www.pbs.org/gunsgermsteel/>
7. Howard Hughes Medical Institute's 2005 series of four Holiday Lectures on Science, Constant Change & Common Threads, Lecture 2, Selection in Action.  
<http://www.hhmi.org/biointeractive/evolution/lectures.html>
8. Mathematical Epidemiology review article  
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2779504/?tool=pubmed>
9. Peter Turchin's website on using science to explain and predict historical events and trends.  
<http://Cliodynamics.info>
10. VSI Episode 50 on the evolution of antibiotic resistance.

## **Assignments**

1. Have students research historical cases of Native American tribes stealing women and children to adopt into their own tribes, such as Kentucky's state heroine Jenny Wiley, or the cheesy movie *Captured Women, Stolen Hearts* (with Janine Turner). There are many examples, some local to every state. Contrast these cases with the treatment of Native American children removed from their families by the government and raised in white society.
2. Have students research and present on antibiotic resistance in disease-causing microbes, or pesticide resistance in insects. There are many more resources available for this situation than there are for disease resistance in humans.

3. Introduce students to mathematical modeling through one of the following.

- a) Inherited genetic resistance to disease can only evolve over multiple generations. Have students calculate the spread of a plague disease resistance gene through the Greek population, using the deadliness of the disease as the selection parameter.

Background and teacher preparation on the process of modeling:

[http://media.collegeboard.com/digitalServices/pdf/ap/bio-manual/CB\\_Bio\\_Lab\\_02\\_WEB\\_1\\_24\\_12.pdf](http://media.collegeboard.com/digitalServices/pdf/ap/bio-manual/CB_Bio_Lab_02_WEB_1_24_12.pdf)

Download the Selection Coefficient Excel Workbook here:

<http://www.hhmi.org/biointeractive/activities/index.html>

- b) The classic SIR model of an epidemic includes only *susceptible*, *infected*, and *recovered* people. *Strangely, it does not include death*. This would make a simple web search frustrating for students. The following two models do include death by disease. The first requires additional software, but is simple. The second runs on the web, but has many more parameters which will be confusing at first. Have students try to match the dynamics of the epidemic in the story.

<http://mvhs.shodor.org/mvhsproj/epidemic/epidemic.html>

[http://www.uni-tuebingen.de/modeling/Mod\\_Pub\\_Software\\_fr.html](http://www.uni-tuebingen.de/modeling/Mod_Pub_Software_fr.html) \*

\*Only the flu model contains death.

4. Organize a class debate around the issues of cause and effect: *Does wealth make societies more or less equal, or does equality make societies more or less wealthy?* How might they influence one another in a feedback loop? Notice how these “logical” debates tend to go in circles. How might an explicit mathematical model clarify the issue?

## “Seven Views of Olduvai Gorge” by Mike Resnick

**(Throughout the span of human existence)**

**T**HIS NOVELLA FOLLOWS a long tradition in science fiction, the fictional future history. It is challenging. It covers a long span of time, has many characters to keep track of, and touches on a large number of seemingly unrelated issues, from slavery to warfare to environmental disaster to extinction. At the root of all of these, however, is the meta-issue of *morality*, the proper balance between competition (striving to obtain a full share for oneself of insufficient resources) and cooperation (working with others for the benefit of all). Evolutionary biology has wrestled with these questions for over a century, and much has been learned, but many questions remain for social scientists and artists to ponder over the next centuries.

### Synopsis

**48** CENTURIES AFTER HUMANITY colonized and ruled the galaxy, a group of aliens come to do an archeological dig to learn about their extinct subjugators. We learn that humans warred, ravaged, and enslaved many different races and species for centuries. The group finds five artifacts, and the main narrator, He Who Views, gives the reader a number of other stories described below as Interludes.

### Vocabulary Terms

1. assuage
2. misnomer
3. intuit
4. strata
5. ambulated

6. undulating

7. veldt

## **Main Characters**

He Who Views

An asexual being who is born possessing parent's knowledge and absorbs objects to know/feel their history

Bellidore

Captain, versed in behavior of sentient beings and is patient

Stardust Twins

Physically connected, who are seemingly mates, but in fact are asexual. Archeologists.

Moriteu

As he eats dirt, his tongue excavates artifacts and delicately cleans them

Historian

He can date things within a decade

Exobiologist

Sees living or dead people with the sweep of a tentacle

Appraiser

Specifically has knowledge concerning human artifacts

Mystic

A seemingly "magical" creature

## **Discussion Questions**

1. According to He Who Views, what is the group's ultimate purpose for being on Earth?
2. What is the brief history of the human race as described by He Who Views?
3. What do they find and what is the significance of it?

## **Search Terms & Key Concepts in Evolutionary Science**

Ugly adaptations

Multilevel selection

Kin selection  
In-group  
Out-group

Homosexuality  
Kin Selection  
Feminization

Honest signaling or costly signaling

Placebo effect

Cognitive dissonance and hypocrisy

Extinction  
Megafauna  
Carrying capacity  
Invasive species  
Endangered species

## **Interlude 1: The Rock: Page 159**

### **Synopsis**

The two main characters, Entonki and Bokatu, explore Earth prior to the evolution of human beings. They debate which species of primate, the tailless monkeys or baboons, will dominate this ecosystem, and why one would survive over the other. They notice the large primates avoid the tailless ones. Bokatu wants to capture a tailless monkey to prove it is not intelligent. They travel down a gorge with a large primate following. When the tailless monkeys kill both main characters, the large primate returns up the gorge and into the safety of the jungle.

He Who Views recognizes the object he was studying as a weapon used by the tailless monkeys. The team discusses the role of aggression as a means of survival, the possibility that weapons may actually increase aggressiveness, and how weapons may have helped them survive.

### **Vocabulary Terms**

1. teemed
2. placid
3. mused
4. rigorous

5. empathic

## **New Characters**

Entonki and Bokatu

Two explorers of Earth in its early existence.

## **Discussion Questions**

1. How is Resnick exploring some key concepts of evolution in this section?
2. What do you suppose the “evolutionary barrier” that Bokatu refers to is?
3. What do you believe is the defining characteristic of the tailless monkey’s supremacy? Use of thumbs? Weapons? Or some other characteristic? Pick one and make your case.
4. What does the Bellidore find particularly interesting about their discovery and why?
5. What do you think about the Historian’s view concerning weapons? Agree? Disagree? Why?

## **[Interlude 2: Chain Link: Page 170](#)**

### **Synopsis**

Mtepwa, a young boy in Africa, is caught and enslaved by a Muslim trader. The trader, Shariff Abdulla, took to Mtepwa and read him the Koran. When Mtepwa converted to Islam, he read in the Koran that bondage of fellow Muslims was not allowed. Mtepwa was let go; then he killed Shariff and took over the reins as the Trader. Mtepwa was a successful slave trader and over time his business flourished. At one point it is implied he took on a personal servant and concubine, ten-year-old Haradi. When the child was caught with a girl, Mtepwa had the girl’s arms and legs torn from her body. Haradi left so Mtepwa decided to kill himself first by a lion and then by an elephant. Both attempts were unsuccessful, so Mtepwa took it as a sign that he was immortal. One night Haradi, 15, returns and kills Mtepwa and then is killed by another who wants the organization. It ends with the slaves freed, the ivory confiscated, and Mtepwa forgotten.

The Appraiser, Bellidore, and He Who Views discuss the findings, surprised that humans enslaved other humans as they did other races in the galaxy. Some looked at Man as a race that took what it wanted, destroyed, made threats, and ignored the rest; Bellidore suggested that man’s use of genocide as a tool for alien subjugation was “practical.” Whether it was moral or not, it was effective in that it was efficient.

## **Vocabulary Terms**

1. dhows
2. forbade
3. foment
4. fervently
5. subjugate
6. progenitors
7. Terran
8. barbaric

## **New Characters**

Mtepwa

Once a slave as young child and now a favored servant of a slave trader

Shariff Abdullah

Slave owner/trader, Muslim

Haradi

Mtepwa's servant and lover

## **Discussion Questions**

1. What did you find interesting or what did you learn about slavery through Mtepwa's experience?
2. Explore the evolution of culture and individuals as it relates to slavery and Mtepwa.
3. The team argued some violence was "practical" and some good came out of genocide. Do you agree or disagree? Why? Try to trace the evolution of Western thought concerning those ideas (You may even be able to begin with religious or mythological texts). Do not attempt to trace the whole history; just mark major shifts in interpretation.

## **Research/Discussion Questions**

Given the murderous behaviors of the slaves Mtepwa and Haradi, how did the ancient practice of killing the men and abducting the women (as in the previous story set in ancient Greece) make evolutionary sense for the men who committed these crimes in those historical environments? Does this excuse such crimes committed in modern environments? Is this pattern even relevant to the moral question?

Mtepwa's homosexuality does not seem to have decreased his taste for violence, as one might expect if homosexuality were simply a lack of masculinity.

1. How does homosexuality arise, biologically, according to current evidence?
2. Was Haradi "biologically" or "culturally" homosexual? Are the two categories different enough to be valid and useful distinctions?
3. Did Mtepwa "choose" to be homosexual? Did Haradi?
4. Were their murders of their respective masters morally justifiable? Was one "better" than the other? Which of Haidt's moral dimensions are relevant to this question?

The aliens seem mystified at the tribal aggression shown by humans. This—"the peaceful people"—is a common theme in science fiction.

1. Have there been entirely peaceful human cultures, without murder or war?
2. What problems do murder and war address, in terms of competition for resources?
3. Are there examples of war in other human species? Other primates? Other mammals? Other non-mammal animals?
4. How likely is the existence of alien cultures that do not have these same problems, or that address them entirely peacefully?

After the Mtepwa episode, the alien Bellidore states that Man's genocide was practical because, "It got him what he wanted with a minimum of risk and effort."

1. How does this concept of minimizing effort fit into evolutionary science?

### **Interlude 3: The Knife: Page 179**

#### **Synopsis**

The next object assimilated is a knife. The story begins in a museum occupied by Lt. Chelmswood as Dr. Leaky goes on search for artifacts. It alludes to a number of wars/uprising in colonized Africa, but Lt. Chelmswood is far removed from it. Racism in the context of biological and cultural evolution threads its way through the story. The

boy sets up Lt. Chelmswood for a confrontation with a Mau Mau villager. The Mau Mau villager kills Lt. Chelmswood.

Bellidore is perplexed about members of the same race enslaving one another and wants to make sure that He Who Views is assimilating the artifacts correctly. They discuss man's propensity and motivations for violence, needs versus wants, and how those two things might motivate behavior.

### **Vocabulary Terms**

1. Homo sapiens
2. colonialism
3. fathom
4. lethargy
5. assimilate
6. conflagration

### **New Characters**

Dr. Leaky

A scientist, archeologist

Lt. Ian Chelmswood

Military man charged with protecting artifacts

The boy

A child from the tribe

The black man

Tribesman

### **Discussion Questions**

1. Why was Lt. Chelmswood at the museum?
2. Why did Lt. Chelmswood call the Mau Mau actions atrocities? Were they?
3. How does the terrorism of the Mau Mau in the story (or the terrorism of other current or historical groups) illustrate the principle of minimizing risk or effort?

4. What is Chelmswood's explanation for the differences in tactics between the American Revolution and the Mau Mau Rebellion? Is this explanation realistic, given current evidence? Are some cultures or races simply more savage than others?
5. What did Lt Chelmswood mean by disavowing the bones as possible ancestors? Why?
6. What kinds of prejudices does Lt. Chelmswood hold? How might science affect those prejudices?
7. How does Lt. Chelmswood feel about violence?
8. Why do you think the boy gets involved and do you think it is all right to employ children in these ways regardless of the situation?
9. Do you think Chelmswood was apolitical? Was it merely his job or something more?
10. Why do men lust after territory and resources?

### **Research/Discussion Questions**

After the 20th century Mau Mau reading, the aliens are confused by the concept of racism. This is another common theme in science fiction, that all humans are members of the same species, and therefore loyalty to groups smaller than the species is the result of stupidity or a lack of imagination.

1. How large were the hunter-gatherer groups in the earlier stories? What adaptations of human biology seem suited to life in small groups?

### **[Interlude 4: Metal Stylus: Page 186](#)**

#### **Synopsis**

The year is 2013 and many of Earth's natural resources are depleted and only a few animals remain, highly protected since they are extremely close to extinction. The Narrator has spent his entire inheritance on a safari to view these creatures up close. The creatures he sees include a ground squirrel and starlings. When Mr. Shiboni falls and breaks his leg, killing a lizard in the process, the group is devastated—for the lizard and their safari. Kevin takes the group down into the gorge where they witness a honey guide and honey badger. The Narrator leaves the stylus, which he had been recording his notes with, in the gorge, happy and excited about seeing “big game.”

#### **Vocabulary Terms**

1. duiker
2. teem
3. spherical
4. gully
5. encroachment
6. trekked
7. clamoring
8. bole
9. bastion

### **New Characters**

Narrator

Mr. Shiboni

Elderly Japanese man and Narrator's roommate

Kevin

The guide for the safari

### **Discussion Questions**

1. What are some of the physical characteristics of this future world described by the narrator?
2. What kinds of game did they look for and find?
3. What were some of the rules they had to follow? Why did they have these rules? Given the circumstances, do you think the Rules were too strict? Not strict enough? Why?
4. The narrator calls some history myths. Imagine some current rituals a future civilization might call myths.
5. What happens to Mr. Shiboni? Why is it significant?
6. What does Kevin show them? What is important between the two animals?

relationship? How might evolutionary theory be explored here?

### **Research/Discussion Questions**

1. Why are the safari-goers so excited about small mammals and birds as opposed to large animals like elephants? Why is the author Resnick making this point?
2. How many rabbits currently live in Yellowstone National Park? What must have happened if only nineteen are left? Why does Resnick not explicitly tell us how many humans are living on the planet at this time?

### **Interlude 5: Jewelry: Page 196**

#### **Synopsis**

The Stardust Twins finds pieces of bones and jewelry down in the gorge, but the Historian is confused, as the “dates” are all wrong. Before He Who Views assimilates the bones connected by wire, the Exobiologist decides to go down into the gorge to see if anything else was missed.

Joseph Meromo is a city employee who takes bribes to hide toxic waste in his country. The latest barrels of toxic waste were deposited in the gorge. Although he does hide the waste, he feels extreme guilt and has nightmares. Finally he goes to a mystic of sorts for help. Mulewo, a witch doctor, gives Meromo a necklace that will pull his nightmares into itself. 134 years later, the barrels leak and pollute the gorge.

He Who Views comes out of his assimilation of the necklace to find the camp in disarray. The Exobiologist has not returned to camp and the team worry that something has happened to her. The Historian and the Appraiser have gone to look for her.

#### **Vocabulary Terms**

1. noxious
2. assuage
3. donned

#### **New Characters**

Meromo

A bureaucrat who takes a bribe

Mulewo

A witch doctor

### **Discussion Questions**

1. What does Meromo do and why is it significant?
2. How does he rationalize his decision?
3. What happens to him after the deed is done? And what does he try to do to “solve” those issues?
4. Do you accept Mulewo’s explanation and rationale for helping Meromo? What would you have done? What is the ultimate goal?
5. What is brought for payment? Why?
6. What is the conclusion of this section? Do you think it is fair or just? Why? Or do fair and just not come into play here?

### **Research/Discussion Questions**

1. Is Joseph Meromo more of a criminal because he contaminated his own people, the Masai?
2. Would he have been more moral to dump the nuclear waste on some other tribe’s land?
3. What modern scientific concepts could explain the effectiveness of Mulewo’s charm in removing Joseph Meromo’s nightmares? Given that this story is fiction, and that the aliens display psychic powers, what is Resnick’s opinion on the reality of Mulewo’s magical powers

## **Interlude 6: The Bullet: Page 207**

### **Synopsis**

The Elders of his tribe, who want Thomas Naikosiai and his family to leave the poisoned planet, confront him. His wife is the daughter of one of the Elders and also wants to leave. His two sons are also leaving because of the radiation. Naikosiai discusses his connection to his culture and the land they live on. In a fit of rage and disappointment, Naikosiai divorces his wife and disowns his sons. After his family leaves, he dons traditional Masai garb and goes outside and waits to “fight” whoever may come. Only

the radiation kills him first.

### **Vocabulary Terms**

1. pustule
2. covenant

### **New Characters**

Thomas Naikosiai  
Husband and father; protagonist

Naikosiai's wife  
Wants to leave

Naikosiai's wife's father  
Wants to take the family to a safe planet

### **Discussion Questions**

1. Why does the family have to leave?
2. Why do you think Thomas does not want to leave?
3. Is he being irrational?
4. Would you act the same way?
5. What types of lessons did he teach his children? Are these "good" lessons, lessons that should be learned? Why or why not?
6. How do you think Thomas defines culture/family?
7. What does He Who Knows learn about humanity?
8. Do you think his interpretations are correct?

### **Research/Discussion Questions**

Humans define their tribes based both on genetic relatedness and on similar cultural practices such as language and religion.

1. What does Thomas Naikosiai mean when he says that his sons are not “real” Masai? How is he defining his tribe? How does this relate to current cultural debates about “real” Americans, for instance?
2. What effect does Thomas’s choice to become a tribe of one person have on his health? On his biological fitness? On his mental state?
3. How does evolutionary science explain conflicts between different levels of organization? How can a trait that is good at one level (mental satisfaction) be bad at another level (bodily health)?

## **Interlude 7: Exobiologist’s Materials: Page 215**

### **Synopsis**

While He Who Views considers the last man on earth, the team brings up remnants of the Exobiologist including bloodstained objects. He Who Views assimilates a bone and confirms that it belongs to the Exobiologist and that she is dead. They perform the funeral rights and call for the ship to take them home. Later He Who Views admits it was not the Exobiologist but a bone of Man that was fashioned to be a weapon. He understood there were other tribes. He Who Views also understood that this Man was not the other form of Terran. It may be the Tailless Apes who were descendants of those who stayed behind on the polluted planet like Thomas Naikosiai, but survived. He Who Views also learned that it had the same emotional base and ambition.

### **Vocabulary Terms**

1. contentious
2. primaries
3. somnolent
4. barbaric

### **Discussion Questions**

1. What does He Who Knows learn?
2. Why do you think he keeps some information to himself?
3. Is this fair?

4. What stood out to you in this section and why?
5. Overall, in Resnick's story, how is scientific knowledge obtained?
  - a. What is the role of the scientists?
  - b. Does he follow the scientific method? Where might he stray?
  - c. How are they rewarded?
  - d. Do you see a movement from poetic description to hard anthropological science? Where does it work?

### **Links & Resources**

1. Baba Brinkman's hip-hop albums *The Rap Guide to Evolution* and *The Rap Guide to Human Nature*, especially the songs "Homicide" and "The Evolution of Gayness"  
<http://www.bababrinkman.com>
2. VSI Episode 21: But What About the Gays? as well as 37–8 with Danielle Lee
3. *The Ghost & The Darkness*. A fictionalized account, starring Michael Douglas, of the man-eaters of Tsavo, lions who may have killed over 150 people.
4. "See Baby Discriminate," a *Newsweek* article by Po Bronson and Ashley Merryman, describing scientific experiments on the development of tribal group preferences in small children.  
<http://www.thedailybeast.com/newsweek/2009/09/04/see-baby-discriminate.html>
5. Richard and Mary Leakey were British paleontologists who made many important discoveries in East Africa.  
<http://www.leakey.com/>  
<http://leakeyfoundation.org/>
6. *The World Without Us*, by Alan Weisman, a book about how quickly human artifacts fall apart without maintenance, or "Radioactive Wolves," an episode of the documentary series PBS Nature, about the forest growing up around the abandoned city of Pripyat after the Chernobyl reactor meltdown.  
<http://www.pbs.org/wnet/nature/episodes/radioactive-wolves/introduction/7108/>
7. *The Righteous Mind: Why Good People are Divided by Politics and Religion*, Jonathan Haidt's book about the roots of human morality. He examines five "dimensions" of human morality, each a psychological adaptation to living in groups, and the ways in which these dimensions interact and conflict with one another to produce moral dilemmas.

Partly summarized in short videos found at:  
[http://www.ted.com/speakers/jonathan\\_haidt.html](http://www.ted.com/speakers/jonathan_haidt.html)

## **Assignments**

1. Engage students in a “bio blitz,” a sort of miniature biodiversity survey of the school grounds (or of a piece of a larger campus). First have them predict how many species they will find as a hypothesis. Then have them catalogue all of the species that they can find in a given amount of time, such as a single class period. Local naturalist groups such as the Audubon Society may be willing to help.
2. Have students research examples of cross-species cooperation, similar to the partnership between the honey guide and the honey badger. How common are these examples? How does this enrich their conceptions of the evolutionary process?
3. Have students organize a posthumous mock trial for Joseph Meromo, the corrupt official, as a way to explore the roots of morality.
4. Have students research examples of environmental disasters such as the radiation leak at Olduvai Gorge, either local or international (such as the BP oil spill in the Gulf of Mexico, or the Chernobyl or Fukushima reactor meltdowns). What common causes run through these disasters? Why do humans consistently fail to recognize dangers to large groups such as nations or ecosystems, as opposed to our own narrow interests and our own small tribes, however they are defined?

## What *Else* Can I Do with Fiction in a Science Class?

**I**NCLUDED HERE ARE A SERIES of additional in-class exercises, teaching techniques, and assessment strategies that may be of use in extending the classroom conversation and assisting the teacher in designing new assignments.

### Checklist for Effective Writing Assignments

- **Assignment Title:** Just as you probably don't want to receive a term paper titled "Term Paper," you might want to consider giving your assignment an appropriate title to introduce the tone of the assignment, to model effective titles, and to help students remember the assignment.
- **Introduction:** An introduction sets up the assignment and gives context to the task at hand. Take for example: "Now that you've read chapters 1-3, you should understand some of the main concepts of personal finance. Specifically, you should be familiar with budgeting, borrowing, and saving . . ." A brief introduction can help orient students in the assignment. You should also explain the purpose and expected outcomes from the assignment, i.e. why you are asking your students to do this work, and what you want them to get out of it.
- **Description:** This section should include basic procedural instructions, using specific directing verbs: *analyze, evaluate, describe, compare, explain*, etc.
- **Sequencing or Layering:** Consider asking students to complete the assignment in stages. You can walk them through the various stages of writing such as prewriting, thesis statements, prospectus/plan, rough draft(s), final draft, and revision. It is useful to explain either your rationale, i.e. "This is the typical process a researcher in the field follows," *or* that the sequence of assignments models the required structure of the essay.
- **Terminology:** If there are specific concepts or terms you are basing your assignment on, consider including definitions and/or examples.
- **Structure:** If you want the student work to have a specific structure and component

parts, be clear. For example, if they are writing a laboratory report, tell them that first they should have an introduction, a literature review, a description of the methodology, a discussion of the results, etc.

- **Logistical Details:** Be sure you are clear about logistics, i.e. length, font, formatting and documentation style, etc.
- **Assessment and Evaluation:** It will be very helpful to your students to know how they will be assessed. Be clear about grading criteria. If you have a rubric (recommended!), include it.
- **Resources:** Provide resources if you can, specifically about writing. (You can, of course, include optional resources for course content.) It is always nice to direct students to writing resources such as online handbooks; useful websites for basic grammar, mechanics, formatting and documentation; and sample papers that you think earn an A grade.

## Other Tips

- **Start with outcomes and work backwards.** Be sure you know what you want students to accomplish before structuring your assignment.
- **Be clear about purpose to your students.** Is the purpose of the assignment to review the information learned, to synthesize, to develop a fresh argument? Be sure you try to make the work relevant to students, being as explicit as you can about how this will help them in their lives and careers. Otherwise, they might simply think: “Okay, great . . . another paper. Blah, blah. Whatever.”
- **Be clear about purpose for yourself.** Be sure you know what your objectives are and the difference between writing to report and “regurgitate” and writing to learn and explore.
- **Make your assignment as real, relevant, and meaningful as possible,** and present it so they see the value in the process of learning and professionalism (We know we’re repeating ourselves here, but we feel it’s that important).
- **Be sure to explain the assignment in class,** rather than sending the students off to read it on their own.
- **Build in prewriting or formative assessment** to ensure students understand the assignment
- **Get them started in class** and allow them opportunities to work on the paper in class with varied, short, in-class assignments.

- **Be aware of your audience.** Do not assign a research paper with twenty sources to a group of freshman, or even sophomores for that matter—unless you are willing to devote the time to the demands of the assignment in class. Be sure you give your students the tools they need to be successful and to satisfy your expectations, whether it is for a short-response paper or a term paper.
- **Model good writing in the assignment.** Be sure that your own grammar and mechanics are effective and that you are clear and specific.
- **Present assignments in the spirit of invitation** or as in a professional call for papers.
- **Use your institution's Writing Center.** (Let them review your writing assignment and assessment strategies, have them visit and present in your class, and refer your students to them.)
- **Be specific about formatting and documentation style,** giving examples (online, handouts, Blackboard and other teaching technologies).
- **Provide feedback in a timely manner.** If you can, require rough drafts, giving students enough time to review and clarify your feedback, work with you one-on-one, revise, and use campus resources such as the writing center.
- **Utilize peer review.** Peer feedback is a great way to get students timely commentary on their work. Get students to collaborate on their individual papers. Set up a structured dialog process. This works nicely particularly with invention, development, and revision.
- **Use the process.** When designing the assignment, you'll want to prewrite your assignment ideas, write the assignment, and revise it. This is the same process students will go through when writing their papers. If you see the value in students working through the process, then you should see the value in going through the drafting process yourself. You might ask a colleague to review the assignment for you.
- **Remember aesthetics.** Document design and visual presentation can be important, especially for visual learners. Think of length, subheadings, organization, and easy to view and locate information.
- **Build on prior knowledge.** Understand your institution's general education writing curriculum and find out if your students have used a standard writing reference/handbook that they might already have and be familiar with. Take advantage of what they should already know.
- **Emphasize time on task.** Devote class time to facilitate the writing process. It doesn't have to be a lot of time, especially if you are focused on small pieces. (Don't worry about not having time to cover course content: you can embed formative

writing assessments around content that also bleeds into the writing process, and use writing to facilitate critical thinking and information reiteration/retention.)

- **Teach students the connection between purpose and audience.** Who are they writing to? A group of professionals? Peers? You can ask students to take on a “persona” or to put themselves in a particular situation, i.e. “Pretend you are a junior researcher and you’ve just discovered something that will make you famous” or “Pretend you are a community organizer addressing a group of corporate business people” or “Pretend you must convince a group of your best friends about why they should stop drinking. . . .”
- **Be sure your assignment sheet is appropriate for the assignment.** Don’t give a paragraph assignment sheet for a ten-page research paper. Conversely, don’t provide a two-page assignment sheet for a one-page paper.
- **Provide structured ways to help students think of questions or concerns.** Check back with students during their writing process to see how it’s going for them. Get feedback from them along the way. Depending on the feedback, you might even want to make some adjustments to the assignment.
- **Encourage students to talk with you.** Writing evaluation is a subjective activity that can be checked with standardized tools such as rubrics and grading calibrations. But, ultimately, only you know what you want and how you want it. Help your students by giving them one-on-one time.
- **Remember that writing assignments require two things from you:** 1) Designing the assignment, and 2) Evaluating student work.

## **Sample Rubrics**

Here are two sample rubrics. Rubrics are designed to be edited to the teacher’s classroom or assignment needs. Feel free to customize.

The first rubric is more complex, itemized, and possibly more suitable when addressing specific content knowledge. The second is a more holistic evaluation.

### **Rubric 1:**

Thesis (10 pts. available)

Thesis is clear and narrow. 9–10 pts (A)

Thesis is clear but should be narrower. 8 pts (B)

Thesis should be clearer and more focused. 7 pts (C)

Thesis is vague and unclear. 6 pts (D)

No thesis is evident. 0–5 pts (F)

**Tone and Audience (5 pts. available)**

Tone is audience-appropriate throughout. 5 pts. (A)

Tone is audience-appropriate with rare inconsistencies. 4 pts. (B)

Tone is usually appropriate to paper's audience. 3 pts. (C)

Tone is sometimes appropriate to the paper's audience. 2 pts. (D)

No regard is given to audience-appropriate tone. 0–1 pts. (F)

**Organization and Development (20 pts. available)**

Structure is clear with well-supported points and logical transitions. 18–20 pts. (A)

Structure is clear with most points supported and adequate transitions. 16–17 pts. (B)

Structure should be clearer; some points not well-supported; some transitions missing or inadequate. 14–15 pts. (C)

Structure is often unclear; many points inadequately supported; many transitions missing or inadequate. 12–13 pts. (D)

No clear structure; little support given for paper's points; transitions are frequently missing or inadequate. 0–11 pts. (F)

**Synthesis (20 pts. available)**

Sources are thoughtfully compared/contrasted with one another and with student's own ideas; quotations are well-chosen and meaningfully integrated into body of paper. 18–20 pts. (A)

Some comparison and contrast between sources and student's own ideas; quotations are adequately integrated into body of paper. 16–17 pts. (B)

Connections made between sources should be clearer; quotations are present but do not contribute strongly to the paper's argument. 14–15 pts. (C)

Few connections made between sources; quotations do not contribute to the paper's argument. 12–13 pts. (D)

Integration of ideas and quotations from outside sources is rare or non-existent. 0–11 pts. (F)

**Outside Sources (10 pts. available)**

All sources are academically appropriate. 9–10 pts. (A)

All sources but one are academically appropriate. 8 pts. (B)

Multiple sources are not academically appropriate. 7 pts. (C)

Sources frequently academically inappropriate; one or more sources are missing. 6 pts. (D)

Multiple sources are missing. 0–5 pts. (F)

**In-text Citation (10 pts. available)**

Full, properly formatted MLA documentation of sources. 9–10 pts. (A)

Full documentation but with some formatting errors. 8 pts. (B)

Incomplete documentation and some formatting errors. 7 pts. (C)

Source identified, not documented. 6 pts. (D)

No identification of sources, tantamount to plagiarism. 0–5 pts. (F)

**Language, clarity, and grammar (15 pts. available)**

Student's writing is clear and precise throughout with no grammatical errors. 14–15

pts. (A)

Student's writing is readable with one or two trouble spots. 12–13 pts. (B)

Student's writing is mostly readable with a few unclear passages. 10–11 pts. (C)

Student's writing is frequently unclear or imprecise and only partly readable. 9 pts.

(D)

Student's writing is barely readable with trouble spots throughout. 0–8 pts. (F)

Works Cited Page (10 pts. available)

All sources cited in proper MLA format. 9–10 pts. (A)

All sources cited with one or two errors in MLA format. 8 pts. (B)

All sources cited with consistent errors in MLA format, or missing information. 7

pts. (C)

Sources missing from citation page; information frequently missing; little attention to MLA format. 6 pts. (D)

No works cited page or no attention given to MLA format. 0–5 pts. (F)

Instructor Comments:

**Rubric 2:** A 9-Point Rubric for writing about literature

(by Carol Jago, <http://www.englishcompanion.com/pdfDocs/aprubricjago.pdf>)

8–9 points:

An 8–9 essay responds to the prompt clearly, directly, and fully. This paper approaches the text analytically, supports a coherent thesis with evidence from the text, and explains how the evidence illustrates and reinforces its thesis. The essay employs subtlety in its use of the text and the writer's style is fluent and flexible. It is also free of mechanical and grammatical errors.

6–7 points:

A 6–7 essay responds to the assignment clearly and directly but with less development than an 8–9 paper. It demonstrates a good understanding of the text and supports its thesis with appropriate textual evidence. While its approach is analytical, the analysis is less precise than in the 8–9 essay, and its use of the text is competent but not subtle. The writing in this paper is forceful and clear with few if any grammatical and mechanical errors.

5 points:

A 5 essay addresses the assigned topic intelligently but does not answer it fully and specifically. It is characterized by a good but general grasp of the text using the text to frame an apt response to the prompt. It may employ textual evidence sparingly or offer evidence without attaching it to the thesis. The essay is clear and organized but may be somewhat mechanical. The paper may also be marred by grammatical and mechanical errors.

3–4 points:

A 3–4 essay fails in some important way to fulfill the demands of the prompt. It may not address part of the assignment, fail to provide minimal textual support for its thesis, or base its analysis on a misreading of some part of the

text. This essay may present one or more incisive insights among others of less value. The writing may be similarly uneven in development with lapses in organization, clarity, grammar, and mechanics.

1–2 points:

A 1–2 essay commonly combines two or more serious failures. It may not address the actual assignment; it may indicate a serious misreading of the text; it may not offer textual evidence or may use it in a way that suggests a failure to understand the text; it may be unclear, badly written, or unacceptably brief. The style of this paper is usually marked by egregious errors. Occasionally a paper in this range is smoothly written but devoid of content.

Grade conversion for rubric 2:

9 = A+

8 = A

7 = A-

6 = B+

5 = B

4 = B-

3 = C

2 = D

1 = F

## Peer Review Activities

- **Devil's Advocate:** (Ask students to pair up and play “Devil's Advocate” to the other's arguments and main points)
- **The Expert:** (Break students into groups and ask each student in each group to be an expert at an element of writing: grammar/mechanics, organization, development, research/synthesis, etc. Students will then rotate a paper around the group.)
- **Peer Review Worksheets:** (see sample)

### **Sample Peer Review Worksheet:**

1. Put a star next to the thesis of the paper. This idea should be the strongest, clearest, and most well-developed idea throughout the paper. On this worksheet, *make one suggestion* to the author of how this idea could be made more effective.
2. Evaluate the structure of the paper. Explain why you think the paper is or is not well

organized at this point, keeping in mind that this is a rough draft. *Provide one suggestion* to help the writer with organization (for example, logical order of ideas, paragraph break needed, stronger introduction, a clear closing, or smoother transitions).

3. Determine the tone of the paper. Remember, we discussed this in terms of the “mood” the author’s language sets (formal, informal, sarcastic, humorous, etc.). Explain why the author’s tone is or is not appropriate to the topic and audience.
4. A writer should carefully choose the words she or he uses to convey the message of the paper to the intended audience. Which words in the paper stand out to you? Which words seem weak? Explain why.
5. How effective/clear/fluid/grammatical are the sentences of the paper? On the draft, circle sentences that need improvement. Also, in the space below, suggest *one recurring* grammar/mechanics issue the author should be careful about.

### **Other In-Class Writing Activities**

- **Short summary** (of lecture, class discussion, readings, etc.)
- **Double-entry notes** (class notes in one column, response in the second column)
- **“The Muddiest Point”** (ask students to write what they are most confused about)
- **“One-Minute Paper”** (ask students to summarize their paper in one minute)
- **Show, Don’t Tell** (incorporate the five senses in the writing)
- **Write a Letter** (to get the writer to open up, and identify an audience)
- **Build Contradictions** (list all the main points and then list counter-arguments)
- **Compare current understanding with previous understanding** (before and after response)
- **Write a proposal** (for a longer paper, research, lab reports, problem solving, etc.)
- **Reverse outline** (take a draft and outline it to see the structure)

### **Teaching Strategies**

Note: Many of the teaching strategies listed below came from these sources:

<http://www.facinghistory.org/teachingstrategies>

## Question Formulation

**Rationale:** The Question Formulation Technique helps students articulate, refine and prioritize questions they have about ideas raised in a text, a problem they hope to solve, or any topic they are studying. This strategy was designed by the Right Question Project ([www.rightquestion.org](http://www.rightquestion.org)). This simple strategy can be easily integrated into the classroom. It can be used as a brainstorming technique at the beginning of a unit or as a synthesis activity at the end of the unit, or anywhere in between. As students get better at formulating questions, they not only have a tool to help them better understand class material, but a tool that can serve them well as citizens in a democracy.

### Procedure:

*Step One:* Create a prompt

The most effective prompts for this activity are statements that are focused clearly enough that there is a direct link to the purpose of the lesson, and are neutral enough that students feel free to respond to the prompt. Many teachers use prompts that begin with stems such as “Your role/task is to . . .” or “You want to / A group wants to.” A prompt could also be a description of a class project.

### Examples:

You want to prevent genocide from ever happening again.

Your role is to draft a class contract—a list of rules or expectations that we will follow this year.

-----  
After World War II, the Allies want to achieve justice for the crimes committed by the Nazis.

You will design a way to teach other students about media literacy.

You can also use visual prompts—a movie or a series of images—as a prompt. After students view the visual prompt, proceed to step two.

*Step Two:* Students generate questions

In groups, give students a fixed amount of time (5–10 minutes) to generate a list of questions, adhering to these rules:

1. Write down the questions exactly as they are said.

2. Do not stop to discuss or answer the questions.
3. Write down as many questions as you can.
4. Statements should be rephrased as questions.

*Step Three:* Students identify open and closed questions

Ask students to look at their lists and put an “O” by all of the open-ended questions (questions with many possible answers) and a “C” by questions that elicit one answer (a “yes/no” question or a question with a factual answer). Then, have students modify one of their open questions to make it a closed question and one closed question to make it an open question.

*Step four:* Students prioritize questions

Have groups select three questions from their list. It could be the three questions they find most interesting or important or the three questions that they think need to be addressed first.

*Step five:* Groups share questions

When groups present their questions, ask them to share why they selected these three. The questions the class generates can be used as the focus of a class discussion, a writing assignment, a research project, or as a tool to help you plan future lessons.

*Step six:* Reflections

Give students the opportunity to reflect on this process by writing in a journal and/or through a brief discussion. What did they learn about formulating questions? About the content? About their own priorities? About working with others? What challenges did they encounter? How did they manage these challenges? You might also give students the opportunity to select one or two questions, from their own list or another group’s, that they would most like to pursue, and then write about why they selected these questions.

## **Graphic Organizer**

**Rationale:** Graphic organizers, like the sample below, can be used to help students organize information about major and minor characters in a text. Completed character charts are useful tools for writing essays and studying for tests. They are often used to record information about literacy characters, but can also be adapted to record information about historical figures.

## **Procedure:**

*Step one:* Decide why you are having students keep these charts.

There are many reasons to have students use identity charts. Here are some:

- To help students more deeply understand characters in the text
- To help students develop the skill of looking for textual evidence
- To ensure accountability that students are reading
- To help students prepare for an essay or final project
- To assess students' understanding of the text

Why are you having students keep a character chart? Your answer to this question will inform how you approach steps two and three.

*Step two:* Designing the character chart template

Which characters would you like students to focus on? What information would you like them to track? Do you want students to track multiple characters or to follow one character? Build a chart based on your answers to these questions. Here are two examples:

A character chart for following multiple characters:

Character's Name	Biographical information	Major actions taken by this character (with page #s)	Important quotations from this character (with page #s)

A character chart for following one character:

Character Name:	
Description of the character:	Dialogue spoken by the character:

### **Deepening Literacy: Text to Self; Text to Text; Text to World**

**Rationale:** Reading comes alive when we make connections beyond the text itself. This is a skill that can be practiced and learned.

In this strategy students will:

- Strengthen their literacy skills
- Make connections between the reading and themselves
- Make connections between the reading and other texts
- Make connections between the reading and the larger world

#### **Procedure:**

##### *Step One:* Building Background Knowledge

After reading a piece of text, ask students questions that draw out the factual information of the reading.

##### *Step Two:* Understanding the Main Idea and Cause and Effect

Ask students about the central purpose, meaning, and outcomes involved in the reading.

##### *Step Three:* Text to Self

After reading, ask students to write questions that relate to themselves, and then discuss them. Example prompts include:

- What I just read reminds me of the time when I . . .
- I agree with/understand what I just read because in my own life . . .
- I don't agree with what I just read because in my own life . . .

#### *Step Four: Text to Text*

After reading, ask students to write about and discuss how the text reminds them of another piece of text. For example, “What I just read reminds me of another story/book/poem I read because . . .”

#### *Step Five: Text to World*

After reading ask students to write how the reading relates to the larger world, and then discuss what they wrote. Example prompts include:

- What I just read reminds me of this thing that happened in history because . . .
- What I just read reminds me of what’s going on in the world now because . . .

### **Exit Cards**

**Rationale:** Exit cards require students to answer particular questions on a piece of paper that is turned in before they leave the class. These cards provide teachers with immediate information that can be used to assess students’ understanding, monitor students’ questions or gather feedback on teaching. For students, exit cards serve as a content review at the end of a daily lesson and enhance their meta-cognitive skills.

### **Procedure:**

#### *Step one: Preparation*

Students should have a pen or pencil and paper. Instructors can prepare half-slips of paper with typed questions or write questions on the whiteboard for students to answer.

#### *Step two: Students respond to prompt*

Often teachers have students complete exit cards during the final 5 minutes of the class period. Since exit cards must be turned in before students leave class, it is best if the prompts are specific and brief. Often they refer directly to the content that was studied, but they can also be general in nature such as:

- List three things you learned in class today.
- What questions, ideas, and feelings have been raised by this lesson?
- What was your favorite moment of class? Why? What was your least favorite part of class? Why?
- Evaluate your participation in class today. What did you do well? What would you like to do differently next time?

Exit cards can be structured using the 3-2-1 style as well. Depending on the purpose for having students complete exit cards, teachers may have students complete them anonymously.

### *Step three: Accountability*

Students may leave class when they turn in an exit card to the teacher.

Variation: Sharing the results of exit cards: Often it is appropriate to share your findings from the exit cards with students at the beginning of the next lesson. For example, you could mention that many students asked similar questions so you will make sure to address these questions in subsequent lessons. Sometimes teachers type up the results of the exit cards (without names) and have students respond to these comments as a warm-up during the next lesson. Letting students know that you have read their ideas and have used them to inform your teaching decisions helps build a classroom culture of respect and trust.

## **The Final Project**

This can be either a traditional essay or a creative work. The research paper or creative project identifies and explores a topic related to the course theme, but can cover topics not listed in the syllabus.

### **Option A: Traditional Research Paper**

Most students choose this option:

Research papers are graded on the quality and diversity of research (both fictional and non-fictional), the writing (including grammar and spelling), and the strength of the topic and argument. Demonstrate what you've learned from the class readings, your outside readings, and class discussions, and synthesize these things to show how they have changed your perspective on the world. This is not something that you can successfully complete at the last minute. The research paper should represent a semester-long investigation of topics that interest you.

### **Option B: Creative Work**

A creative work (story, series of poems, play, short film, website, creative nonfiction, and so forth) must dramatize how science and technology could affect believable, interesting characters living in a convincing, fully-realized world, in addition to revealing substantial research. For the purposes of this course, you want a diversity of readings that help you develop your work (both fictional and non-fictional). Show the research with a bibliography, and make your story stand on its own as a story. Be aware that Option B is more challenging—especially if you haven't taken formal writing courses—because we'll expect the same level of research as in Option A plus a good story.

## References

- Gunn, T. M. (2008). "The effects of questioning on text processing." *Reading Psychology, 29*, 405–442.
- Lei, S. A., Rhinehart, P. J., Howard, H. A., & Cho, J. K. (2010). "Strategies for improving reading comprehension among college students." *Reading Improvement, 47*(1), 30–41.
- Marr, M. B., & Gormley, K. (1982). "Children's recall of familiar and unfamiliar text." *Reading Research Quarterly, 89*–104.
- McDaniel, M. A., Howard, D. C., & Einstein, G. O. (2009). "The read-recite-review study strategy." *Psychological Science, 20*, 516–522.
- Shaw, J. D., Duffy, M. K., Lockhart, D. E., Mitra, A., & Bowler, M. (2003). "Reactions to merit pay increases: A longitudinal test of a single sensitivity perspective." *Journal of Applied Psychology, 88*(3), 538–544. doi:10.1037/0021-9010.88.3.538
- Shaw, V. N. (1999). "Reading, presentation, and writing skills in content courses." *College Teaching, 47*, 153–157.
- Sherfield, R. M., & Moody, P. G. (2010). *Cornerstone: Creating success through positive change* (6th ed.). Upper Saddle River, NJ: Prentice Hall.
- Taking science to school: Learning and teaching science in grades K–8* [White Paper]. (2007). Washington, DC: National Research Council.

### Online Resources:

- "A 9-Point Rubric for Writing About Literature" by Carol Jago  
<<http://www.englishcompanion.com/pdfDocs/aprubricjago.pdf>>
- "Making Effective Writing Assignments in the Sciences"—This is a list of resources compiled by Linda Tate, University of Denver Writing Program (2004).  
<<http://www.du.edu/writing/documents/MakingEffectiveWritingAssignmentsintheSciences.pdf>>

- MIT Online Writing and Communication Center. “Creating Effective Writing Assignments.” 1999. Massachusetts Institute of Technology (MIT). 10 November 2008.  
<<http://web.mit.edu/writing/Faculty/createeffective.html>>
- *Reference Guide to Writing Across the Curriculum*—By Charles Bazerman, Joseph Little, Lisa Bethel, Teri Chavkin, Danielle Fouquette, and Janet Garufis (2005).  
<[http://wac.colostate.edu/books/bazerman\\_wac/wac.pdf](http://wac.colostate.edu/books/bazerman_wac/wac.pdf)>
- “The Science of Scientific Writing”—By George D. Gopen and Judith A. Swan in *American Scientist*, Nov/Dec 1990, Vol. 78 Issue 6, p. 550, 9p.  
<<http://www.americanscientist.org/issues/feature/the-science-of-scientific-writing/1>>
- Question Formulation.  
<<http://rightquestion.org>>
- UMUC Effective Writing Center (EWC). “Effective Writing Assignments.” The University of Maryland University College (UMUC). 10 November 2008.  
<<http://www.umuc.edu/ugp/ewp/design.html>>  
“Facing History: Various sample assignments”  
<<http://www.facinghistory.org>> May 17, 2011  
The Teaching Professor. “Multiple Newsletters” May 17, 2011  
<<http://www.facultyfocus.com/topic/articles/teaching-professor-blog>>  
Concatenation’s Science Fact and Fiction Portal Page.  
<<http://www.concatenation.org/stuff/links.html>>

### **Key SF & Science links from which to start surfing.**

Biology in the real world.

<<http://www.societyofbiology.org/education/educational-resources/bitrw>>

Practical biology.

<<http://www.societyofbiology.org/education/educational-resources/practical>>

Useful links on science fiction:

<<http://www.depauw.edu/sfs/links.htm>>

<<http://www.sil.si.edu/libraries/Dibner/resources.htm#gh>>

<<http://www.lablit.com>>

<<http://www.lessonsfromliterature.org/academy/litacademy.html>>

<[Science Fiction teaching guides search](#)>

An E-QUALITY PRESS BOOK



[www.e-qualitypress.com](http://www.e-qualitypress.com)