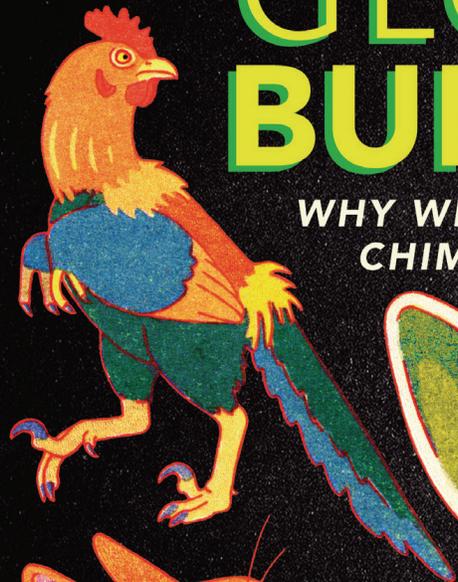# GLOWING BUNNIES!?

WHY WE'RE MAKING HYBRIDS, CHIMERAS, AND CLONES

JEFF CAMPBELL

Lerner™

ABOUT THE BOOK AND THIS GUIDE

Glowing Bunnies!?: Why We're Making Hybrids, Chimeras, and Clones explores how genetic engineering is being used with animals to solve some of the biggest problems facing the world today. It helps readers understand what can be done, including the benefits and dangers, and guides them to evaluate what should be done in any particular situation. One goal of this wide-ranging survey is to show how genetic engineering is not one field that's used in only one way. Technology and methods, types of genetic changes, the resulting animals, goals, and applications vary tremendously. This guide is organized to help educators focus on the different questions and issues raised in each part of the book.

INTRODUCTION: GENETIC ENGINEERING

Keywords & Concepts: anthropocene (p. 11), bioengineering (p. 177), chimera (p. 7, 87), crossbreeding (p. 13, 24), DNA (p. 13), evolution (p. 12), gene (p. 13), genetic engineering (p. 13), genome (p. 12), precautionary principle (p. 15)

READING RESPONSE

1. Before reading the book: In general, does the idea of genetic engineering bother you? Explain why or why not.

2. Describe the different ways that people can modify the genes of animals.

3. Describe some of the problems that genetically altered animals might solve.

4. Compare and contrast how modern genetic technologies and evolution alter genes in different ways.

5. What is the precautionary principle, and what are some examples of how it can be applied?

6. What are some issues to consider when weighing the potential benefits of genetic engineering against possible dangers?

7. After reading the book: Have your feelings about genetic engineering changed? Do your feelings vary depending on the animal, the type of change, or the goals and application?

PROJECTS & DISCUSSIONS

Create Your Own Chimera: Imagine a new genetically engineered animal, whether it's realistic or impossible. Describe what animals or genes would be combined and the new animal's attributes and behavior. Draw a picture of this animal and write a story of what might happen if it existed in real life.

Bioengineering in Pop Culture: As a research paper or group discussion, explore how bioengineering is presented in movies, fiction, TV shows, and media. Citing examples, when is it portrayed as a good thing and when a bad thing? Do scenarios seem realistic or are they exaggerated for entertainment? When genetic engineering is presented negatively, what fears do stories represent?

PARTS 1 & 2: CONSERVATION & THE ENVIRONMENT

Keywords & Concepts: back-breeding (p. 78), conservation (p. 37), CRISPR-Cas9 (p. 69, 70), cryobanking (p. 90), de-extinction (p. 57), directed evolution (p. 52), epigenetics (p. 61), extinction (p. 178), functionally extinct (p. 45), hybrid (p. 24), introgression (p. 27), keystone species (p. 77), portmanteau (p. 24), rewilding (p. 75), species concept (p. 28), taxonomy (p. 28)

READING RESPONSE

1. Name the ways scientists can genetically modify endangered species to help them survive.

2. What are the traditional goals of conservation, and how does genetically altering wild animals conflict with them?

3. What are some problems that might occur if genetically modified animals are released into the wild?

4. In what ways might de-extincting species like the woolly mammoth and passenger pigeons help heal ecosystems and combat climate change?

5. In what ways can climate change and population declines impact wild species?

6. In order to preserve endangered species like the red wolf, should conservationists try to stop species from crossbreeding and creating hybrids? Explain why or why not.

7. Compare and contrast the various ways that conservationists are trying to save the northern white rhino from extinction. Which seem best or most effective? Do you feel saving this species is worth the effort and why?

PROJECTS & DISCUSSIONS

Write a Law: As a paper or group discussion, choose one of the four de-extincted animals in part 2 and draft wildlife regulations for it. If the animal was released into the wild, how should it be protected (or contained)? How will human-animal conflicts be managed? What human activities should be restricted (like hunting, tourism, zoos, and so on)? Create contingencies for various possible outcomes.

Save a Species: As further research, identify an endangered species not described in this book and propose how genetically altering that animal might improve its survival. Describe why the species is endangered and how the genetic change will address that problem. Anticipate any problems that the altered species might cause, whether with other species or humans, and suggest solutions.

PART 3: AGRICULTURE & FOOD

Keywords & Concepts: assisted reproductive technology (p. 96, 98), cloning (p. 96), FDA regulations (p. 112), somatic cell nuclear transfer (p. 97), stem cells/somatic cells (p. 97), transgenesis (p. 109)

READING RESPONSE

1. Name some of the problems caused by agriculture and how modifying animals might help solve those problems.

2. Name some of the illnesses and issues farm animals have and how modifying those animals might improve their lives.

3. How many animals (at minimum) are needed to make a clone, and in what ways are other animals used?

4. What reasons do people give for criticizing and refusing to eat genetically modified animals like the AquAdvantage salmon? Do you agree with these reasons or not?

5. Would you eat food from genetically altered animals and why? Does your answer differ depending on the type of genetic change or the animal?

PROJECTS & DISCUSSIONS

How Do You Feel about GMOs?: As an individual or group project, create a public opinion survey that asks a series of questions about how people feel about consuming genetically modified animals and their products (like milk and eggs). Include as many scenarios as you can think of. Then conduct this survey—whether in class, in school, or in town—and report on the results.

PART 4: PETS & DOMESTIC COMPANIONS

Keywords & Concepts: breed (p. 129), green fluorescent protein (GFP, p. 122), selective breeding (p. 129), optogenetics (p. 146), synthetic biology (p. 116)

READING RESPONSE

1. If glowing bunnies were available as pets, would you want one? If not, would it be okay if others had them?

2. In what ways was the clone of Chance, the Brahman bull, the same as the original animal and in what ways was it different?

3. Since crossbreeding dogs and cats can lead to inherited physical problems, should we use genetic engineering to fix those problems? Explain why or why not.

4. What problems might arise if we allow pets to be genetically modified in whatever ways people want?

5. What genetic changes, if any, do you think should be allowed for animals that are kept as pets?

PROJECTS & DISCUSSIONS

As Seen on TV: As an individual or group project, brainstorm various ways animals might be genetically modified or combined in order to create new products, provide new services, or perform jobs. These could be realistic and credible, or ridiculous and impossible. Create an ad or promo video for this new animal and its new product or service.

PART 5: MEDICINE & RESEARCH

Keywords & Concepts: farmeceuticals (p. 153), gene drive (p. 160), nonhuman rights (p. 171), transhumanism (p. 149), xenotransplantation (p. 167)

READING RESPONSE

1. Describe the ways that transgenic animals can be used to make medicine.

2. Explain how a gene drive works and why it's being used on mosquitos.

3. In medical research, what are some of the issues that can arise if researchers modify animals in human-like ways in order to study disease?

4. Do you think it's okay to bioengineer animals like pigs to provide organs for human transplant? Explain why or why not.

5. Some people believe genetic engineering should be used on humans to cure disease. If this were allowed, what changes might be good and which might be bad?

PROJECTS & DISCUSSIONS

Curing Disease: Do further research on an illness or disease mentioned in part 5 and investigate how scientists propose using genetic engineering to develop medicine or to eliminate the disease. Describe the impact of the disease, current treatments and their effectiveness, the bioengineering methods involved, and the impact on the animals used. Compare the benefits and risks of using genetic engineering and advocate a choice.

Bioethics for Bioengineers: After reading the book, as a paper or group discussion, explore the many bioethical questions raised by genetic engineering. Identify what seem like the most and least important reasons for changing animals, as well as the most and least problematic types of genetic changes. Distill this into a decision-making rubric or chart to guide today's bioengineers.

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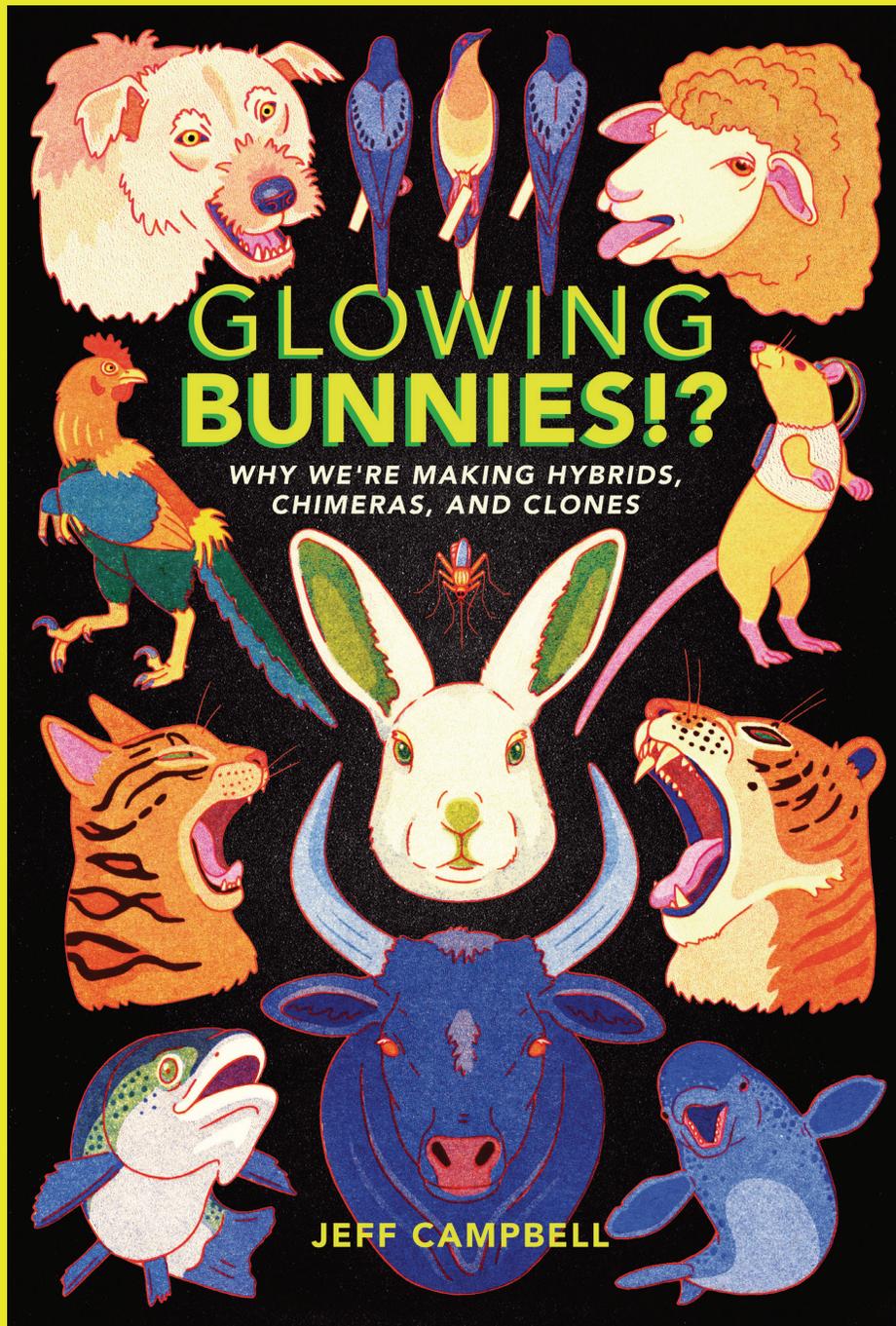
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JEFF CAMPBELL has published two previous young adult books about animals: *Daisy to the Rescue* (a 2015 IPPY gold medal winner), about animals saving human lives and the science of animal intelligence; and *Last of the Giants* (a 2016 Junior Library Guild selection), about conservation and our current extinction crisis. For twelve years, Jeff was an award-winning travel writer for Lonely Planet, and he's also a book editor and creative writing teacher. He is based in Morristown, New Jersey.

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