CASE TEACHING NOTES for "Bringing Back Baby Jason: To Clone or Not To Clone?"

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INTRODUCTION / BACKGROUND

Cloning as a Topic of Public Concern

Until the mid-1990s, American society relegated cloning to the ranks of science fiction. With the completion of the Human Genome Project, creation of "Dolly" the sheep, and other mammalian clones, the potential for the production of human clones moves from fiction to the foreground of reality. Public opinion changed from quiet skepticism to outright concern. Today the public raises ethical, medical, political, economic, and religious questions about the potential uses and misuses of this new technology. For our students to be able to make informed opinions about cloning technology, it is important for them to consider the societal issues in connection with the genetics and cell biology that make human cloning a real possibility. Often in our undergraduate science courses there is little opportunity to engage in didactic exchanges about current events while teaching the basic facts and concepts. Case-based instruction provides faculty the opportunity to do both.

Kipp Herreid teaches us that cases are often more engaging for students if they have a real world connection or are designed from real world events (Herreid **1994**; **1997/1998**). "Bringing Back Baby Jason" is a dilemma case that explores the concept of human cloning. While this case presents a fictitious scenario, it is grounded in fact. In September 1999, Charleston attorney and former state delegate Mark Hunt and his wife Tracey began contemplating cloning their infant son Andrew, who died after a heart surgery procedure. The Hunts felt that the duplicate child would provide them a sense of peace over losing their only child. To pursue their goal of producing a clone of Andrew, the Hunts provided at least $500,000 to Clonaid president Bridgette Bossilier to develop a laboratory and purchase equipment. In 2001, the Hunts ended their relationship with Bossilier and Clonaid, citing a "loss of confidence" in her ability to produce a clone of their dead son.

Human Cloning as an Instructional Topic in Undergraduate Genetics

Research indicates that current pedagogical approaches to genetics instruction often leave students with misconceptions about basic concepts and an inability to relate concepts to the real world (**Alabadejo and Lucas 1988**; **Engelclough and Wood-Robinson 1985**; **Gerow 1999**; **Kargbo, Hobbs and Erickson 1980**; **Lewis, Driver, Leach and Wood-Robinson 1996a,b**; **1997a,b**; **Locke and Miles 1993**; **Wandersee, Mintzes and Novack 1994**; **Wood-Robinson, Lewis, Driver and Leach 1996a,b**). In particular students struggle with the basic concepts of mitosis and meiosis and their relationships to human inheritance patterns. The topic of human cloning provides faculty the opportunity to bridge the basic concepts of mitosis and meiosis with issues related to human inheritance. This topic could of course be presented in lecture, but research indicates that student critical thinking and conceptual

understanding are improved when course material is presented in multiple ways. Providing students with a case on human cloning offers a valuable opportunity to engage students in content while having a discussion on a current topic of social, ethical, and legal relevance.

This case was designed for use in an undergraduate genetics course at the University of Maryland, College Park. The University of Maryland, College Park, is a large research-1 institution with 2,500 biological sciences majors. All biological sciences majors are required to complete a 200-level course in introductory genetics. This course is offered each semester to over 400 students in a large lecture hall setting. As large lecture courses often prohibit engaged discussions, students are required to attend a three-hour discussion each week. This course is open to students of all majors, but enrollment is largely composed of life sciences majors. Students enrolled in this course must have completed one year of introductory biology and inorganic chemistry and have at least an average level ("C" or better) of understanding of basic cell biology and genetic mechanisms. The discussion section is taught by a graduate teaching assistant and is typically used to examine homework problems and their solution. During the fall of 2001, the faculty member in this course, Dr. Spencer Benson, graciously allowed me to explore the use of case-based instruction during the discussion section. This case is a result of that initiative. This case was assigned to the students near the end of the fall 2001 semester.

Case Learning Objectives

- To introduce students to the concept of human cloning.
- To develop an understanding of the basic genetic concepts underlying the cloning process, including imprinting, mitosis, meiosis, asexual reproduction, and sexual reproduction.
- To encourage students to consider the scientific and social aspects of human cloning.
- To have students integrate key course terms with the concept of human cloning. These key terms include: *dominant, recessive, co-dominance, partial dominance, recessive lethal, pleiotropic, intergenetic suppressor, intragenetic suppressor, recessive lethal, epistasis, penetrance, expressivity, imprinting, totipotency, pleuropotency, stem cell, embryonic stem cell, enucleation, biotechnology, in vitro fertilization, cloning,* and *transgenic organisms*.
- To enhance students' critical thinking skills.

CLASSROOM MANAGEMENT

Students were assigned this case, in either an on-line (WebCT) format or paper copy, one week in advance of the case discussion to enhance lecture material pertaining to imprinting, cloning, and biotechnology. Three graduate teaching assistants were trained to conduct the classroom discussion of this case. Students were required to read the case and answer the associated questions as preparation for an in-class discussion. On the day of the case discussion, students were put into groups of four to discuss the question, "What should Ted consider in making a decision about whether to clone his son or not?" Students were allowed 30 minutes to explore the related issues. At the end of the time period, the graduate teaching assistants asked a member from each group to present one key concern to the class. As the students presented their concerns the graduate teaching assistants encouraged the other students to comment on the concern presented, elaborate upon related issues, and discuss key terminology. At the end of the discussion period (70 minutes), the students were asked to return to their groups for 10 minutes to decide what Ted should do based on the in-class discussion.

I developed a list of potential concerns prior to the case discussion. There is no one correct answer to the case and each discussion section may develop different issue lists. I have provided some brief answers to the case questions in the answer key below.

Answer Key

Answers to the questions posed in the case study are provided in a separate answer key to the case. Those answers are password-protected. To access the answers for this case, go to **the key**. You will be prompted for a username and password. If you have not yet registered with us, you can see whether you are eligible for an account by reviewing our **password policy and then apply online** or write to **answerkey@sciencecases.org**.

BLOCKS OF ANALYSIS

This case should encourage undergraduate genetics students to explore the feasibility of human cloning from a scientific and ethical standpoint. In order to fully comprehend this possibility, students will need to understand state of the art cloning technology, the problems encountered in cloning animals, and the potential scientific problems associated with human cloning. Underlying this process are the basic concepts they should have learned throughout the semester-long course.

The Cloning Process

Most cloning takes place through a process known as nuclear transfer. Nuclear transfer requires a dormant enucleated oocyte and a donor cell. The nucleus of the donor cell is either fused with or transplanted into the oocyte. It is important for students to realize that the donor cell is an adult somatic cell, not a sperm cell. Once nuclear transfer is complete, the resulting embryo is transplanted into the uterus of a surrogate mother. Students should consider why a somatic cell is used in place of a sperm cell in this situation. How is this different than sexual reproduction? What would the consequences of using a sperm be in the cloning process? How does epistasis, penetrance, expressivity, and imprinting play a role in this process? How would their role be different if a child was produced through sexual reproduction? If you are going to clone baby Jason, where will the donor cell and oocyte come from? What accounts for the low success rates for production of animal clones?

Somatic Cell Changes

Ted McMasters is a man who underwent radiation therapy as a young adult. Exposure to high levels of radiation is known to result in DNA damage. Are there any potential consequences to the cloned baby Jason? Students should realize that the donor cell would come from the original baby Jason, so the radiation therapy Ted McMasters has undergone is inconsequential in this scenario. If Ted desired to have a clone made of himself there could be potential consequences to a clone.

Epigenetic Inheritance

Sexual reproduction results in offspring with one copy of genes from the maternal source and one copy of genes from the paternal source. During development, autosomal genes are tagged as "maternal" or "paternal" by the developing embryo. All functional genes necessary for development are still present in adult somatic cells. Some of these genes are susceptible to epigenetic inheritance in which the activity of a particular gene is dependent upon the basis of its ancestry. For example, a mouse will only express the Igf2 gene if the gene was inherited from his/her father. The Igf2 gene in active form acts to slow growth rate during development. If the mouse receives the Igf2 gene from his/her mother, the gene is termed maternally imprinted and will be inactive. If the maternal copy of the Igf2 gene is accidentally turned off in a mouse with an imprinted Igf2 gene, the offspring typically suffers from large offspring syndrome and dies before birth. Genes can be accidentally activated or inactived during the cloning process. In the

case of human cloning, what role will epigenetic inheritance play in expression of certain genes? This question may be very difficult for students to answer since imprinting is a poorly understood area of genetics, particularly in humans. Recent reports indicate that imprinting will not be as detrimental to human clones as it is to other mammalian clones because genes in primates are not as imprintable as those of non-primate mammals.

Possible Social Issues for Discussion

There are many social issues that arise with the topic of human cloning. These may include, but are not limited to, the following questions:

- Do cloned humans have a soul?
- If evolution is based on the theory of "survival of the fittest," is it scientifically appropriate to bring baby Jason back through cloning?
- If we clone humans for infertile couples, what is to prevent us from using clones as organ farms?
- What impact will cloning have on the world economic situation? Consider cattle production.
- Is human cloning feasible from an economic standpoint? Many clones die at or before birth; considering the high expense vs. success ratio, is this a valuable use of time and resources?
- What impact will cloning have on the world eco-systems and genetic diversity?

While the social implications of human cloning are certainly meaningful, the main focus of this case was to develop an understanding of the basic scientific topics outlined in the learning objectives and promote student critical thinking on a topic of social relevance. In the future, adding a second discussion week that explores the social ramifications of cloning technology would be interesting. With new learning objectives, an exploration of the ethical and social implications of human cloning would certainly be an exciting topic for another course.

CONCLUDING REMARKS

The case-based experience outlined above was given to 200 undergraduate genetics students during the fall 2001 semester. Graduate teaching assistants in the course indicated that they appreciated the opportunity to expose their students to new teaching techniques, and the students commented that they enjoyed the opportunity to explore course content through case analysis. An analysis of the relationship of case-based instruction to conceptual understanding in this course is ongoing.

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