

Activity 2: A Source of Embryonic Stem Cells: Human Clones?

Teaching Notes

The assignment in this activity guides students through primary and secondary literature articles describing the work of the South Korean stem cell research team. The assignment should be used with introductory level biology majors or non-majors who have an understanding of DNA and protein functions. Since the focus here is on experimental methods, having students complete the relevant textbooks readings either before or during this activity is strongly recommended (see the Background Reading selections below for textbook readings). The activity also introduces students to the dynamic nature of scientific communication, and specifically addresses the protocols of peer-review, investigational review boards, and the publishing industry. The activity would be best introduced in the middle to latter half of a course.

The articles selected for **Activity 2** were published between 2000 and 2006 and represent media coverage, secondary scientific literature and primary literature focused on stem cell research performed by the South Korean team of Hwang and Moon. It is imperative that both the secondary and primary literature be assigned, though time constraints may allow for the inclusion of only one from each category. Together, the eleven associated articles, one research article, review articles and University of Michigan animation website could serve as a comprehensive educational module.

Many of the answers to questions in this assignment will not be addressed in the research article published by Hwang and Moon's research team. Rather, some of those most provocative lines of thinking arise from content contained in the review, news, and bioethics articles. One example is the failure to achieve heterologous SCNT in 2004, while many of the news articles describe the investigation of this study that resulted in its retraction. The news article by Recer highlights the ethical and social dimensions of this work, paying close attention to universally accepted informed consent practices, while the Faiola interview provides students with a glimpse into the personality of Hwang, one of the lead scientists in this field. The Cyranoski, Fairclough, and Magnus and Cho articles address the ethics and oversight of oocyte donation while the Kevles, Fifield, Normile et al., Wade and Jung articles illustrate the falsification of data and the violations to human rights protocol and the implications for the scientific, financial, medical, and publishing communities.

In addition for the stem cell novice, a collection of review articles is also recommended. The review article by Shaw describes the efforts of the Harvard Stem Cell Institute and highlights the work of female scientist, Jill McMahon, in establishing seventeen freely available stem cell lines for research using private funding. The recommended article by Hall, although published in 2000 and rather focused, depicts many of the current ethical dilemmas surrounding this research field and like the Faiola piece delves into the characteristics of Cibelli and West, scientists who continue to explore the frontiers of stem cell technologies. The *Scientific American* article is written by a lead researcher in this field and provides a comprehensive overview, while the more recent *Scientific American* and *Financial Times Supplement* contains a series of articles that review the

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business, therapeutic, and legal perspectives associated with stem cell research. Collectively the articles illustrate the private and the public efforts to conduct stem cell research and develop related therapeutic technologies, but span a wide array of perspectives and writing genres.

Thus, this activity encourages students to continue to ask questions and be critical of work regardless of the reputation of the journal or the researcher. By pointing to the follow up research article in 2005, students gain a sense of the speed of progress in this field and the challenges that lie ahead for both basic science and stem cell therapies.

Furthermore, the list of key terms and experimental methods cue the students to the salient points of the research article, helping them focus on the experimental approach, controls, and reported data of this study.

The assignment in this activity aims for students to be able to do the following:

- Articulate the premise, approach, value and limitations of the study.
- Analyze data critically, propose models and make predictions.
- Distinguish between *in vitro* and *in vivo* studies and identify the merits of each.
- Understand relevant experimental techniques such as RT-PCR, cell transplantation, karyotyping, DNA fingerprinting, immunocytochemistry, and genomic imprinting analyses.
- Appreciate science as an ever-evolving process.
- Understand the regulations and ethics surrounding human subjects research in both the private and public sector.
- Realize that the scientific publications span a wide range of formats and that research publications undergo a great deal of peer review and that many journals are now publishing online at a faster rate.
- See that both secondary and primary literature are essential for a full understanding of the field and that both result in extended dialogue long after publication.

Activity 2 at a Glance

Class	Small classes (20-50) for Introductory Biology Majors or Non-Majors Large classes (100-150) for advanced Biology majors in a course with teaching assistants
Instructor Preparation	Approximately two hours, excluding grading: Review Assignment Review Student Vocabulary Aid for Activity 2 Review Answers Review the Stem Cell Research Background .
Useful Media	Please see the References document for useful media to introduce this Assignment The choice will be dependent on the background of the target audience and the timing of implementation in a course. For instance, if a

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	freshman seminar, you may choose to show the CNN Video Debate Gallery clips, which review some of the human rights issues surrounding oocyte donation. If students are more science oriented, you may choose to show clips of embryogenesis from the PBS special <i>Life's Greatest Miracle</i> .
Student time	Out of class: approximately four to eight hours. Due to the amount of assigned reading, allow non-biology major students two weeks to complete this assignment. In class: none required, but see Alternatives for options for smaller classes which can extend the activity to six weeks.

Background Reading

The following textbook selections are interchangeable:

Molecular Biology of the Cell **Fourth Edition**

Alberts, et al. (2002). Garland Science. New York.

- **Chapter 4:** “DNA and Chromosomes.” p. 191-234
- **Chapter 7:** “Control of Gene Expression.” This chapter is very detailed. These sections are particularly useful:
 - *An Overview of Gene Control.* p. 375-379.
 - *How Genetic Switches Work* p. 398-408.
 - *The Molecular Genetic Mechanisms That Create Specialized Cell Types.* p. 415-435.
- **Chapter 8:** “Manipulating proteins, RNA, and DNA.” p. 476-500, 504-525 and 532-546.
- **Chapter 9:** “Visualizing cells.” p. 547-580.
- **Chapter 17:** “The Cell Cycle and Programmed Cell Death.” p. 983-1026.
- **Chapter 20:** “Germ Cells and Fertilization.” p. 112-1156.
- **Chapter 21:** “Development of Multicellular Organisms” Note that this chapter is very long and is divided in

Essential Cell Biology **Second Edition**

Alberts, et al. (2004). Garland Science. New York.

- **Chapter 4:** “Protein Structure and Function.” p. 160-165.
- **Chapter 5:** “DNA and Chromosomes.” p. 169-194.
- **Chapter 8:** “Control of Gene Expression.” p. 267-292.
- **Chapter 10:** “Manipulating Genes and Cells.” p. 321-364.
- **Chapter 16:** “Cell Communication.” p. 533-571.
- **Chapter 18:** “Cell-Cycle Control and Cell Death” p. 611-636.
- **Chapter 19:** “Cell Division” p. 637-657-658.
- **Chapter 20:** “Genetics, Meiosis, and the Molecular Basis of Heredity.” p. 659-696.
- **Chapter 21:** “Tissues and Cancer.” p. 717-726.

Biology Today **Third edition**

Minkoff and Baker (2004). Garland Science. New York.

- **Chapter 1:** “Biology: Science and

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sections that review specific organisms.

These sections are particularly useful:

- *Universal Mechanisms of Animal Development*. p.1157-1170.
- *The Mouse* p. 1223-1227.
- **Chapter 22:** “Histology: The Lives and Deaths of Cells in Tissues.” Note that this chapter is very long. These sections are particularly useful:
 - *Epidermis and Its Renewal by Stem Cells*. p.1259-1267.
 - *Renewal By Multipotent Stem Cells: Blood Cell Formation*. p.1283-1296.
 - *Stem Cell Engineering*. p. 1308-1311.
- **Chapter 4:** “Genetic Engineering and Genomics.” p. 95-122.
- **Chapter 9:** “The Population Experience” section *Human Reproductive Biology Helps Us to Understand Fertility and Infertility*. P. 296-317.
- **Chapter 12:** “Stem Cells, Cell Division, and Cancer.” p. 413-432. Note that this very short chapter touches on transcription, translation, gene expression, and cell signaling, but for a more comprehensive overview please see the following chapters:
 - **Chapter 2:** “Genes Chromosomes and DNA” p. 33-62
 - **Chapter 3:** “Human Genetics.” P. 63-94.

Recommended Reading:

Rensberger, B. (1998) Chapter 6: “One Cell Becomes Two,” Chapter 7: “Two Cells Become One,” and Chapter 8: “Constructing a Person,” in *Life Itself: Exploring the Realm of the Living Cell*. Oxford University Press, New York, NY: 117-188.

Implementation

1. Before assigning the reading for this activity, present media clips that outline the social and/or scientific dimensions of this work.
2. Direct students to **Assignment, Student Vocabulary Aid for Activity 2, and Resource Seven: Worksheet for Reading Primary Literature**.
3. Have students complete the reading and the **Assignment** outside of class over the course of at least one week. (please note that for non-majors or introductory biology majors it is best to use the third alternative described below and that four to six weeks should be set aside to complete this assignment using The **Student Vocabulary Aid for Activity 2**).
4. Have students submit essay-style answers to the questions that appear in the **Assignment** for grading. Some questions require drawing and therefore students should be directed on how best to submit their work (electronically or otherwise).

Alternatives

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- In small classes, students could work in small groups to complete the questions and present their answers to the class. If you choose this latter option, direct students to **Resource One: Group Role Profiles**.
- The instructor may choose to have small groups of students or individuals present the method and significance of one of the figures in these articles instead of the entire paper.
- More time could be spent working through the research article. In small classes, this activity can take the form of student mini-lectures. Each student is assigned a key scientific term from those listed in the assignment, and should define these terms and their significance in understanding the findings of the study. They would be expected to provide visual aids, handouts, and a bibliography of sources for the class and would be graded on their presentation. In classes where this approach is taken, note that if there is time for discussion and questions, only three to four terms will be covered per class period.

Assessment

Assessment will be dependent on the delivery method of the activity. Options include:

- Assessing student learning by reviewing answers to the questions on **Resource Seven: Worksheet for Reading Primary Literature**.
- Grading the answers to the questions that appear in **Assignment** using **Activity 2: Answers** (available only to instructors).
- If students present their work as a group, presentations of significant figures or scientific terms could be graded using **Resource Two: Self-assessment of Group Work, Resource Three: Peer-assessment of Group Work, and Resource Four: Class assessment of Group Work**. In addition the instructor could grade the presentation.