

## Activity 4: Stem Cell Technologies Applied to Public Health

### Teaching Notes

This writing activity is designed for more advanced students who are familiar with literature research, writing, and biology. Though many biology courses require students to write a term paper focused on science, few will ask students to place the science within the ethical and political context. In this regard, this rather traditional assignment is non-traditional with respect to the content. Since stem cell research progress is being influenced by policy makers interested in aspects that go beyond the science, students are encouraged to be aware of these perspectives and to imagine how scientists can address ethical concerns such as universal access and reduce the risks currently endured by oocyte donors, stem cell donors, and stem cell recipients.

The assignment asks students to write a research paper on the therapeutic implications of stem cell research as they relate to one of four diseases, or to describe how stem cells can help gauge the effects of novel drugs or environmental toxins on human health. Guiding questions are included and an expansive reading list is broken down into categories that focus on the basic science, ethical perspectives, and legal and economic perspectives. The category entitled “The Ethics and Protocols Associated with Clinical Trials Using Stem Cells” includes a particularly comprehensive and relevant review in the *Kennedy Institute of Ethics Journal* and is authored by two bioethicists, Kahn and Mastroianni. The category entitled “Therapeutic Applications” is short, and it is expected that students will conduct research that is relevant to their topic to round out the bibliography. Instructors may choose to have students focus on only one category or select readings which are appropriate for their students.

In general, the assignment asks students to imagine the future of stem cell research as it applies to medicine and public health. Hopefully, this assignment will promote student engagement with the stem cell literature long after the course is complete, as most students have a friend or family member suffering from disease or concerned about the harmful effects of environmental pollutants or recently approved medications.

### Activity 4: At a Glance

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|-------------------------------|---|
| <b>Class</b>                  | Intermediate to advanced level biology majors<br>Any size class (20-300)  |
| <b>Instructor Preparation</b> | One to two hours (excluding grading)<br>Review the <b>Assignment</b> and assign diseases or let students choose their topic.<br>Read <b>Stem Cell Research Background</b> .<br>Read <b>Activity 5, Answers</b> as this activity has some overlap and will provide instructors with highlights that should appear in student papers. |
| <b>Useful Media</b>           | Please see the <b>References</b> document for useful media to introduce this <b>Assignment</b>  |
| <b>Student time</b>           | Outside of Class: several weeks<br>In Class: no class time  |

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### 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 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:*

#### ***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 Ethics.”p. 1-32.
- **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

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*Blood Cell Formation*. p.1283-1296.

- *Stem Cell Engineering* .p. 1308-1311.

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

Rensberger, B. (1998) Chapter 6: “One Cell Becomes Two,” Chapter 7: “Two Cells Become One,” Chapter 8: “Constructing a Person,” Chapter 10: “Heal Thyself,” and Chapter 11: “In Self-Defense,” in *Life Itself: Exploring the Realm of the Living Cell*. Oxford University Press, New York, NY: 117-188, 204-228.

### Implementation

1. Decide whether students should focus on one of the diseases listed in the assignment, choose a topic of their own, or address stem cells as they relate to the testing of novel drugs and/or environmental toxins. Be sure to communicate expectations to the students as the assignment can be interpreted in a variety of ways.
2. Choose references to be assigned and direct students to the **Assignment and Resource Seven: Worksheet for Reading Primary Literature**. There are three important things to note in assigning references
  - Some references are quite long, while others are short. It is important for students be aware of the number of pages of reading being assigned. If books from the reading list are selected, relevant chapters should be highlighted.
  - Students should receive advance notice of this assignment as it is time consuming and preferably after some material on stem cell biology is reviewed.
  - Additional references which address specific diseases can be found in the **Reference Document** in the **Core Materials** section of this web site. If the course is pressed for time, students may be assigned these readings rather than identify their own sources. However, it should be noted that the field moves rather quickly and many findings will quickly become outdated.
3. Outside of class, over the course of a few weeks, students read the assigned textbook, online book sections, reports, and research article selections. During these weeks, material on scientific techniques, basic immunology, and rDNA methods should be reviewed in class.
4. Over the course of the semester, students write their papers, and periodically, you could ask students to share their answers to the questions posed in the **Assignment**.

**Comment:** Please check that this edit is correct and not that you had intended to change the points listed below.

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- Grade students on the quality of their research paper. A **rubric** which can serve as a general guide for grading evidence-based work can be found in the **Core Materials** section of this module and adapted for this assignment.

### Alternatives

- If the course has an environmental or biotechnology focus, students could move away from a specific disease based paper and instead describe how the establishment of clonal stem cell lines or tissues may serve as more accurate models for environmental toxin screening or novel drug development. In this scenario, students should be directed to FDA. (1995). Consumer: From Test Tube to Patient: New Drug Development in the United States, which reviews animal and clinical studies and the regulations that safeguard patients and consumers including informed consent. [http://www.fda.gov/fdac/special/newdrug/ndd\\_toc.html](http://www.fda.gov/fdac/special/newdrug/ndd_toc.html)
- Students could be assigned a 10-minute oral presentation that summarizes their research so that peer learning can occur via discussion. Instructors should allocate enough class sessions for presentations. If students do not have experience presenting scientific material, the presentations may move more slowly and contingency plans should include “catch up” days

### Assessment

Student learning can be assessed and options follow:

- Student discussions organized by topic on-line via the Classwire site can be reviewed by the instructor.
- Students can undergo peer review with a member of the class.
- Student learning can be assessed by reviewing answers to the questions on **Resource Six: Self-assessment of Writing** and **Resource Five: Peer Assessment of Writing**
- All drafts and peer review comments can be graded. Attention should be given to language, clarity, style, organization, originality, rationale, evidence, and creativity.