

Stem Cells: Science, Ethics and Politics

Introduction

Stem Cells: Science, Ethics, and Politics provides instructors and students with resources and activities that highlight the basic science, techniques, and applications of stem cell research. Each assignment focuses on a particular aspect of stem cell biology and its relationship with clinical medicine, environmental toxicity screening, and reproduction. The five activities that comprise this curriculum supplement have three central objectives. The first is to use stem cell research as a vehicle to teach basic scientific principles and concepts of cell biology, specifically signal transduction, gene expression, apoptosis, and cell differentiation. The second is to attract and maintain student interest in science by making connections to the ethical and political dimensions of this research. Ideally, by unraveling these stories for themselves and grappling with the scientific and social issues in both their individual studies and classroom activities, students will teach themselves the basic science and thoughtfully reflect upon its social relevance. And this is the third central objective of these teaching activities: to teach students to actively learn for themselves, rather than be passive consumers of information fed to them by a teacher or textbook.

On the scientific front, much has been learned about cell plasticity, cell differentiation, and cell death. No longer is the path of cell differentiation considered a series of linear steps for which there is no reversal. In the last decade, we have seen a number of scientific reports that describe how standard biochemical and cellular techniques were used to elucidate the mechanism of cell differentiation and cell reprogramming. On the social front, "stem cell" has become a household term due to the controversies surrounding the sources of these cells and the applications of the related technologies, but continued research in the field requires individuals to grapple with the ethical issues relevant to both the practicing scientist and the state. With few other topics does the advancement of scientific knowledge intersect with such a meaningful range of social and ethical questions.

The activities in this teaching module draw upon a broad array of resources related to stem cells: from informative pieces in the press and television, to textbook excerpts, to the secondary and primary scientific literature. As the instructor, you will need to decide which of the suggested readings and media items will be most appropriate for your students. The selection of primary literature was chosen to help students learn that science is a gradual process: a series of experiments built on previous findings conducted by members of a community striving to increase their understanding about the world around them. The selection of secondary literature was chosen to place these incremental advances in scientific understanding within a larger conceptual context by reviewing the prior research, summarizing the impact of the present discoveries, highlighting unanswered questions, and pointing to future experiments and applications.

Regardless of which readings and activities might work best for your class, the topic readily lends itself to a wide variety of learning experiences, from basic discussion of the social issues to more advanced scientific activities, such as planning new experiments or envisioning new applications. Perhaps what is most exciting about the topic is that the

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story, on either the scientific or social level, is not yet complete. With respect to scientific research, the identity of the many growth factors involved in cell differentiation and the details of genetic reprogramming remain unknown. New applications for the stem cells and the methods by which they are derived are being developed, and this in turn leads back to questions regarding the social impact of science. In addition, all these avenues of research offer students a view into the world of high-tech biology.

The "Stem Cell Research Background" reading provides the necessary scientific and historical foundation needed to administer the learning activities, and it reviews the ethical and social dimensions of the field as it applies to public health. Instructors may choose to distribute this mini-review to students. Alternatively, instructors may decide it is better for students to construct their own knowledge of the subject by working through the assignments offered in the learning activities.

Each of the five activities has been developed modularly in order that it can be used on its own, in combination with another activity or activities, or as a complete series. Student learning outcomes are listed on the home page for each activity, with links to assignments, teaching notes and answer keys. The assignments explore a variety of learning styles: **Activity 2** and **Activity 4** resemble more traditional learning, focusing on primary literature readings and analysis, while **Activity 1**, **Activity 3**, and **Activity 5** ask students to engage with the content in much the same way as working scientists do via interviews with the media, journal club meetings, conferences, symposia, and letters to policy makers. Because teaching students how to comprehend and analyze primary literature is an important goal of this module, prominent research studies and reviews may appear in multiple activities. Thus, the recent work of Hwang and Moon reporting the first successful attempt at cloning human blastocysts is referenced in all activities, but approached in different ways: In **Activity 1**, a few news articles touch on these studies, in **Activity 3**, **Activity 4**, and **Activity 5** the associated research articles appear as important background reading, whereas in **Activity 2** these articles are themselves the focus of a close reading and detailed analysis.

The "Teaching Notes" for each activity provide an overview of the activity itself, the assigned readings and media assets, implementation plans, and options for assessment. To accommodate a wide variety of educational environments the Teaching Notes provide step-by-step instructions for implementation. And since the activities aim also to be as flexible as possible, the Teaching Notes include alternative versions of activities and assignments. While these "Teaching Notes" provide a detailed guide, instructors are encouraged to modify the activities, swap components, or simply use the suggested media resources to complement a course.

There are also additional resources. Instructors and students both might benefit from the **Timeline**, **references**, and **grading rubric** in the **Core Materials** area, as well as the many links to useful media clips. For instructors, there are several answer keys, and for students the **Student Resources** section includes guides to peer assessment and self-reflective reading and writing guides. The **References** page contains over 200 references

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organized by subject and media format, and many items take advantage of the internet, utilizing animations, colorful imagery, and interactive components. For instructors who are teaching introductory biology major courses or advanced level non-majors courses, Life Itself, written by Boyce Rensberger, could be assigned as a supplement to the Molecular Biology of The Cell, Essential Cell Biology, or Biology Today texts. In addition, instructors and students are encouraged to review the National Institutes of Health stem cell primer, *Stem Cells: Scientific Progress and Future Research Directions*.

Because some instructors have limited access to journals, citations refer to freely available papers whenever possible, but primary references are included in the resources and bibliography.