



Socially-based Curriculum Unit: Use of Science Technologies in Society

Unit Title: Use of Science Technologies in Society

Time Frame: 5 lessons or days required

Unit Developer(s): Stella Lee

Developed for Course Name and Course Code: Grade 11 Biology, University Preparation (SBI3U)

Strand(s) and Curriculum Learning Expectations Addressed:

Genetic Continuity Strand

GCV.03 · outline the scientific findings and some of the technological advances that led to the modern concept of the gene and to genetic technology, and demonstrate an awareness of some of the social and political issues raised by genetic research and reproductive technology.

GC2.05 – research genetic technologies using sources from print and electronic media, and synthesize the information gained (e.g., describe the Human Genome Project, transgenics, or the process of genetic screening; list the advantages and disadvantages of cloning or the genetic manipulation of plants).

GC3.02 – describe and analyse examples of genetic technologies that were developed on the basis of scientific understanding (e.g., the improvement of an experimental procedure to extract DNA from bacterial or plant cells).

Desired Results

Unit Description:

This 5-day unit covers specific lessons within the Genetics Continuity unit of the SBI3U course. It specifically focuses on the advantages and disadvantages in the application of science technologies such as DNA fingerprinting, cloning and genetic engineering in society, especially in the fields of forensics, medicine, and agriculture.

The goal of this socially-based curriculum plan is to facilitate students in becoming more compassionate and socially-responsible scientists so that they can avoid being perpetrators or bystanders in a society indifferent to the suffering of others.

Enduring Understandings / Learning:

- Students will learn how to use various genetic technologies in science such as PCR machines and gel electrophoresis used for DNA fingerprinting and/or micropipettes and agar plates used for bacterial gene



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transformation.

- Students will learn how genetic technologies in science have helped police solve rape and/or homicide cases in the field of forensics, advanced the treatment of disorders and diseases in medicine, engineered agricultures that are more insect-resistant and commercially productive.
- Students will learn why scientists must have moral and social responsibilities in the application of science in society.
- Students will build critical thinking skills by evaluating scientific information from history, journals, the media, and political organizations while recognizing issues of funding inequities, political initiatives, biased and prejudicial perspectives, issues of discrimination and principles of morality.
- Students will develop global awareness by researching current events on genocide and recently published scientific studies on racial biology.

Assessment Tasks

Performance Tasks and Other Evidence That Will Demonstrate the Knowledge and Skills Acquired:

- Critical thinking posters on how to evaluate information from scientific journals, the media, and political organizations.
- Researched opinion paper on current events on genocide and recently published scientific studies on racial biology.

Assessment Criteria:

Critical thinking posters and researched opinion papers will be evaluated with rubrics.

Unit Planning Notes

Preparation Notes:

Teachers will need to contact guest speakers and plan field trips prior to the beginning of this unit.



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Learning Plan

Lesson 1: Genetic Technologies in Science

Have students use various genetic technologies in science such as PCR machines and gel electrophoresis used for DNA fingerprinting and/or micropipettes and agar plates used for bacterial gene transformation:

- The Ontario Science Centre (<http://www.OntarioScienceCentre.ca>) has programs called “DNA Fingerprinting” and “Way to Glow! Bacterial Transformation” that allow students to obtain hands-on experience in using various genetic technologies in science.
- The University of Toronto Let's Talk Science Partnership Program (<http://www.utm.utoronto.ca/~w3ltsutm/>) offers free forensics and biotechnology programs run by student volunteers for classroom teachers in the Greater Toronto Area which can be tailored to fit the particular needs and goals of a particular classroom.
- The University of Western Ontario Outreach Science Ontario Program (<http://www.biochem.uwo.ca/oso/biotech/index.html>) offers free loans of kits that come complete with all equipment, reagents and manuals to perform 10 experiments to high school teachers for students to conduct hands-on wet labs in biotechnology.

Lesson 2: Advantages in the Application of Science Technologies

Show educational videos that exemplify how genetic technologies have helped police solve rape and/or homicide cases in the field of forensics, advanced the treatment of disorders and diseases in medicine, engineered agricultures that are more insect-resistant and commercially productive:

- Show PBS programs such as NOVA's “Cracking the Code of Life” and “Our Genes / Our Choices” or Scientific American Frontiers' “Gene Hunters” (http://www.pbs.org/science/science_health.html).
- Use the National Science Foundation's Bio-Link as a biotechnology education resource (<http://www.bio-link.org/>).
- Use Dolan DNA Learning Center as a molecular genetics research resource (<http://www.dnalc.org/home.html> and <http://www.dnafb.org/dnafb/>).
- Use the Genomics as a Human Genome Project education resource (http://www.ornl.gov/sci/techresources/Human_Genome/education/education.shtml).
- Show how Interpol uses DNA profiling (<http://www.interpol.int/Public/Forensic/dna/default.asp>).
- Download digital videos from Molecular Expressions (<http://micro.magnet.fsu.edu/moviegallery/>).
- Download PowerPoint slides from BioEd Online (<http://www.bioedonline.org/slides/>).



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Lesson 3: Disadvantages in the Application of Science Technologies (Part I: Analyzing Biases and Prejudices in Science)

- **40 minutes:** Show the movie “GATTACA”: Introduction (from when the main character discusses the world that he was born into to when he was hired by GATTACA after to his DNA test) and Conclusion (from when his brother, the detective, speaks directly to him at GATTACA to when he reflects on his success after the shuttle launches and leaves Earth’s atmosphere).
- **5 minutes:** Set the context of how society can misuse science and technologies by having a class discussion to explore the explicit and implicit messages of the director of the movie.
- **5 minutes:** Analyze television commercials and/or magazine advertisements about products supported by scientific research to facilitate students in building critical thinking skills when evaluating scientific information offered by the media. For example, discuss how pharmaceutical companies market their drugs as the miracle pill, but list the side effects as rare and minor consequences, in particular, how some anti-depressants can cause suicidal tendencies.
- **10 minutes:** Analyze conclusions drawn from current studies from scientific journals, for example, the effects of diet pills. Help students develop an awareness of funding inequities and political initiatives by discussing why some research studies are generously funded by particular industries and/or societal pressures while other research studies are limited in funding and therefore have less visibility in the commercial arena. Help students how to recognize information with biased and/or prejudicial perspectives, and how to identify the controversial issues surrounding a topic, by facilitating a class discussion on how scientific conclusions are sometimes inaccurately drawn from experimental observations and data due to extraneous variables and/or poor procedural designs. In particular, discuss whether the scientific merit of a product should be measured by material success and/or popularity; and whether a noble scientific goal can justify immoral tactics used in scientific research.
- **5 minutes:** Facilitate a class discussion about how the government, media, and various political organizations influence which ideologies our society should focus on. Popular culture may be used to emphasize particular ideologies. For example, show the Black Eyed Peas “Where is the love?” or Nelly Furtado’s “Powerless” and have students listen to the lyrics to inquire the importance of human rights for all individuals in society; and/or show Sarah McLachlan’s “World on Fire” and have students read the messages to inquire what impact the media has on the human spirit.
 - “Where is the Love?”: <http://www.youtube.com/watch?v=MJpyskHMwRs>
 - <http://www.lyrics007.com/Black%20Eyed%20Peas%20Lyrics/Where%20Is%20The%20Love%20Lyrics.html>
 - “Powerless”: http://www.dailymotion.com/video/x1fe1t_nelly-furtado-powerless_music
 - [http://www.lyrics007.com/Nelly%20Furtado%20Lyrics/Powerless%20\(Say%20What%20You%20Want\)%20Lyrics.html](http://www.lyrics007.com/Nelly%20Furtado%20Lyrics/Powerless%20(Say%20What%20You%20Want)%20Lyrics.html)
 - “World on Fire”: <http://www.worldonfire.ca/> or <http://www.youtube.com/watch?v=hzoNInZ2CIQ>
 - <http://www.azlyrics.com/lyrics/sarahmclachlan/worldonfire.html>
- **10 minutes:** Facilitate a class discussion about why it is very dangerous to consider improving the human



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race even with the best of intentions, and what qualities a compassionate and sociably-responsible scientist should have. Discuss how every action always has a consequence. Discuss why is it dangerous to act on the opinion of one individual or even a large collective group that shares a common opinion. Discuss how resistance to particular actions may give insights to unconsidered, but morally-responsible consequences. Discuss how scientists should be well-informed from many different perspectives, be honest, have integrity, and must contribute to humanity in a positive manner. Discuss why scientists should be accountable for their actions and words, and should be morally obligated to “police” themselves. Famous quotations may be used to emphasize these characteristics. For example:

- ❖ Martin Luther King, Jr. – “Nothing in the world is more dangerous than sincere ignorance and conscientious stupidity.”
- ❖ Anatole France – “An education isn't how much you have committed to memory, or even how much you know. It's being able to differentiate between what you know and what you don't.”
- ❖ Will Durant – “Education is a progressive discovery of our own ignorance.”
- ❖ Albert Einstein – “Try not to become a man of success but rather try to become a man of value.”
- ❖ William Menninger – “Six essential qualities that are the key to success: sincerity, personal integrity, humility, courtesy, wisdom, charity.”
- ❖ Frank Outlaw – “Watch your thoughts; they become your words. Watch your words; they become your actions. Watch your actions; they become your habits. Watch your habits; they become your character. Watch your character for it will become your destiny.”

Lesson 4: Disadvantages in the Application of Science Technologies (Part II: Reflecting on Scientific Applications in History)

Examine the science that supported the Jewish Holocaust to help students understand how scientific research is motivated by political initiatives, how conclusions from scientific studies are biased and have prejudicial perspectives, and why it is important to recognize issues of discrimination and principles of morality in the application of science technologies in society:

- **10 minutes:** Facilitate a class discussion exploring the differences between Darwin's theory of evolution and natural selection and Nazis' theory of social Darwinism to further illustrate how scientific information can be misinterpreted and misused. Use the following websites for teaching resources: <http://www.ushmm.org/> and <http://yad-vashem.org.il/education/>.
- **15 minutes:** Facilitate a class discussion on the term “race” by examining the scientific paradigm versus the social construct. Illustrate how scientific information can be misinterpreted and misused by showing images of “racial characteristics” such as those defined by Nazis which stereotyped Jews (<http://www.jewishvirtuallibrary.org/jsource/Holocaust/Giftpilz.html>) through a “Who is Jewish?” game using photographs or caricatures. Have the class read recent articles that show scientific evidence that supports that the theory for human race does not exist where from a genetic point of view, humans are all African (<http://www.ncbi.nlm.nih.gov/sites/entrez>).



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- **20 minutes:** Emphasize how science and mathematics are not neutral subjects where the knowledge and skills learned can have both beneficial and harmful applications. Discuss how professionals such as architects designed and civil engineers coordinated construction of buildings and gas chambers for concentration camps and how chemical engineers determined the amount of lethal gas required to kill a certain volume of people in a particular length of time. Discuss why it is important to question authority figures. Emphasize how doctors and nurses performed unethical medical experiments on prisoners to test the threshold for human survival (<http://www.ushmm.org/wlc/article.php?lang=en&ModuleId=10005168>). In particular, discuss Dr. Josef Mengele who conducted horrific genetic experiments with twins (http://history1900s.about.com/od/auschwitz/a/mengeletwins_2.htm).
- **20 minutes:** Emphasize the insidious nature of immoral applications of science and the dangers of not speaking out against small injustices that can expand to more serious issues. Discuss the initial targets of the euthanasia program where it focused on an invisible disabled population, which then escalated to limiting rights of inferiors and Jews, which then escalated to the vandalism and destruction of property, which then escalated to internment in camps, which then began with the murder of men, then women, and finally, children (<http://www.pbs.org/auschwitz/40-45/background/ideology.html>). Emphasize that Hitler did not kill the Jews alone, but he did so with the cooperation of many people who were willing to apply their knowledge of science and mathematics to mass murder, and how many countries did nothing to stop this from occurring.
- **10 minutes:** Facilitate a class discussion on why it is important to be socially responsible scientists and why it is dangerous to consider improving the human population even with the very best of intentions. As a class, brainstorm methods on how to achieve this goal.

Lesson 5: Disadvantages in the Application of Science Technologies (Part III: Research Current Events and Recently Published Scientific Studies)

Invite a guest speaker such as the Human Rights and Equity Resource Teacher from the District School Board office to further facilitate the fostering of critical thinking skills and global awareness for the 75 minutes period or:

- **30 minutes:** Have students work in pairs to create posters that teach people how to evaluate information from scientific journals, the media, and political organizations.
- **45 minutes:** Have students work in pairs to research current events on genocide, atrocities and catastrophes against humanity, and recently published scientific studies on racial biology (<http://www.historyplace.com/worldhistory/genocide/>).



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Appendices

Appendix A: Critical Thinking Poster Assignment and Rubric

Appendix B: Researched Opinion Paper Assignment and Rubric

Other Possible Course Applications

Grade 12 Biology, University Preparation (SBI4U)

Molecular Genetics Strand:

MGV.03 · describe some of the theoretical issues surrounding scientific research into genetic continuity; the general impact and philosophical implications of the knowledge gained; and some of the issues raised by related technological applications.

MG2.04 – describe the major findings that have arisen from the Human Genome Project (e.g., create a timeline of the project, or make a chart of the discoveries).

MG3.01 – explain the roles of evidence, theories, and paradigms in the development of scientific knowledge about genetics (e.g., explain the impact of cloning a sheep on the theory of differentiation; explain the impact of the discovery of the structure of DNA as the universal molecule for living organisms).

MG3.02 – describe the principal elements of the Canadian regulations on biotechnological products, and explain their implications (e.g., consult Environment Canada or Food and Health Canada for the regulations; or use current websites for agencies such as Agriculture Canada that list new products).