Ahimsa Center- K-12 Teacher Institute Lesson Plan

**Title:**
Sustaining ‘Happy Genes’ through Epigenetics

**Lesson By:**
Wilfred Berlin, Daniel Webster Digital Media & Broadcasting High School, Tulsa, OK

**Grade Level/ Subject Areas:**
9 - 10 / Biology

**Duration of Lesson:**
55 minutes, 3 days

**Content Standards:**
Common Core Reading Standards for Literacy in Science and Technical Subjects: Grades 9 - 10

1. **Key Ideas and details**
   - Determine the central ideas or conclusions of a text; trace the text’s explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

2. **Craft and Structure**
   - Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

3. **Integration of Knowledge and Ideas**
   - Assess the extent to which the reasoning and evidence in a text support the author’s claim or a recommendation for solving a scientific or technical problem.

4. **Range of Reading and Level of Text Complexity**
   - By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

Common Core Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects: Grades 9 - 10

1. **Text Types and Purposes**
   - Write arguments focused on discipline-specific content.

2. **Production and Distribution of Writing**
   - Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology’s capacity to link to other information and to display information flexibly and dynamically.

3. **Research to Build and Present Knowledge**
   - Draw evidence from informational texts to support analysis, reflection, and research.

4. **Range of Writing**
   - Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

**Lesson Abstract:**
Sustainment of happiness and environmental stresses are generally not a common topic in the typical high school biology class. The new field of epigenetics is showing how your environment and your choices can influence your genetic tendencies, as well as that of your offspring. Studying and contemplating epigenetics will require that the basic understanding of heredity from this course will help to realize what is becoming a recognizable example of cause and effect within the adaptable structures we have.
**Guiding Questions:**
How can genes that have been assorted through the process of meiosis develop a change in the results that was not originally coded for during transcription or by the typical forms of mutations?

What are possible results in hereditary patterns based on both the emotional and physical stresses put upon a parent before their offspring is produced?

How could changes in attitude and the knowledge one receives in regard to engineering happiness play a role in changing the genome of a new born individual?

**Content Essay:**
“The cells in a multicellular organism have nominally identical DNA sequences (and therefore the same genetic instruction sets), yet maintain different terminal phenotypes. This nongenetic cellular memory, which records developmental and environmental cues (and alternative cell states in unicellular organisms), is the basis of epigenetics.” (J. B. Andersen et al., Sci. Transl. Med. 2, 54ra77 (2010).)

Many terms in the above statement are those common to a biology unit and textbook covering the basic tenets of heredity and DNA. Science, as a collective ideal of understanding how the physics and physiology of a subject works, typically doesn’t care to have a sudden change in thought to be put upon, despite the fact that change is so involved in how we come to the understanding we have of a subject as compared to past generations.

Some may recall an older relative commenting about how what we are doing now can affect those who come along generations later. ‘The Lord is slow to anger and abounding in steadfast love, forgiving iniquity and transgression, but he will by no means clear the guilty, visiting the iniquity of the fathers on the children, to the third and the fourth generation.’ (Numbers 14:18, ESV/114 helpful notes) This verse of what is commonly known as The Bible is repeated in about ten different verses, depending on the version used. Many other statements relate to how the next generation or two will ‘be cursed’ by way of the actions of the parents. One of the stories involving the Buddha relates to behavior with one who terrorizes the villages because of the problems brought on by status as the caste system has helped to ensure that determinate factors will be put on his future and then the rebellion comes about. Science has relegated many of these ideas to the ‘social sciences’, with perhaps the syndrome that some people are influenced by genes that may be more easily recognized than others in regard to the triggers brought about by environmental factors. Through the past twenty years of investigating genetic traits, many researchers have wondered why such discrepancies exist between relatives; even identical twins who have similar and exact copies of DNA. Discoveries have been made that a mode of genetic traits that seems to ‘hover’ over the RNA codes which normally endorse what will be realized into the traits that form the DNA we are born with. More than just the DNA codes are determining the traits we are born with, and this ‘ghost of a gene’ seems to be above the standard code, and so the term epigenetics is born.

Whereas covering the basis of epigenetics can bring about a wide variety of terms and factors that can be confusing, a more proper definition should be used in helping to narrow the subject matter. “The development and maintenance of an organism is orchestrated by a set of chemical reactions that switch parts of the genome off and on at strategic times and locations. Epigenetics is the study of these reactions and the factors that influence them.” (Genetic Science Learning Center, University of Utah, http://learn.genetics.utah.edu.) The factors involved with this orchestration are environmental and include stress, diet, behavior, toxins, etc. At this point, one can realize the connections science needs to make involving a variety of subject matter. Researchers are noticing that the choices made by one generation are determining the traits shown in later generations. This is the phenotype realized, but without the normal expression of genotypes observed in ‘classical’ genetics. A case can be made that the level of happiness of the parent, grand or even great grandparents are affecting the override of what had been an established genotype. In this sense, they are ‘engineering happiness’. As studies regarding happiness have become more common, it’s becoming apparent that a literal description of what helps to define happiness may also serve in better realizing the big picture of what aids in driving the levels of happiness that is shaped by one generation to another.
“EXPECTATIONS CHANGE BY ADAPTATION...Simply put, what you get in the past can determine your expectations for the future...To frame it as an equation, this change of expectations by adaptation suggest that: HAPPINESS equals WHAT I GET TODAY minus WHAT I GOT IN THE PAST”  (Engineering Happiness, p. 61)

It is not so difficult to imagine this phenomenon as to how it may appear. We know that various forms of stress affect the immediate functions of various bodily organs and glands. Blood flow is affected and long term problems such as cancer, ulcers and even diabetes have been associated with some of the stresses put upon us. These stresses also affect the growing individual at the time they are still developing, and results of their genetic code also changes in their own lifetime. The child with too much emotional stress placed on them can have a stunted growth in the height that they otherwise were destined to become. This used to be relegated to the physical stresses, but it’s a multifaceted issue. If the physical body can be affected in real time, then the very codes that give instruction to the physiological processes can well be affected. Those who work in facilities involving problematic children can see a trend of multigenerational problems that seem to be ingrained in these children. Infants that are taken away from their environment upon birth; who may even be addicted to a drug before they are born and have a rough start in life can thrive better if placed in a more positive environment with productive stimuli. This is assuming they’ve not received brain damage. An elevated degree of happiness is found in these children and degrees of courage, ambition, mental and physical prowess, etc. is observed. This may not be automatic, as many factors can have influence, but the odds favor the ones taken out of the negative environments and agencies who serve for adoptions or foster care recognize that timing of removal is of essence.

History has to be full of accounts how children have been either fortified or mortified by the actions of their parents, and then the revamping or degrading of the epigenetic traits would take place. As Gandhi has had such an effect on generations of his beloved India, how much more effective were younger ones being born a generation and more afterwards with the self-satisfaction of swaraj and the empowering aspects of satyagraha. We can be thankful that Gandhi had a positive role model in his father. One of the accounts that really shaped the attitudes Gandhi would aspire with revolved how he dealt with the issue of his strict father when he had to admit to stealing and lying about it. He wrote “I was trembling as I handed the confession to my father. He read it through, and pearl drops trickled down his cheeks, wetting the paper. For a moment he closed his eyes in thought and then tore up the note...I could see my father’s agony. If I were a painter, I could draw a picture of the whole scene today. Those pearl drops of love cleansed my heart and washed my sin away.” (Gandhi – Pioneer of Nonviolent Social Change, p. 13) We are left with an understanding that love was realized even more by the act of forgiveness, and this became one of the iconic features of Gandhi that went on to help affect his higher calling for sarvodaya. More evidence that he was raised with positive values that were not only instilled in him behaviorally, but came natural by way of parents who had carried out their positive commitments, is that he had his chances to divert to a more material side of life. The temptations were there, but he routinely defaulted to a sense of morality. This went on to affect the way he led, as described here in an account where he was addressing an economic society: “Does economic progress clash with real progress? By economic progress, I take it, we mean material advancement without limit and by real progress we mean moral progress, which again is the same thing as progress of the permanent element in us.” (‘Hind Swaraj’ and Other Writings, p. 154) Money is considered the more tangible of these comparisons, but the moral progress became more valuable as he and the Indian people were put to the test and the moral convictions that became an enduring part of their mindset made the primary difference in the final outcome of freedom without massive bloodshed.

Other factors of epigenetics that promote a cause and effect relationship are of diets and toxins. Unfortunately, these two aspects often go together. Even the wrong diet can become a toxin to our system, (protein poisoning comes to mind with too much consumption) and this promotes a stress factor. Our bodies, and offspring who come along later, may well be more prone to negative conditions, e.g. diabetes. Gandhian trademarks of swaraj and even the aspiration of vegetarianism comes to mind as methods of sustaining happiness and the good health that comes with it. One of these factors will influence the other. Even the healthy diet can be subverted with
materialistic pursuits of using GMOs with our food supply as testing is showing a correlation of our RNA codes being affected by the unnatural codes and genes being manipulated through various forms of biotechnology. Epigenetically, we are affecting those are yet to come with the consumption of these altered crops. We need to be satisfied with the natural satiety that comes with the less extreme acts of manipulation. Happiness is being shown to result from simplicity more than the ways we complicate our lives. Forgiveness is also among the intrinsic values that will aid in the positive epigenetic process as studies suggest the release of stress involved with this. We can take stock in how the Buddha helped to affect for change when Ahimsaka had been on trial. “If Sujata is prepared to forgive, they thought, then the rest of us must follow her. Sujata’s sorrow, filled with longing and dignity, was spellbinding.” (The Buddha and the Terrorist, p. 103) It is hoped as future generations better understand the underlying facts regarding the outer force involving genetic influence that they will have the impetus and likelihood of the capacity to act on that forgiveness towards us. That story talks about transformation, and we should seek the same within.

Teaching Activities

DAY 1.

Bellringer. (5 minutes). Students will open a dictionary to the term ‘epigenetic’ and write the definition into their journals. (Most standard dictionaries will not have this term.) If they find it, they may write it, or then define the term as unveiled by the teacher on the whiteboard, Smartboard or similar screens.

Discussion. (10 minutes). The teacher will open discussion by relating that the term is new enough that average age dictionaries will not have this term yet, but that it is showing up in more science texts. Discuss the premise behind the concept of epigenetics and how this definition may be added to the descriptions of basic heredity by way of newer findings that are becoming more widely accepted. The teacher may entertain thoughts involving Gandhi with information about his background and how he could have been affected differently if he had been raised much differently. Students may need some background information in regard to the health, personal interests and parenting styles that he was raised with. Students may be quizzed of what they may have heard about, and how many of these concepts will be expanded upon in the video ‘Ghost in Your Genes’. (Videos and websites listed in the bibliography will help to give pertinent information that will help to give ideas for discussions, activities and topics to write about.) Students should also be reminded to look for positive results that may be gained from the effects of epigenetics that they will see.

Video Activity. (25 minutes). Students will view the video ‘Ghost in Your Genes’. (This may be in a Safari Montage selection if the school library is equipped. There are two easy to use sources and which one works well for a computer viewing system can be used: http://watchdocumentary.org/watch/the-ghost-in-your-genes-video_8ed7cfa88.html or, this site: http://www.youtube.com/watch?v=BEzW7LWr1Ws

Activity. (10 minutes). Students may move quickly into groups of three or four and collaborate by consensus the two most interesting topics and sharing their thoughts as a group quick-write paragraph or two. These may be written and saved on any of the following items to be used for later discussion: poster or construction paper, hand held whiteboard, electronic pads and/or devices that can be saved. Names of those involved in the quick-write should be saved with it. (Teachers with classes who do not move quickly in deciding who to work with may prefer to have pre-arranged groups ready to work in fours. If one is absent, a group of three is good, or other arrangements may quickly be made if others are absent.)

Closure and/or Homework. (5 minutes). The teacher may allow a few more minutes of the writing if this is going well and needed, give help for ideas and further directions, or use the time to discuss an essential question and leave thoughts in regard to continuing the study another day and be thinking about what may be discussed in an essay. Remind students to consider aspect of happiness in accessing the subject. If homework is desired, vocabulary of newer terms regarding heredity may be worked with. Indian terms from the above lesson content essay may be searched and written about.

DAY 2.

Bellringer. (5 minutes). Students may write an opinion in their journals of any behaviors they have, or stress that affects them, and may affect the tendencies that their DNA will instruct for.
Discussion. (10 minutes.). The teacher will share any website, publications and/or videos that may be good for extra research that students may receive ideas from in writing an essay (not yet formally assigned). Some suggestions would be the following website that is dedicated to the discussion, research, and publication of epigenetic subject matter:  
http://www.landesbioscience.com/journals/epigenetics/. This website has a new monthly volume, and archived articles. Videos that help to explain the subject matter quickly and in a way to hold student attention would be a couple from the ‘Mr. Anderson’ lectures (well known science teacher who shares his videos on ‘Youtube’ and keeps them on file with his website:  
http://www.youtube.com/watch?v=kp1bZEUgqVI and/or  
http://www.bozemanscience.com/epigenetics. Any of these may easily be shared in the classroom if more time, or less of the other activity, is taken.

Video Activity. (25 minutes.). Students will continue the video ‘Ghost in Your Genes’. (This may be in a Safari Montage selection if the school library is equipped. There are two easy to use sources and which one works well for a computer viewing system can be used:  
or, this site:  
http://www.youtube.com/watch?v=BEzW7LWr1Ws

Activity. (10 minutes.). Students may again move quickly into groups of three or four, but seek other partners and collaborate by consensus the two most interesting topics. They will share their thoughts as a group quick-write paragraph or two. These may be written and saved on any of the following items to be used for later discussion: poster or construction paper, hand held whiteboard, electronic pads and/or devices that can be saved. Names of those involved in the quick-write should be saved with it. (Teachers with classes who do not move quickly in deciding who to work with may prefer to have pre-arranged groups ready to work in fours. If one is absent, a group of three is good, or other arrangements may quickly be made if others are absent.)

Closure and/or Homework. (5 minutes.). The teacher may allow a few more minutes of the writing if this is going well and needed, give help for ideas and further directions, or use the time to discuss an essential question and leave thoughts in regard to continuing the study another day and be thinking about what may be discussed in an essay.

DAY 3.

Bellringer. (10 minutes). A reading about happiness is to be encouraged (as many of the themes of genetic change can lean to the negative results). The teacher may have a copy of the: ‘HAPPINESS is an S-curve of REALITY minus SHIFTING EXPECTATIONS’ equation posted on the screen(s), with other quotes from the Engineering Happiness: a new approach for building a joyful life book listed above. Some of the content of this is quoted in the content essay and this can work as one of the quotes. This may help to affect what they decide to write about.

Activity. (35 minutes.). The teacher will direct students to assemble the quick-writes into categories of paper or digital and have them placed for viewing. The paper driven ones can be placed around the room for a ‘Gallery Walk’. The digital ones can be ready for upload so they may be shown in order on a screen. (Much of this may be set up ahead of time, if possible.) Students will be instructed to visit, in a clockwise fashion (or a method that works well for the individual class), the writings and take a moment to read up on the interests and observations that are shared. They can take notes if they see something that will help give them an idea or a question. After this portion is complete, writings may be read by a variety of students of what is projected on a screen while the other students read on their own. Some time can be saved in having discussion or questions in regard to what they’ve been learning about.

Closure and/or Homework. (10 minutes.). The teacher will relate an assignment that a number of days will be allowed for in homework time for an essay to be written in regard to the subject of ‘Epigenetics’. Students may research both given and newly found sources that will give good background information in regard to a topic of behavior and/or genetic results involved with the concept of epigenes. If a student feels capable, they may find information that disputes the findings that other researchers claim. They may equate happiness as both the impetus, and result of developing a positive approach to the subject of genetic health. They may include evidence whether the genetic codes are overridden by a higher physiological influence, or if the changes in generational tendencies are the result of more environmental factors. Could social movements, e.g. the
movement Gandhi presided over, be affected by information affecting the stress levels and behavior patterns of societies who are seeking change? Students can be given a chance to come up with their own topic, as well as receive teacher help with the resources given. (A rubric that works well for the individual class may be given in how this will be counted and evaluated. More time in class may be of preference in establishing the essay if the homework time is not needed.) The standards of rigor, length, scope and other factors of the essay may be decided by what is relevant for that class and the differentiation of students enrolled.

Optional. This source added below may provide for an interesting read in helping with discussion or in giving another topic that may be written about. The webpage here may also serve for a student who needs more rigor in promoting the differentiation they may need:  
Another excellent, worthwhile video that can bring about good material to write about, as well as substantiate much about biology and genetic patterns, is ‘Journey of Man’. This is also good for reaching students through the affective domain as the producer goes to great length in showing physical, emotional and cultural similarities of all who are human. 

Materials Needed

- Journals and writing utensils
- LCD projector or Smartboard system.
- Computer with internet access connected to LCD projector and/or Smartboard.
- Biology textbook and/or other texts explaining basic genetics.
- Poster or construction paper. (Optional choice)
- Hand held whiteboards. (Optional choice)
- School and/or student owned electronic recording devices. (Optional choice)

Bibliography: