Flexible Conductive Materials In the Treatment of Spinal Cord Injuries

Tracy Ebert

Olympia High School, Orlando, FL 32835

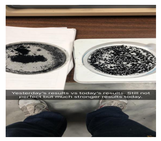
Summary

In anatomy one of the topics that we discuss is the how nerves transmit electrical signals and what happens when those signals are unable to be transmitted. This is the case that occurs when there is damage done to the spinal cord. Because the spinal cord basically asks as a closed circuit when the circuit is severed than the circuit no longer works and as a result function is lost in that part of the body. In the research conducted this summer with Dr. Gou, I was introduced to Carbon Nanotubes (CNT) and the many physical characteristics that make them appealing to multiple industries. Because of my biology background I immediately started looking into the biomedical uses for CNT and was surprised at the number of areas where they could be beneficial. Because of their strength they could be used as a composite mixture to help with osteoporosis or osteogenesis imperfecta. CNT are also being explored for both the diagnosis of cancer as well as the treatment of cancer. CNT is a heat conductor and as a result heat could be delivered directly to the site of the cancer and then basically burn the cancer. Anoher of the physical characteristics of CNT is their ability to be extremely good conductors of electricity. Therefore, CNTs could be used, doped with other substances, to help bridge the gap in the severed spinal cord as well as stimulate growth of possibly new cells. A model can be created in my classroom that will allow the students to visualize this severing of the circuit and discuss ways that could close the circuit.

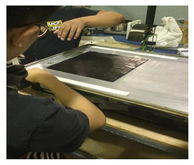
Research Activities

Attended lectures on the properties of, history of, and production process of carbon nanotubes (CNT).

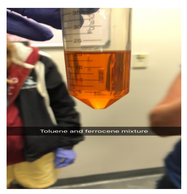
Attempted to create buckypaper using a multiwalled carbon nanotube (CNT) suspension and vacuum extraction. In order to optimize the product different factors were changed. For example, first picture is 1.5g MWCNT per 1.4L of acetone and the second picture is 3.0g MWCNT per 1.4L of acetone.

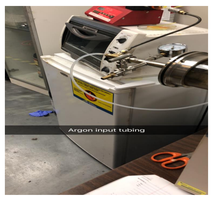


Created a 12X12 carbon fiber plates by stacking impregnated carbon fibers, containing epoxy, and then autoclaving to cure the epoxy. The end result being a substance that is stronger and lighter weight than most metals which would be used in multiple industries.



Our last experiment was to grow MWCNT using a 2.5% mixture of ferecine and toluene. The mixture was subjected to heat (750C) so that the solution was vaporized. A substrate, glass slide, was added to the quartz column and the MWCNT than formed on the slide.

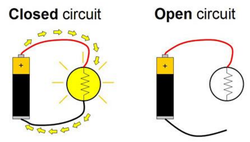




Lesson Plan

Day 1:

1. Students will be introduced to the circuit model. There will be a closed circuit as well as a severed circuit. On the hand out they will have to explain the difference between the two and what observation they make about the severed circuit



2. The students will watch the video and answer some guiding questions on the worksheet
https://www.youtube.com/watch?v=sZD_2mtKPrE
3. Students will then be asked, on the worksheet, to relate what they observed with the circuit to what they learned in the video.

Day 2:

1. Lecture on the spinal cord and how nerves transmit signals

Day 3:

1. Closed reading of the article: **Nanomaterials for Spinal Cord Injury Recovery**
2. Guided questions, will be asked, to help them understand the carbon nanotubes and their possible use in spinal cord injuries.
3. Students will then work with a partner to research possible experimental treatments that are now being used with spinal cord injuries. They will have to compare and contrast the two and then explain the benefits as well as the shortfalls of each.

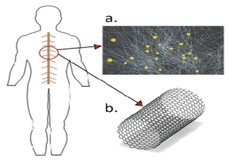


Figure 1 There are several approaches to treating spinal cord injury. A few common approaches include (a) using nanoparticles as drug delivery systems (yellow), self-assembling peptides to form nano bers thus creating a scaffold to promote regeneration, and (b) carbon nanotubes, which offer favorable conductive and material properties for SCI.

Day 4:

Guest speaker who is paralyzed from the waist down speak about her injury and what life is like for her now

Day 5:

1. Guest speaker from UCF, College of Sports Medicine, to show the students how to backboard and also rehab someone with a spinal cord injury

Day 6:

1. The students will answer a few post activity questions which will consist of 2 or 3 questions from each of the activities. In addition, they will have to write a 5 sentence summary of their learning

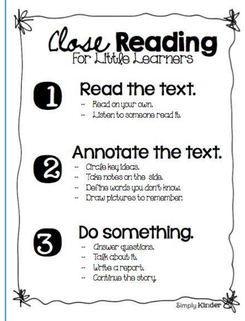
.

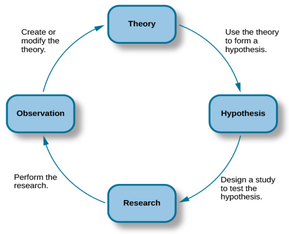
Misconceptions that the students may have:

1. That only metal can be a good conductor of electricity
2. That a broken back automatically means that you will be paralyzed
3. That there are no new treatments that are being studied for possible treatment of spinal cord injuries
4. That every experiment that you do will always work exactly as expected
5. That scientists work alone and in isolation in their labs
6. That there is nothing that might ever be able to be used to bridge the gap of a severed spinal cord
7. That just because you are paralyzed you are not able to do the things that "normal" people are able to do
8. That there is no way they could ever read a scientific journal article and understand any of it or take away any knowledge from the article

Implementation Strategies

1. Inquiry lab
2. Cooperative groups
3. Closed reading
4. Think /pair/ share
5. Questioning
6. Modeling





Acknowledgments

RET Site: COMET Program, College of Engineering and Computer Science, University of Central Florida. This content was developed under National Science Foundation grant EEC-1611019.

References

P.M. Chaudhari*, S.C. Daswadkar , Dr.P.V.Kasture (2009). A review of carbon nanotube: Boon to osteoporosis. Journal of Pharmacy Research 2009, 2(8),1179-1183.

Rodolfo Amezcua, Gina Vimbela and David A Stout (2017). Nanomaterials for Spinal Cord Injury Recovery. iMedPub Journals, 3, 1:3. DOI: 10.21767/2471-8173.10003

Hong-Sun Ahn, Ji-Young Hwang, Min Soo Kim, Ja-Yeon Lee, Jong-Wan Kim, Hyun-Soo Kim, Ueon Sang Shin, Jonathan C. Knowles, Hae-Won Kim, Jung Keun Hyun. (2015). Carbon nanotube-interfaced glass fiber scaffold for regeneration of transected sciatic nerve. Acta Biomaterialia 13, 323-334.