

## Lesson Plan for Understanding Regenerative Medicine

### Overview

This curriculum has been developed to help students construct their own understanding of regenerative medicine and stem cells by working in collaborative groups of three or four. Parts 1 to 5 have been adapted from Unit IV: Regenerative Medicine of *RX for Science Literacy* by the North Carolina Association for Biomedical Research (NCABR) which provides an overview of regenerative medicine, alignment with North Carolina’s Essential Standards, background information, and lesson plans. The University of Utah’s Learn Genetics web site is also an excellent resource. Part 6 was adapted from worksheets and activities found at The Biology Corner, as well as HHMI’s Biointeractive Educational Materials. Part 7 is an adaptation from the lesson plan “Endlessly Beating” linked to “The Mysterious Human Heart”, a series by David Grubin.

### Quick Links

Unit IV: Regenerative Medicine <a href="#">RX for Science Literacy</a> by NCABR	<a href="http://www.ncabr.org/downloads/curricula/rxManual/chapter_regenerativeMedicine.pdf">http://www.ncabr.org/downloads/curricula/rxManual/chapter_regenerativeMedicine.pdf</a>
The Biology Corner	<a href="http://www.biologycorner.com">www.biologycorner.com</a>
HHMI’s Biointeractive Educational Materials	<a href="http://www.hhmi.org/biointeractive">http://www.hhmi.org/biointeractive</a>
What is Spina Bifida? by <a href="#">Spina Bifida Association</a>	<a href="http://www.spinabifidaassociation.org/atf/cf/{85F88192-26E1-421E-9E30-4C0EA744A7F0}/What%20is%20Spina%20Bifida.pdf">http://www.spinabifidaassociation.org/atf/cf/{85F88192-26E1-421E-9E30-4C0EA744A7F0}/What%20is%20Spina%20Bifida.pdf</a>
Regenerative Medicine presentation	<a href="#">Regenerative Medicine</a>
WFIRM website	<a href="http://www.wakehealth.edu/WFIRM/">http://www.wakehealth.edu/WFIRM/</a>
Dr. Anthony Atala’s TED talk, Mar. 2011	<a href="https://www.ted.com/talks/anthony_atala_printing_a_human_kidney">https://www.ted.com/talks/anthony_atala_printing_a_human_kidney</a>
“Organ Bioprinting”, ABC Australia	<a href="http://www.abc.net.au/catalyst/stories/3618385.htm">http://www.abc.net.au/catalyst/stories/3618385.htm</a>
Tissue Engineering Activities	<a href="#">Tissue Engineering Activities</a>
Learn.Genetics: Stem Cells	<a href="http://learn.genetics.utah.edu/content/stemcells/">http://learn.genetics.utah.edu/content/stemcells/</a>
Stem Cell WebQuest	<a href="#">Stem Cell WebQuest</a>
NIH Stem Cell Information	<a href="http://stemcells.nih.gov/info/basics/Pages/Default.aspx">http://stemcells.nih.gov/info/basics/Pages/Default.aspx</a>
Tissue Regeneration in Animals	<a href="http://www.hhmi.org/biointeractive/tissue-regeneration-animals">http://www.hhmi.org/biointeractive/tissue-regeneration-animals</a>
“Endlessly Beating” Lesson Plans	<a href="http://www.pbs.org/wnet/heart/educators/activity-endlessly.html">http://www.pbs.org/wnet/heart/educators/activity-endlessly.html</a>
Recipient Case Study Cards	<a href="http://www-tc.pbs.org/wnet/heart/educators/CaseStudyCards.pdf">http://www-tc.pbs.org/wnet/heart/educators/CaseStudyCards.pdf</a>
Planaria Activities	<a href="#">Planaria Observation and Lab</a> <a href="#">Planaria Data Form</a>

**Part 1: Case study from NCABR – Teacher Notes**

Students will read paragraph 1 of “Healing Promise” on page [Unit IV-4.5 of RX for Science Literacy](#) and create two lists.

What do you know? (Facts provided in the case study.)	What do you need to know? (What questions do you have?)

Items that might be found on the “Facts” list:

1. Luke Massella was born with spina bifida
2. He could not play outside because he was very ill.
3. His bladder was paralyzed, which lead to kidney damage.
4. Luke received a new bladder.
5. The bladder was grown outside his body.
6. Techniques of regenerative medicine were used.
7. Luke became healthier.
8. Luke’s doctor was Dr. Anthony Atala of WFIRM in Winston-Salem, NC.

Items that might be found on the “Questions” list:

1. What is spina bifida?
2. What is regenerative medicine?
3. How are kidneys grown outside the body?
4. What is WFIRM?

Once the lists have been created, lead the students in a discussion of what each group has included in their lists. Groups may add or remove items from their lists as desired.

**Part 2: Answering the questions – Teacher Notes**

1. What is spina bifida? Read the information found at <http://www.spinabifidaassociation.org/atf/cf/{85F88192-26E1-421E-9E30-4C0EA744A7F0}/What%20is%20Spina%20Bifida.pdf>.
2. What is regenerative medicine? Read paragraphs 3 and 4 on pages [Unit IV-4.5 to 4.6](#) or use the [Regenerative Medicine](#) slide show presentation.
3. What is WFIRM? Read and watch the videos found at <http://www.wakehealth.edu/WFIRM/>, Dr. Anthony Atala’s TED talk at [Anthony Atala: Printing a human kidney | Talk Video | TED.com](#) or the ABC Australia news report at <http://www.abc.net.au/catalyst/stories/3618385.htm>.
4. How are kidneys grown outside the body? Read “Background Science” on pages [Unit IV-4.6 to 4.12](#) or use the [Regenerative Medicine](#) slide show presentation.

### **Part 3: Discovering the Scaffolding of Tissue – Teacher Notes**

Use the Lesson Plans found on pages [Unit IV-4.19 to 4.23](#). [Tissue Engineering Activities](#) provide discovery activities that help students build their understanding.

### **Part 4: Building Better Tissue – Teacher Notes**

Lesson Plans found on pages [Unit IV-4.2.4 to 4.30](#) include a lab for creating “Alginate Worms”. [Tissue Engineering Activities](#) provide discovery activities that help students build their understanding.

### **Part 5: Stem Cells – Teacher Notes**

Lesson plans for creating a commercial to explain stem cells is found on pages [Unit IV-4.31 to 4.40](#). Teachers may use the [Regenerative Medicine](#) slide show presentation. Alternatively, students may explore on their own using a [web quest](#) based on the University of Utah Health Science’s web site “[Learn.Genetics: Genetic Science Learning Center](#)”.

### **Part 6: Regeneration in Planaria – Teacher Notes**

Planaria are a small, flat worm used to demonstrate regeneration and stem cell function in the classroom. Containers of 25 to 30 planaria can be purchased from Carolina Biological (Item #132950) for \$8.95. Allow a week to receive the planaria. Care instructions will be provided with the shipment.

The planarian section containing the photoreceptors regenerates quickly; the tail is much slower. Consider regeneration complete when the tail section reacts negatively when exposed to light, usually within a week.

Materials needed:

Planaria – 1 per group of 2 or 3 students  
Small, plastic petri dish or other small container  
Soft bristle paint brush (used to gently move the planaria)  
Spring water (not distilled or tap water)  
Transfer pipet  
Ruler

Begin with an introduction to animal regeneration by reading and viewing HHMI Biointeractive Click and Learn “[Tissue Regeneration in Animals](#)”.

Follow the introduction with a lab on planaria regeneration. [Student instructions](#) and [data sheets](#) provide the information students need for planaria regeneration.

## Part 7: Organs ‘R Us – Teacher Notes

As a final project for the Unit, student groups are to develop a plan to regenerate a new organ. Each group is provided a [recipient case study card](#) describing a patient in need of an organ transplant. (Teachers may create additional groups and cards, if needed.) Students use the information found on the card as well as the information learned in this unit and any additional information needed to design an engineered organ for the patient. As a group, the students should decide the best type of scaffold, what cells are needed and the source(s), as well as environmental factors needed to support growth. They also need to consider whether to create a whole new organ or just part of an organ. The product can be a slide show presentation, detailed drawing with annotations, or any other method that demonstrates appropriate understanding.

### **Acknowledgements**

*This curriculum was developed by Terry Howerton of [Atkins High School](#) and Melanie Stancil of [Davie High School](#) in collaboration with faculty and staff at the Wake Forest Institute for Regenerative Medicine, with funding support from [North Carolina New Schools](#).*