Lesson 1

Introduction to MRI | Unit Overview

As an introduction to biomedical engineering for middle school students, the interactive lesson plan will allow students to learn about magnetic resonance imaging machines (MRI) and its connection to biomedical engineering as a whole. The first lesson will cover the history of imaging devices, the early pioneers that contributed to the creation of MRI, and how MRI works on a physical level.

Recommended Grade Levels: 6-8

Learning Objectives:

- Discuss characteristic properties of nuclei under magnetic fields
- Describe technological and scientific advancements that enabled MR technology
- Describe in terms of waves how the gradient magnetic field encodes and manipulates signals during MRI.

Lesson Approaches:

The materials and group setups used for the lesson can vary based on three approaches. Each approach uses the interactive online lesson with worksheets and a Google Form available. Supplemental materials and assessments are available for teachers and students to expand on each lesson.

Lecture approach: A lecture style class session that uses one device to show the students the interactive lesson and a correlated worksheet for each student. A Google Form can also be answered as a whole class to both assess and discuss what the students have learned.

Materials used:

- A computer with internet access
- A large screen to project to the class
- A worksheet or access to Google Form for each student

Small group approach: A cooperative student learning approach that organizes the class into small groups, each with their own device to learn from the interactive lesson and fill out a worksheet that highlights areas of focus in the lesson. A Google Form can also be used, either within those groups or as a whole class, to elicit engagement and discussion.

Materials used:

- A computer with internet access for each group of several students
- A worksheet or access to Google Form for each student or group

Individual approach: An individual learning approach that allows students to engage with the interactive lesson at school or at home, answering questions on a worksheet along the way. This approach may be supported with classroom discussions after each lesson.

Materials used:

- A computer with internet access for each student, either a school computer or personal computer at home
- A worksheet or access to Google Form for each student

Activities:

Individual	Small Group	Whole Class
Draw and label a timeline for the years discussed in the lesson, explaining the importance of each point.	Each person in the group chooses a pioneer in imaging technology or an important event in the history of imaging. Every student should write bullet points about why their topic is important and share with the others.	Students should cooperate as a class to make a list of the most important points of the lesson plan. They should include: pioneers, what MRI is, and how MRI works on a particle level.
Write out a paragraph or list explaining the history of MRI and the early pioneers in imaging technology.	**Requires:** Computer with internet for each group **Link:** https://phet.colorado.edu/sims/cheerpj/mri/latest/mri.html?simulation=mri Each group of students should interact with the website together, exploring what each option does. Try switching tabs to "Simplified MRI" and noting the difference when switching between 0 tesla and 3 tesla on the right side slider.	Overview what the students have learned in a class discussion. Discussion questions should be consist of: - Who invented the MRI machine? - What does MRI do? - How does MRI work on a physical level?

Resources:

- Worksheet: [PDF]

Supplemental Videos

Small videos that may help teachers and students establish a basic understanding of the lesson topics.

History of Medical Imaging:

- https://youtu.be/gsV7SJDDCY4: history of the X-Ray
- https://youtu.be/L0KqrHPp5Gg: history of scientists involved with the development of MRI

Particle Physics:

- https://youtu.be/nFkBhUYynUw: components and basic physics
- https://youtu.be/1CGzk-nV06g: particle physics I (NIBIB)
- https://youtu.be/jLnuPKhKXVM: particle physics II

Supplemental Reading:

Glover G. H. (2011). Overview of functional magnetic resonance imaging. *Neurosurgery clinics of North America*, *22*(2), 133–vii. https://doi.org/10.1016/j.nec.2010.11.001

Haacke, E. M., Brown, R. W., Thompson, M. R., & Venkatesan, R. (1999). *Magnetic resonance imaging: Physical principles and sequence design*. John Wiley & Sons.

Lauterbur, P. C. (1973). Image formation by induced local interactions: Examples employing nuclear magnetic resonance. *Nature, 242*, 190-191.

Mansfield, P., & Grannell, P. K. (1973). NMR 'diffraction' in solids? *Journal of Physics C: Solid State Physics, 6*(22), L422.

National Institute of Biomedical Imaging and Bioengineering. (n.d.). Magnetic Resonance Imaging (MRI). https://www.nibib.nih.gov/science-education/science-topics/magnetic-resonance-imaging-mri

Nishimura, D. G. (2010). *Principles of magnetic resonance imaging*. Stanford University.

NobelPrize.org. (2003). The Nobel Prize in Physiology or Medicine 2003. [Website]. https://www.nobelprize.org/prizes/medicine/2003/summary/

RadiologyInfo.org. (n.d.). How does MRI work? [A patient-friendly resource from the Radiological Society of North America (RSNA) and the American College of Radiology (ACR)]. https://www.radiologyinfo.org/