Lesson 1

Introduction to MRI | NGSS Standards

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
NGSS Standards in Lesson: MS PS 1-4, MS PS 4-2

In this lesson focusing on how MRI machines work, students will delve into the fundamental principle of nuclear magnetic resonance (NMR) and its relevance to MRI. This directly connects with the PS1.A standard, engaging students in discussions about the distinct properties of matter (specifically nuclei) within defined conditions. The lesson then progresses to exploring the significance of potent magnetic fields in MRI and their influence on the hydrogen nuclei within the human body. This aligns with the PS1.A standard as well, prompting students to articulate the interplay between matter (hydrogen nuclei) and magnetic fields. Next, students will be introduced to the concept of radiofrequency (RF) pulses and their pivotal role in the MRI process. This segment aligns with the PS1.B standard, fostering conversations about how substances (hydrogen nuclei) behave when subjected to varying conditions (RF pulses). The discussion continues by delving into the intricacies of relaxation and its role in generating signals that contribute to image creation. Here, alignment with the PS1.B standard is evident, as students grasp how substances (hydrogen nuclei) undergo transformations, yielding new entities (signals) with distinct properties. Lastly, the lesson explicates the function of gradient magnetic fields in spatially encoding signals to produce intricate images. This alignment extends to the MS-PS4-2 standard, which underscores the interaction of waves with materials. In the MRI context, gradient magnetic fields simulate wave behavior, encoding and manipulating signals to facilitate the imaging process.

NGSS Standard	NGSS Performance Expectation	Lesson Alignment Criteria
MSPS1-4	Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. MS-PS1-4	- Discuss characteristic properties of nuclei under magnetic fields - Describe the interaction of hydrogen nuclei with magnetic fields - Discuss behavior of hydrogen nuclei under different conditions (RF Pulses)
MSPS4-2	Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. MS-PS4-2	- Describe in terms of waves how the gradient magnetic field encodes and manipulates signals during MRI.

Lesson Performance Expectation:

- Students should be able to describe how the properties of hydrogen nuclei within the body facilitate the process of imaging in MRI.
- Students should be able to describe how the gradient magnetic field alters the magnetic field to produces an electrical signal that can be measured by the MRI machine