Lesson Title: Robot Arm Lab

Description: Students will create a physical model of the arm and arm muscles to demonstrate flexion and extension of the arm at the elbow and the wrist using Robot Diaries Kit.
Subject: Biology/Anatomy
Grade Level: 9th – 12th grade
Lesson Goals: Students will apply knowledge of muscles, bones, and attachments as they create a robotic arm model that moves in response to sensors (light or distance).
Lesson Time Requirements: 10 class periods (40 minute class periods)
Developed by Theresa Richards

Overview

This lesson would be conducted as part of a series of lab activities after the skeletal system and muscle system units are completed. Other lab activities completed by the student include *Dissection of a Bovine Long Bone* where they learn about macroscopic anatomical features such as the difference between spongy bone and compact bone. Students also dissect a chicken wing (or chicken arm) learning macroscopic features of skin, connective tissues (ligaments, tendons, adipose tissue, bone), and muscles. The new lab using Arts & Bots integrates new material about circuits, programming, and robotics with their knowledge of the anatomy of the arm.

Standards

PA Science Technology and Engineering Education Standards:

- BIO.A.1.2.2: Describe and interpret relationships between structure and function at various levels of biological organization (i.e., organelles, cells, tissues, organs, organ systems, and multicellular organisms).
- 3.1.12.A5: Analyze how structure is related to function at all levels of biological organization from molecules to organisms.
- 3.1.10.A8: Investigate the spatial relationships of organisms' anatomical features using specimens, models, or computer programs.
- S11.A.3.2: Compare observations of the real world to observations of a constructed model.
- 3.2.10.4: Describe quantitatively the relationship between voltage, current, and resistance to electrical energy and power.
- 3.4.10.C1: Apply the components of the technological design process.

NSES

- 3.3.12B Analyze the chemical and structural basis of a living organism
    - Evaluate relationships between structure and functions of different anatomical parts given their structure
- 3.6.12B Analyze knowledge of information technologies of process encoding, transmitting, receiving, storing, retrieving and decoding.
    - Apply and analyze advanced information techniques to produce a complex image ("model") that effectively conveys a message

Materials Required

- One computer for each student group
- One Hummingbird Kit for each student group
- One to two glue guns with 10- 12 glue sticks for student group
- Classroom Model Skeleton
- Scissors

Suggested craft supplies:

- Rubber bands (tendons)
- Corrugated Cardboard or foam core boards (bones)
- Foam ball (shoulder)
- Fabric/material (muscle)
- Red Nylon Stockings (for muscles)
- Tape (white, red) (labels)
- Construction Paper – assorted colors
- Markers - Fine point sharpies
- Craft sticks
- Fishing Line / Thread
- Needles
- White all-purpose tying twine (low-stretch)
- Styrofoam cups and bowls
- Repurposed containers that held food items
- Cardboard tubes
- Brass brads

Class Outline

Complete Pre Art & Bots Survey *(half class session)*

Part 1: Introduction to Robotics

(*one or two class sessions*)

1) What is a robot?
    i) Be able to identify a robot and its functions
    ii) Be able to distinguish between an autonomous and a tele-operated robot.
2) What is a sensor?
    i) Be able to identify a sensor and its functions
3) What is an electric circuit?
    i) Be able to create a complete electric circuit using wires, a battery, and a light bulb.
4) Identify the components of the Robot Diaries Kit.
    i) Be able to identify the components and their functions.
    ii) Be able to identify the parts of the Hummingbird board.
5) Students will use the Hummingbird compatible software to program their robotic model
    i) Install the Hummingbird software onto student laptops.

Part 2: Making the model

Creating this model will allow students to apply their knowledge of the names of muscles, locations of muscles, the attachments, and functions.

1) Creating the table of muscles. (*one class session*)
   a) Determine the muscles involved in flexion and extension of the arm at the elbow
      i) Include name, attachments (origin, insertion), and function.
   b) Determine the muscles involved in flexion and extension of wrist
      i) Include name, attachments (origin, insertion), and function.
   c) Muscles to consider including:
      i) Brachialis
      ii) Brachioradialus
      iii) Biceps brachii
      iv) Triceps brachii
      v) Deltoid
      vi) Extensor carpi ulnaris
      vii) Flexor carpi radialus

2) Using the provided craft materials make the models of the bones and muscles which are capable of being repositioned (*two class session*)
   a) Create the components of the model: the humerus, radius, ulna, wrist, hand using the above materials.
   b) Students may find and include images of real anatomic parts for their model from the internet.

Part 3: Integrate the model with the Art & Bots Kit

Set up the model of the bones, muscles and attachments.

1. Using hot glue attach the modeled anatomical parts to the motors, servos, and foam board background. (*three – four class sessions*)
   A. Include LED(s)
   B. Include at least 1 sensor
   C. Include at least 2 servos
      i. Set up the servo correctly so you know the initial and final positions of the horn.
   D. Write the expressions for the motion
   E. Write the sequences for the motion.
   F. Combine sequences with counts and loops.
2. Teams demonstrate their models (*one class session*)

Complete the Post Arts & Bots Surveys (*half class session*)

Rubric for Assessment

Robot Diaries Arm Lab Rubric

CONTENT/POINTS	5	4	3	2
Chart of Arm Muscles (2)	All 10 arm muscles included. All origins, insertions, functions are correct.	8 arm muscles included. All origins, insertions, functions are correct.	6 arm muscles included. All origins, insertions, functions are correct.	4 arm muscles included. All origins, insertions, functions are correct.
Muscles on the model (2)	10 arm muscles are placed on the model.	8 arm muscles are placed on the model.	6 arm muscles are placed on the model.	4 arm muscles are placed on the model.
Accuracy of attachments of muscles (2)	All attachments are labeled correctly and legibly	Between 1 and 3 errors in attachment labels	Between 4 and 6 errors in attachment labels	Greater than 6 errors in attachment labels
Accuracy of models of bones (1)	All bones are labeled correctly and connected correctly	One bone is mislabeled	2 bones are mislabeled	There are no correctly labeled bones
Functionality of the sensors (1)	1 sensors is included and it functions	1 sensor is included and it does not function	2 sensors but they do not function	No sensors
Functionality of model (2)	Model demonstrates 5 or more motions including both extension and flexing of the arm and wrist	Model demonstrates 4 motions including both extension and flexing of the arm and wrist	Model demonstrates 3 motions including both extension and flexing of the arm and flexing or extending of the wrist	Model demonstrates 2 one extension and and one flexing of the arm or wrist
50 points possible				