

Jumping Into BEAM

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Adapted from: A Handful of Fun! by Stephanie Huang and Soumita Boseby, Fall 2017

Field(s) of Interest: anatomy, physiology, musculoskeletal system

Brief Overview:

In this lesson, mentees will be introduced to BEAM and learn about how the musculoskeletal system helps us move.

Agenda:

- Introduction (5 min)
- Module 0: Name Game (10 min)
- Module 1: Let's Move It (10 min)
- Module 2: Aesthetic Prosthetic (25 min)
- Module 3: Vitamin B(eam) (5 min)
- Conclusion (5 min)

Teaching Goals/Key Terms:

- Introduce BEAM and learn everyone's names!
- **Motion:** movement of a body or object
- **Bone:** forms the skeleton of the body
- **Muscle:** a bundle of tissues that are responsible for our movements
- **Joint:** areas that allow you to bend/stretch your body
- **Prosthetics:** a substitute for a missing body part
- **Engineering Design Process:** the repetitive process of trial and error that engineers use to improve their products
- **Vitamin D & Calcium:** nutrients that work together to build and keep bones strong

Mentor Development Goals:

- Utilize this week as trial and error.
- Develop a structure for the site each week.
- Get to really know the kids!

Mentor Development Notes

Written by Kyle

Name Game

For larger sites, be sure to stay within the time allotted for this module because there is a lot to do today! If necessary, consider splitting off into smaller groups and having a mentor lead the game for each of these groups. Also it's a great idea to create a written list of names to review at the end of site with the mentors so everyone remembers as many as they can.

Site Structure

As this is the first week of sites for the semester, it is important that you utilize this week to establish how a site will look like on a weekly basis. Make sure to have a discussion with your site leaders to talk about the organization of your site. For example, you can discuss which modules each mentor should lead during the lesson.

Accessibility

There are several barriers to students' learning, especially after over a full year of virtual learning. Some students may have learning disabilities; others have physical disabilities. It's important to reflect on how disability status can affect students' abilities to succeed in the classroom, especially given that we have a module in this lesson about prosthetics. Please make sure to be mindful of the things you say during site to make BEAM an accessible space for all our students and mentors.

General Notes for COVID-19 Precautions

Curriculum

The lessons this semester are designed to minimize contact between the mentees.

- For the **demonstrations**, make sure that the mentors are handling all of the materials and for the **hands-on activities**, each mentee will have individual materials.
- When handing out materials, wear gloves and have the mentors individually pass out materials to students to minimize contact.
- Make sure that you are aware of the classroom requirements for your site and follow the public health guidelines.
 - Maintain at least 3 feet of physical distance between students within the classrooms if possible.
 - Use hand sanitizer and Lysol wipes often to clean surfaces and shared materials.

Be sure to check the classroom notes for specific COVID-19 precautions for each module.

Background for Mentors

Module 1

- Motion
- Flexion/ extension
- Abduction/ Adduction
- Rotation

A skeletal muscle attaches to bone (or sometimes other muscles or tissues) at two or more places. If the place is a bone that remains immobile for an action, the attachment is called an origin. If the place is on the bone that moves during the action, the attachment is called an insertion. The triceps brachii happens to have four points of attachment: one insertion on the ulna and three origins (two on the humerus and one on the scapula).

The muscles surrounding synovial joints are responsible for moving the body in space. These muscle actions are often paired, like flexion and extension or abduction and adduction. Below the common terms are listed and defined, with animations to help you picture the muscles and joints in motion.

Flexion and extension are usually movements forward and backward from the body, such as nodding the head.

Flexion: decreasing the angle between two bones (bending).

Extension: increasing the angle between two bones (straightening a bend).

Abduction and adduction are usually side-to-side movements, such as moving the arm laterally when doing jumping jacks.

Abduction: moving away from the body's midline.

Adduction: moving toward the body's midline.

The gluteus medius, gluteus minimus, tensor fasciae latae, and sartorius are muscles that abduct the hip. The pectineus, adductor longus, adductor brevis, adductor magnus, and gracilis adduct the hip.

The triceps brachii and anconeus are muscles that extend the elbow. The biceps brachii, brachialis, and brachioradialis flex the elbow.

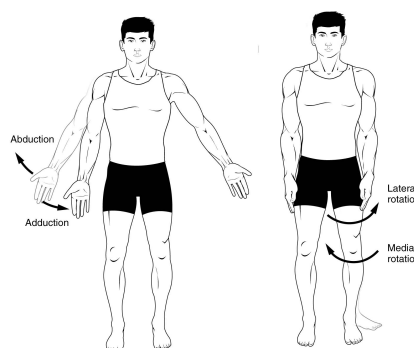


Figure 1: muscle motion, rotation

Module 2

- Bone
- Joint
- Muscle
- Prosthetics
- Engineering Design Process

The skeleton and **muscles** function together as the musculoskeletal system. This system (often treated as two separate systems, the muscular, and skeletal) plays an important homeostatic role: allowing the animal to move to more favorable external conditions. Certain cells in the bones produce immune cells as well as important cellular components of the blood. Bone also helps regulate blood calcium levels, serving as a calcium sink. Rapid muscular contraction is important in generating internal heat, another homeostatic function.

Although bones vary greatly in size and shape, they have certain structural similarities. **Bones** have cells embedded in a mineralized (calcium) matrix and collagen fibers. Compact bone forms the shafts of long bones; it also occurs on the outer side of the bone. Spongy bone forms the inner layer. Bones continue to change as adults, to adapt to the stresses generated by physical activity. Exercise can increase the diameter and strength of bone; inactivity can decrease them. Osteoporosis is a disease that primarily affects older, postmenopausal women. Increasing calcium intake, reducing excessive protein intake, and exercise are effective treatments for osteoporosis.

There are three types of **joints**: immovable, partly movable, and synovial. Immovable joints, like those connecting the cranial bones, have edges that tightly interlock. Partly movable joints allow some degree of flexibility and usually have cartilage between the bones; example: vertebrae. Synovial joints permit the greatest degree of flexibility and have the ends of bones covered with a connective tissue filled with synovial fluid; example: hip.

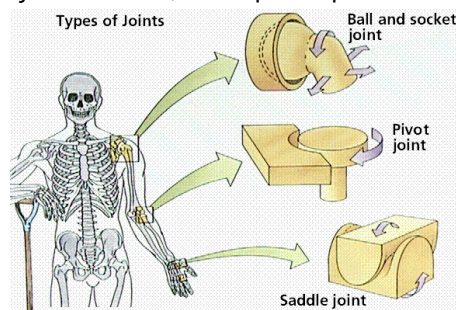


Figure 2: types of joints

A **prosthetic** is an artificial device that substitutes for a missing body part. These body parts may be lost for numerous reasons including trauma, disease, or injury. Prostheses can be modeled through CAD which allows for 2D and 3D graphics.

Module 3

- Vitamin D
- Calcium

Vitamin D is a group of fat-soluble hormones. The two major forms of vitamin D are vitamin D2 (or ergocalciferol) and vitamin D3 (or cholecalciferol). Vitamin D3 is produced in skin when exposed to ultraviolet B radiation.

Vitamin D is crucial for the maintenance of several organ systems.

- Vitamin D regulates the calcium and phosphorus levels in the blood by promoting their absorption from food in the intestines, and by promoting re-absorption of calcium in the kidneys.
- It promotes bone formation and mineralization and is essential in the development of an intact and strong skeleton.
- Vitamin D affects the immune system by promoting immunosuppression and anti-tumor activity.



Figure 3: the sun - a good source of vitamin D

Calcium is a mineral that is found mainly in the hard part of bones and teeth. Calcium's functions extend beyond keeping our bones strong and healthy. It also enables our blood to clot, our muscles to contract, and our heart to beat.

Each day we lose calcium through our skin, nails, hair, sweat, urine, and feces. Our bodies are unable to produce calcium, therefore, it is crucial that we obtain adequate consumption of calcium rich foods. In the event that calcium consumption is not meant, our body begins to extract calcium from our bones which can lead to detrimental effects such as bone breakage.

Introduction

<p>Concepts to Introduce</p> <ul style="list-style-type: none"> • Welcome the mentees to BEAM! Like today's lesson, we will be using actions and hands-on activities to learn about science. • The musculoskeletal system is a part of our body that helps us move. The system includes muscles, bones, joints, and more. • We will also connect these concepts of motion and musculoskeletal anatomy to the real-life application of prosthetics and have the students model motions of a hand. • In order to keep our bones strong, we need nutrients including vitamin D and calcium. 	<p>Current or Past Events</p> <ul style="list-style-type: none"> • Muscle health has been shown to be a leading indicator of health and longevity. <ul style="list-style-type: none"> ◦ https://health.usnews.com/wellness/fitness/articles/2018-09-12/muscles-many-powers • Prosthetics date back to ancient times and are also associated with pirates. • Ambroise Paré is the father of the modern prosthetic leg. • Athletes are using prosthetic legs to compete in the paralympic games. Now, prosthetics can also be controlled by your brain. <ul style="list-style-type: none"> ◦ https://www.bbc.com/news/topics/cq23pdqvrldwt/prosthetics • Our bones have evolved and our skeletons are malleable <ul style="list-style-type: none"> ◦ https://www.bbc.com/future/article/20190610-how-modern-life-is-transforming-the-human-skeleton
<p>Questions to Pique Interest</p> <ul style="list-style-type: none"> • How are we able to move? What parts inside of our body are used when we run, jump, write, and more? • How do your arms and legs bend? • How many bones does the human body have? • Has anyone ever broken a bone? • What are sources of vitamin D? How does drinking milk help grow our bones? 	<p>Inspiring Scientists, Careers, Applications</p> <ul style="list-style-type: none"> • Athletic Trainer: work to prevent and treat athletic injuries and provide rehabilitative services to athletes • Physical therapists help injured or ill people improve movement • Many different types of doctors and surgeons deal with the musculoskeletal system: orthopedic surgeons, hand surgeons, orthopedic oncologists, spine surgery, pediatric orthopedics, sports medicine • Forensic Science Technicians: investigate bones and human anatomy

Module 0: Name Game

Mentors will introduce the mentees to BEAM and play a name game.

Teaching Goals: <ol style="list-style-type: none">1. Introduce BEAM and learn everyone's names! <hr/> Tips for Virtual Sites <p><i>*written by MD, not applicable for every module*</i></p> <p>List and explain how to reinforce MD goals during the module.</p>	Materials <ul style="list-style-type: none">• none
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Procedure

1. Ask the mentees questions about BEAM. Here are some examples:
 - a. What is BEAM?
 - b. What does BEAM stand for?
2. Tell the mentees to think of a food they like that starts with the same letter as their name
3. Have the mentees say the name of their food + their name (eg. Cheeto Christine)
4. Go around in a circle and introduce yourselves!

Module 1: Let's Move It

Through a game of charades, students will be able to identify moveable joints and specific motions and learn about how the musculoskeletal system allows us to move.

Teaching Goals <ol style="list-style-type: none">1. Motion: movement of a body or object2. Common Types of Motion:<ol style="list-style-type: none">a. Flexion/extension: bend/stretchb. Abduction/Adduction: away/toward the bodyc. Rotation: a circular movement	Materials <ul style="list-style-type: none">• 10 flashcards• pen
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Procedure

1. Prepare different movements and write them on the flashcards **before** site (eg. running, throwing a baseball, etc.)
2. Have mentees volunteer to come up and choose a card (do not let the other mentees peek!)
3. The mentee will perform the action described by the card
4. Have the rest of the mentees guess what movement their peer is doing
5. After each card, ask mentees what types of movements they saw (eg. bending/stretching, rotation, etc.)
6. Repeat till cards run out.

Module 2: Aesthetic Prosthetic

Mentees will learn about the mechanism by which muscles control their bones to create motion. Through constructing a model of a human arm, mentees will also learn about bending at joints.

<p>Teaching Goals</p> <ol style="list-style-type: none"> 1. Bone: forms the skeleton of the body 2. Muscle: a bundle of tissues that are responsible for our movements 3. Joint: areas that allow you to bend/stretch your body 4. Prosthetics: a substitute for a missing body part 5. Engineering Design Process: repetitive trial and error to improve products <hr/> <p>Virtual Sites Alternate Activity</p> <ul style="list-style-type: none"> • Prosthetics Video • Ask mentees about what they think of the video and have a discussion 	<p>Materials</p> <ul style="list-style-type: none"> • Scissors • Tape • plastic straws (5 per student) • Popsicle stick (1 per student) • Cardboard (lots) • String (3 feet per student) • index card (5 per student) • Paper/ping pong (per site) • 2 paper cups (per site) • Video Link
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Procedure

1. Introduce the module by asking students what they think is going on inside their hands when we are moving our fingers.
2. Fold the index card over itself three times and secure it with tape (this is the finger).
3. Cut out pieces of straw and tape them onto the finger (*make sure there are spaces in between the straws so the fingers can bend*)
4. Loop a piece of string through the straws and tape the end of the string to the soft plastic/index to secure it in place
5. To create a “palm” for the hand, cut out a piece of cardboard and securely tape it to the top of the large popsicle stick.
6. Tape the fingers onto the palm.
7. Pull the strings to use the robot arm/prosthetic.
8. Have the mentees try out different tasks: pick up a paper ball and throw it in a paper cup, pick up a paper cup, and walk around with a paper ball
9. Split the mentees into two lines. Have mentees race and pass the paper ball down the line until it reaches the end. If the ball drops, the mentees have to start from the beginning.



Figure 1: Fingers taped on cardboard palm

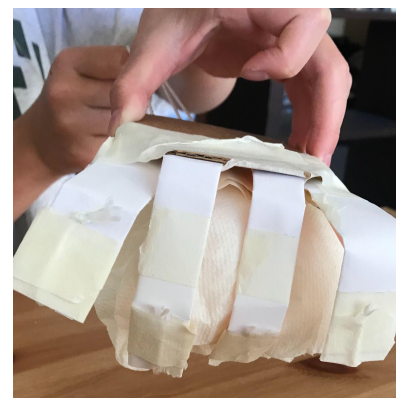


Figure 2: Picking up a paper towel ball

Module 3: Vitamin B(eam) — Optional

Mentees will learn about how to keep their bones healthy! Mentors will then have a short discussion with mentees on what foods contain vitamin D and calcium.

Teaching Goals <ol style="list-style-type: none">1. Vitamin D & Calcium: nutrients that work together to build and keep bones strong<ol style="list-style-type: none">a. Vitamin D is typically found in oily fish, red meat, liver, egg yolks, the sun, and more!	Materials <ul style="list-style-type: none">• none
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Procedure

1. Introduce bone health to the mentees. Ask them if they can think of any things they can do to keep our bones healthy and strong.
2. If they didn't already bring it up, talk about how eating foods rich in vitamin D and calcium help keep bones strong. Talk about foods that are good sources of vitamin D and calcium.
3. (for advanced sites/if time allows) Discuss with the mentees about what could happen if you do not keep your bones healthy.
4. Feel free to talk about your own experiences or any other knowledge you have about bone health!

Sample Answers:

1. *Eating foods rich in calcium and vitamin D, getting plenty of exercise (bones and muscle both become stronger with exercise), and having good health habits (don't smoke, minimize drinking alcohol)*
2. **Vitamin D sources:** egg yolks, saltwater fish, liver, milk with vitamin D, can also take nutritional supplements (Vitamin D helps our bodies absorb calcium and is mostly made under the skin in reaction to sunlight, but can also be found in foods); **Calcium sources:** milk, yogurt, cheese, paneer, sardines, spinach, tofu, cooked collards, bok choy, and kale, almonds, cooked beans, fortified cereals; other foods that can be important: fruits and vegetables
3. *Bones can become weak and break. Broken bones (fractures) can be painful and sometimes need surgery to heal. There are also long-lasting health problems, such as osteoporosis that make it easier for your bones to break.*

Conclusion

Our musculoskeletal systems include many parts that help us move around and more. Because of these systems, we are able to move around and do many of our everyday activities. Injuries, disease, and other processes that cause problems in the musculoskeletal system can cause pain, stiffness, and problems with motion. It is important that we protect our musculoskeletal system with healthy exercise and nutrients like vitamin D and calcium.

References

- Robot Finger, Mystery Science
https://mysteryscience.com/body/mystery-1/muscles-skeleton/59?utm_source=pinterest&utm_medium=social&utm_create=robot-finger&s=ad%3Apinterest-primary-robot-finger&o=ad%3Apinterest-primary-robot-finger&pp=1&epik=dj0yJnU9NTNucENWSmJoVWExaXJOeThIRThaN08wNms0MzdhdhOXlmcD0wJm49OERuU2ZPTIZxVmJSXzNUYIZnbFIZZyZ0PUFBQUFBR0RIZGN3&fbclid=IwAR26p17N-2z-HYXzKI6qALBOHbP1ykD7Roe5fqT9c4_pTqwi_mhnh2u9Tio#slide-id-1464
- Movable Joints Charade, American Heart Association
https://www.heart.org/idc/groups/heart-public/@wcm/@fc/documents/downloadable/ucm_306500.pdf
- Bone Health for Life, NIH
<https://www.bones.nih.gov/health-info/bone/bone-health/bone-health-life-health-information-basics-you-and-your-family#e>
- Bone Zone Calcium Worksheet, Dairy Foundation
<https://bcdairy.ca/uploads/bcdairy/Lessons/bonezone-calcium-activity-sheets.pdf>

Summary Materials Table

Material	Amount per Site	Expected \$\$	Vendor (or online link)
Plastic straws	5 per student		https://www.amazon.com/Colorful-Plastic-Disposable-Drinking-0-23diameter/dp/B085BZJQ87/ref=sr_1_14?dchild=1&keywords=straws&qid=1630388135&sr=8-14
Scissors	5 per site		
Cardboard	A lot		https://www.amazon.com/Juval-e-Corrugated-Cardboard-Sheet-5-Inches/dp/B07TFGJD8S/ref=sr_1_7?dchild=1&keywords=cardboard&qid=1630388379&sr=8-7
String	3 feet per student		https://www.amazon.com/Cotton-String-Cooking-Kitchen-Wrapping/dp/B07KVSVTVV/ref=sr_1_5?dchild=1&keywords=string&qid=1630388268&sr=8-5
Popsicle Stick	1 per student		https://www.amazon.com/Karlash-Jumbo-craft-sticks-length/dp/B077X293TJ/ref=sr_1_8?dchild=1&keywords=popsicle%2Bstick&qid=1630388645&sr=8-8&th=1
Paper or plastic cup	2 per site		https://www.amazon.com/Pack-White-Paper-Cups-Coffee/dp/B078RVYM9P/ref=asc_df_B078RVYM9P/?tag=hyprod-20&linkCode=df0&hvadid=242014065805&hvpos=&hvnetw=g&hvrandid=6293135024254245746&hvpon=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvllocphy=9032083&hvtargid=pla-407994083935&pssc=1
Index card	5 per student		