Be a Biomedical Engineer

Project:

Your assignment is to use recyclable materials to design an arm/hand or foot/ankle prosthetic prototype. Remember that a prototype is just your preliminary model. It is not going to look or function exactly like your final product would. A couple of questions to help guide you through your ask & imagine stages of the engineering design process are:

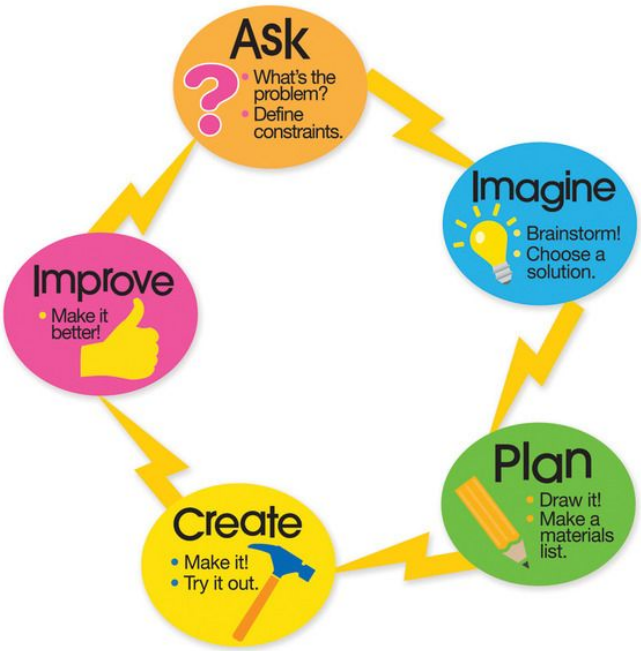
- How will you make it move and control the movements? Will it move?
- What would you want to study or look at to learn how the body parts move?
- What do you want the prosthetic to do? What is its basic function? Are there extra, special functions you want it to have?

Background Info:

Scientists analyze the way bones are shaped, how they fit together, and what features they have – these are called structural details. Scientists observe the different motions of the leg; where it bends, which direction it can rotate, and how far it can rotate – these are called functional details. The shape or structure of a bone gives it a particular motion or function – this is called a structure-function connection. Prosthetics are engineered body parts, made of structures that have a similar – or even better – function than the original body part.

Prosthetists and biomedical engineers study the human body, its structures, and functions and build machines that replace limbs that may have been lost to disease, accident, or due to genetics. These specialists want to help people who have lost limbs due to common diseases like diabetes, cancer, or because of environmental causes like car accidents. They get to learn about human biology, engineering, machines, and also robotics. Prosthetics used to be carved from wood – however, modern prosthetics are made with robotics specialists to create limbs that can connect to your brain and be moved by your thoughts. Prosthetists and biomedical engineers help people participate in a world built for people who can walk, grab, steer, and climb – when they might not be able to otherwise.

Engineering Design Process:



Engineers work together through the engineering design process. It is a cycle that not only helps scientists create a solution to a problem, but helps them work through testing their product and making improvements as necessary. It sometimes takes hundreds of "redo's", or making improvements and re-testing, before a product is ready for the public. Rarely do scientists get it exactly right on the very first try! So, don't give up!

Materials:

- Cardboard tubes
- Pieces of cardboard
- Two-liter soda bottles (cut in half)
- Fuzzy sticks/pipe cleaners
- Pieces of felt
- Pieces of foam
- Craft sticks
- String
- Rubberbands
- Straws
- Velcro
- Bandaging rolls
- Scissors
- Tape
- Markers

**These are just suggestions for your materials. Be creative and use miscellaneous items that you have around your home. What you want the structure & function of your prosthetic to be will help guide you to the materials you want to use for your prototype!

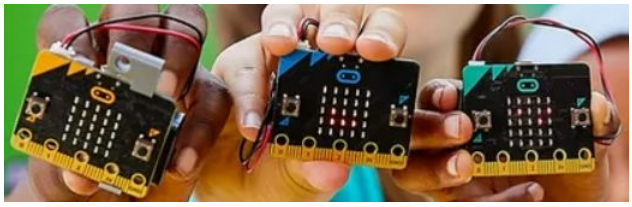
Directions:

Work your way through the engineering design process:

- You have been ASKed to design a prosthetic.
- Brainstorm and IMAGINE what you want your prosthetic to do and look like. Come up with as many ideas as possible. (see the Resources page at the end of this document for links & videos to help you understand the mechanics of joints, some basic anatomy/physiology of the wrist and ankle, and information on prosthetics)
- Now PLAN your prototype by drawing what you want your prosthetic to look like and list the materials you want to use.
- CREATE! Gather your materials and build your prototype.
- Test your prototype. Does it work/move the way you want it to? Make any IMPROVEments necessary to help your prototype function even better.

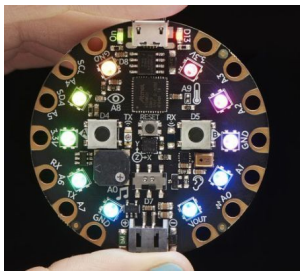
Extension Ideas:

Know how to code or want to learn some programming skills? These technology pieces can be incorporated and coded for specific functions for your prosthetic.

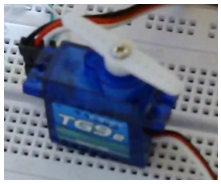
1. 

Code a microbit to be a built-in compass or temperature sensor.

2. Program a Circuit Playground Express to read your heart rate.

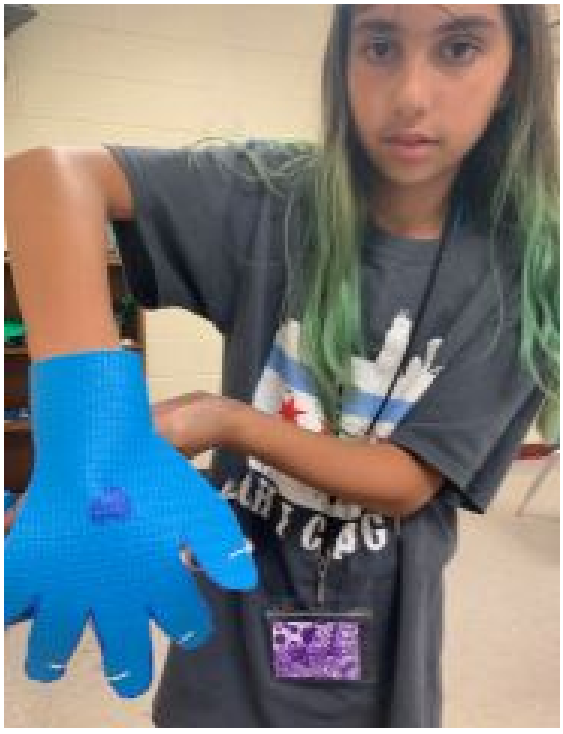


3. 



Code an arduino that would use micro servos to move parts of your prototype.

Check out photos of what some STEM summer campers created for their prosthetic prototypes:



Resources:

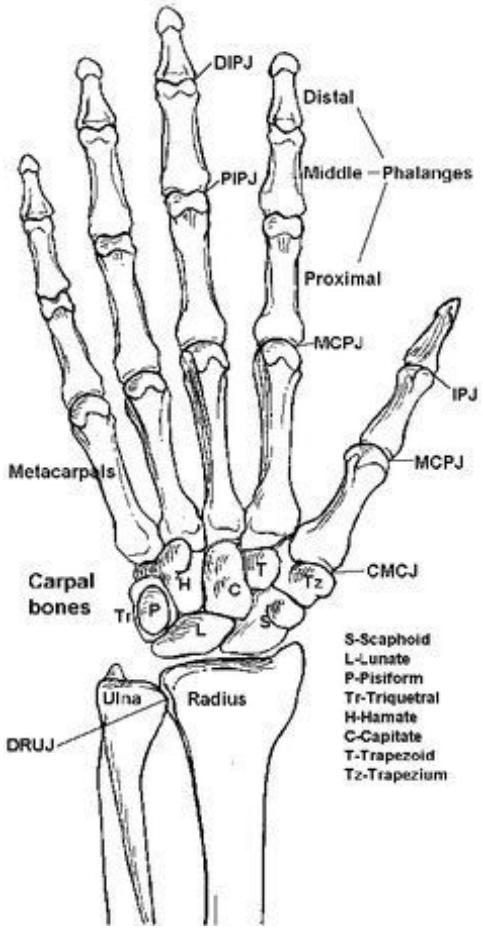
Skeletal System & Joints:
https://www.healthline.com/human-body-maps/skeletal-system
https://kids.kiddle.co/Anatomy
https://kids.kiddle.co/Skeleton
https://www.healthline.com/health/how-many-joints-in-human-body
https://bodytomy.com/joints-in-body
https://kidshealth.org/en/teens/bones-muscles-joints.html

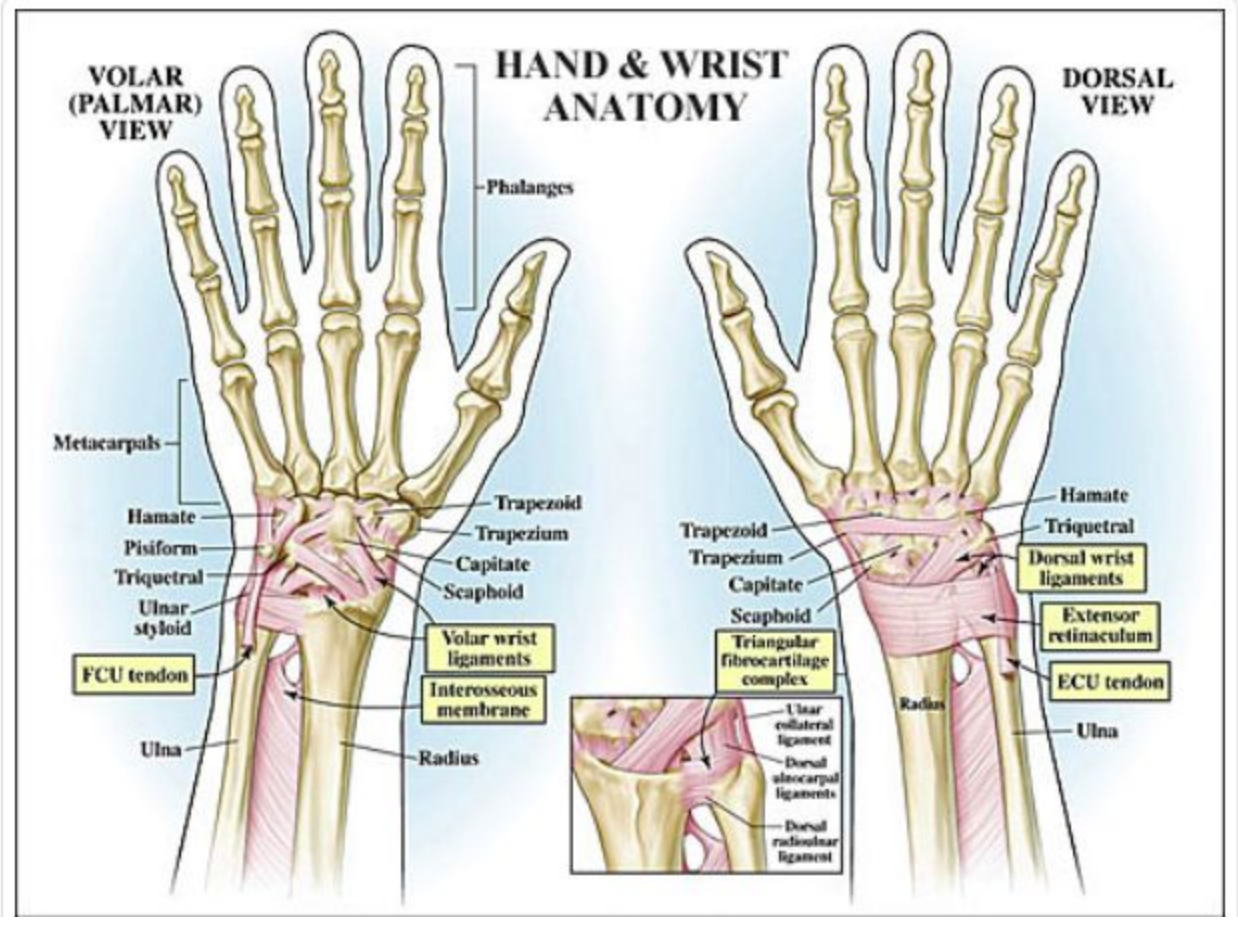
Prosthetics:
https://kids.kiddle.co/Prosthesis
http://kidsahead.com/subjects/19-prosthetics/articles
https://science.howstuffworks.com/prosthetic-limb.htm

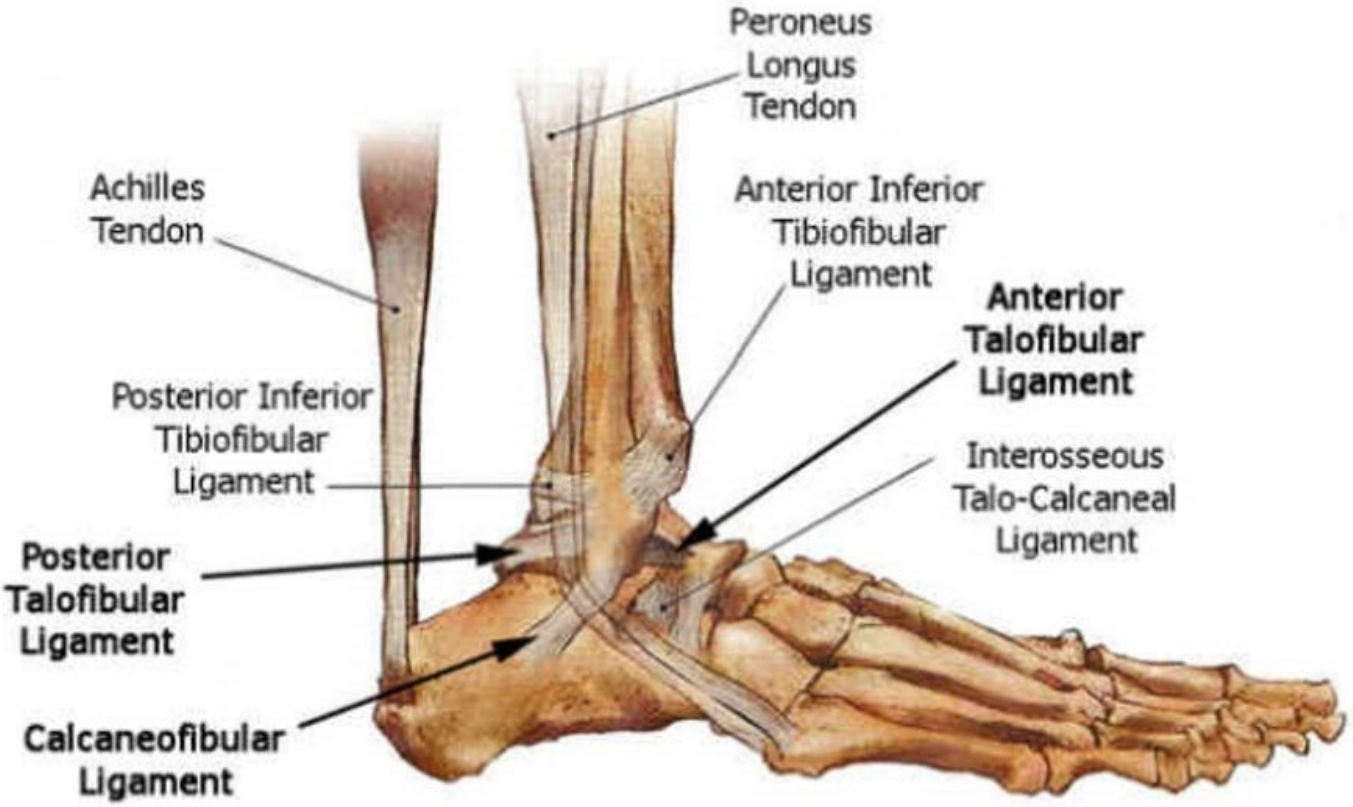
Videos:

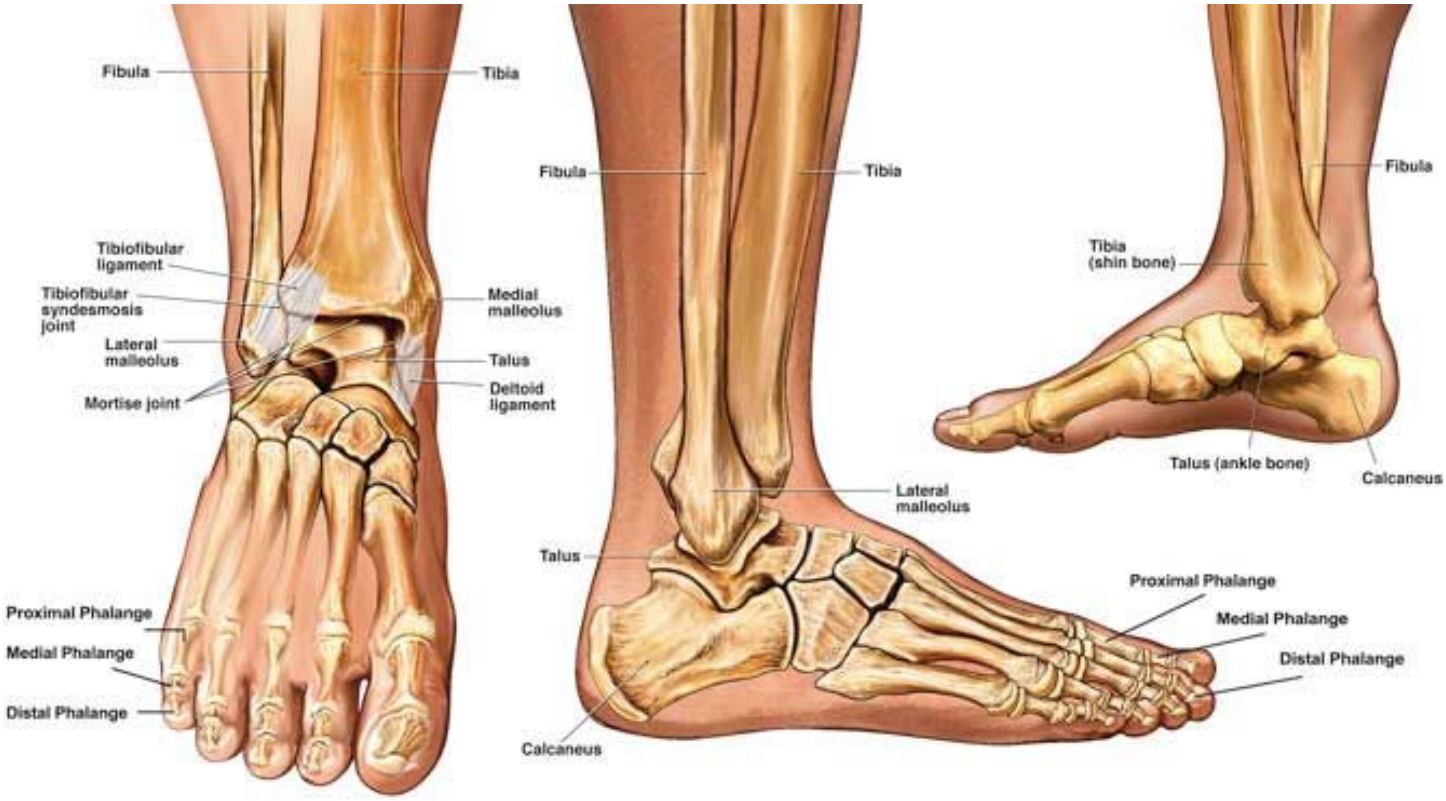
Skeleton & Joints:
Your Super Skeleton
What Are Joints Video

Prosthetics:
History of Prosthetics
3D Printed Prosthetic Hands
What's Inside a Prosthetic Leg?


DIPJ
Distal
Middle
Phalanges
PIPJ
Proximal
MCPJ
IPJ
MCPJ
Metacarpals
CMCJ
Carpal bones
Tr
P
H
C
T
Tz
L
S
Ulna
Radius
DRUJ
S-Scaphoid
L-Lunate
P-Pisiform
Tr-Triquetral
H-Hamate
C-Capitate
T-Trapezoid
Tz-Trapezium


HAND & WRIST ANATOMY
VOLAR (PALMAR) VIEW
DORSAL VIEW
Phalanges
Metacarpals
Hamate
Pisiform
Triquetral
Ulnar styloid
FCU tendon
Trapezoid
Trapezium
Capitate
Scaphoid
Volar wrist ligaments
Interosseous membrane
Ulna
Radius
Hamate
Triquetral
Trapezoid
Trapezium
Capitate
Scaphoid
Dorsal wrist ligaments
Extensor retinaculum
Triangular fibrocartilage complex
ECU tendon
Radius
Ulna
Ulnar collateral ligament
Dorsal ulnocarpal ligaments
Dorsal radioulnar ligament


Peroneus
Longus
Tendon
Achilles
Tendon
Anterior Inferior
Tibiofibular
Ligament
Anterior
Talofibular
Ligament
Posterior Inferior
Tibiofibular
Ligament
Interosseous
Talo-Calcaneal
Ligament
Posterior
Talofibular
Ligament
Calcaneofibular
Ligament


Fibula
Tibia
Tibiofibular
ligament
Tibiofibular
syndesmosis
joint
Lateral
malleolus
Mortise joint
Medial
malleolus
Talus
Deltoid
ligament
Proximal Phalange
Medial Phalange
Distal Phalange
Fibula
Tibia
Lateral
malleolus
Talus
Calcaneus
Proximal Phalange
Medial Phalange
Distal Phalange
Fibula
Tibia
(shin bone)
Talus (ankle bone)
Calcaneus