REHABILITATION ENGINEERING

ECE 331 – INTRODUCTION TO BIOMEDICAL ENGINEERING

Monday, November 22, 2024

WHAT IS REHABILITATION?

1. **Rehabilitation** is the action of restoring someone to health or normal life through training and therapy after imprisonment, addiction, or illness.
    - Example: "she underwent rehabilitation and was walking within three weeks"
2. **Rehabilitation** is the action of restoring something that has been damaged to its former condition.
    - Example: "the rehabilitation of the mangrove forests“
3. ~~**Rehabilitation** is the action of restoring someone to former privileges or reputation after a period of disfavour.~~
    - ~~Example: "a posthumous rehabilitation of the activist.~~

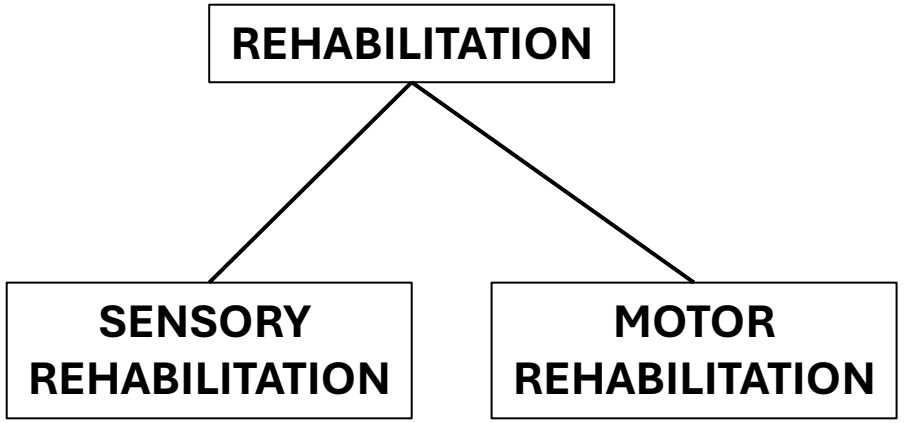
WHAT IS REHABILITATION ENGINEERING?

1. **Rehabilitation engineering** is the Application of science and technology to ameliorate the handicaps of individuals with disabilities.
2. **Rehabilitation technology** is the selection, design, manufacture and maintenance of augmentative or assistive devices that are appropriate for the individual with a disability.
3. **Assistive technology** is a term used for devices, equipment, and services that help people with disabilities or the elderly perform daily activities.

TYPES OF REHABILITATION

There are primarily two types of rehabilitation:

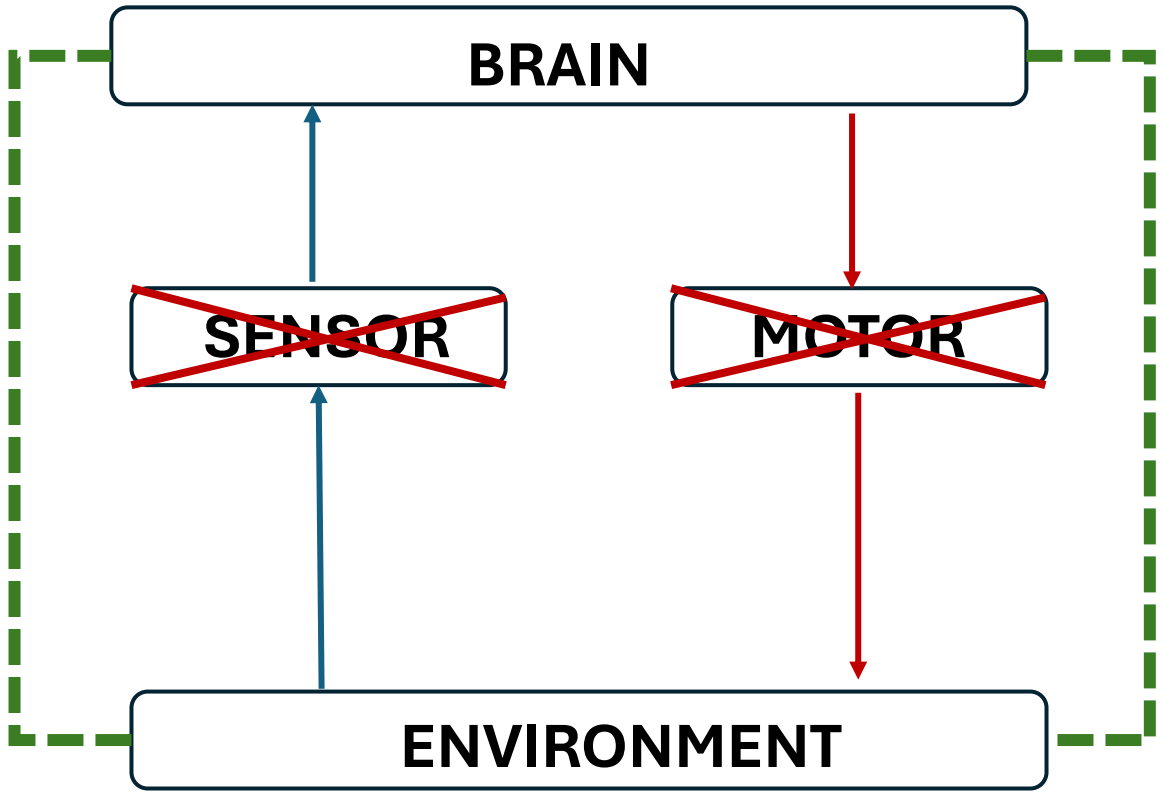
1. **Sensory rehabilitation** is done to restore the functionality of any of the **five senses**.
2. **Motor rehabilitation** which aims at **restoring mobility** to any part of the human body.



TYPES OF REHABILITATION

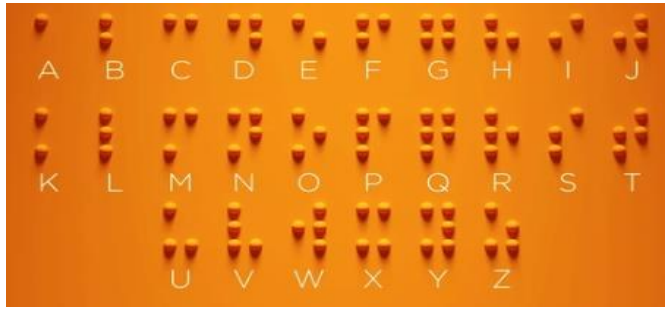
Rehabilitation can be classified into two types, i.e sensory or motor as follows:

1. **Sensory Rehabilitation** assists people with loss or impaired senses (hearing, vision, taste, touch, smell) by augmenting or substituting the sensory function.
2. **Motor Rehabilitation** assists people with loss or impaired mobility with mobility substitution devices such as wheelchairs or artificial limps.



SENSORY REHABILITATION

1. **Of the five traditional senses**, vision and hearing most define the interactions that permit us to be human.
2. **Vision and hearing** are the main input channel through which data with high information content can flow between the brain and the environment.
3. **Rehabilitation engineers** attempt to restore the functions of these senses through use of:
   a) **Sensory augmentation devices** which are technologies that enhance human abilities. Augmentation is used when some residual capacity remains. Eyeglasses and hearing aids are examples of augmentative devices
   b) **Sensory Substitution devices** help people with sensory impairments by converting information from one sense into another. For instance, sight can be substituted by hearing and vice versa.

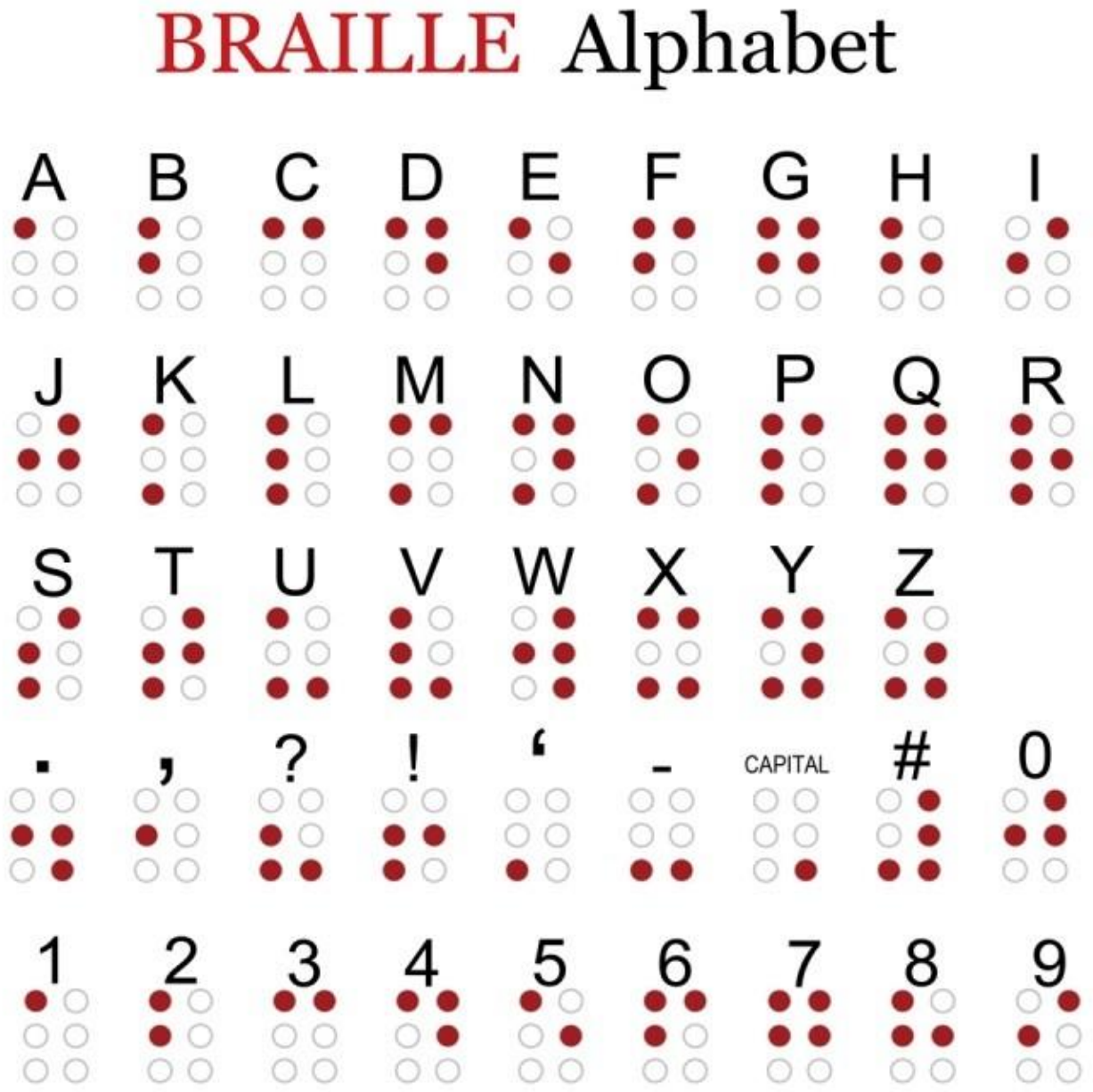


SENSORY REHABILITATION FOR VISION DISABILITY

1. **Vision sensory augmentation** presents an image of the scanned data directly to the visual cortex or retina via an array of implantable electrodes that are used to electrically activate nearby cortical or retinal structures. It assumes that other structures of the eye are fine and bypasses defective parts.
2. **Vision sensory substitution, for instance,** uses page scanning devices to converts the scanned image to text by using optical character recognition, and then outputs the text as speech via text-to-speech algorithms. Here vision is substituted by hearing. The same applies to braille.

SENSORY REHABILITATION FOR VISION DISABILITY-BRAILLE

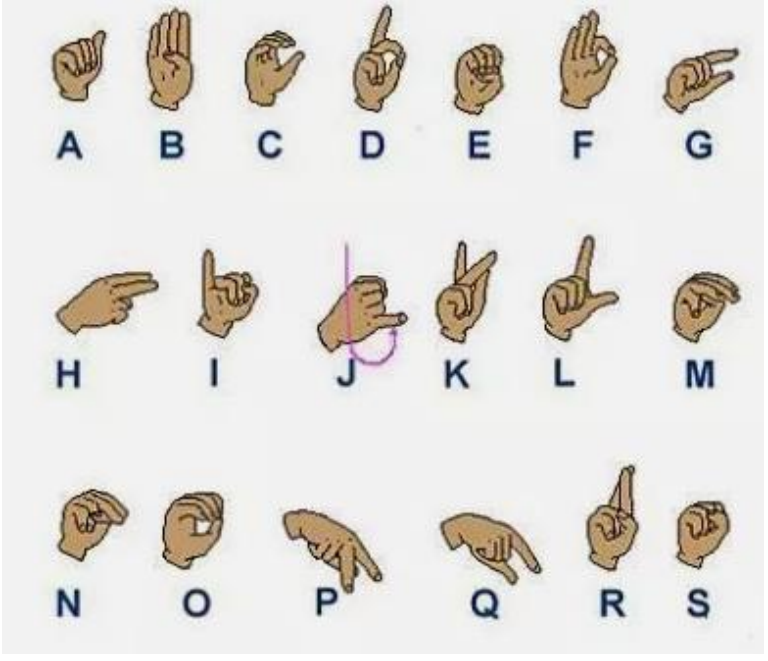
Hearing sensory substitution: Braille is a tactile writing system of raised dots that people who are blind or partially sighted can read by touch.



SENSORY REHABILITATION FOR HEARING DISABILITY

1. **Hearing sensory augmentation**: Hearing aids are now commercially available that can adaptively filter out background noise (a predictable signal) while amplifying speech (unpredictable)using autoregressive, moving average (ARMA) signal processing.

2. **Hearing sensory substitution**: Totally deaf individuals can use vision as a substitute input channel when communicating via sign language (also a substitute code),and can sign at information rates that match or exceed that of verbal communication.



MOTOR REHABILITATION

1. **Motor rehabilitation** is caried out to overcome mobility limitations which can severely restrict the quality of life of an individual.
2. **Motor rehabilitation** aims to reacquire lost movement skills through meaningful, repetitive, intensive, task-specific practice in an enriched environment.
3. **Motor rehabilitation** is often used for patients with physical impairments caused by strokes, fractures, lower-back pain, or age-related impairments.

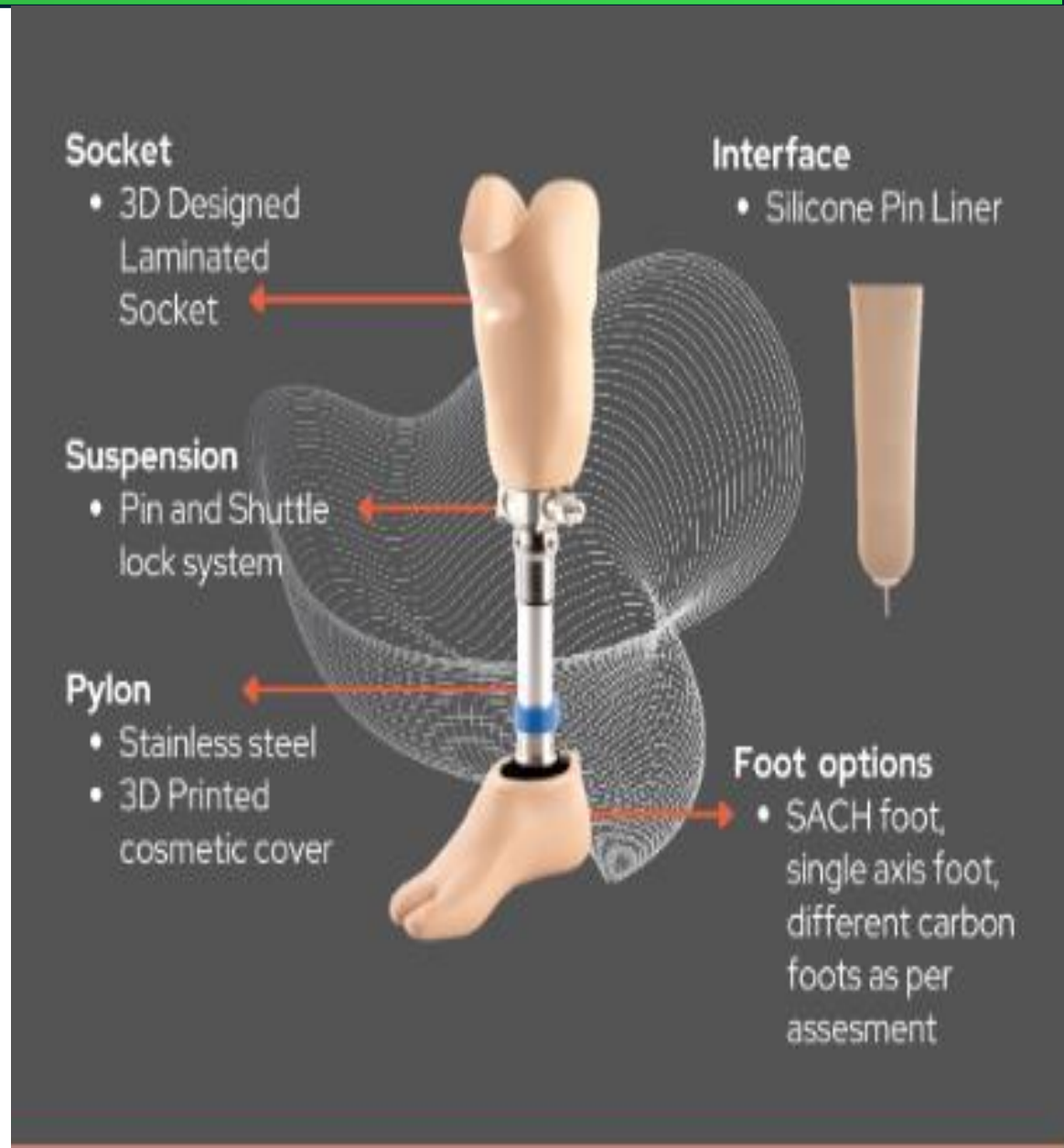
EXAMPLES OF MOTOR REHABILITATION DEVICES

1. **Wheelchair** is an example of a prosthesis which can restore mobility to people who cannot walk.
2. **A prosthesis** is an artificial replacement part for your body. **Prosthetic limb**, for instance, can assist a person without a limb to walk around.
   a) **Dynamically lockable knee joints** were designed for artificial limbs for above-knee amputees.
   b) **Artificial hands, wrists and elbows** were designed for upper limb amputees.
   c) **Bionic artificial arms** use electrical activity (myoelectric signals) generated by the muscles remaining in the stump to control the actions of the elbow, wrist and hand

PARTS OF LIMB PROSTHETICS

A limb prosthesis has FOUR main parts:

1. **Interface:** Although prosthesis can be directly attached to the body, most of the time it is attached by an interface made of various, thin cushion materials worn over the residual limb.
2. **Suspension** refers to how the prosthesis is held to the residual limb. Examples of suspension include vacuum, passive suction, belts and straps.
3. **Structural components** which include sockets, joints and connecting module (pylon).
4. **Appearance components** for aesthetic purposes.



PARTS OF LIMB PROSTHETICS: INTERFACE

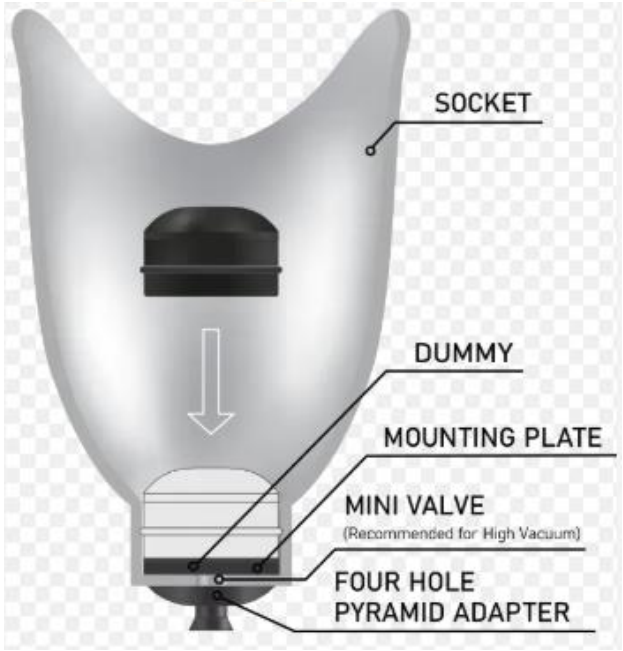
The interface between the residual limb and prosthesis can be gel or socks.

1. **Gel cushion interface** is worn over the residual limb. It protects the skin and helps even out pressures. Custom molded interfaces may be necessary for irregular residual limb contours (because of, for example, deep scars, sharp bones, or burns).
2. **Prosthetic sock** are made of wool, nylon, or synthetic fabrics, sometimes with gel sandwiched between the layers of fabric. Socks are available in different thicknesses (plies).

PARTS OF LIMB PROSTHETICS: VACUUM & PASSIVE SUSPENSION

The following prosthesis suspension systems are commonly used:

1. **Vacuum:** An electric or mechanical vacuum pump removes air from the socket.
2. **Passive suction:** When the residual limb is put in the socket, air is forced out. A seal above prevents air from reentering, creating suction. A one-way valve may be incorporated in the bottom of the socket to allow air out.

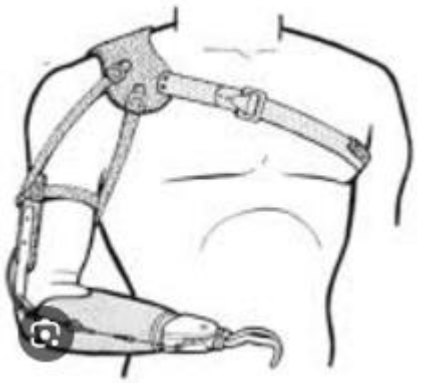


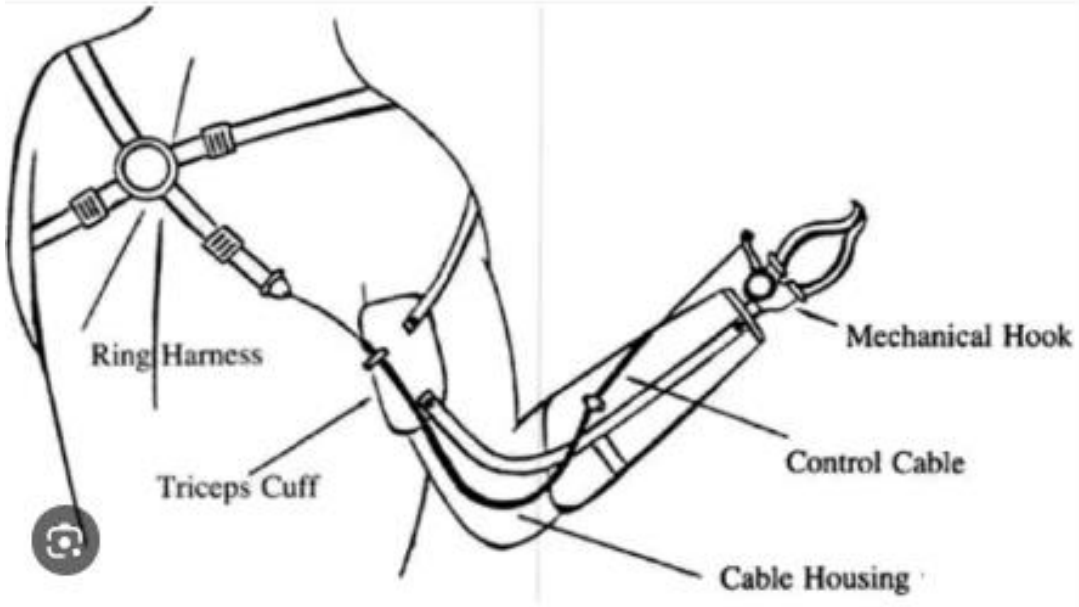
PARTS OF LIMB PROSTHETICS: LOCKING PIN & ANATOMICAL SUSPENSION

3. **Interface with a locking pin:** A cushion interface that has a removable, adjustable stainless steel suspension pin at the bottom is inserted into a locking mechanism in the bottom of the plastic socket. To remove the prosthesis, the person presses a release button to disengage the pin.
4. **Anatomical suspension:** Bumps at the ends of bones, such as at the knee, ankle, or elbow, can be used to help hold the socket to the body.

PARTS OF LIMB PROSTHETICS: BELTS & STRAPS SUSPENSION

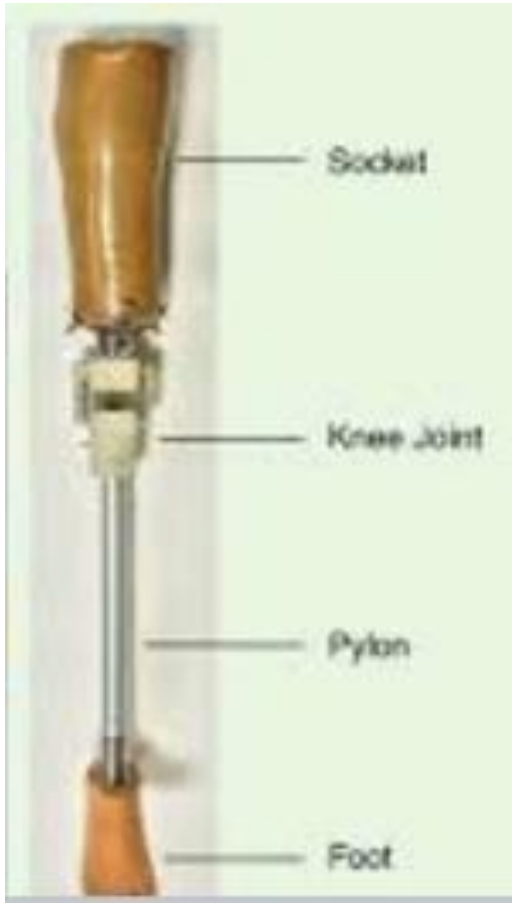
5. **Belts and straps:** A belt and/or straps may be used to hold the prosthesis on if the person cannot tolerate or finds the vacuum, suction, or pin systems too difficult





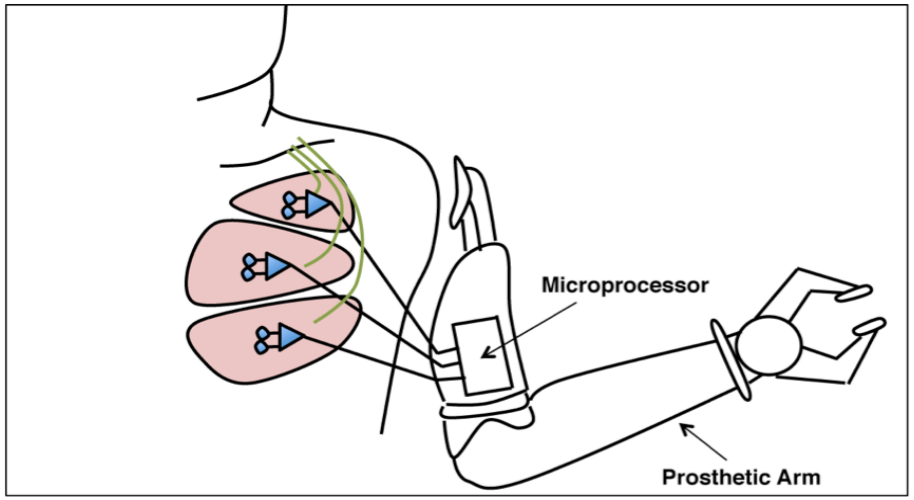
LIMB PROSTHESIS: STRUCTURAL COMPONENTS

1. **The structural components** of a limp prosthesis include:
   a) **Socket:** plastic receptacle in which the residual limb is contained.
   b) **Appendage:** hand or foot.
   c) **Joint:** wrist, elbow, shoulder, ankle, knee, or hip.
   d) **Connecting module** that connects the appendage and joint to the socket.



PASSIVE & ACTIVE PROSTHETICS

- **Passive prosthesis** allows for no active movement of any of the joints. These are the lightest-weight devices because they contain no motors and few mechanical systems.
- **Active prostheses** are biocompatible mechatronic devices aimed at restoring, maybe partially but as satisfactorily as possible, the physiological functions lost after the amputation of a limb.



COMPONENTS OF PASSIVE PROSTHETIC ARM

1. **Limb:** The limb is made from durable and lightweight materials, so it's comfortable yet sturdy.
2. **Suspension system** secures the prosthetic to the limb. Different suspension systems include an elastic sleeve, a suction socket, a harness, or a self-suspending socket.
3. **Socket** connects the residual limb to the arm prosthetic. The socket must be a comfortable fit to improve the functionality and wearability of the prosthetic arms.

Prosthetic Arm: Function, Types, Cost

COMPONENTS OF A PROSTHETIC ARM

1. **Interface:** Attaches the prosthesis to the body, either directly to the skin or through a cushion material.
2. **Socket:** A plastic receptacle that holds the residual limb. Prosthetists customize the socket to fit the wearer's limb.
3. **Appendage:** The hand or foot.
4. **Joint:** The wrist, elbow, shoulder, ankle, knee, or hip.
5. **Connecting module:** Connects the appendage and joint to the socket.
6. **Suspension system:** Secures the prosthesis and attaches the socket to the residual limb. It's usually made of straps, belts, pins, and locks.
7. **Control system:** Provides electronic control in mechanical prosthetics.

DEFINITION: ORTHOPEDICS

1. **Orthopedics** is a medical specialty that focuses on treating injuries and diseases of the musculoskeletal system
2. **Orthopedics, or orthopedic services**, aim at the treatment of the musculoskeletal system. This includes your bones, joints, ligaments, tendons, and muscles.
3. **Orthopedic doctors** use both surgical and nonsurgical means to treat:
   a) musculoskeletal trauma
   b) spine diseases
   c) sports injuries
   d) degenerative diseases
   e) infections, tumors, and congenital disorders

SITUATION IN ORTHOPEDIC WARDS IN KENYA

Victims of boda-boda accidents often suffer from a variety of injuries, including the following:

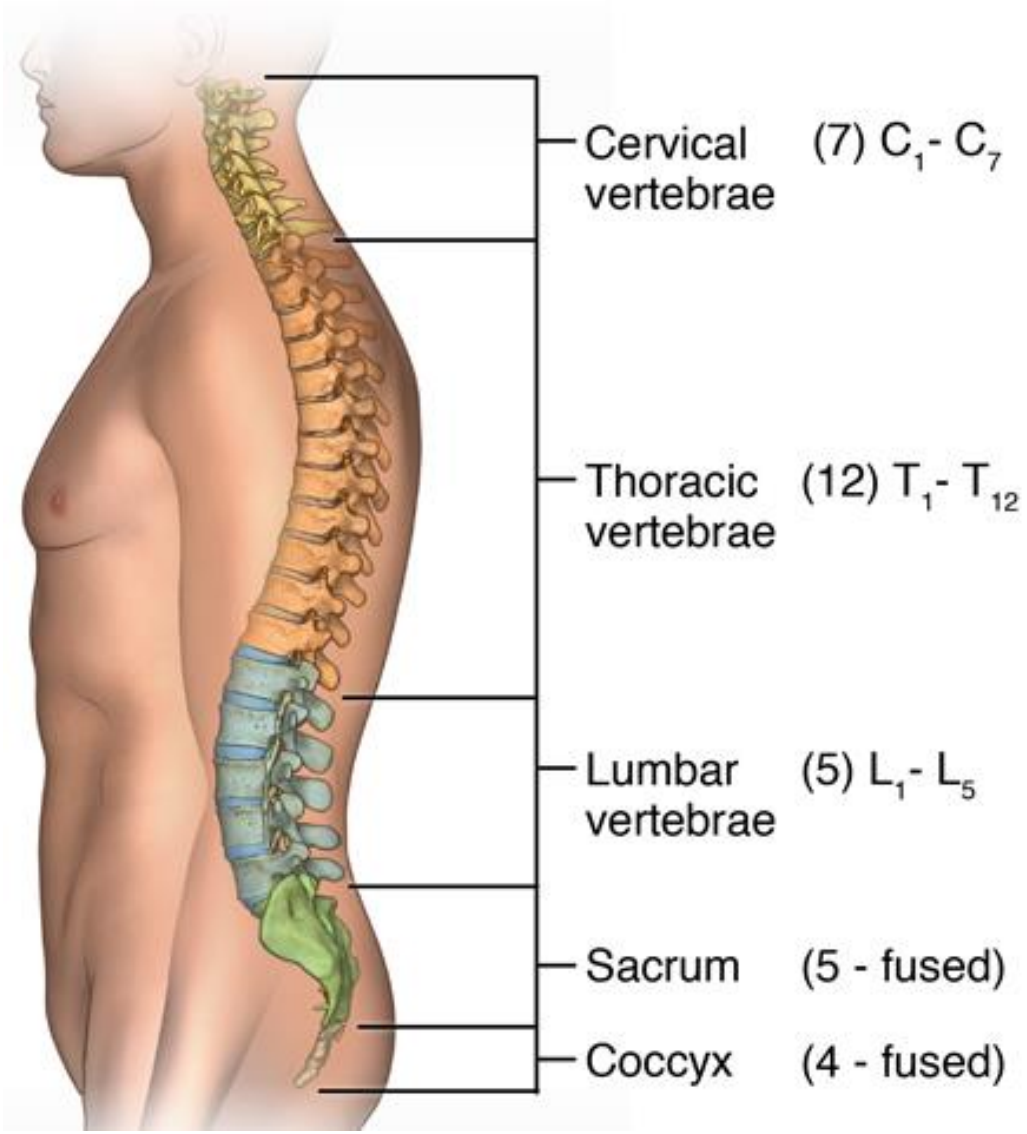
1. Fractures
2. Spinal Cord Injuries
3. Head Injuries
4. Soft Tissue Injuries
5. Dislocations

SITUATION IN ORTHOPEDIC WARDS IN KENYA /01

1. **Fractures:** High-speed collisions and falls frequently result in broken bones.
2. Most common fractures include those of:
   a) the arms
   b) legs
   c) ribs
   d) collarbones
3. **In severe cases**, compound fractures may occur, where the bone pierces the skin, leading to more complex treatment and longer recovery times.

SITUATION IN ORTHOPEDIC WARDS IN KENYA /02

2. **Spinal Cord Injuries:** These are among the most devastating outcomes of motorcycle accidents.
   - Spinal injuries can lead to partial or complete paralysis.
   - Victims often require long-term rehabilitation and specialized equipment to manage their condition.



SITUATION IN ORTHOPEDIC WARDS IN KENYA /03

3. **Head Injuries:** Despite regulations requiring the use of helmets, many riders and passengers still forgo this critical safety measure.
   a) Head injuries include:
   b) concussions
   c) skull fractures
   d) traumatic brain injuries.
4. These injuries can have long-lasting effects on cognitive function and quality of life.

SITUATION IN ORTHOPEDIC WARDS IN KENYA /04

4. **Soft Tissue Injuries:** Muscles, ligaments, and tendons are often damaged in motorcycle accidents, leading to sprains, strains, and tears.

These injuries may seem minor but can cause significant pain and require extensive physiotherapy to heal properly.

SITUATION IN ORTHOPEDIC WARDS IN KENYA /05

5. **Dislocations:** The impact of an accident can force bones out of their normal position, leading to joint dislocations.
   a) Shoulders, knees, and elbows are particularly susceptible.
   b) Treatment often involves not only setting the joint back into place but also extensive rehabilitation to restore full function

REHABILITATION PRODUCTS FOR ACCIDENT VICTIMS /01

Recovering from the physical and emotional trauma of an accident is a daunting journey. The following products are available in medical stores:

1. **Orthopedic Supports and Braces** including cervical collars for neck injuries to knee and ankle supports for lower limb rehabilitation.

REHABILITATION PRODUCTS FOR ACCIDENT VICTIMS /02

2. **Supports and Braces** including:

- Cervical collars for neck injuries.

- Knee and ankle supports for lower limb rehabilitation.

(b) Knee support braces

REHABILITATION PRODUCTS FOR ACCIDENT VICTIMS /02

1. **Mobility Aids** including:
   a) Crutches
   b) Walkers
   c) Wheelchairs.

(a) Crutches

(b) Walkers

(c) Wheelchairs

REHABILITATION PRODUCTS FOR ACCIDENT VICTIMS /03

3. Therapeutic Equipment including:

(a) Hot and cold therapy packs

(b) Massage devices

(c) Exercise bands.

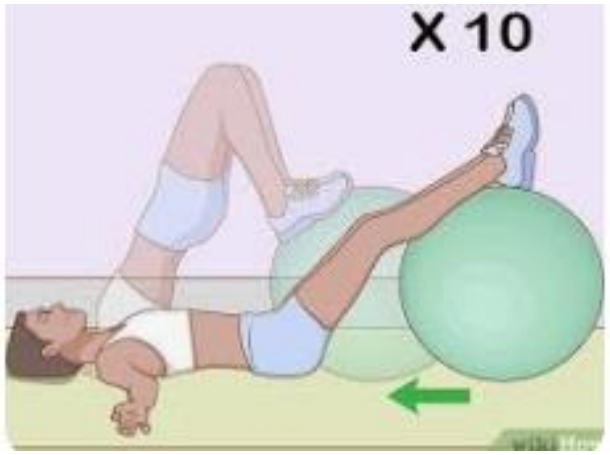
(c) Exercise bands

(d) Massage therapy device

REHABILITATION PRODUCTS FOR ACCIDENT VICTIMS /03

Rehabilitation Equipment including balance boards, resistance bands, and therapy balls.

(a) Balance board



(b) Therapy ball

(c) Resistance band

REHABILITATION PRODUCTS FOR ACCIDENT VICTIMS /03

- **Home Care Products** including hospital beds, pressure relief cushions.