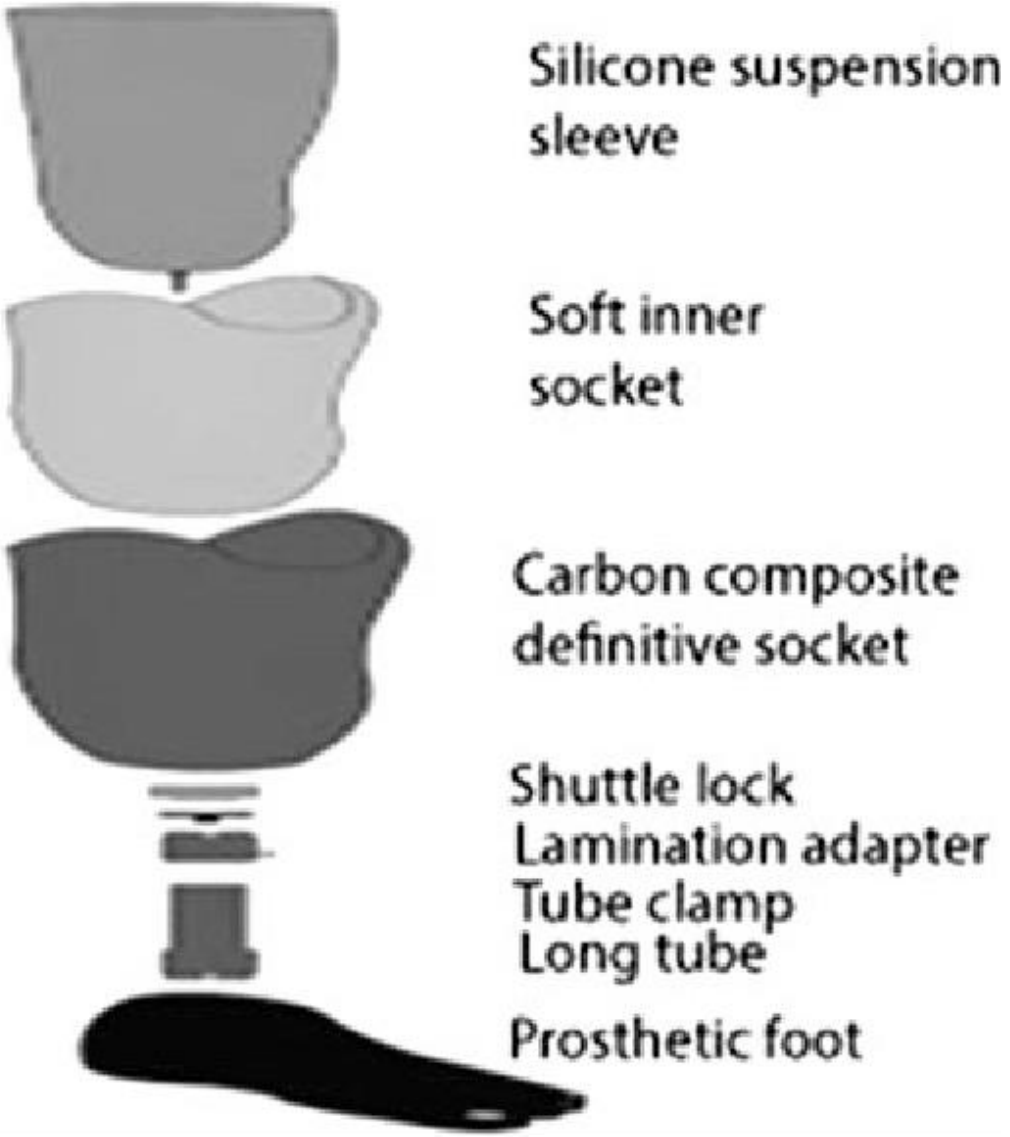
# lower limb prostheses

# Transtibial (Below Knee)

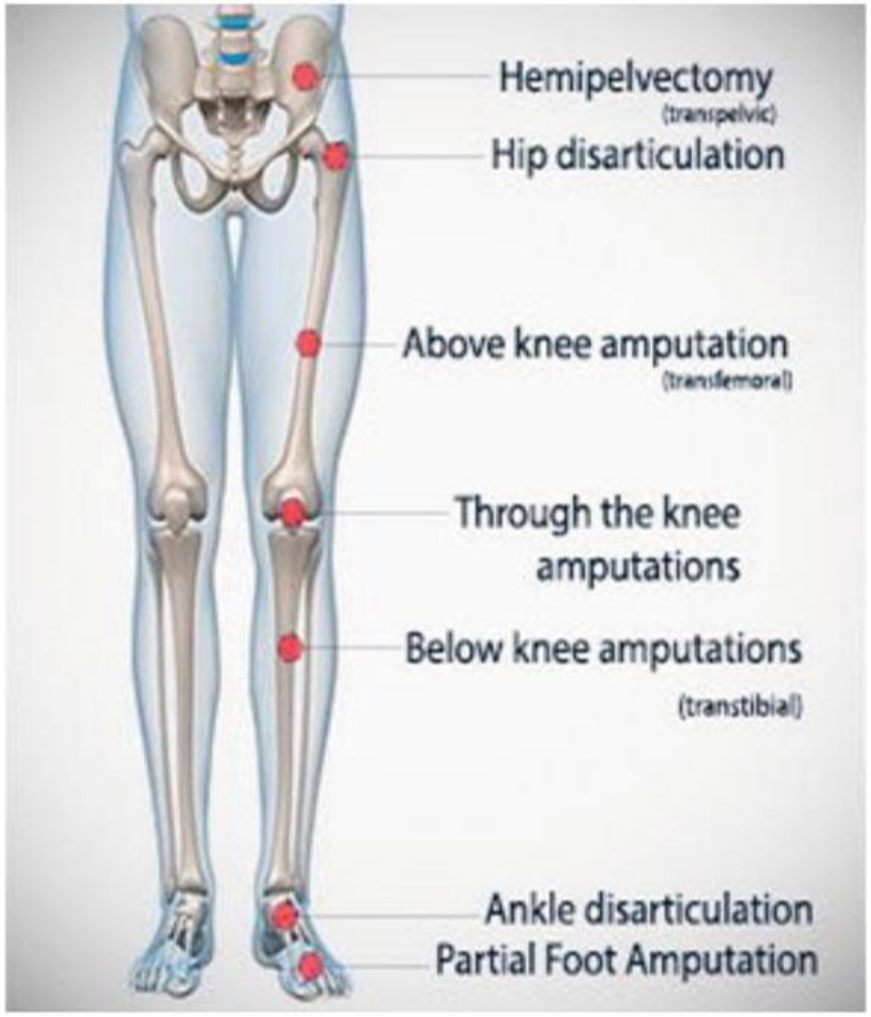
Prostheses is most commonly prescriped for lower limb amputation. Amputation is defined as the removal of the limb through a part of the bone . the lower limb amputation is the most common amputation nearly 85 percent of all amputations. The function of lower limb is weight bearing and locomotion. Lower limb prostheses is used to provide an individual who has an amputated limb with the opportunity to perform functional tasks, particularly ambulation (walking) which may not be possible without the limb.


Silicone suspension sleeve
Soft inner socket
Carbon composite definitive socket
Shuttle lock
Lamination adapter
Tube clamp
Long tube
Prosthetic foot

# Types of lower limb prostheses

The types of prostheses (Figure 1) is determined by an extend of the level of amputation (Figure 2). The lower limb amputation are performed at different levels based on that the prostheses are developed. The types of prostheses are:

1. Hemipelvectomy prostheses – for hemipelvectomy surgeries
2. Hip disarticulation prostheses – for hip disarticulation
3. Above knee prostheses – Transfemoral/Above knee amputation.
4. Below knee prostheses - Transtibial/below knee amputation. The prosthetic socket encases the residual limb , and is often classified as either “Patellar tendon bearing” - dispersing weight distribution onto several pressure tolerance areas including patellar tendon or “Total surface bearing” creating more equal weight distribution throughout the entire socket.
5. Symes prostheses - Symes amputation/Ankle disarticulation


Hemipelvectomy
(transpelvic)
Hip disarticulation
Above knee amputation
(transfemoral)
Through the knee
amputations
Below knee amputations
(transtibial)
Ankle disarticulation
Partial Foot Amputation

# Prosthetic construction design

The prosthetics are designed into two types

Endoskeletal prostheses 2.Exoskeletal prostheses

**Endoskeletal prostheses** (Figure 3) is a type of prostheses in which the supporting structure is internal it is also called as modular prostheses, it is most commonly used type of prostheses. The endoskeletal prostheses use the human skeleton as the model it has the tube frame provides the weight bearing function and a foam cover gives the prostheses it's near natural appearance . A tube frame is a central part it is called as pylon. The pylon is constructed from Aluminium, Titanium or Stainless steel, it connect proximally socket and distally prosthetic foot. The endoskeletal prostheses includes the joint components to suit the need of the individual amputee.

**Advantages of endoskeletal prostheses are**

•Changes may be done at any point of time

•Light weight and comfortable for weight bearing

•Cosmetically acceptable and it gives the appearance of near to normal

•Suitable for all levels of amputation

•It gives adequate adjustment and good dynamic alignment.

**Disadvantages**

•Less resistant to external wear

•The foam cover is not last for a longer period and needs to be changed often.

# Exoskeletal prostheses

The exoskeletal prostheses (Figure 4) is a type of prostheses in which the supporting structure are on outside. It is also called as conventional or crustacean prostheses. The exoskeletal prostheses has a rigid outer shell as a supporting structure it provides shape and weight bearing function. The weight is beared through the outer shell. It is constructed of wood, or rigid polyurethane covered with a rigid plastic lamination

**Advantages of exoskeletal prostheses are**

- Lasted for a longer period
- More resistant to external wear
- Cost effective

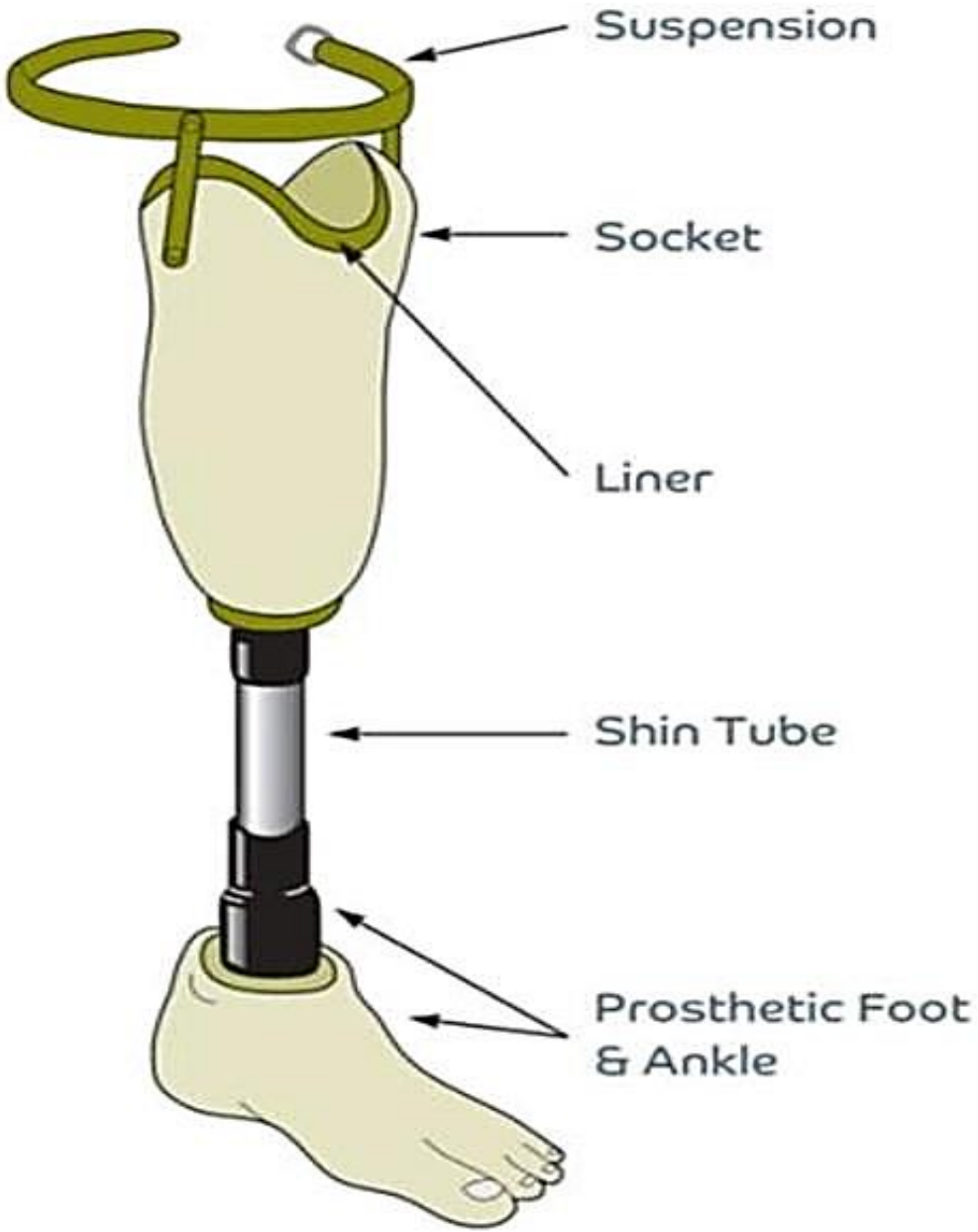
**Disadvantages are**

- Heavy & uncomfortable for use
- Fabrication time is longer
- Alignment cannot be changed & couldn’t be adjusted
- Not suitable for through knee amputation.

# Components of lower limb prostheses

- The lower limb prostheses has the following components (Figure 5)

1. **Socket** : Is the most important part it is the connection between the stump and the prosthesis. It protects the stump and transmits forces. Contoured sockets fit closer to bone, muscle, soft tissue. It provide support. It can be made of thermoplastic or metal.
2. **Suspension** : This holds the artificial limb on to stump. Eg. Sleeve, belt, straps, cuffs, suction prostheses.
3. **Liner** : This is a removable inner socket made of flexible material.
4. **Pylon or Shank** : This lies between the socket and the prosthetic foot. It is made of strong and lightweight material such as Carbon fibre, Aluminium & Titanium.
5. **Prosthetic foot & ankle** : Designed to provide support during standing/walking and shock absorption.


Suspension
Socket
Liner
Shin Tube
Prosthetic Foot
& Ankle

# Description of lower limb prostheses

## Design of prostheses

The prostheses required a high level of customization and represents the interface with the human body or parts of it, the artificial prostheses that have to be designed according to the shape of the specific anatomical area. Considerations taken into account when designing prostheses are basic structure of a lower limb prostheses, materials, weight and mass considerations, power requirements, biomechanics, and tradeoffs in motion and stability.

# Temporary prostheses

The temporary prostheses is also called as preparatory prostheses. Temporary prostheses are used for early rehabilitation purpose to speeds the recovery process and it ease the transition into a definitive prostheses. The advantage of the temporary prostheses is it fastened the mobility of the amputee postoperatively, prevents the complications of prolonged bed rest and it promote early discharge from the hospital. It’s applied within few days after surgery and limited early gait training is given. Indications are

- Applied for early rehabilitation
- Unhealed residual limb like Burns, Skin grafts, Open wounds, Infection.
- Dermatological condition
- Painful residual limb
- Fracture healing process

## Permanent prostheses

The permanent prosthesis is also called as definitive prostheses. It is applied when the surgical wound is completely healed and the residual limb become shrinken and shaped. The permanent prostheses is changed when the prostheses become excess wear and the atrophy of the residual limb. The permanent prostheses are should be proper fit there by the patient will get proper weight bearing & movement.

## Special-use prostheses

The prostheses are specifically designed for certain number of patients will require special-use prostheses and it is designed specifically for sports activities such as running, swimming, or skiing. Special-use prostheses can be valuable to the amputee who wishes to expand his activities and participate in a full range of sports and recreation.

# Materials used

The various materials are used to design the prostheses, the materials should be strong enough, light weight, resistant to thermal conditions, longer durability and biocompatible it should not cause allergic reactions to the body. The materials are

**Metals**: Titanium, Aluminium and stainless steel. The metals are used both in exo & endoskeletal prostheses e.g Socket, Pylon.

**Plastic**: Socket is made of plastic, the thermoplastic materials like polypropylene, polyethylene, polyurethane, acrylic are commonly used. The thermosetting plastic also used for laminated sockets in which the resin is combined with the reinforcing materials like glass fibre, nylon,carban fibre.

**Wood:** Is used in lowerlimb prostheses for foot assembly e.g SACH foot Solid-ankle, cushion-heel (SACH) feet have an interior hardwood heel that provides structural strength to the foot. This heel is bolted to the rest of the prosthesis.

**Leather:** Is used for suspension straps, socket linings.

Rubber: The foot in the prostheses made by vulganised rubber

**Fabric/cotton:** Socks is made of cotton. Socks are used as an interface between residual limb & socket and it provides comfort & prevent friction between the residual limb and socket.

**Fiber reinforcement**: Two basic types of high-strength fiber reinforcements are used in prosthetics are glass and carbon. Carbon fibers are more expensive than fiberglass but have superior strength and stiffness. Carbon fibers are generally set in epoxy and can provide a material with a stiffness. In addition to this high strength-to-weight ratio, carbon fiber composites have a fatigue resistance. Prefabricated carbon fiber prosthetic components such as pylon tubes, knee joints, and connectors can significantly reduce the weight of the prosthesis while increasing its strength.

- **Function of prostheses**

1. To substitute for a lost limb
2. To restore function of Amputee
3. Comfortable ambulation
4. Reduce expenditure of energy
5. Minimizing the shift of the center of gravity of the body during gait.

**Advantages of prostheses**

- Loss of limb not only causes physical handicap but also leads to Social, Psychological and economic effects on the individual and family. This loss can be overcome to a greater extent by the application of artificial limb which restores the function as well as total body image.

**Disadvantages of prostheses**

1. Choke syndrome - caused by obstructed venous outflow due to tight socket leads to red, indurated skin with orange-peel appearance, venous stasis ulcers.
2. Skin problems:
    1. Contact dermatitis most commonly caused by liner, socks, and suspension mechanism
    2. Cysts
    3. Hyperhydrosis
3. Erythema, skin damage – due to shear forces and improperly fit of prostheses.
4. Painful residual limb – due to pressure in the bony prominence.