Al-Mustaqbal University

Collage of Engineering

Prosthetics and Orthotics Engineering

Third Stage

PROSTHETICS II

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1st term – Lecture 4

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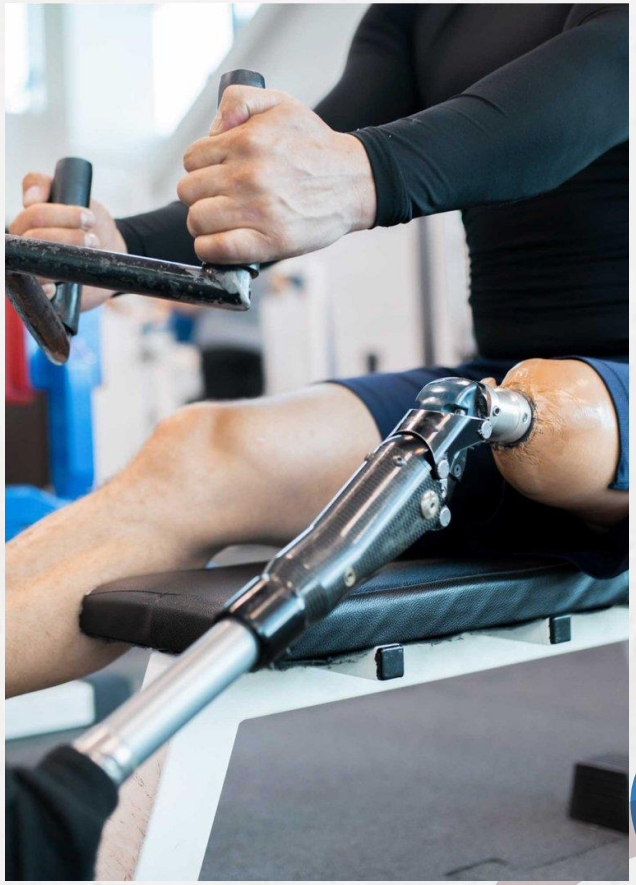


Types of Bone

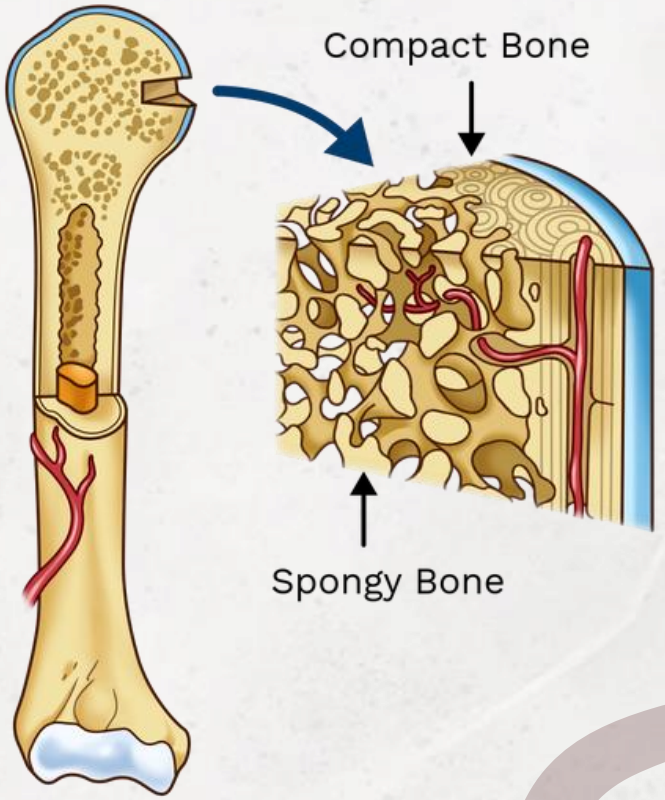
1

Compact Bone

- Forms the outer layer of long bones.
- Organized into three concentric systems:
  - Outer circumferential (near periosteum).
  - Inner circumferential (near endosteum).
  - Intermediate zone with Haversian systems (osteons).
- High density, low porosity (5–30%).

Cancellous (Spongy) Bone

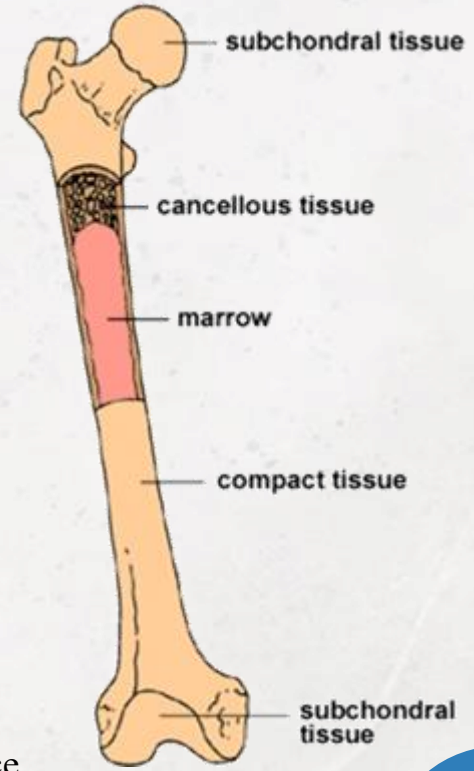
- Found in epiphyses of long bones, flat and short bones.
- Composed of trabeculae forming a lattice-like structure.
- Lower density, high porosity (30–90%).



2

Femur Composition

- Cortical (Compact) bone → thick outer wall, provides strength for load bearing.
- Cancellous bone → fills the epiphysis, absorbs shock, distributes forces.



Implant/Prosthesis Interaction

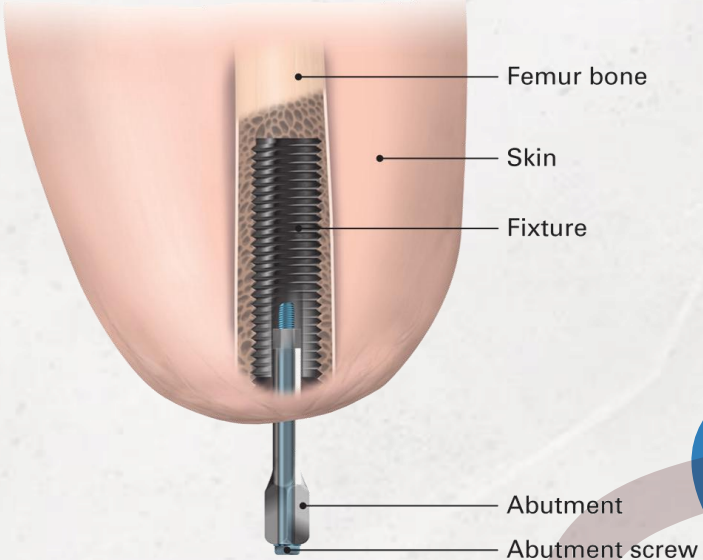
- Compact bone provides primary stability for fixation (press-fit or cemented).
- Cancellous bone allows bone ingrowth and osseointegration around implant surface.
- Balance between strength (compact) and biological adaptation (cancellous) is crucial for long-term success.

3

Bone-Anchored Prostheses

Bone-anchored (osseointegrated) prostheses are surgically attached directly to the residual bone of an amputated limb, with a small skin opening used to connect the internal implant to an external prosthetic limb.

The implant is a custom-made, porous, coated titanium device precisely aligned with the residual bone to ensure stability and proper load transfer.



Applicable Bones:

- Femur → most widely used and considered the safest and most established site for osseointegration.
- Tibia
- Humerus
- Radius & Ulna

4 Types of Osseointegrated Implant Prostheses

- **OPRA (Osseointegrated Prostheses for the Rehabilitation of Amputees, Sweden)**

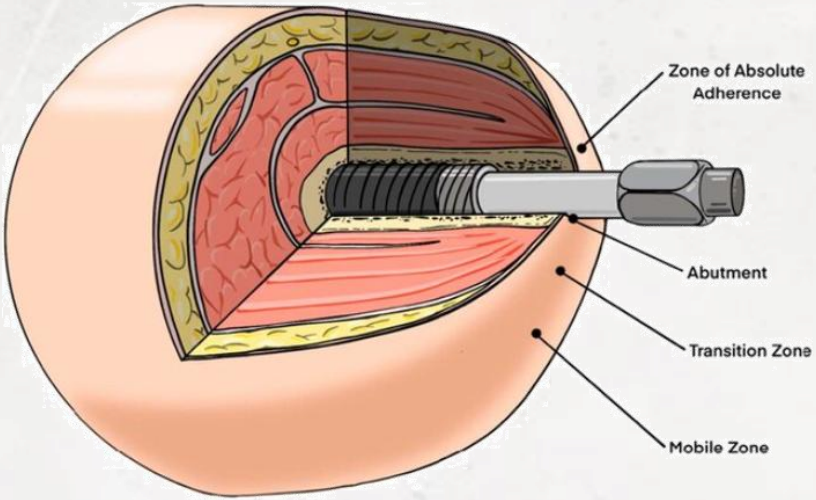
Consists of three main components:

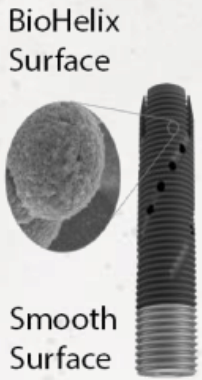
- Fixture: a fully implanted, externally threaded cylindrical component.
- Abutment: the percutaneous component connecting the implant to the prosthesis.
- Abutment screw: secures the abutment to the fixture.

- **ILP (Integral Leg Prosthesis, Germany)**

- Implant stem length: 140–180 mm, slightly curved.
- Curvature prevents rotation within the intramedullary cavity and matches the natural femoral curve.

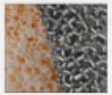
- **OPL (Osseointegrated Prosthetic Limb, Milan, Italy)**
- **POP (Percutaneous Osseointegrated Prosthesis, USA)**
- **ITAP (Intraosseous Transcutaneous Amputation Prosthesis, UK)**
- **COMPRESS (USA)**
- **Distal Weight-Bearing Implant (Spain)**





OPRA

(Ti6A14V) alloy

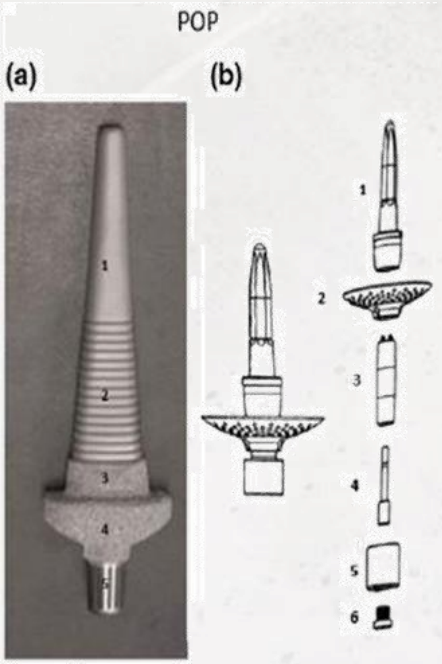


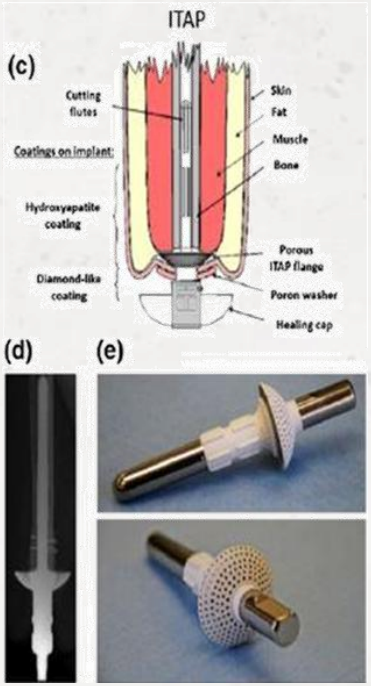
ILP

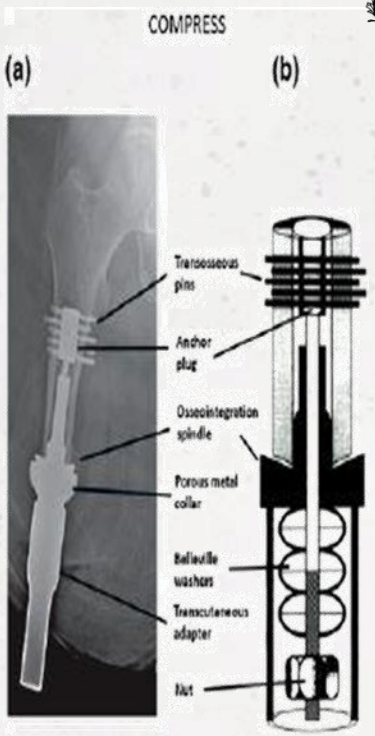
(CoCrMo) alloy

OPL

(Ti6A14V) alloy

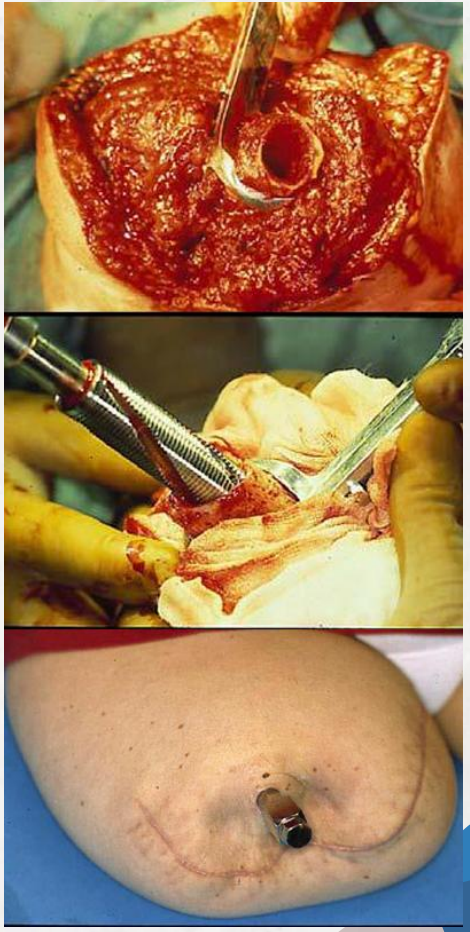






Distal weight-bearing implant

Surgery



Surgical Challenges:

- Risk of implant or bone fractures and implant loosening.
- Infection at the implant site.
- Stoma care for the skin opening.
- Pain management.
- High cost of the procedure and rehabilitation.

Surgical Process:

Two-Stage Procedure:

Stage 1: Insertion of the endo-prosthesis (internal implant fixed into the bone).

Stage 2: Attachment of the exo-prosthesis (external prosthetic limb connected to the implant).

Good Candidates for Osseointegration

- Have problems using conventional socket prostheses, such as pain, skin irritation, or sweating.
- Find it hard to sit, stand, or walk with a socket prosthesis.
- Have difficulty with the fit of their prosthetic socket.
- Have completed skeletal growth.
- Have normal bone structure suitable for implant placement.
- Are between 18 and 70 years old.
- Meet medical and physical requirements for surgery.
- Can follow the treatment plan and attend follow-up appointments.

Not a Good Candidates for Osseointegration

- Have diabetes.
- Suffer from severe peripheral vascular disease.
- Are pregnant.
- Have exposure of the legs to radiation.
- Have osteoporosis or weak bones.
- Are smokers.
- Have skin disorders on the amputated limb.
- Have a mental illness or psychotic disorder.
- Are satisfied with conventional socket prostheses and do not experience problems.

Bone Surface and Material Properties

Natural Bone Surface:

- Often contains features about 100 nm in size.
- If an artificial bone implant is left smooth, the body may try to reject it, forming a fibrous tissue layer around the implant.

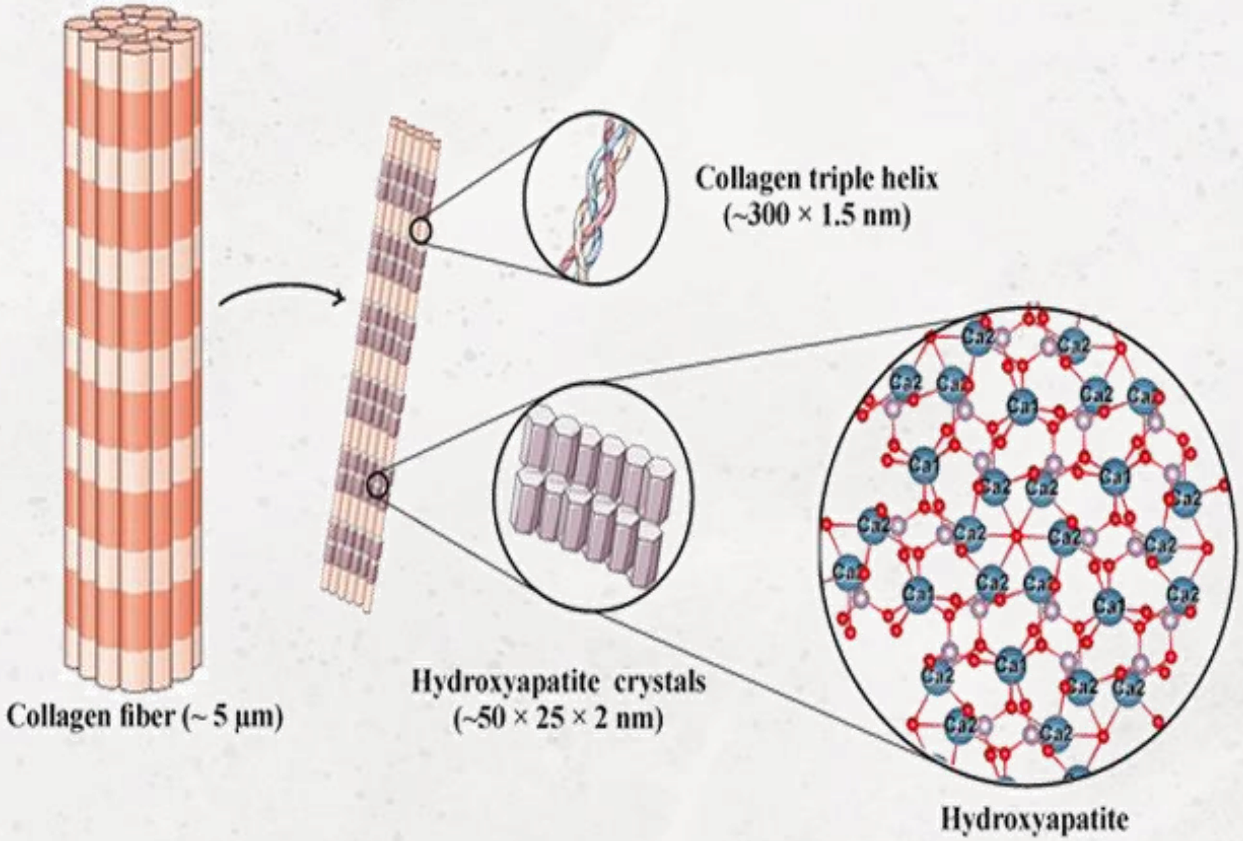
Bone Composition:

- Bone is a nanocomposite material, made of hydroxyapatite crystallites embedded in an organic matrix, mainly collagen.
- This combination makes bone mechanically tough yet flexible, allowing it to recover from mechanical damage.
- The exact nanoscale mechanism behind this combination of strength and plasticity is still under study.

Requirements for Bone Scaffolds/Implants:

- Must be biocompatible (accepted by the body).
- Biodegradable if needed.
- Contain pores suitable for cell growth to allow integration with natural tissue.

Bone Surface and Material Properties




Thank
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