

# Bone Repair and Biomedical Engineering

# Repairing Bones: Overview

- **Some serious breaks need the aid of engineers because:**
  - Need to restore function and position
  - Likely not to heal correctly
  - High risk of infection
  - Very long healing time
- **Biomedical engineers use internal and external fixation approaches**
- **While beneficial, added challenges and possible complications exist**

# Internal vs. External Fixation

- **Internal fixation:**  
Temporary or permanent fixtures directly attached to the bone under the skin, for alignment and support
  - pins
  - rods or nails
  - plates
  - screws
  - wires
  - grafting
- **External fixation:**  
Temporary repair supports outside of the skin that stabilize and align bone while the body heals
  - screws in bone to hold in place
  - metal braces or casts
  - can be externally adjusted

# Internal Fixation

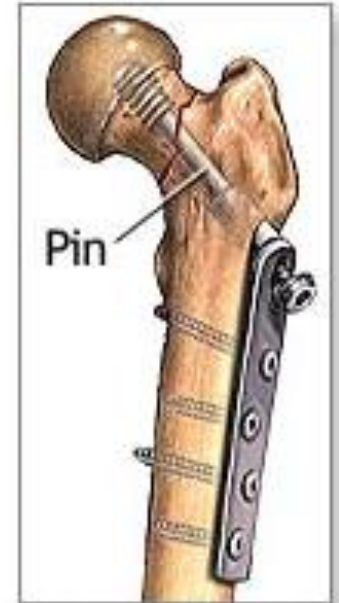
To determine the best repair technique, the break type and location are considered



Plate



Intra-medullary rod

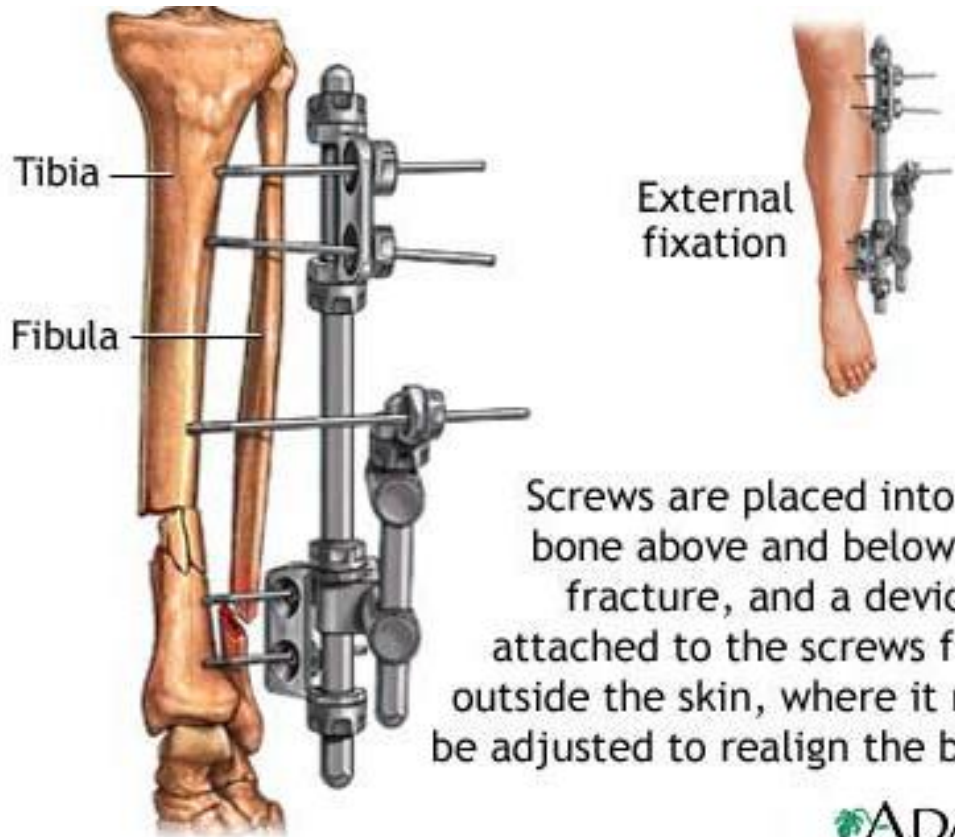


Pin

# External Fixation

Installing temporary repair supports outside of the skin to stabilize and align bone while the body heals.

**Examples:** screws in bone, metal braces, casts, slings.



Screws are placed into the bone above and below the fracture, and a device is attached to the screws from outside the skin, where it may be adjusted to realign the bone

ADAM.

# Example

## Spiral fracture-torsion break



**Tibia and fibula broken while skiing and repaired with a rod and pins.**



# Example: Rods, Plates and Screws

- **Rods** are used for alignment and support of long and large bones
- **Plates** hold together loose pieces of bone and support smaller bones
- **Screws** hold plates and rods in place

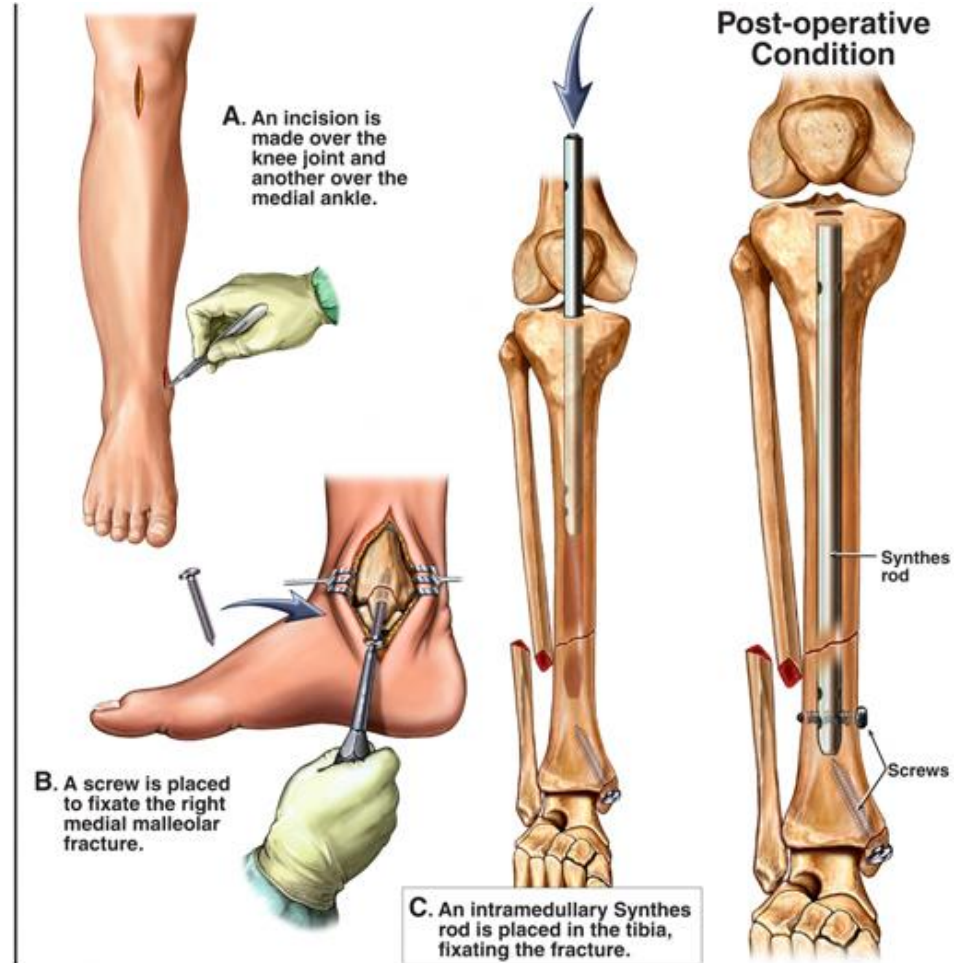


# Example: Rods, Screws and Pins



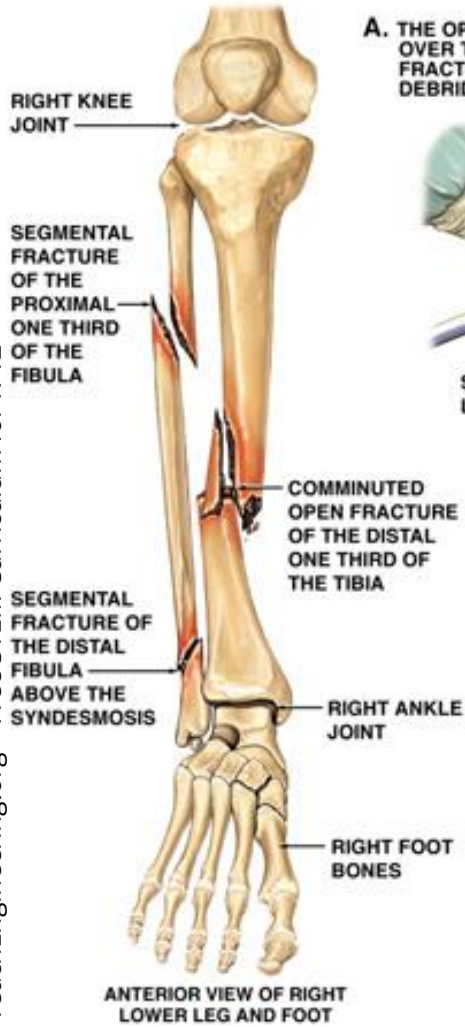
TeachEngineering.org - Free STEM Curriculum for K-12

**Pins** are similar to screws and usually affix a detached piece of bone



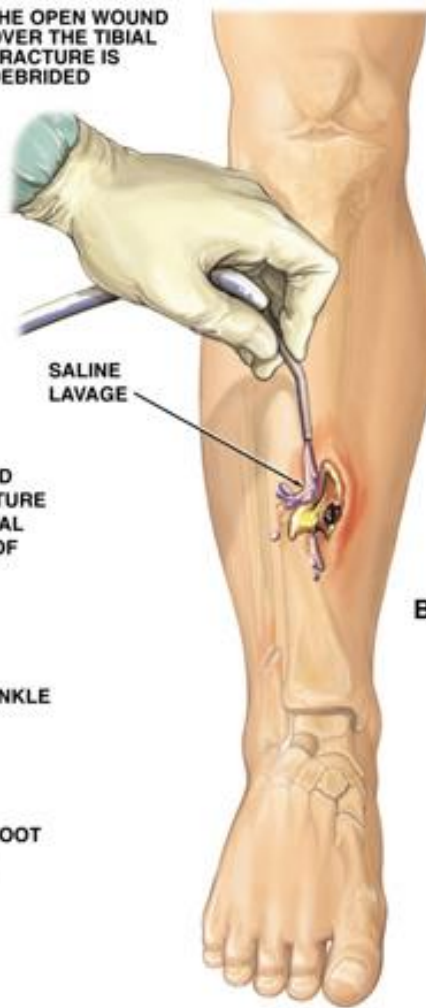


### POST-ACCIDENT CONDITION



### SURGICAL DEBRIDEMENT OF WOUND WITH CLOSED RODDING PROCEDURE

A. THE OPEN WOUND OVER THE TIBIAL FRACTURE IS DEBRIDED



B. AN OPENING IN THE TIBIAL BONE IS MADE AND THE NAIL IS INSERTED ACROSS THE FRACTURES



C. INTERLOCKING SCREWS ARE PLACED ABOVE AND BELOW THE FRACTURES

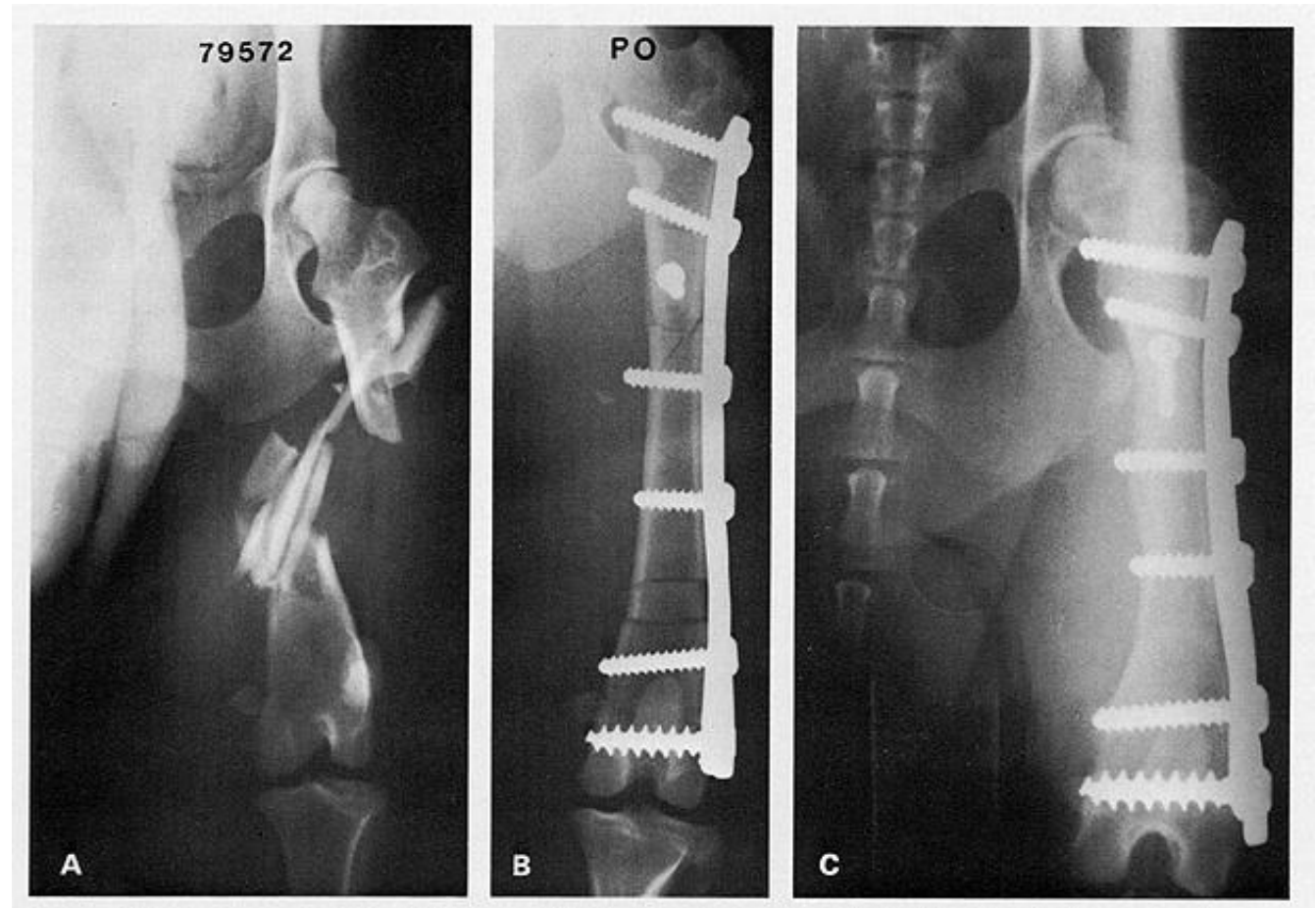


### POST-OPERATIVE CONDITION



# More Plates and Screws

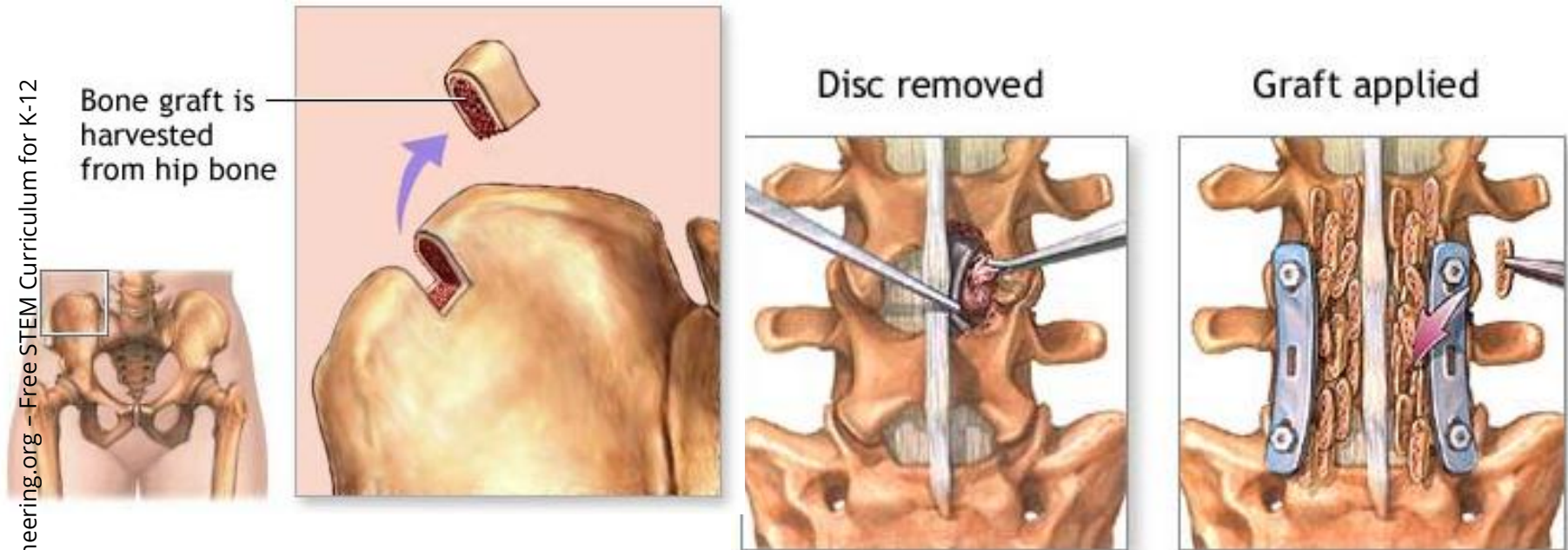
**X-ray example  
of shattered  
dog femur  
that was  
repaired with  
a plate and  
seven screws**



# Bone Grafting Example

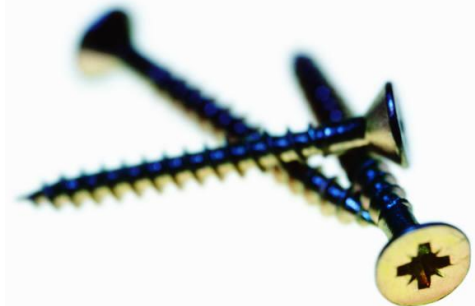
Graft material is removed from patient's ilium (pelvis, hip) [left]

Bone graft fills a gap in a human spine [right]



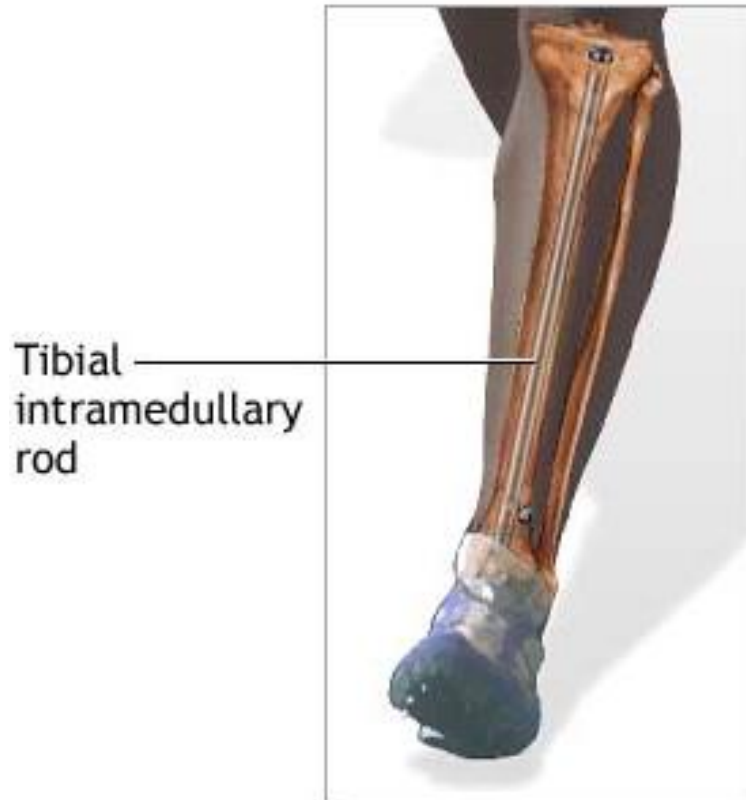
# Medical Implant Materials

- Bone is an amazing material: **strong and flexible**
- Most human-made materials that are strong are also brittle
- To be accepted by the body and not cause other problems, the materials for rods, pins, screws and plates must also be **biocompatible**.
- Engineers design materials especially for medical implants that are made of:
  - Surgical stainless steels  
(blends of nickel, chrome and molybdenum)
  - Titanium alloys
  - Polymers



# Results

**After a few months, patients should be back on their feet, ready to participate in everyday activities**



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