

# 2 PROCESSES OF BONE OSSIFICATION

- ENDOCHONDRAL OSSIFICATION

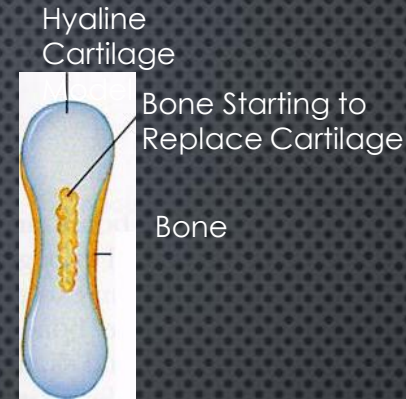
- 6 STEPS

1. CARTILAGE ENLARGES, BY APPositionAL GROWTH; CHONDROCYTES AT CENTER OF CARTILAGE GROW IN SIZE; MATRIX REDUCES IN SIZE & SPICULES CALCIFY; CHONDROCYTES DIE & LEAVE CAVITIES IN CARTILAGE
2. BLOOD VESSELS GROW AROUND EDGES OF CARTILAGE; OSTEOLASTS FORM IN THE PERICHONDRIUM; CARTILAGE BECOMES ENCASED IN BONE
3. PERICHONDRIUM NEEDS OXYGEN & FOOD SO CAPILLARIES BEGIN TO GROW WHERE THE CARTILAGE HAS DIED OFF; FIBROBLASTS BECOME OSTEOLASTS & REPLACE CARTILAGE WITH SPONGY BONE; HAPPENS IN AN AREA CALLED **PRIMARY CENTER OF OSSIFICATION** WHERE BONE GROWS TOWARDS THE ENDS OF THE BONE; ENTIRE DIAPHYSIS IS SPONGY BONE
4. AS THE BONE CONTINUES TO GROW, OSTEOCLASTS APPEAR BREAKING DOWN THE TRABECULAE OF SPONGY BONE STARTING A MARROW CAVITY; NOW BONE GROWS IN 2 WAYS: LENGTH & DIAMETER BY APPositionAL GROWTH
5. CAPILLARIES & OSTEOLASTS MIGRATE TO THE EPIPHYSIS CREATING SECONDARY OSSIFICATION CENTERS
6. EPIPHYSIS FILLS WITH SPONGY BONE; A SMALL LAYER OF CARTILAGE REMAINS & BECOMES ARTICULAR CARTILAGE

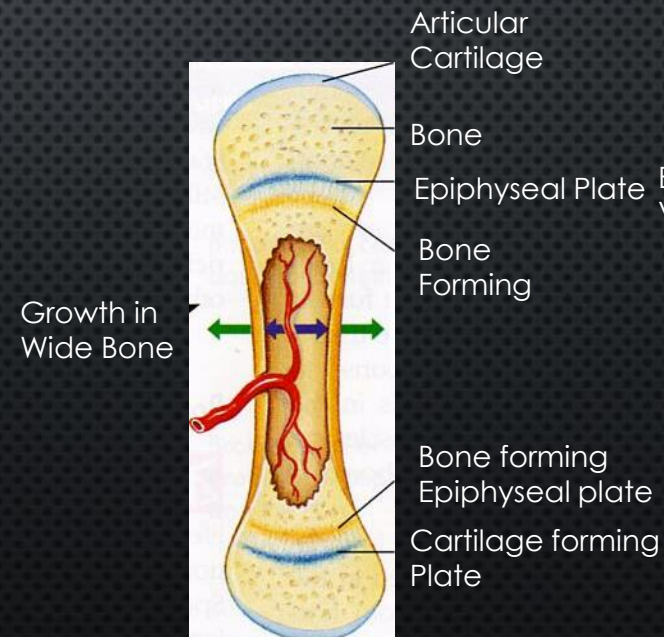
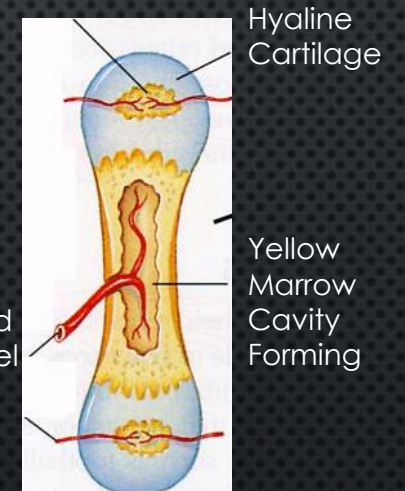
# FETAL OSSIFICATION

- 4 STEPS

1. HYALINE CARTILAGE MODEL IS COMPLETELY COVERED WITH BONE MATRIX BY BONE-FORMING CELLS CALLED OSTEOLASTS
2. FETUS HAS CARTILAGE "BONES" ENCLOSED BY "BONY" BONES
3. ENCLOSED HYALINE CARTILAGE MODEL IS DIGESTED AWAY, OPENING UP MEDULLARY CAVITY WITHIN NEWLY FORMED BONE
4. BY BIRTH OR SHORTLY AFTER, MOST HYALINE CARTILAGE MODELS HAVE BEEN CONVERTED TO BONE

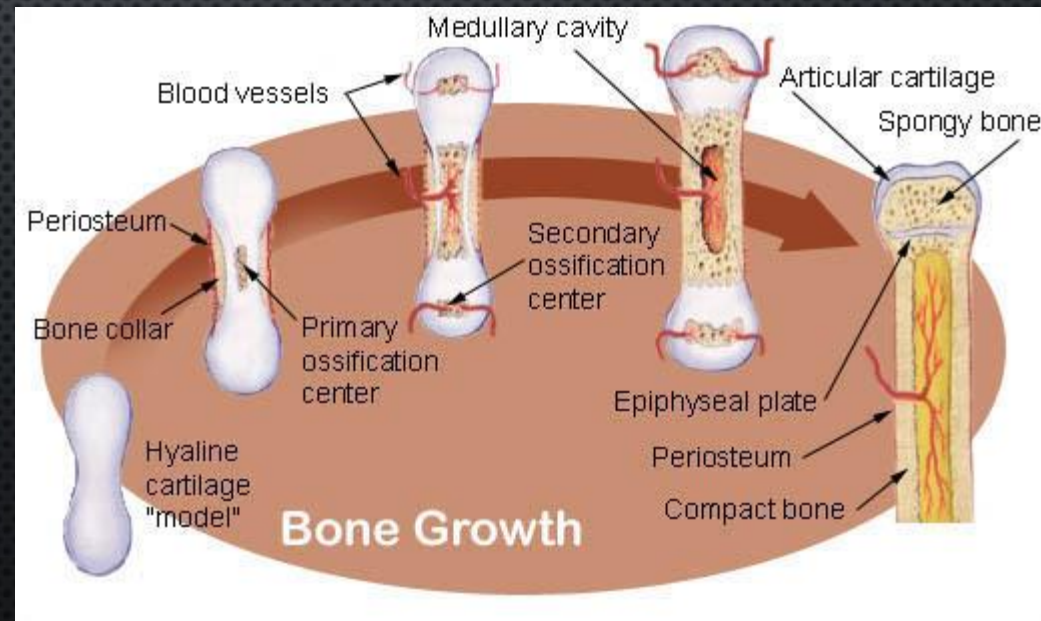


New Center of Bone Growth



# BONE GROWTH

- BONES CANNOT GROW BY INTERSTITIAL GROWTH LIKE CARTILAGE, LIGAMENTS, & TENDONS
- BONES GROW BY 2 METHODS:
  1. APPOSITIONAL GROWTH
  2. ENDOCHONDRAL GROWTH



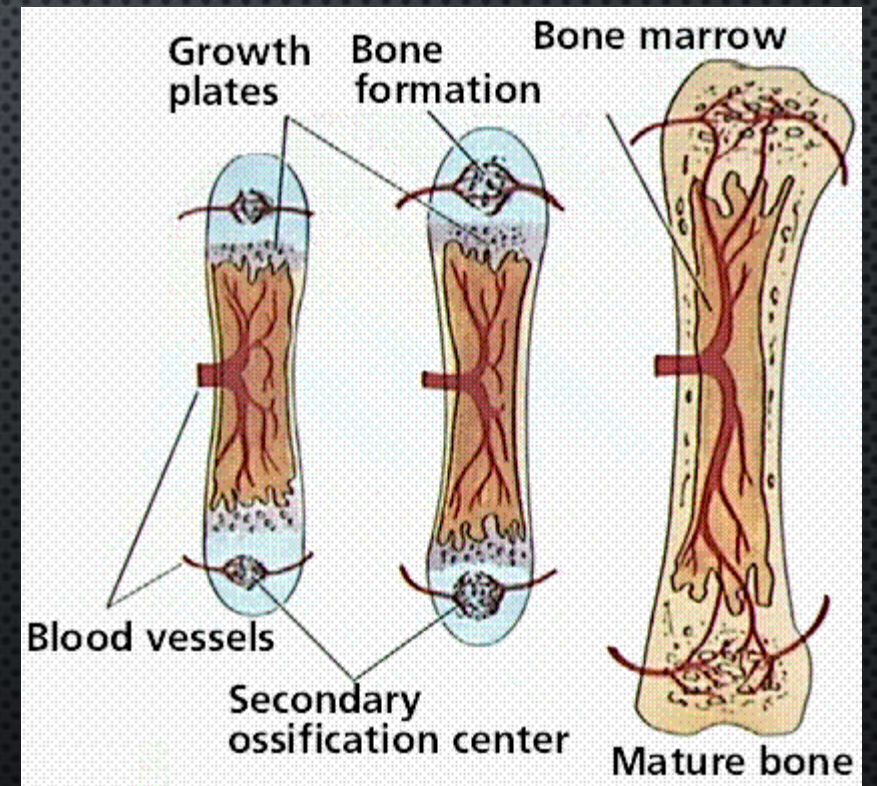
# BONE GROWTH

- APPOSITIONAL GROWTH

- RESPONSIBLE FOR THE INCREASE IN DIAMETER OF LONG BONES AND MOST GROWTH OF OTHER BONES
- CELLS ON THE INNER LAYER OF PERIOSTEUM DIFFERENTIATE INTO OSTEOLASTS & CAUSE GROWTH OF THE BONE MATRIX; BECOME SURROUNDED WITH MATRIX & BECOME OSTEOCYTES
- ON THE SURFACE OF THE BONE, APPOSITIONAL GROWTH ADDS LAYERS OF BONE THAT BECOME LAMELLAE
- REMEMBER, BONE IS DEPOSITED BY OSTEOLASTS ON THE SURFACE OF THE BONE & REABSORBED BY OSTEOLASTS ON THE INNER SURFACE OF THE BONE SO MARROW CAVITY ENLARGES AS BONE GROWS

# BONE GROWTH

- ENDOCHONDRAL GROWTH (LONGITUDINAL GROWTH)
  - “NEW” CARTILAGE IS FORMED CONTINUOUSLY ON THE EXTERNAL FACE OF THE ARTICULAR CARTILAGE AND ON THE EPIPHYSEAL PLATE SURFACE THAT IS FARTHER AWAY FROM THE MEDULLARY CAVITY
  - AT THE SAME TIME, THE “OLD” CARTILAGE ABUTTING THE INTERNAL FACE OF THE ARTICULAR CARTILAGE AND THE MEDULLARY IS BROWN DOWN AND REPLACED BY BONY MATRIX
  - PROCESS OF LONG BONE GROWTH IS CONTROLLED BY HORMONES – GROWTH HORMONES DURING PUBERTY & SEX HORMONES
  - ENDS DURING ADOLESCENCE WHEN THE EPIPHYSEAL PLATES ARE COMPLETELY CONVERTED TO BONE

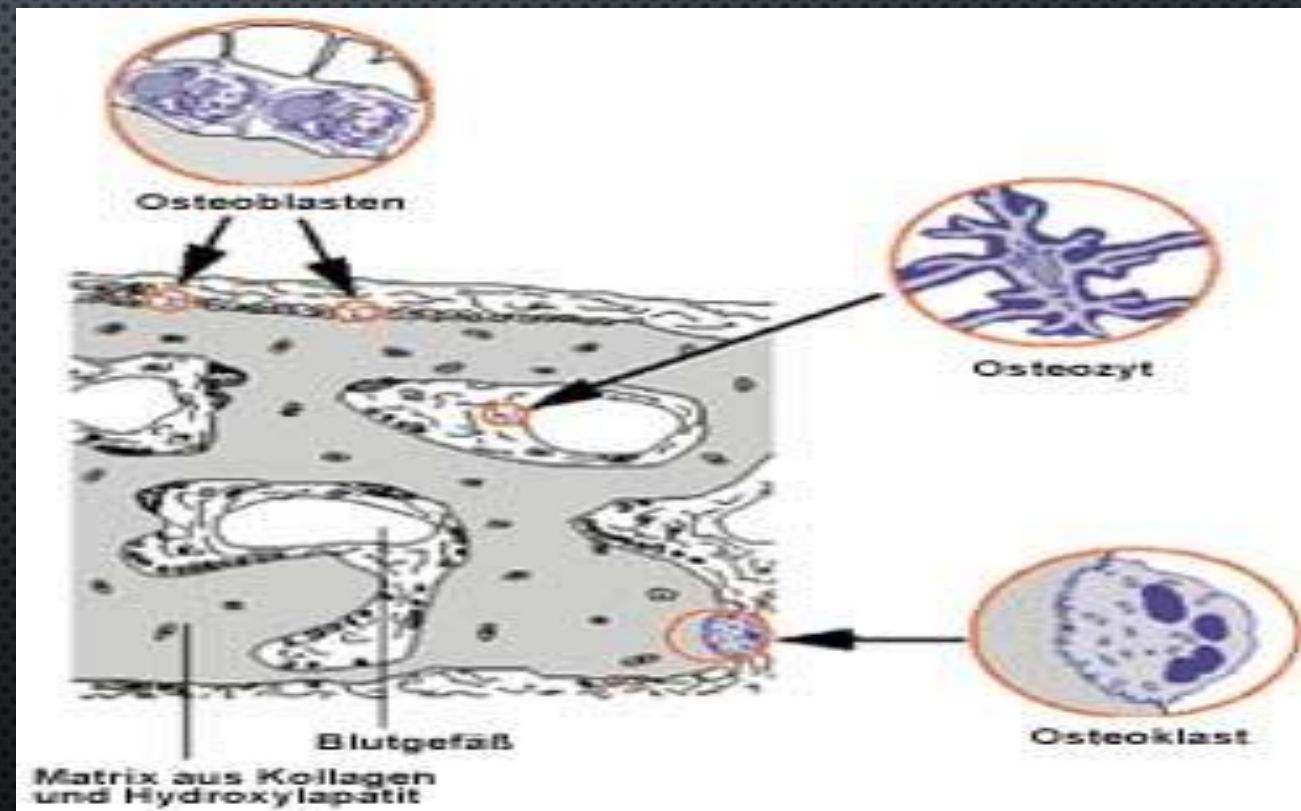


# BLOOD & NERVE SUPPLY

- BONE TISSUE IS WELL SUPPLIED WITH BLOOD – HIGHLY VASCULAR!!!
- BLOOD VESSELS SUPPLY THE DIAPHYSIS BY ENTERING THE CARTILAGE MODEL BEFORE OSSIFICATION OCCURS
  - MAJORITY OF BONES HAVE ONLY ONE VESSEL TO SUPPLY BLOOD
- LONG BONES (FEMUR) HAVE 3 BLOOD VESSELS
  - NUTRIENT FORAMINA TUNNELS IN THE BONE THAT BLOOD VESSELS ENTER THROUGH
- METAPHYSEAL VESSELS
  - SUPPLY BLOOD TO THE INNER SURFACE OF THE EPIPHYSEAL CARTILAGE
  - LOCATION WHERE CARTILAGE IS REPLACED BY BONE
- PERIOSTEAL VESSELS
  - PROVIDE BLOOD TO THE SUPERFICIAL OSTEONS OF THE BONE SHAFT
- NERVES
  - FOUND THROUGHOUT THE BONE, ESPECIALLY IN THE ENDOSTEUM
  - WHY BONE BREAKS ARE SO PAINFUL

# BONE REMODELING

- ESSENTIAL IF BONES ARE TO RETAIN NORMAL PROPORTIONS AND STRENGTH
- ACCOUNTS FOR BONES BECOMING THICKER
- FORMS LARGE PROJECTIONS FOR MUSCLES TO ATTACH
- OSTEOLASTS LAY DOWN MATRIX & BECOME OSTEOCYTES
- PHYSICALLY INACTIVE PEOPLE LOSE BONE MASS & ATROPHY (CELL DEATH)



# BONE IS DYNAMIC

- BONES ARE REMODELED CONTINUALLY IN RESPONSE TO 2 FACTORS:
  1. CALCIUM LEVELS IN BLOOD
  2. PULL OF GRAVITY AND MUSCLES ON THE SKELETON
- BLOOD CALCIUM LEVELS DROP
  - PARATHYROID GLANDS ARE STIMULATED TO RELEASE PARATHYROID HORMONE (PTH) INTO BLOOD
  - PTH ACTIVATES OSTEOCLASTS (BONE-DESTROYING CELLS)
  - OSTEOCLASTS BREAK DOWN BONE MATRIX & RELEASE CALCIUM IONS INTO BLOOD
- WHEN BLOOD CALCIUM LEVELS ARE TOO HIGH (HYPERCALCEMIA)
  - OSTEOBLASTS DEPOSIT CALCIUM IN BONE MATRIX
  - CALCITONIN IS RELEASED



# BONE FRACTURES

- HEMATOMA IS FORMED
  - BLOOD VESSELS ARE RUPTURED WHEN THE BONE BREAKS
  - AS A RESULT, A BLOOD-FILLED SWELLING CALLED A HEMATOMA FORMS
- BREAK IS SPLINTED BY FIBROCARILAGE CALLUS
  - GROWTH OF NEW CAPILLARIES AT THE SITE OF DAMAGE
  - PHAGOCYTES DISPOSE OF DEAD TISSUE
  - CONNECTIVE TISSUE FORM A MASS OF REPAIR TISSUE
- BONY CALLUS IS FORMED
- OVER THE NEXT FEW MONTHS, THE BONY CALLUS IS REMODELED IN RESPONSE TO THE MECHANICAL STRESSES PLACED ON IT SO THAT IT FORMS A STRONG PERMANENT “PATCH” AT THE FRACTURE SITE

# BONE FRACTURES



Hematoma

Internal callus (fibrous tissue and cartilage)



Hematoma

Internal callus (fibrous tissue and cartilage)

Spongy bone trabecula



Bony callus of spongy bone

Healed fracture

