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Poultry Research Centre
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Trace element nutrition and bone metabolism

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THE WORLD'S POULTRY SCIENCE ASSOCIATION
EDUCATION ORGANIZATION RESEARCH

ASSOCIAZIONE SCIENTIFICA DI AVICOLTURA
Italian Branch of World's Poultry Science Association

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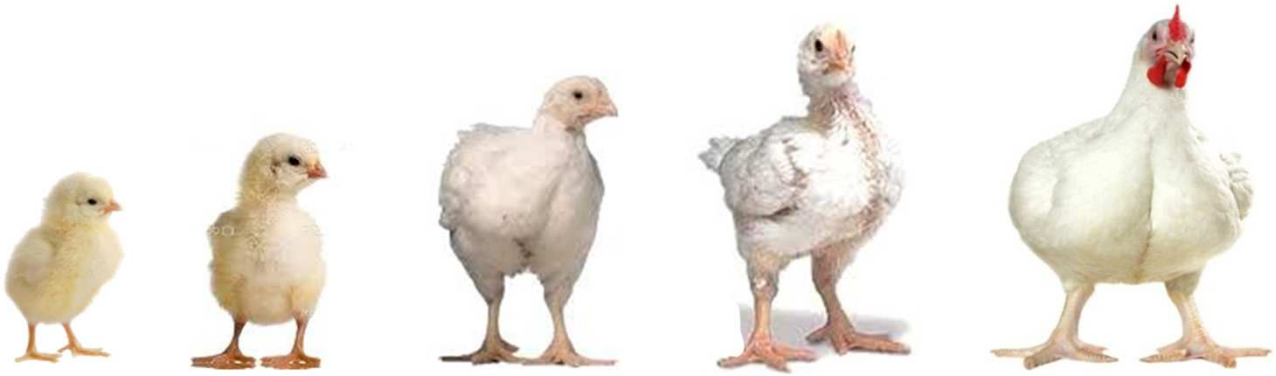
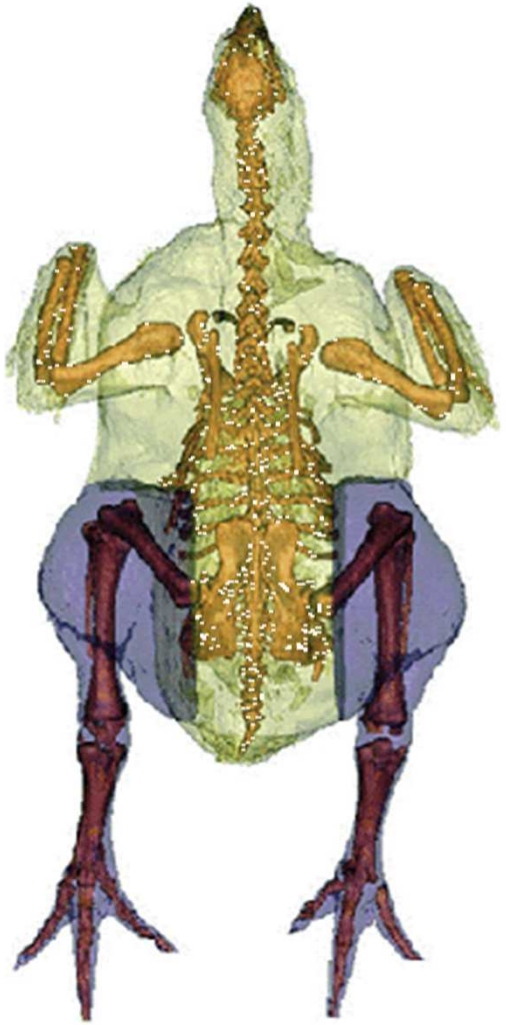
The Broiler Skeleton



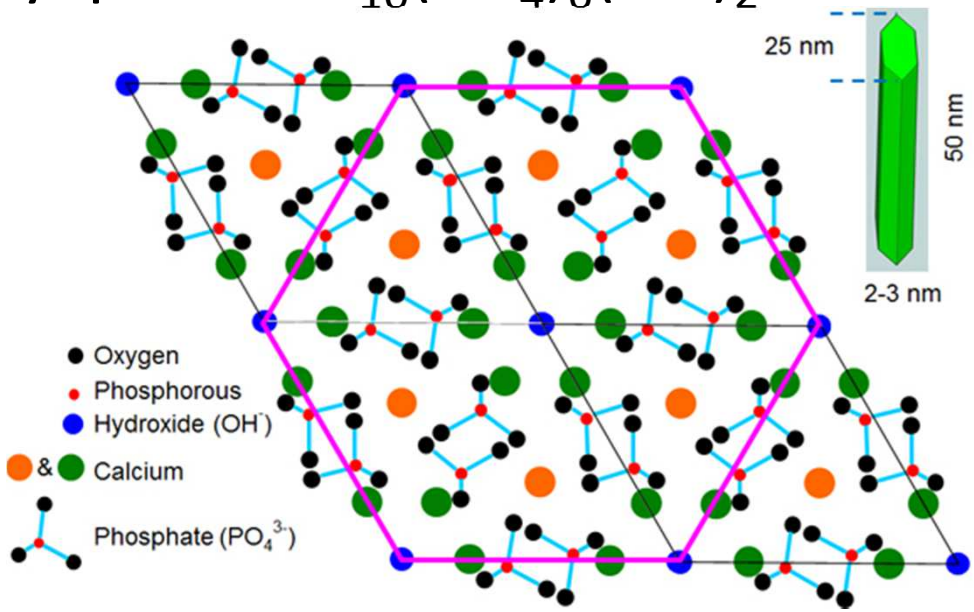
<----------50 x in 5 weeks ---------->



http://www.thepoultrysite.com/articles/2216/biomechanical-compromises-and-constraints-on-locomotion-and-breathing-in-broiler-chickens

Bone mineral

- Mineralization
  - Hydroxyapatite $Ca_{10}(PO_4)_6(OH)_2$



http://www.iupui.edu/~bbml/boneintro.shtml

- Bone strength
  - brittleness

Cartilage matrix

- Tensile strength & elasticity

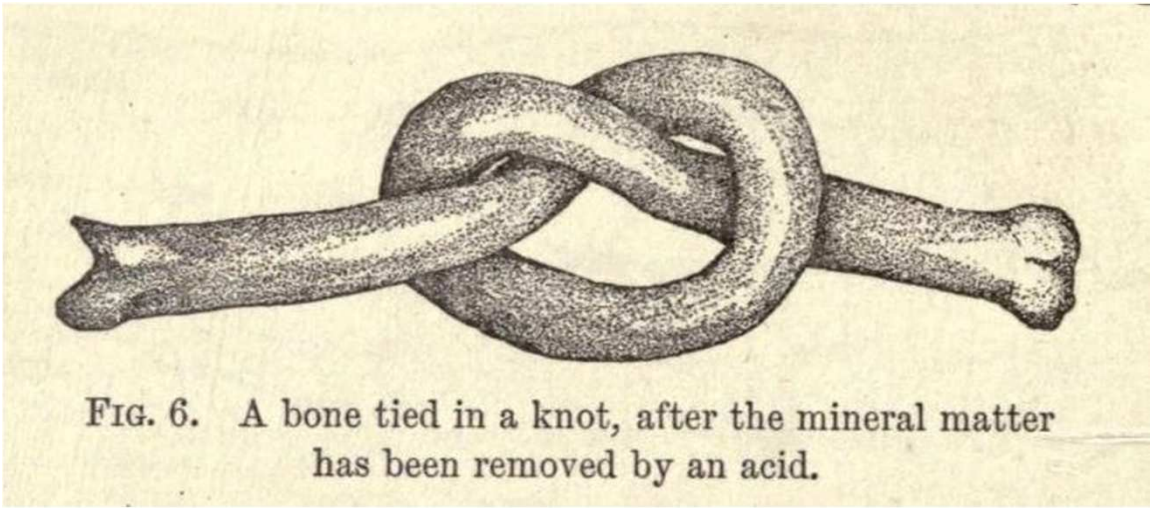
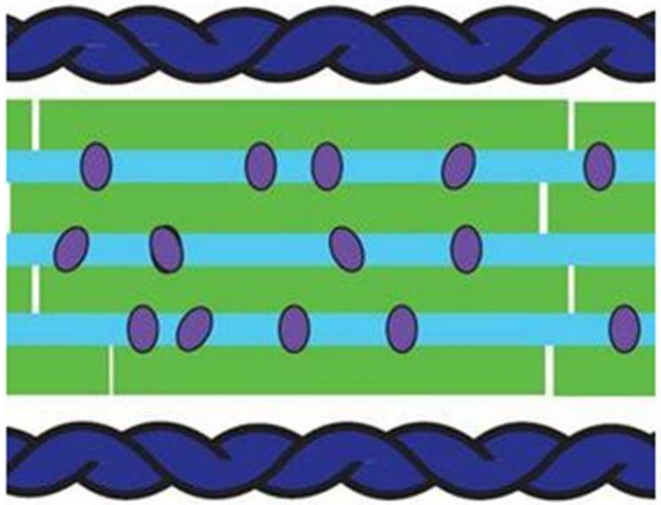


FIG. 6. A bone tied in a knot, after the mineral matter has been removed by an acid.

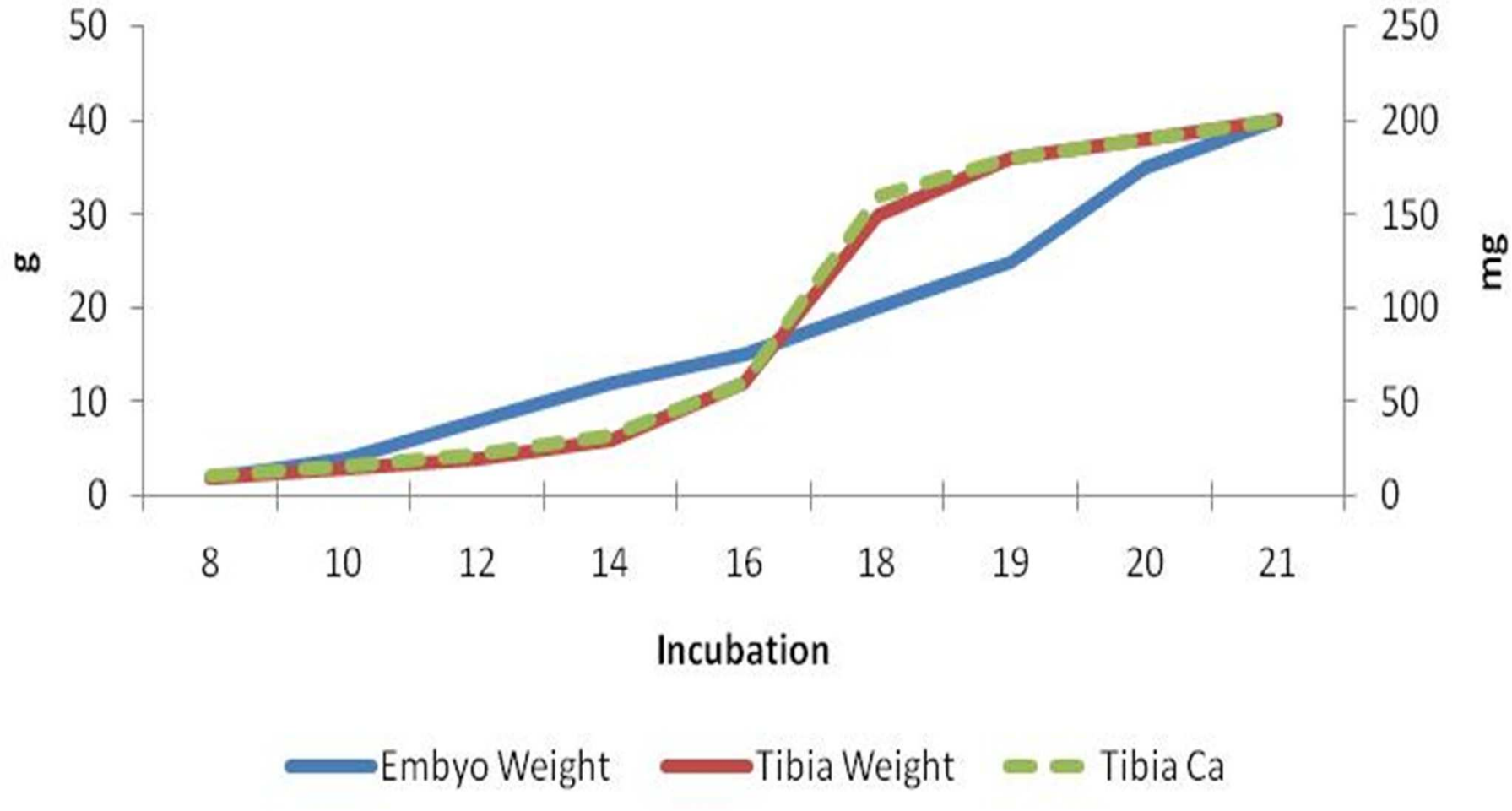


*Bone structure. Collagen fibres (blue) surround mineral platelets (green) which are cushioned by a water (light blue) and citrate (purple) layer. Courtesy **U of Cambridge***

Embryonic bone growth

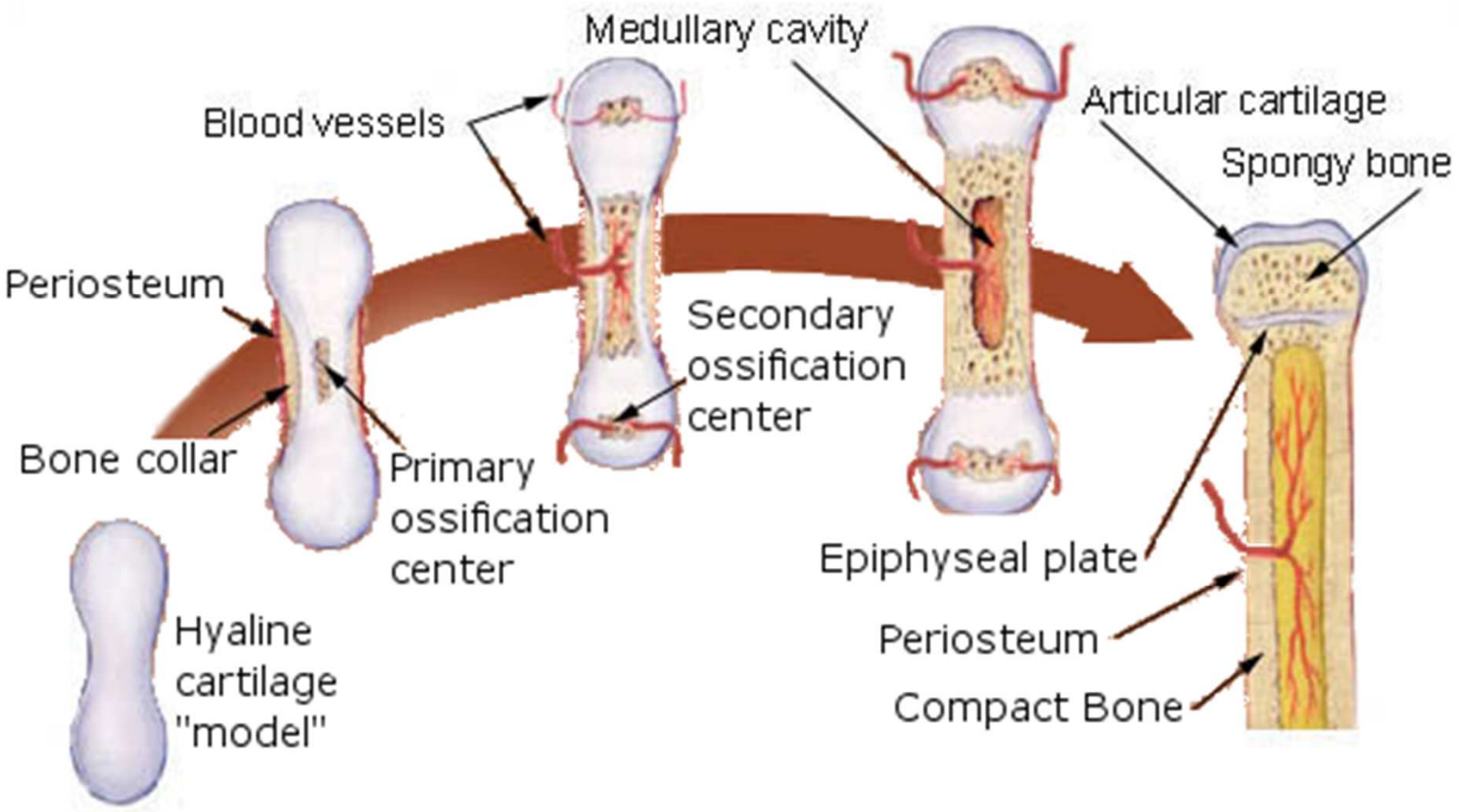
Cartilage model **Femur – 20d embryo** **20d chicken embryo**

Embryonic bone growth

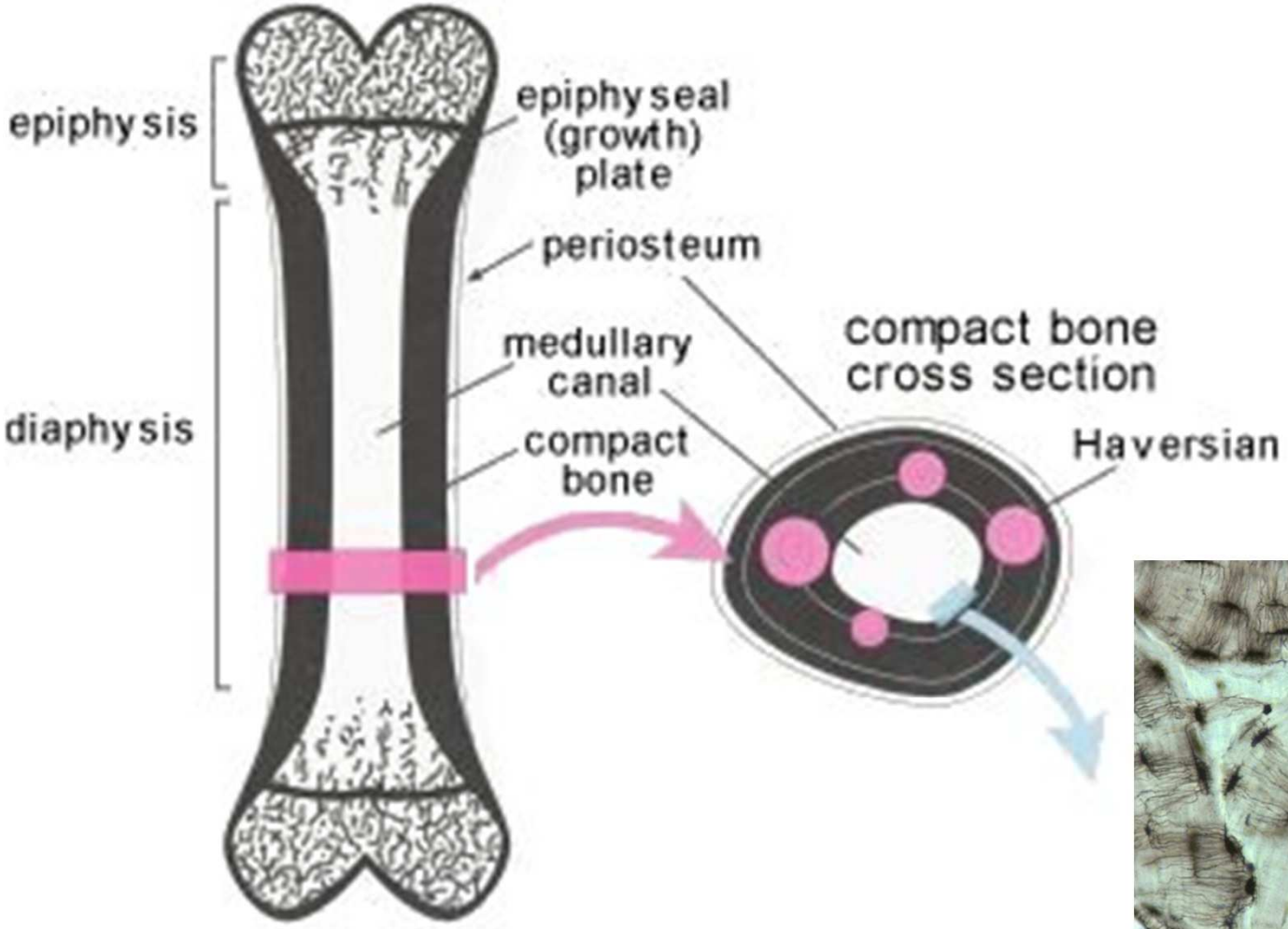


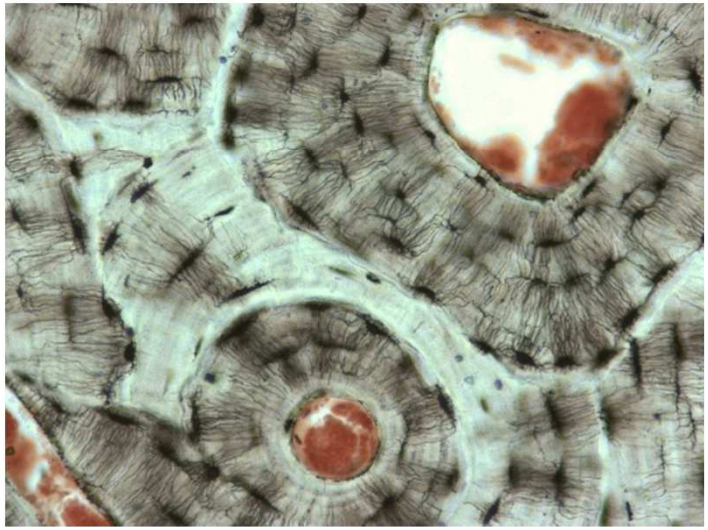
Adapted from Kubota et al., (1981)

Bone growth - elongation

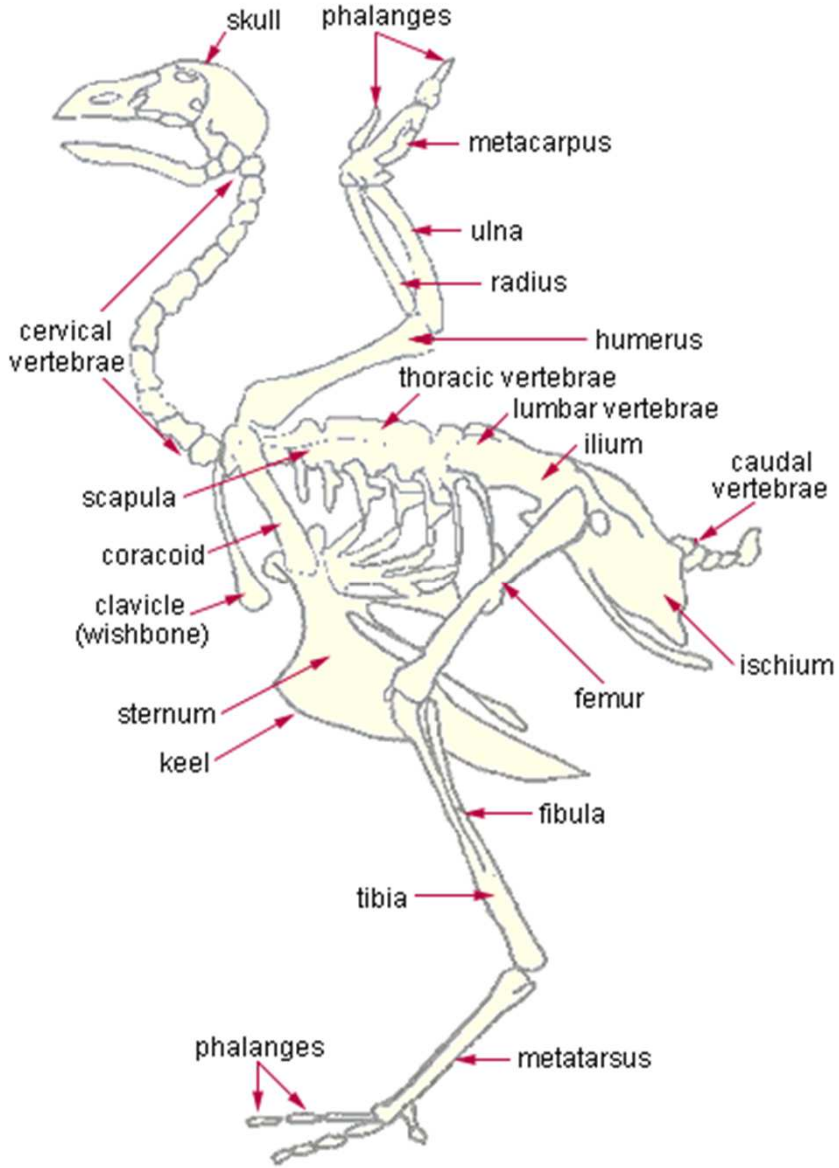


Bone growth - width



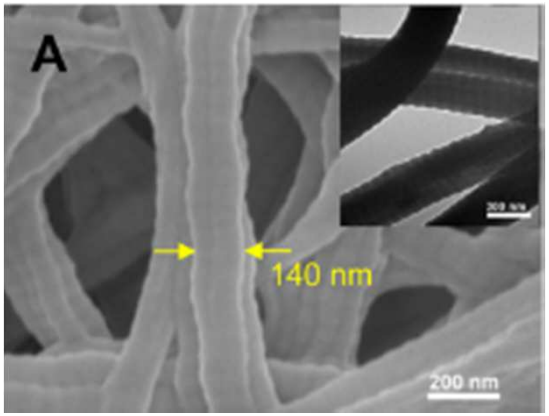


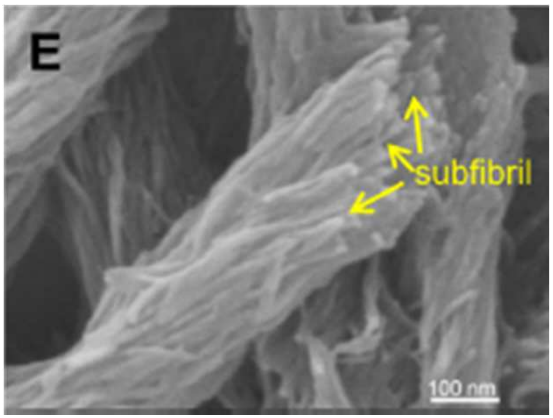
Trace elements & bones

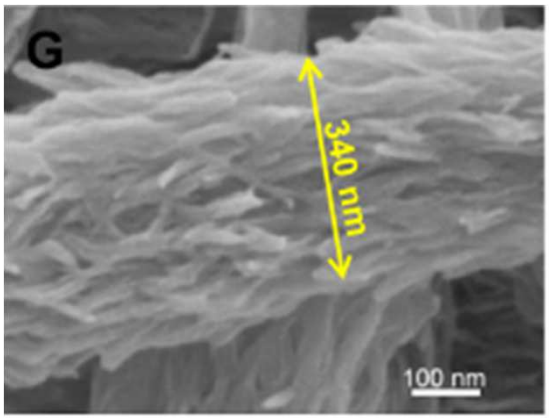


Trace elements & bones

- Copper
  - Lysyl oxidase
    - Elastin and collagen cross-linking
      - Tensile strength and elasticity





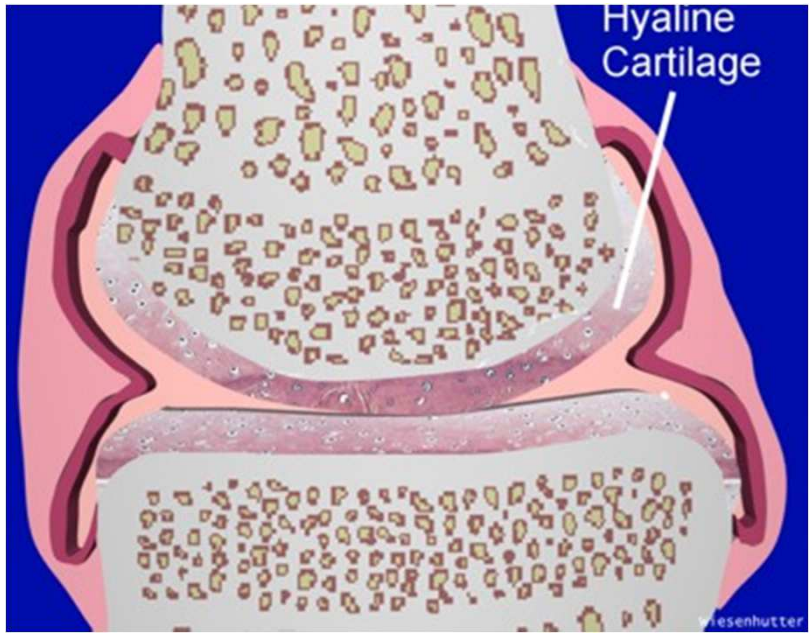


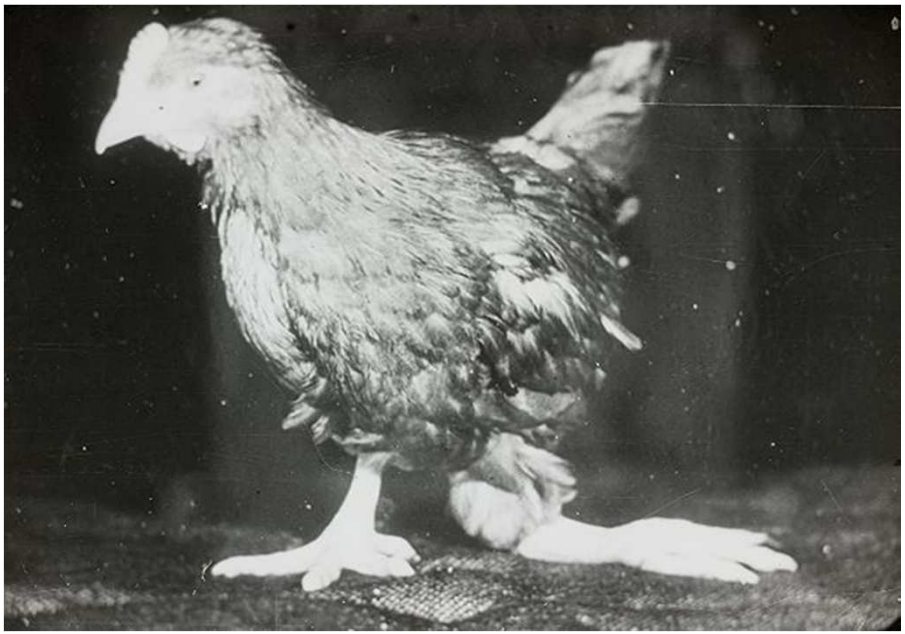
A: non-crosslinked collagen fibrils
E,G: crosslinked collagen fibrils after mineralization composed of bundles of subfibrils

Yi & Aparicio, 2013

Trace elements & bones

- Manganese
  - – Polymerase & galactotransferase
    - Chondroitin sulfate – hyaline cartilage



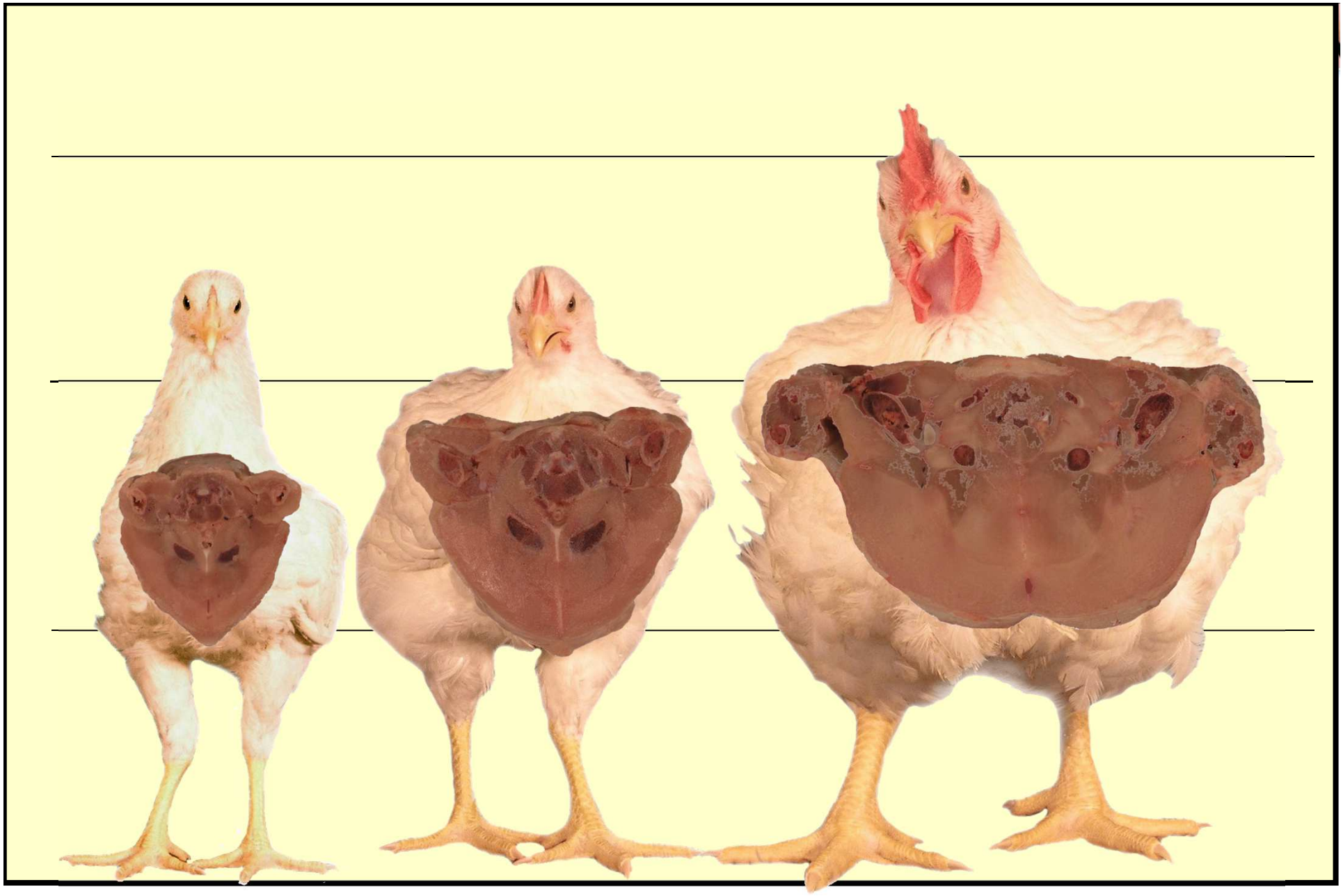


Trace elements & bones

- Zinc
  - Collagenase cofactor
    - Collagen formation
  - Alkaline phosphatase
    - Bone mineralization
  - Osteoblast proliferation
  - Growth plate gene expression

Trace element requirements

- Little new research
  - Dietary requirements well understood
  - Low cost of supplementation
  - Toleration of excess
- Opportunities
  - Selection for rapid growth
  - Maternal nutrient transfer
  - Organic trace minerals
  - Phytase

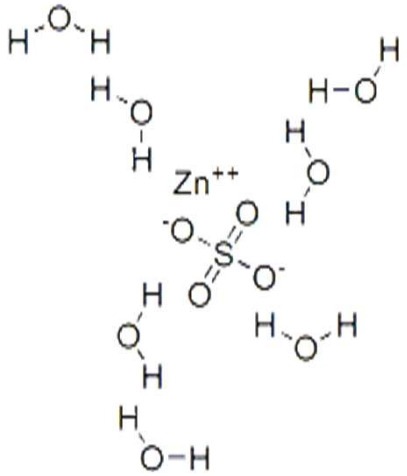


Broiler 50 years ago Broiler 30 years ago Today's Broiler

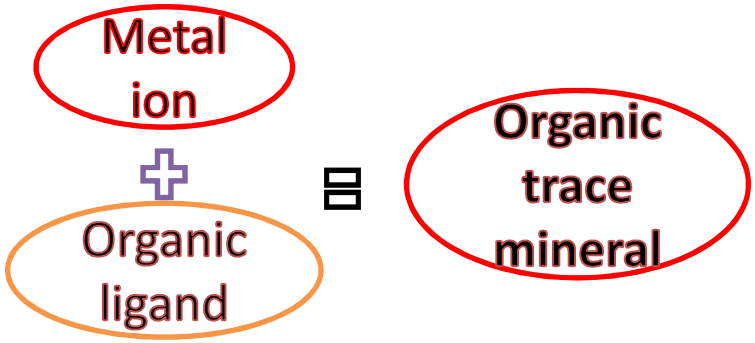
M. Zuidhof, University of Alberta

Organic trace elements

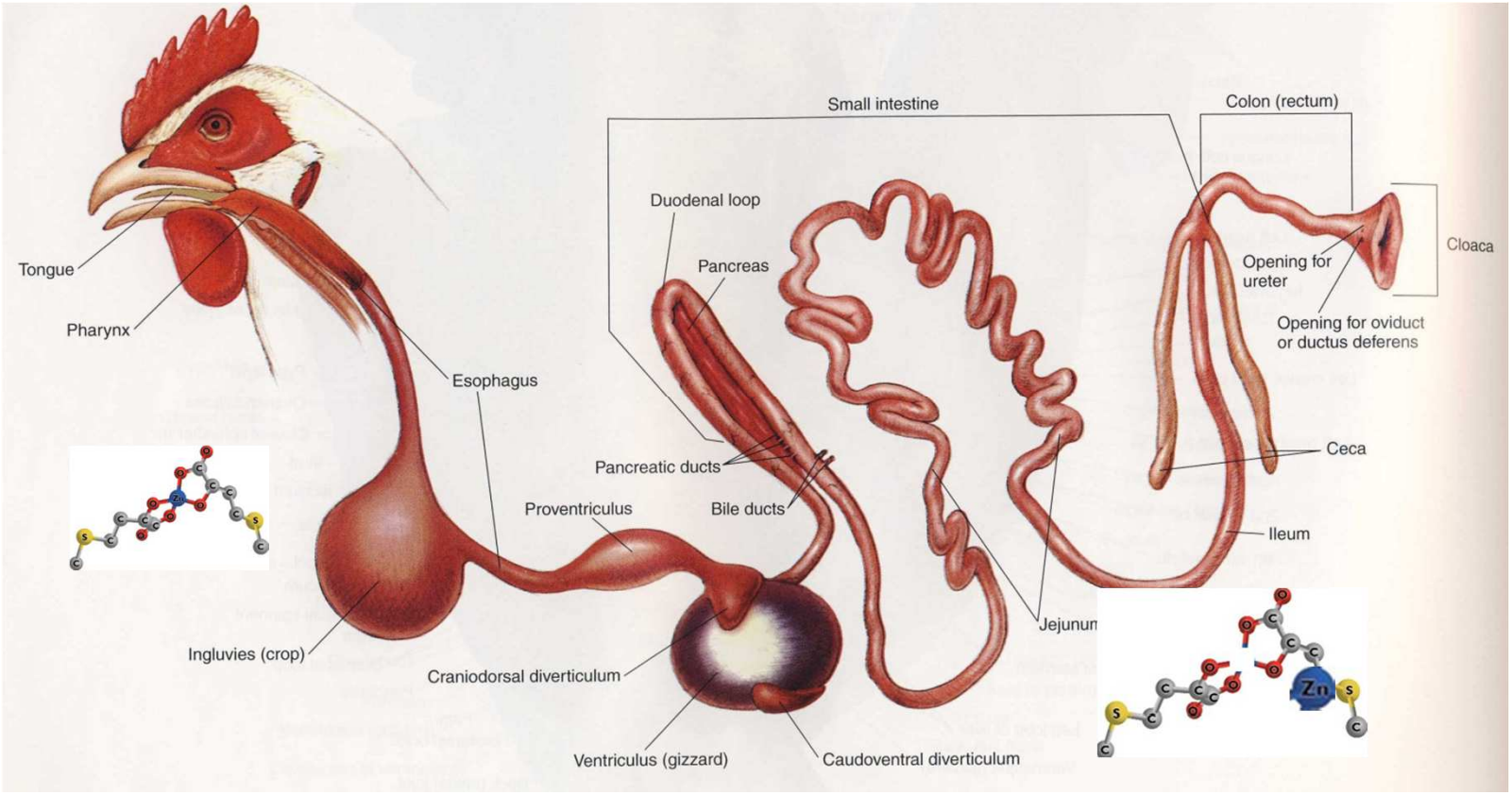
- **Inorganic trace minerals (ITM)**



- **Organic trace minerals (OTM)**



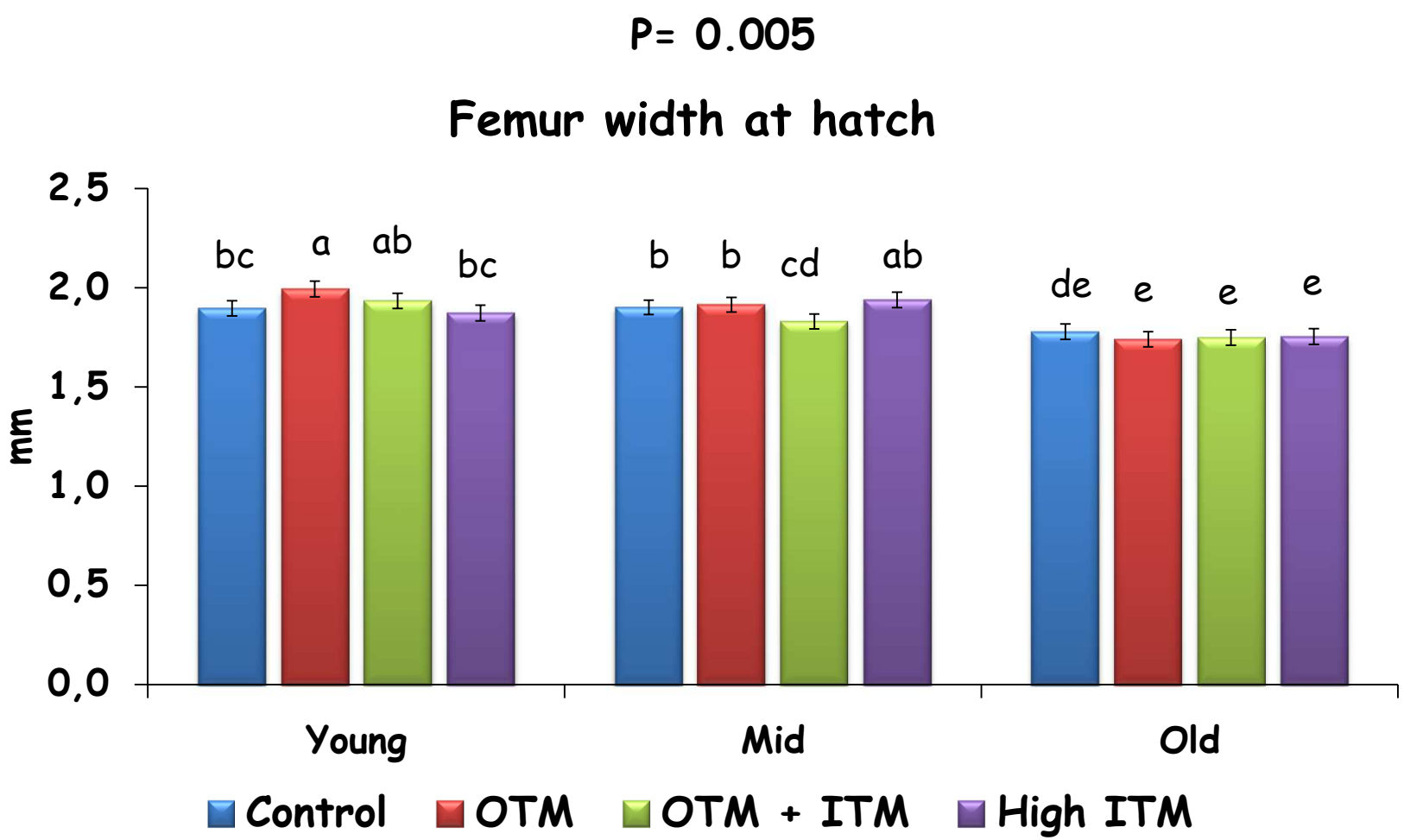
Organic trace elements



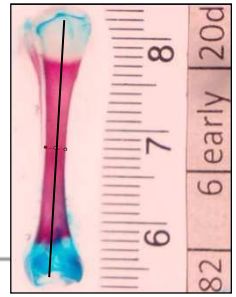
Organic forms are assumed to have increased bioavailability

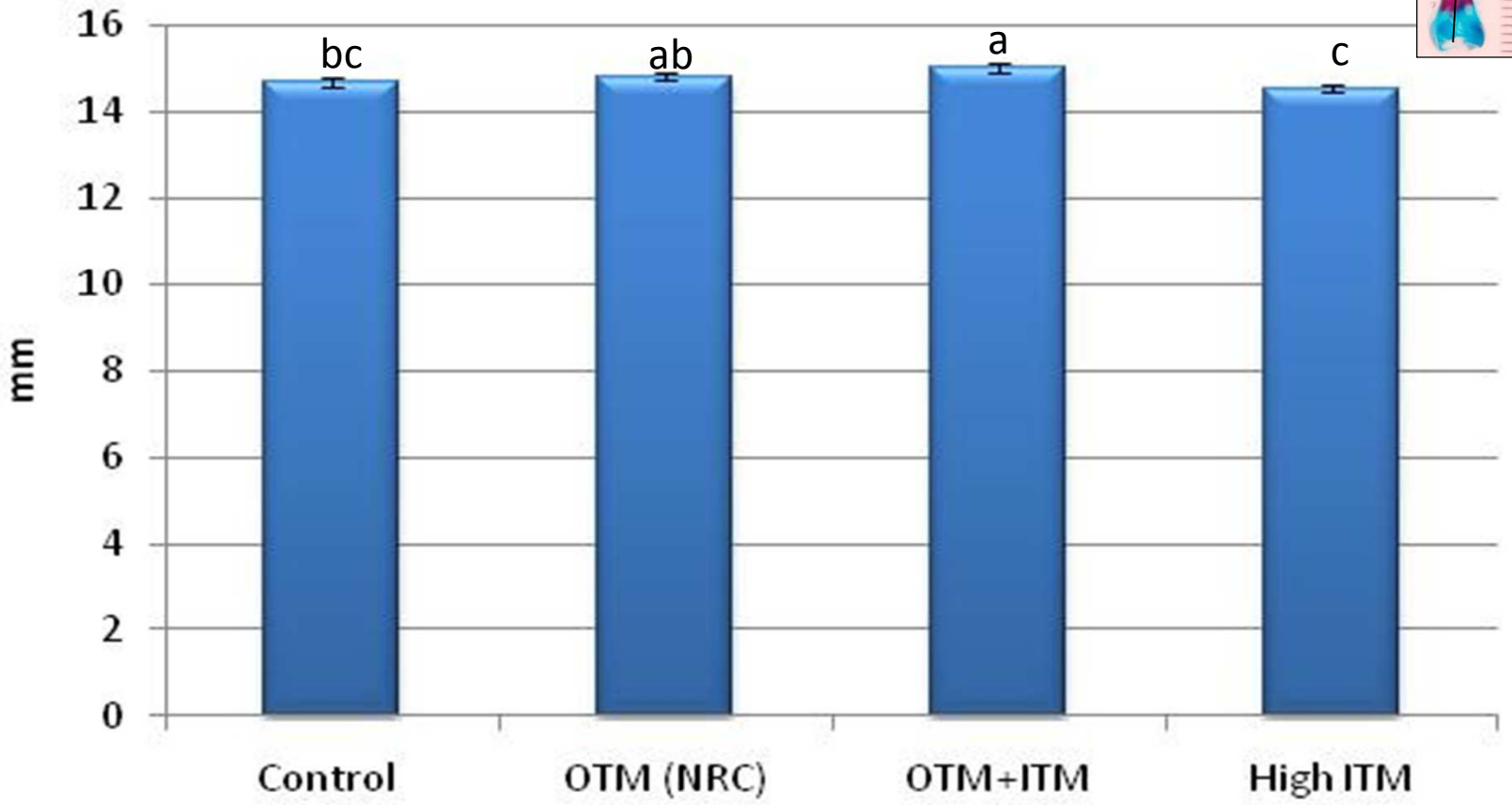
(Lesson, 2003)

Maternal trace element nutrition



Femur length E15



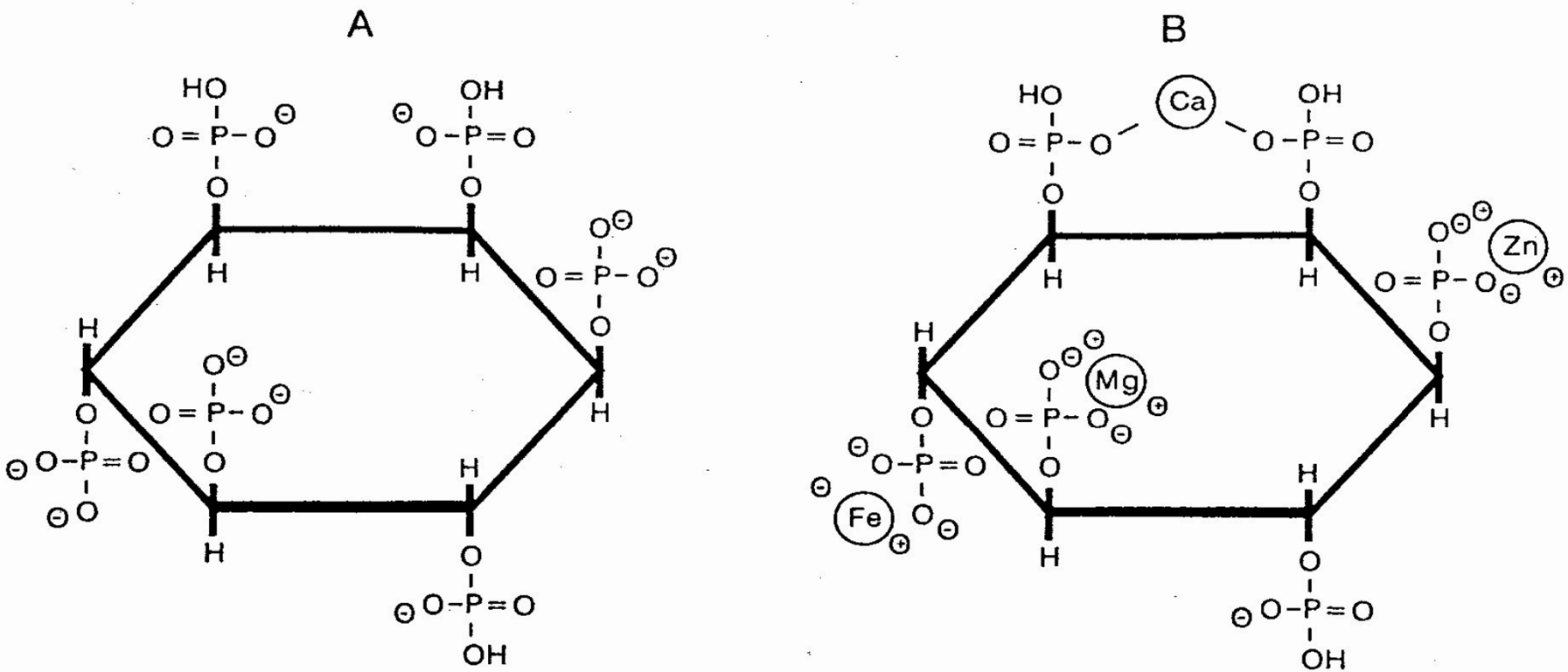


Treatment: P=0.005
BW <.0001

a, b, c LSmeans with different letters are significantly different (P≤0.05).

Phytase

Structure of Phytic Acid (A) and Phytic Acid Chelate (B)



Myo-inositol hexaphosphoric acid

Conclusion

- Trace minerals are essential for bone formation

- Little current research on trace minerals and bone metabolism
  - Physiological limits to skeletal growth/development?
  - Specialized application of supplements
    - Organic trace elements
    - Phytase