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A Study of Bone Histology Procedures and Applications

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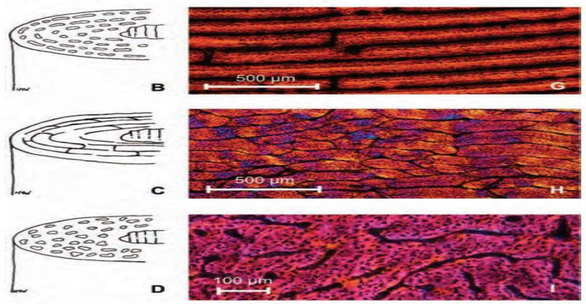
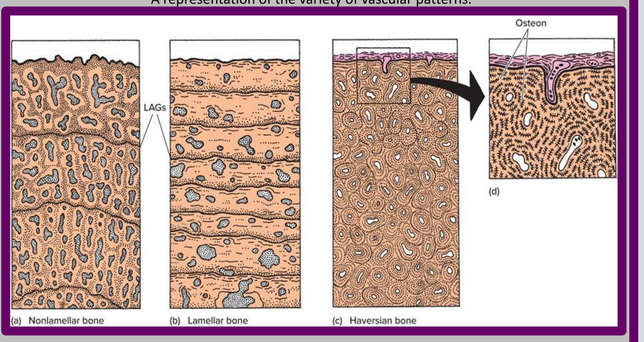
Introduction:

Bone histology permits the testing of questions related to ontogenetic age and growth rate, which would be otherwise unobtainable from the external morphology. However, the histology of bone microstructure comes in many types and differences in terminology can often lead to differences in interpretations.

Vascular patterns allow for the differentiation of growth rates and growth periods. But what does each vascular pattern explain? Does every bone and all parts exhibit the same information?



(modified from fig 2.4 Huttenlocker *et_al.,* 2013)
A representation of the variety of vascular patterns.



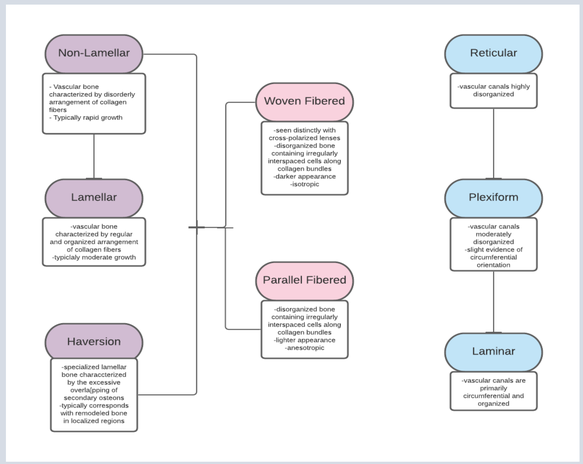
(fig. 5:22 Kardong, 2019)
A schematic diagram representing general bone types and the presence of growth marks.

Terminology:

What is zonal bone?

Zonal bone is bone that exhibits distinct cyclical periods, or zones, of sustained deposition interrupted by growth marks, which are intermittent pauses in the bone growth of the animal. Growth marks can be categorized based on their morphology and the major types are listed below:

- LAG (line of arrested growth): a complete cessation of bone growth; no fibrous connections demonstrated with adjacent zones
- Annulus: an interruption in bone growth that typically coincides with an annual cycle
- Cyclical growth mark: a line of restation occurring in regular pattern



Selection of Specimens:

Weight-bearing or non-weight-bearing bones?

Growth Marks are necessary to study the growth rate and age of an individual, which are best preserved in long bones (e.g humerus, femur, tibia, fibula).

Why section at the diaphysis?

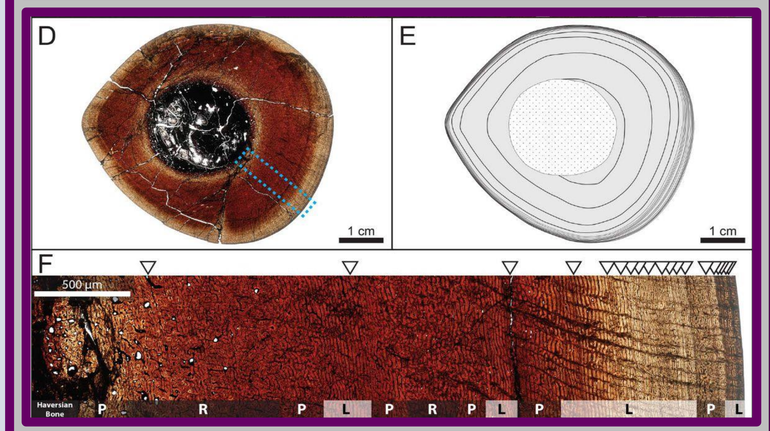
Long bones have the thickest cortical bone along the diaphysis (shaft), particularly at the minimal circumference.

Why section in the transverse plane?

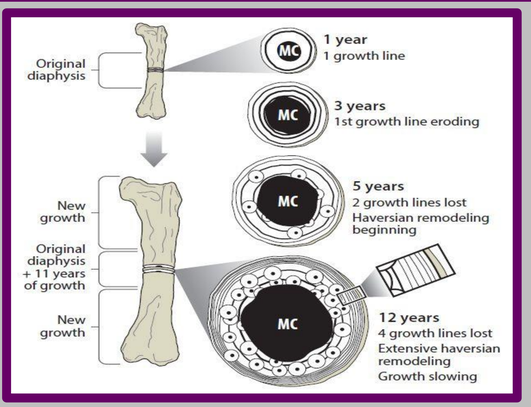
Thin sections in the transverse plane allow for the demonstration of demonstrate deposition patterns represented by growth marks and mechanical stresses.

Secondary remodeling

It is important to avoid sections featuring significant secondary remodeling as growth records can be obliterated by secondary osteons which act as patches along the longitudinal axis of the bone.



(modified from fig. 5 Wosik *et al.,* 2020)
A cross sectional specimen exhibiting the varies vascular patterns as well as the presence of secondary remodeling.



(fig. 4 Erickson, 2014)
A schematic representation of the growth of the medullary cavity and the effects of secondary remodeling.

Applications:

1.Biomechanics

a.How does the skeletal structure affect the individual's locomotion

b.Muscle scars

2.Nutrition

a.What is the individual consuming

b.Does the individual hibernate/nocturnal

c.Is the speed of bone growth correlated to metabolic rate

3.Physiological factors

a.Individual ages = weight shift

b.Hormone levels (changes with age)

4.Environmental factors

a.Inside the egg vs. the stresses of the outside world

b.What is the environment/habitat

Discussion:

A single specimen can demonstrate multiple vascular patterns and bone types. As explained above, each bone type and vascularity pattern have separate and distinguishable characteristics. These concepts can be further examined in fig. 5.

All distinct LAGs are identified by arrows. Starting with the medullary cavity on the leftmost region of Image F, secondary osteons are spread throughout and likely obliterated some of the early growth record. Reticular bone vascularization can be observed indicating fast growth.

Moving toward the outer most surface on the right most region of Image F, plexiform patterns become apparent, indicating a slower, slightly more organized growth.

Laminar patterns, representing the greatest organization and slowest pace, are observed in significant amounts along the right third of the section.

Early growth record can often be obliterated by the secondary remodeling of stressed areas of the bone. Later growth record is preserved. This concept can be seen in fig. 4.

References:

Erickson GM. 2014. On Dinosaur Growth. *The Annual Review of Earth and Planetary Sciences*.

Huttenlocker AK, Woodward HN, and Hall BK. 2013. *The Biology of Bone*.

Kardong KV. 2019. Vertebrates: Comparative Anatomy, Function, Evolution.

Wosik M, Chiba K, et al. 2020. Testing Size-frequency Distributions as a Method of Ontogenetic Aging. *Paleobiology*.