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# Mechanical & Materials Engineering

## *Pierson Graduate Seminar*

### Multiscale characterization of Bone Tissue: from modelling approaches to the patient's bed

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**Bone is a complex multiscale anisotropic medium. At the scale of several hundred nanometres, mineralized bone is composed of elementary components such as hydroxyapatite, collagen molecules and water. At the scale of 1 to 10 µm, bone is constituted by the ultrastructure composed of fibrils and extrafibrillar spaces. At the scale of several hundred micrometers, the microstructure of cortical bone is made of cylindrical units called osteons whereas that of trabecular bone is made of an interconnected network of more or less disordered trabeculae.**

**First, Quantitative ultrasound (QUS) methods aiming at estimating trabecular bone quality will be considered. The coupling of numerical simulation tools with high resolution imaging techniques led to the estimation of the sensitivity of ultrasonic parameters to controlled modifications of bone properties by considering an *in silico* approach of osteoporosis.**

**Second, QUS methods applied to cortical bone will be presented. An experimental multimodal approach allowed a better understanding of ultrasonic propagation at 4 MHz. Finite element numerical simulation tools aiming at modelling the axial transmission configuration have been developed.**

**Third, osseointegration of endosseous implants will be studied from a biomechanical point of view. A fundamental approach consisting in studying a dedicated animal model with a planar bone-implant interface will be studied. Then, an ultrasonic device dedicated to dental implant stability estimation, which is now under clinical transfer, will be described. Another approach using impact analysis for the estimation of the primary stability of acetabular cup implants used in hip implant surgery will be presented.**

**Eventually, future paths for potential research projects will be proposed.**

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