Stevens Institute of Technology

Nanotechnology Graduate Program

Nanoscale Biomineralization of Bone and Tendon in Orthopaedic Repair

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Bone is a renewable living tissue that provides our internal skeleton and serves as a repository for calcium in the human body. It is an intricate composite of bi-continuous organic (collagen) and inorganic (hydroxyapatite) phases that remodels itself nearly yearly in response to stress. Bones are connected through ligaments (e.g., the ACL in the knee) and to musculature through intermediary tendon (e.g., connecting shoulder and back muscles to the bones of the shoulder). Bone is separated from other bone at joints by a layer of cartilage. When bones, joints or the associated connective tissues fail, surgical intervention is necessary: a failed hip joint can be replaced by inserting the stem of a replacement alloy femoral neck and ball joint into the marrow cavity of the femur; a severed ACL can be replaced by an excised section of hamstring tendon; or a tendon pulled off the scapula in a typical rotator cuff injury can be sutured back to bone and reattached. In all three cases, the integrity of the repair is reliant on nanoscale mineralization of new tissue forming at the bone-repair interface. Mineralization occurs on a surprisingly rapid time scale (days) and can be encouraged by osteoconductive or bioactive additives (e.g. hydroxyapatite coatings or calcium compound particulates) to orthopaedic implant devices, such as femoral stems, interference screws, or bioresorbable polymer sutures or anchors. This presentation will present electron microscopy studies of bone, cartilage and tendon biomineralization in the three cited examples derived from both human and animal models.

Prof. Linn W. Hobbs was educated at Northwestern University (B.S., Materials, 1966) and at Oxford University (D.Phil., Materials, 1972, as a Marshall Scholar), where he afterwards held an NSF Postdoctoral Fellowship and was subsequently elected a Research Fellow of Wolfson College, Oxford and worked for the UK Atomic Energy Research Establishment at Harwell. He has held professorial appointments at MIT for the last 30 years and was the inaugural holder of the John F. Elliot Chair in Materials (1992-99). His research spans a wide compass of materials studies: spectroscopy and microscopy of point defects and radiation damage, non-stoichiometry and extended defects in non-metals, computational modeling of the atomic structure of glasses and amorphized materials, high-temperature corrosion, and biomineralization and orthopaedic biomaterials. He has served as president of the Microscopy Society of America (1987), a director of the Materials Research Society (1983-86), and a director of the American Ceramic Society (2003-06). He chaired New England regional selection committees for the Marshall Scholarships for thirteen years and the Truman Scholarships for the last four. He was made an Officer of the Order of the British Empire by Queen Elizabeth in 2001.

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