WORKSHOP 8

Tissue Engineered Medical Products

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Standards for Tissue Engineered Medical Products

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Abstract

The developments of consensus standards for orthopaedic and other medical products were initiated within the American Society for Testing and Materials (ASTM) through the formation of Committee F04 in the early 1960's. Within a decade, hundreds of documents were processed and standards published. Considerable emphasis was placed on specifications for synthetic origin biomaterial properties and testing methods for obtaining quantitative data about components and constructs of implant devices. Another aspect included guides and terminologies where groups comprised of users, manufacturers and general interests came together twice annually to achieve consensus. To assist in gaining current science and technology, focused Workshops and Symposia were held, leading to pier-reviewed information as Standard Technical Publications (STP's). In the 1990's, this process was expanded to include Tissue Engineered Medical Product Standards (TEMPS). Since this area of medical products was rapidly evolving and many were in a phase of research, terminology and reference materials were considered as a starting point.

The TEMPS activities, named Division IV of ASTMFF04 expanded rapidly as the multiple benefits of developing consensus standards were realized, especially consideration for Food and Drug Administration (FDA) regulatory processes. At this time, the FDA has formally recognized many of the TEMPS and Division IV remains very alive at the May and November meetings.

Since consensus standards are developed for intended applications, the need for extending research and development towards applications (medical-products) strongly supports the need for more basic and applied information and interpretation related to the intended benefit to risk ratio. Those participating in ASTMF04 and especially standards related to TEMPS, continue to seek more participation. One intent of this presentation is to offer an open invitation to members and participants of the Orthopaedic Research Society (ORS). If questions exist, please contact the author or the organizers of this Workshop.

Current list of ASTM F04 Standards on Tissue Engineered Medical Products

F04.41 Classification and Terminology for TEMPs

F2211-13 Standard Classification for Tissue Engineered Medical Products (TEMPs)
F2311-08 Standard Guide for Classification of Therapeutic Skin Substitutes
F2312-11 Standard Terminology Relating to Tissue Engineered Medical Products

F04.42 Biomaterials and Biomolecules for TEMPs

F2027-08 Standard Guide for Characterization and Testing of Raw or Starting Biomaterials for Tissue-Engineered Medical Products
F2064-00(2006)e1 Standard Guide for Characterization and Testing of Alginates as Starting Materials Intended for Use in Biomedical and Tissue-Engineered Medical Products Application
F2103-11 Standard Guide for Characterization and Testing of Chitosan Salts as Starting Materials Intended for Use in Biomedical and Tissue-Engineered Medical Product Applications
F2131-02(2012) Standard Test Method for In Vitro Biological Activity of Recombinant Human Bone Morphogenetic Protein-2 (rhBMP-2) Using the W-20 Mouse Stromal Cell Line
F2150-13 Standard Guide for Characterization and Testing of Biomaterial Scaffolds Used in Tissue-Engineered Medical Products
F2212-11 Standard Guide for Characterization of Type I Collagen as Starting Material for Surgical Implants and Substrates for Tissue Engineered Medical Products (TEMPs)
F2259-10(2012)e1 Standard Test Method for Determining the Chemical Composition and Sequence in Alginate by Proton Nuclear Magnetic Resonance (1H NMR) Spectroscopy
F2260-03(2012)e1 Standard Test Method for Determining Degree of Deacetylation in Chitosan Salts by Proton Nuclear Magnetic Resonance (1H NMR) Spectroscopy
F2347-11 Standard Guide for Characterization and Testing of Hyaluronan as Starting Materials Intended for Use in Biomedical and Tissue Engineered Medical Product Applications
F2450-10 Standard Guide for Assessing Microstructure of Polymeric Scaffolds for Use in Tissue Engineered Medical Products
F2602-13 Standard Test Method for Determining the Molar Mass of Chitosan and Chitosan Salts by Size Exclusion Chromatography with Multi-angle Light Scattering Detection (SEC-MALS)
F2603-06(2012) Standard Guide for Interpreting Images of Polymeric Tissue Scaffolds
F2605-08e1 Standard Test Method for Determining the Molar Mass of Sodium Alginate by Size Exclusion Chromatography with Multi-angle Light Scattering Detection (SEC-MALS)
F2791-09 Standard Guide for Assessment of Surface Texture of Non-Porous Biomaterials in Two Dimensions
F2883-11 Standard Guide for Characterization of Ceramic and Mineral Based Scaffolds used for Tissue-Engineered Medical Products (TEMPs) and as Device for Surgical Implant Applications
F2900-11 Standard Guide for Characterization of Hydrogels used in Regenerative Medicine

F04.43 Cells and Tissue Engineered Constructs for TEMPs

F2149-01(2007) Standard Test Method for Automated Analyses of Cells-the Electrical Sensing Zone Method of Enumerating and Sizing Single Cell Suspensions

F2210-02(2010) Standard Guide for Processing Cells, Tissues, and Organs for Use in Tissue Engineered Medical Products
F2315-11 Standard Guide for Immobilization or Encapsulation of Living Cells or Tissue in Alginate Gels
F2664-11 Standard Guide for Assessing the Attachment of Cells to Biomaterial Surfaces by Physical Methods
F2739-08 Standard Guide for Quantitating Cell Viability Within Biomaterial Scaffolds
F2944-12 Standard Test Method for Automated Colony Forming Unit (CFU) Assays—Image Acquisition and Analysis Method for Enumerating and Characterizing Cells and Colonies in Culture

F04.44 Assessment for TEMPs

F2451-05(2010) Standard Guide for in vivo Assessment of Implantable Devices Intended to Repair or Regenerate Articular Cartilage
F2529-13 Standard Guide for in vivo Evaluation of Osteoinductive Potential for Materials Containing Demineralized Bone (DBM)
F2721-09 Standard Guide for Pre-clinical in vivo Evaluation in Critical Size Segmental Bone Defects
F2884-12 Standard Guide for Pre-clinical in vivo Evaluation of Spinal Fusion
F2903-11 Standard Guide for Tissue Engineered Medical Products (TEMPs) for Reinforcement of Tendon and Ligament Surgical Repair

F04.45 Adventitious Agents Safety

F2383-11 Standard Guide for Assessment of Adventitious Agents in Tissue Engineered Medical Products (TEMPs)

F04.46 Cell Signaling

No standards to date.

Title: Scaffolds for Bone and Cartilage Repair: When and Which!

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Abstract:

For several decades, scaffolds have been developed in combinations with biologics, drugs or cells for bone and cartilage repair. A number of biodegradable and bioresorbable materials, as well as scaffold designs, have been experimentally and clinically studied. General paradigms were that scaffolds should have the following characteristics: (i) three-dimensional and highly porous with an interconnected pore network for cell growth and flow transport of nutrients and metabolic waste; (ii) biocompatible and bioresorbable with a controllable degradation and resorption rate to match cell/tissue growth *in vitro* and/or *in vivo*; (iii) suitable surface chemistry for cell attachment, proliferation, and differentiation and (iv) mechanical properties to match those of the tissues at the site of implantation. Several factors such as addition of growth factors and the osteogenic or chondrogenic properties of the scaffolds have shown to influence *in vivo* repair. However, optimal and reliable repair outcome in a large range of cases has not been achieved so far.

In this talk the importance of understanding the tissue and the cause for the damage will be emphasized when considering a repair therapy. Indeed, a transition from the concept of targeting engineered tissue to that of engineering process recapitulating the stages of tissue development and enhance the endogenous repair is taking place in musculoskeletal regenerative research. In the context of long bone repair, the principle of engineering processes targets the engineering of bone through endochondral ossification, the embryonic development pathway of long bones. The natural process of endochondral bone formation is associated with several advantages when translated to approaches for bone TE. It has the potential to overcome issues critical to the functioning of engineered bone grafts, such as resistance to hypoxic conditions, vascularization and mechanical stability. In the context of cartilage repair, the enhancement of the endogenous repair via bioactive scaffold releasing chemokines is also explored. The potentially impact of scaffold design properties will be discussed.