



Robert Lane Smith

Professor (Research) of Orthopedic Surgery, Emeritus
Orthopaedic Surgery

Bio

ACADEMIC APPOINTMENTS

- Professor Emeritus, Orthopaedic Surgery
- Member, Bio-X

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

Our group is interested in the molecular and cell biology underlying bone and cartilage metabolism in health and disease. Normal daily activities are linked to the ability of the articular cartilage to withstand normal joint forces that may reach 5-7 times body weight and bone homeostasis depends on daily mechanical loading histories. The phenotypic stability of cartilage and bone depends on a complex interplay between stimuli influencing cell metabolism, physical forces, cytokines, hormones and growth factors, and the genetic expression determining the material properties of the tissue. Our lab applies modern biochemical techniques to analyze:

1. Mechanisms of cartilage degradation in inflammation and sepsis;
2. Stimulation of cartilage growth and repair by growth factors and hormones in serum-free culture;
3. Effects of adherence and deposition of glycocalyx on bacterial resistance to antibiotic treatment;
4. Effects of mechanical stresses and strains on cartilage and bone cell gene expression and matrix syntheses;
5. Analysis of metal particles on bone resorption and prosthetic loosening in total joint arthroplasty.

The experimental techniques include development of primary cultures of human chondrocytes, quantification of proteoglycan and collagen synthesis and degradation, zymogen and kinetic analysis of neutral metalloproteinases, western analysis of protein expression, northern and slot blot analysis of mRNA levels and cloning of connective tissue and bacterial genes.

Publications

PUBLICATIONS

- **Local versus distal transplantation of human neural stem cells following chronic spinal cord injury** *SPINE JOURNAL*
Cheng, I., Githens, M., Smith, R. L., Johnston, T. R., Park, D. Y., Stauff, M. P., Salari, N., Tileston, K. R., Kharazi, A. I.
2016; 16 (6): 764-769
- **Identification of Human Juvenile Chondrocyte-Specific Factors that Stimulate Stem Cell Growth** *TISSUE ENGINEERING PART A*

- Taylor, S. E., Lee, J., Smeriglio, P., Razzaque, A., Smith, R. L., Dragoo, J. L., Maloney, W. J., Bhutani, N.
2016; 22 (7-8): 645-653
- **Biochemical and Cellular Assessment of Acetabular Chondral Flaps Identified During Hip Arthroscopy** *ARTHROSCOPY-THE JOURNAL OF ARTHROSCOPIC AND RELATED SURGERY*
Hariri, S., Truntzer, J., Smith, R. L., Safran, M. R.
2015; 31 (6): 1077-1083
 - **T1 rho Dispersion in Articular Cartilage: Relationship to Material Properties and Macromolecular Content** *CARTILAGE*
Keenan, K. E., Besier, T. F., Pauly, J. M., Smith, R. L., Delp, S. L., Beaupre, G. S., Gold, G. E.
2015; 6 (2): 113-122
 - **Interaction Between Osteoarthritic Chondrocytes and Adipose-Derived Stem Cells Is Dependent on Cell Distribution in Three-Dimension and Transforming Growth Factor- β 3 Induction.** *Tissue engineering. Part A*
Lai, J. H., Rogan, H., Kajiyama, G., Goodman, S. B., Smith, R. L., Maloney, W., Yang, F.
2015; 21 (5-6): 992-1002
 - **Collagen VI Enhances Cartilage Tissue Generation by Stimulating Chondrocyte Proliferation.** *Tissue engineering. Part A*
Smeriglio, P., Dhulipala, L., Lai, J. H., Goodman, S. B., Dragoo, J. L., Smith, R. L., Maloney, W. J., Yang, F., Bhutani, N.
2015; 21 (3-4): 840-849
 - **Comparative potential of juvenile and adult human articular chondrocytes for cartilage tissue formation in three-dimensional biomimetic hydrogels.** *Tissue engineering. Part A*
Smeriglio, P., Lai, J. H., Dhulipala, L., Behn, A. W., Goodman, S. B., Smith, R. L., Maloney, W. J., Yang, F., Bhutani, N.
2015; 21 (1-2): 147-155
 - **Inhibition of Chondrocyte and Synovial Cell Death After Exposure to Commonly Used Anesthetics Chondrocyte Apoptosis After Anesthetics** *AMERICAN JOURNAL OF SPORTS MEDICINE*
Rao, A. J., Johnston, T. R., Harris, A. H., Smith, R. L., Costouros, J. G.
2014; 42 (1): 50-58
 - **Stem cells catalyze cartilage formation by neonatal articular chondrocytes in 3D biomimetic hydrogels** *SCIENTIFIC REPORTS*
Lai, J. H., Kajiyama, G., Smith, R. L., Maloney, W., Yang, F.
2013; 3
 - **Effects of Heme Oxygenase-1 on Bacterial Antigen-Induced Articular Chondrocyte Catabolism In Vitro** *JOURNAL OF ORTHOPAEDIC RESEARCH*
Mawatari, T., Nakamichi, I., Suenaga, E., Maloney, W. J., Smith, R. L.
2013; 31 (12): 1943-1949
 - **Local effect of IL-4 delivery on polyethylene particle induced osteolysis in the murine calvarium.** *Journal of biomedical materials research. Part A*
Rao, A. J., Nich, C., Dhulipala, L. S., Gibon, E., Valladares, R., Zwingenberger, S., Smith, R. L., Goodman, S. B.
2013; 101 (7): 1926-1934
 - **Direct subcutaneous injection of polyethylene particles over the murine calvaria results in dramatic osteolysis.** *International orthopaedics*
Rao, A. J., Zwingenberger, S., Valladares, R., Li, C., Lane Smith, R., Goodman, S. B., Nich, C.
2013; 37 (7): 1393-1398
 - **Local effect of IL-4 delivery on polyethylene particle induced osteolysis in the murine calvarium** *JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A*
Rao, A. J., Nich, C., Dhulipala, L. S., Gibon, E., Valladares, R., Zwingenberger, S., Smith, R. L., Goodman, S. B.
2013; 101A (7): 1925-1934
 - **Combined Transplantation of Human Neuronal and Mesenchymal Stem Cells following Spinal Cord Injury.** *Global spine journal*
Park, D. Y., Mayle, R. E., Smith, R. L., Corcoran-Schwartz, I., Kharazi, A. I., Cheng, I.
2013; 3 (1): 1-6
 - **Functional assessment of the acute local and distal transplantation of human neural stem cells after spinal cord injury** *SPINE JOURNAL*
Cheng, I., Mayle, R. E., Cox, C. A., Park, D. Y., Smith, R. L., Corcoran-Schwartz, I., Ponnusamy, K. E., Oshtory, R., Smuck, M. W., Mitra, R., Kharazi, A. I., Carragee, E. J.

2012; 12 (11): 1040-1044

- **A relationship between mechanically-induced changes in serum cartilage oligomeric matrix protein (COMP) and changes in cartilage thickness after 5 years** *OSTEOARTHRITIS AND CARTILAGE*
Erhart-Hledik, J. C., Favre, J., Asay, J. L., Smith, R. L., Giori, N. J., Muendermann, A., Andriacchi, T. P.
2012; 20 (11): 1309-1315
- **The effect of suture coated with mesenchymal stem cells and bioactive substrate on tendon repair strength in a rat model.** *journal of hand surgery*
Yao, J., Woon, C. Y., Behn, A., Korotkova, T., Park, D., Gajendran, V., Smith, R. L.
2012; 37 (8): 1639-1645
- **The Effect of Suture Coated With Mesenchymal Stem Cells and Bioactive Substrate on Tendon Repair Strength in a Rat Model** *JOURNAL OF HAND SURGERY-AMERICAN VOLUME*
Yao, J., Woon, C. Y., Behn, A., Korotkova, T., Park, D., Gajendran, V., Smith, R. L.
2012; 37A (8): 1639-1645
- **Revision joint replacement, wear particles, and macrophage polarization** *ACTA BIOMATERIALIA*
Rao, A. J., Gibon, E., Ma, T., Yao, Z., Smith, R. L., Goodman, S. B.
2012; 8 (7): 2815-2823
- **Effect of a CCR1 receptor antagonist on systemic trafficking of MSCs and polyethylene particle-associated bone loss** *BIOMATERIALS*
Gibon, E., Yao, Z., Rao, A. J., Zwingenberger, S., Batke, B., Valladares, R., Smith, R. L., Biswal, S., Gambhir, S. S., Goodman, S. B.
2012; 33 (14): 3632-3638
- **Molecular profile of osteoprogenitor cells seeded on allograft bone** *JOURNAL OF TISSUE ENGINEERING AND REGENERATIVE MEDICINE*
Smith, K. E., Huang, Z., Ma, T., Irani, A., Smith, R. L., Goodman, S. B.
2011; 5 (9): 704-711
- **Cross-relaxation Imaging of Human Articular Cartilage** *MAGNETIC RESONANCE IN MEDICINE*
Stikov, N., Keenan, K. E., Pauly, J. M., Smith, R. L., Dougherty, R. F., Gold, G. E.
2011; 66 (3): 725-734
- **Role of the Toll-like receptor pathway in the recognition of orthopedic implant wear-debris particles** *BIOMATERIALS*
Pearl, J. I., Ma, T., Irani, A. R., Huang, Z., Robinson, W. H., Smith, R. L., Goodman, S. B.
2011; 32 (24): 5535-5542
- **Effects of Intermittent Hydrostatic Pressure and BMP-2 on Osteoarthritic Human Chondrocyte Metabolism In Vitro** *JOURNAL OF ORTHOPAEDIC RESEARCH*
Smith, R. L., Lindsey, D. P., Dhulipala, L., Harris, A. H., Goodman, S. B., Maloney, W. J.
2011; 29 (3): 361-368
- **Prediction of glycosaminoglycan content in human cartilage by age, T1 rho and T2 MRI** *OSTEOARTHRITIS AND CARTILAGE*
Keenan, K. E., Besier, T. F., Pauly, J. M., Han, E., Rosenberg, J., Smith, R. L., Delp, S. L., Beaupre, G. S., Gold, G. E.
2011; 19 (2): 171-179
- **Viability and Proliferation of Pluripotential Cells Delivered to Tendon Repair Sites Using Bioactive Sutures-An In Vitro Study** *JOURNAL OF HAND SURGERY-AMERICAN VOLUME*
Yao, J., Korotkova, T., Smith, R. L.
2011; 36A (2): 252-258
- **Viability and proliferation of pluripotential cells delivered to tendon repair sites using bioactive sutures--an in vitro study.** *journal of hand surgery*
Yao, J., Korotkova, T., Smith, R. L.
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- **Effects of orthopedic polymer particles on chemotaxis of macrophages and mesenchymal stem cells.** *Journal of biomedical materials research. Part A*
Huang, Z., Ma, T., Ren, P., Smith, R. L., Goodman, S. B.
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2010; 94A (4): 1264-1269
- **Modulating osteogenesis of mesenchymal stem cells by modifying growth factor availability** *CYTOKINE*
Huang, Z., Ren, P., Ma, T., Smith, R. L., Goodman, S. B.
2010; 51 (3): 305-310
- **Surveillance of systemic trafficking of macrophages induced by UHMWPE particles in nude mice by noninvasive imaging** *JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A*
Ren, P., Huang, Z., Ma, T., Biswal, S., Smith, R. L., Goodman, S. B.
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- **Surveillance of systemic trafficking of macrophages induced by UHMWPE particles in nude mice by noninvasive imaging.** *Journal of biomedical materials research. Part A*
Ren, P., Huang, Z., Ma, T., Biswal, S., Smith, R. L., Goodman, S. B.
2010; 94 (3): 706-711
- **Effects of Tensile Strain and Fluid Flow on Osteoarthritic Human Chondrocyte Metabolism In Vitro** *JOURNAL OF ORTHOPAEDIC RESEARCH*
Mawatari, T., Lindsey, D. P., Harris, A. H., Goodman, S. B., Maloney, W. J., Smith, R. L.
2010; 28 (7): 907-913
- **Polymethylmethacrylate particle exposure causes changes in p38 MAPK and TGF-beta signaling in differentiating MC3T3-E1 cells** *JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A*
Ma, G. K., Chiu, R., Huang, Z., Pearl, J., Ma, T., Smith, R. L., Goodman, S. B.
2010; 94A (1): 234-240
- **Polymethylmethacrylate particle exposure causes changes in p38 MAPK and TGF-beta signaling in differentiating MC3T3-E1 cells.** *Journal of biomedical materials research. Part A*
Ma, G. K., Chiu, R., Huang, Z., Pearl, J., Ma, T., Smith, R. L., Goodman, S. B.
2010; 94 (1): 234-240
- **Flexor Tendon Tissue Engineering: Bioreactor Cyclic Strain Increases Construct Strength** *TISSUE ENGINEERING PART A*
Saber, S., Zhang, A. Y., Ki, S. H., Lindsey, D. P., Smith, R. L., Riboh, J., Pham, H., Chang, J.
2010; 16 (6): 2085-2090
- **Polymethylmethacrylate Particles Impair Osteoprogenitor Viability and Expression of Osteogenic Transcription Factors Runx2, Osterix, and Dlx5** *JOURNAL OF ORTHOPAEDIC RESEARCH*
Chiu, R., Smith, K. E., Ma, G. K., Ma, T., Smith, R. L., Goodman, S. B.
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- **POLYMETHYLMETHACRYLATE PARTICLES INHIBIT HUMAN MESENCHYMAL STEM CELL DIFFERENTIATION INTO OSTEOBLASTS** *Western Regional Meeting of the American-Federation-for-Medical-Research*
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- **POLYMETHYLMETHACRYLATE PARTICLES INHIBIT HUMAN MESENCHYMAL STEM CELL DIFFERENTIATION INTO OSTEOBLASTS** *Western Regional Meeting of the American-Federation-for-Medical-Research*
Chiu, R., Smith, R. L., Goodman, S.
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- **Biocompatibility of poly(ethylene glycol)/poly(acrylic acid) interpenetrating polymer network hydrogel particles in RAW 264.7 macrophage and MG-63 osteoblast cell lines.** *Journal of biomedical materials research. Part A*
Yim, E. S., Zhao, B., Myung, D., Kourtis, L. C., Frank, C. W., Carter, D., Smith, R. L., Goodman, S. B.
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- **Analysis of Bone Mineral Density and Bone Turnover in the Presence of Polymethylmethacrylate Particles** *JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART B-APPLIED BIOMATERIALS*
Zilber, S., Lee, S. W., Smith, R. L., Biswal, S., Goodman, S. B.
2009; 90B (1): 362-367
- **Flexor Tendon Tissue Engineering: Acellularized and Reseeded Tendon Constructs** *PLASTIC AND RECONSTRUCTIVE SURGERY*
Chong, A. K., Riboh, J., Smith, R. L., Lindsey, D. P., Pham, H. M., Chang, J.
2009; 123 (6): 1759-1766
- **Ultrahigh molecular weight polyethylene wear debris inhibits osteoprogenitor proliferation and differentiation in vitro.** *Journal of biomedical materials research. Part A*
Chiu, R., Ma, T., Smith, R. L., Goodman, S. B.
2009; 89 (1): 242-247
- **Efficacy of a p38 mitogen activated protein kinase inhibitor in mitigating an established inflammatory reaction to polyethylene particles in vivo** *JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A*
Ma, T., Ren, P., Larsen, D. M., Suenaga, E., Zilber, S., Genovese, M., Smith, R. L., Goodman, S. B.
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- **Ultrahigh molecular weight polyethylene wear debris inhibits osteoprogenitor proliferation and differentiation in vitro** *JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A*
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2009; 89 (1): 117-123
- **In vivo murine model of continuous intramedullary infusion of particles—a preliminary study.** *Journal of biomedical materials research. Part B, Applied biomaterials*
Ma, T., Ortiz, S. G., Huang, Z., Ren, P., Smith, R. L., Goodman, S. B.
2009; 88 (1): 250-253
- **POLYMETHYLMETHACRYLATE PARTICLE-INDUCED SUPPRESSION OF OSTEOGENITOR DIFFERENTIATION INVOLVES INHIBITION OF RUNX2, OSTERIX, DLX5, AND beta-CATENIN EXPRESSION** *Western Regional Meeting of the American-Federation-for-Medical-Research*
Chiu, R., Smith, R. L., Goodman, S.
LIPPINCOTT WILLIAMS & WILKINS.2009: 228–28
- **POLYMETHYLMETHACRYLATE PARTICLE-INDUCED SUPPRESSION OF OSTEOGENITOR DIFFERENTIATION INVOLVES IMPAIRMENT OF OSTEOGENITOR VIABILITY BY NECROSIS** *Western Regional Meeting of the American-Federation-for-Medical-Research*
Chiu, R., Smith, R. L., Goodman, S.
LIPPINCOTT WILLIAMS & WILKINS.2009: 140–40
- **POLYMETHYLMETHACRYLATE PARTICLE-INDUCED SUPPRESSION OF OSTEOGENITOR DIFFERENTIATION INVOLVES INHIBITION OF RUNX2, OSTERIX, DLX5, AND beta-CATENIN EXPRESSION** *Western Regional Meeting of the American-Federation-for-Medical-Research*
Chiu, R., Smith, R. L., Goodman, S.
LIPPINCOTT WILLIAMS & WILKINS.2009: 228–28
- **New Bone Formation by Murine Osteoprogenitor Cells Cultured on Corticocancellous Allograft Bone** *JOURNAL OF ORTHOPAEDIC RESEARCH*
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- **Bioactive Sutures for Tendon Repair: Assessment of a Method of Delivering Pluripotent Embryonic Cells** *JOURNAL OF HAND SURGERY-AMERICAN VOLUME*
Yao, J., Korotkova, T., Riboh, J., Chong, A., Chang, J., Smith, R. L.
2008; 33A (9): 1558-1564
- **Continuous Intramedullary Polymer Particle Infusion Using a Murine Femoral Explant Model** *JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART B-APPLIED BIOMATERIALS*
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- **Bioactive sutures for tendon repair: assessment of a method of delivering pluripotent embryonic cells.** *journal of hand surgery*
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- **An in vivo murine model of continuous intramedullary infusion of polyethylene particles** *BIOMATERIALS*
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2008; 29 (27): 3738-3742
- **Fluid shear stress magnitude, duration, and total applied load regulate gene expression and nitric oxide production in primary calvarial osteoblast cultures** *PLASTIC AND RECONSTRUCTIVE SURGERY*
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2008; 122 (2): 419-428
- **Polymethylmethacrylate particles inhibit osteoblastic differentiation of MC3T3-E1 osteoprogenitor cells** *JOURNAL OF ORTHOPAEDIC RESEARCH*
Chiu, R., Ma, T., Smith, R. L., Goodman, S. B.
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- **Hydrostatic pressure enhances chondrogenic differentiation of human bone marrow stromal cells in osteochondrogenic medium** *ANNALS OF BIOMEDICAL ENGINEERING*
Wagner, D. R., Lindsey, D. P., Li, K. W., Tummala, P., Chandran, S. E., Smith, R. L., Longaker, M. T., Carter, D. R., Beaupre, G. S.
2008; 36 (5): 813-820
- **Quantitation of bone area in undecalcified frozen sections with fluorescent microscopy** *JOURNAL OF HISTOTECHNOLOGY*
Ren, P., Ma, T., Huang, Z., Smith, R. L., Goodman, S. B.
2008; 31 (1): 15-17
- **Validation and quantification of an in vitro model of continuous infusion of submicron-sized particles.** *Journal of biomedical materials research. Part B, Applied biomaterials*
Ortiz, S. G., Ma, T., Epstein, N. J., Smith, R. L., Goodman, S. B.
2008; 84 (2): 328-333
- **Histomorphometric Analysis of the intramedullary bone response to titanium particles in wild-type and IL-1R1 knock-out mice: A preliminary study** *JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART B-APPLIED BIOMATERIALS*
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2008; 84B (2): 559-570
- **Validation and quantification of an in vitro model of continuous infusion of submicron-sized particles** *JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART B-APPLIED BIOMATERIALS*
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Chiu, R., Smith, R. L., Goodman, S. B.
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- **Mouse femoral intramedullary injection model: Technique and microCT scan validation** *JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART B-APPLIED BIOMATERIALS*
Zilber, S., Epstein, N., Lee, S., Larsen, M., Ma, T., Smith, R. L., Biswal, S., Goodman, S. B.
2008; 84B (1): 286-290
- **Mouse femoral intramedullary injection model: technique and microCT scan validation.** *Journal of biomedical materials research. Part B, Applied biomaterials*
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- **Ultrahigh molecular weight polyethylene wear debris suppresses osteoblast differentiation of bone marrow osteoprogenitors and MC3T3-E1 preosteoblasts in vitro** *Western Regional Meeting of the American-Federation-for-Medical-Research*
Chiu, R., Smith, R. L., Goodman, S. B.
LIPPINCOTT WILLIAMS & WILKINS.2008: 243-43
- **The sequential expression profiles of growth factors from osteoprogenitors to osteoblasts In vitro** *TISSUE ENGINEERING*
Huang, Z., Nelson, E. R., Smith, R. L., Goodman, S. B.
2007; 13 (9): 2311-2320
- **Modulation of allograft incorporation by growth factors over a prolonged continuous infusion of duration in vivo** *BONE*
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Goodman, S. B., Ma, T., Spanogle, J., Chiu, R., Miyanishi, K., Oh, K., Plouhar, P., Wadsworth, S., Smith, R. L.
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Chiu, R., Ma, T., Smith, R. L., Goodman, S. B.
2007; 25 (4): 450-457
- **Inhibition of marrow stromal cell osteogenesis by polymethylmethacrylate wear particles and soluble factors released from polymethylmethacrylate particle-activated macrophages.** *8th Conference of the Western Student Medical Research Forum/Western Section of the American-Federation-for-Medical-Research/Western Association-of-Physicians/Western-Society-for-Pediatric-Research/Western-Society-for-Clinical-Investigation*
Chiu, R., Smith, R. L., Goodman, S. B.
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- **Effects of orthopaedic wear particles on osteoprogenitor cells** *BIOMATERIALS*
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- **Effects of local infusion of OP-1 on particle-induced and NSAID-induced inhibition of bone ingrowth in vivo** *JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A*
Ma, T., Nelson, E. R., Mawatari, T., Oh, K. J., Larsen, D. M., Smith, R. L., Goodman, S. B.
2006; 79A (3): 740-746
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Li, K. W., Lindsey, D. P., Wagner, D. R., Giori, N. J., Schurman, D. J., Goodman, S. B., Smith, R. L., Carter, D. R., Beaupre, G. S.
2006; 12 (9): 2611-2618
 - **Dose- and time-dependent effects of cyclic hydrostatic pressure on transforming growth factor-beta 3-induced chondrogenesis by adult human mesenchymal stem cells in vitro** *TISSUE ENGINEERING*
Miyanishi, K., Trindade, M. C., Lindsey, D. P., Beaupre, G. S., Carter, D. R., Goodman, S. B., Schurman, D. J., Smith, R. L.
2006; 12 (8): 2253-2262
 - **Comparison of VEGF-producing cells in periprosthetic osteolysis** *BIOMATERIALS*
Spanogle, J. P., Miyanishi, K., Ma, T., Epstein, N. J., Smith, R. L., Goodman, S. B.
2006; 27 (21): 3882-3887
 - **Polymethylmethacrylate particles inhibit osteoblastic differentiation of bone marrow osteoprogenitor cells.** *Journal of biomedical materials research. Part A*
Chiu, R., Ma, T., Smith, R. L., Goodman, S. B.
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