Welcome to the Second International Spine Research Symposium

November 6-8, 2013 • Philadelphia

The Philadelphia Spine Research Society welcomes you to the Second International Philadelphia Spine Research Symposium. The meeting is being held on the campus of Thomas Jefferson University from November 6-8, 2013 and has attracted leading researchers and clinicians from all parts of the world.

For the past 8 years, PSRS held one-day symposia that focused on the basic biology and biomechanics of the intervertebral disc and the pathogenesis and treatment of degenerative disc disease. In 2011, the Society held its first international meeting on the campus of the University of Pennsylvania that was very well received by the disc research community. The meeting attracted participants from academia and industry, clinicians, postdoctoral fellows and students from many countries. Based on positive feedback from the participants and the need for a focused meeting on the intervertebral disc, the Society will continue holding this international meeting on a biannual basis.

The 2013 meeting focuses on topics ranging from cell, molecular and developmental biology of the disc, tissue-engineering and regenerative strategies, biomaterials, imaging modalities and spine biomechanics. The conference goal is to encourage dissemination of cutting edge science and presentation of novel findings and ideas. The format provides opportunities for new investigators, postdoctoral trainees and graduate students to present their work in podium/poster sessions and to exchange ideas with experienced investigators who are at the forefront of their field. This year the plenary lecture will be given by Dr. Gunnar BJ. Andersson, an international authority on both clinical and basic aspects of disc research. The Society is also happy to confer its inaugural Lifetime Research Achievement Award on Dr. Irving M. Shapiro in recognition of his long standing contributions to the field of disc biology. Lastly, the Organizing Committee thanks the NIH, many academic institutions and individual sponsors and volunteers for their generous support.
LECTURES

Wednesday, November 6
SYMPOSIUM 1:  
*Mechanisms of Disc Degeneration*  
12:25 P.M. – 3:05 P.M.

Thursday, November 7
SYMPOSIUM 2:  
*Cell and Molecular Biology of the Disc*  
8:00 A.M. – 12:00 NOON

SYMPOSIUM 3:  
*Biomechanics and Imaging*  
1:30 P.M. – 4:30 P.M.

PLENARY LECTURE:  
*Disc Research: What are the Clinical Implications?*  
Gunnar Andersson, M.D.  
5:10 P.M. – 6:05 P.M.

Friday, November 8
SYMPOSIUM 4:  
*Tissue Engineering and Regenerative Medicine*  
8:00 A.M. – 11:15 A.M.

SYMPOSIUM 5:  
*Translational and Clinical Studies*  
1:30 P.M. – 2:55 P.M.

SYMPOSIUM 6:  
*Hot and Late Breaking Topics*  
4:05 P.M. – 5:10 P.M.

PANEL DISCUSSIONS

Wednesday, November 6
PANEL DISCUSSION I:  
*How Do Basic Research Findings Impact Treatment of Disc Disease and Back Pain*  
3:35 P.M. – 4:20 P.M.

Thursday, November 7
PANEL DISCUSSION II:  
*How Can We Use New Tools in Cell Biology, Biomechanics and Imaging to Further Our Understanding of Disc Degeneration and Pain?*  
4:30 P.M. – 5:10 P.M.

POSTERS

Wednesday, November 6
POSTER SESSION I:  
5:00 P.M. – 7:00 P.M.

Thursday, November 7
POSTER SESSION II:  
12:00 NOON – 1:25 P.M.

Friday, November 8
POSTER SESSION III:  
11:50 A.M. – 1:30 P.M.
WEDNESDAY • NOVEMBER 6, 2013

8:45 – 10:45 a.m.  PRE-MEETING WALKING TOUR OF HISTORIC PHILADELPHIA
10:45 a.m. – 12:15 p.m.  REGISTRATION AND BOXED LUNCH
12:15 p.m.  Welcome to the Second International Philadelphia Spine Research Symposium
  M Risbud, Ph.D. & I Shapiro, B.DS., Ph.D., Thomas Jefferson University, USA

SYMPOSIUM 1

MECHANISMS OF DISC DEGENERATION I: GENETICS
  Moderated by R Serra and C Dahia

12:25 p.m.  S1.1: Invited Talk: Degenerative disc disease: what’s in a name?
  M Battie, Ph.D., University of Alberta, Canada
12:45 p.m.  S1.2: Invited Talk: The Hong Kong Genome Wide Association Study: How should we move forward?
  D Chan, Ph.D., University of Hong Kong, PR China
1:05 p.m.  S1.3: Invited Talk: Genetics of intervertebral disc degeneration
  F Williams, M.D., King’s College London, UK
1:25 p.m.  DISCUSSION
1:45 p.m.  BREAK

MECHANISMS OF DISC DEGENERATION II: INFLAMMATION AND PAIN
  Moderated by L Setton and C LeMaitre

2:00 p.m.  S1.4: Luminescent imaging of NF-κB activity and relationships to pain sensitivity in a model of neuropathy
  • R Bowles, Ph.D., Duke University, Durham, USA
2:10 p.m.  S1.5: Both expression of cytokines and posterior annulus fibrosus rupture are essential for pain behavior changes induced by degenerative intervertebral disc: an experimental study in rats
  Z Li, Ph.D., First Affiliated Hospital of Sun Yat-Sen University, PR China
2:20 p.m.  S1.6: The role of class 3 semaphorins in human intervertebral disc degeneration
  A Binch, B.S., Sheffield Hallam University, UK
2:30 p.m.  S1.7: Molecular profiles of degenerative biomarkers in the ligamentum flavum and their relationships with disc disease severity
  • D Alipui, M.D., The Feinstein Institute for Medical Research, NY, USA
2:40 p.m.  S1.8: The extracellular calcium-sensing receptor as a regulator of cartilaginous end-plate intervertebral disc calcification
  • M Grant, Ph.D., Lady Davis Institute for Medical Research, Montreal, Canada
2:50 – 3:05 p.m.  DISCUSSION
3:05 – 3:35 p.m.  COFFEE BREAK
3:35 – 4:20 p.m.  PANEL DISCUSSION: How do basic research findings impact treatment of disc disease and back pain?
  • MODERATORS: Edward Vresilovich, M.D., Ph.D., Pennsylvania State University • F Mwale, Ph.D., McGill University • PANEL: G Andersson, M.D., Rush University, Chicago • D Sakai, M.D., Tokai University, Japan • C Kepler, M.D., Rothman Institute and Jefferson Medical College • N Malhotra, M.D., University of Pennsylvania • A Bowden, Ph.D., Brigham Young University • P Maurer, M.D., BBB Orthopedic Institute, Philadelphia • C LeMaitre, Ph.D., Sheffield Hallam University
4:30 – 5:00 p.m.  NETWORKING BREAK AND POSTER SETUP
5:00 – 7:00 p.m.  WELCOME RECEPTION AND POSTER SESSION OPENING

THURSDAY • NOVEMBER 7, 2013

SYMPOSIUM 2

CELL AND MOLECULAR BIOLOGY OF THE DISC I
  Moderated by J Hoyland and N Fujita

8:00 a.m.  S2.1: Invited Talk: Regulation of IVD development by TGF-β
  R Serra, Ph.D., University of Alabama, Birmingham, USA
8:20 a.m.  **S2.2: Invited Talk:** CCN2 functions as an anti-inflammatory molecule in the nucleus pulposus  
*M Risbud, Ph.D., Thomas Jefferson University, Philadelphia, USA*

8:40 a.m.  **S2.3: Invited Talk:** Genetic approaches to understanding the role of matricellular proteins in the intervertebral disc  
*C Seguin, Ph.D., University of Western Ontario, Canada*

9:00 a.m.  **S2.4:** Anti-inflammatory effect of Epigallocatechin-3-gallate in intervertebral disc cells is partly mediated by IRAK/p38 and NF-kB signaling pathways  
*K Wuertz, Ph.D., ETH Zurich, Switzerland*

9:10 a.m.  **S2.5:** Aquaporins expressed in the human intervertebral disc – A link to disc degeneration?  
*R Day, B.S., Sheffield Hallam University, UK*

9:20 a.m.  **DISCUSSION**

**CELL AND MOLECULAR BIOLOGY OF THE DISC II**  
*Moderated by M Risbud and L Haglund*

10:00 a.m.  **S2.6: Invited Talk:** Role of chemokines in stem cell homing into the degenerative disc  
*S Grad, Ph.D., AO Research Institute, Switzerland*

10:20 a.m.  **S2.7: Invited Talk:** HIF-1 is essential for development of the nucleus pulposus  
*E Schipani, M.D., University of Michigan, Ann Arbor, USA*

10:40 a.m.  **S2.8:** HIF-1-PHD2 axis controls syndecan-4 expression in hypoxic nucleus pulposus cells: Syndecan-4 regulates Sox9 level  
*N Fujita, M.D., Ph.D., Keio University School of Medicine, Japan*

10:50 a.m.  **S2.9:** The origin of non-aggregating proteoglycans in the human intervertebral disc  
*P Roughley, Ph.D., Shriners Hospital for Children, Canada*

11:00 a.m.  **DISCUSSION**

**CELL AND MOLECULAR BIOLOGY OF THE DISC III**  
*Moderated by J Urban and C Seguin*

11:10 a.m.  **S2.10:** Genetics of intervertebral disc formation  
*B Harfe, Ph.D., University of Florida, Gainesville, USA*

11:30 a.m.  **S2.11:** Unraveling new cell subpopulations on nucleus pulposus of intervertebral disc  
*M Molinos, M.S., Instituto Nacional de Engenharia Biomédica, Portugal*

11:40 a.m.  **S2.12:** Role of Shh and Wnt signaling in mouse disc growth, differentiation, and maintenance  
*C Dahia, Ph.D., Hospital for Special Surgery, NY, USA*

11:50 a.m.  **DISCUSSION**

12:00 – 1:25 p.m.  **LUNCH AND POSTER SESSION II** (Hamilton Lobby)

**SYMPOSIUM 3**

**BIOMECHANICS AND IMAGING I**  
*Moderated by A Espinoza and B Winkelstein*

1:30 p.m.  **S3.1:** Early physiological loading after endplate fracture induces chronic degenerative changes in the disc  
*S Ferguson, Ph.D., ETH Zurich, Switzerland*

1:50 p.m.  **S3.2:** Imaged-based modeling of the intervertebral disc  
*D Elliott, Ph.D., University of Delaware, Newark, USA*

2:10 p.m.  **S3.3:** Hydrogel implant restores human disc mechanics under physiologic cyclic loading following nucleotomy  
*B Showalter, B.S., University of Pennsylvania, Philadelphia, USA*

2:20 p.m.  **S3.4:** Upregulation of NGF & BDNF in cervical intervertebral discs exposed to painful whole body vibration  
*S Kartha, Ph.D., University of Pennsylvania, Philadelphia, USA*

2:30 p.m.  **DISCUSSION**

2:40 p.m.  **BREAK**
BIOMECHANICS AND IMAGING II
Moderated by S Ferguson and D Elliott

2:50 P.M.  **S3.5: Invited Talk:** Spines in Space: adverse effects of microgravity on the intervertebral disc
J Lotz, Ph.D., University of California San Francisco, USA

3:10 P.M.  **S3.6: Invited Talk:** Two disc degeneration phenotypes: annulus-driven and endplate-driven
P Dolan, Ph.D., Bristol University, UK

3:30 P.M.  **S3.7:** A longitudinal in vivo study of lumbar spine degeneration – Focus on disc height and facet joint space width
H Nojiri, M.D., Ph.D., Rush University Medical Center, Chicago, USA

3:40 P.M.  **S3.8:** Biomechanical role of posterior column components in a distractive-flexion injury model: Effects on load sharing and mobility
R Hartman, M.S., University of Pittsburgh, USA

3:50 P.M.  **S3.9:** Biomechanical investigation of the fracture toughness of torn spinal ligaments
G Von Forell, M.S., Brigham Young University, Provo, USA

4:00 P.M.  **S3.10:** Instantaneous center of rotation behavior of the lumbar spine with ligament failure
S Inceoglu, Ph.D., Loma Linda University, CA, USA

4:10 – 4:30 P.M.  **DISCUSSION**

4:30 – 5:10 P.M.  **PANEL DISCUSSION:** How Can We Use New Tools in Cell Biology, Biomechanics and Imaging to Further our Understanding of Disc Degeneration and Pain?
MODERATOR: Irving Shapiro, Ph.D., Thomas Jefferson University, USA • PANEL: R Kandel, M.D., Mount Sinai Hospital, Toronto • P Roughley, Ph.D., Shriners Hospital, Montreal • J Urban, Ph.D., Oxford University • S Ferguson, Ph.D., ETH Zurich • J Iatridis, Ph.D., Mount Sinai, NY • T Schaer, V.M.D., University of Pennsylvania • M Marcolongo, Ph.D., Drexel University

5:10 P.M.  **INTRODUCTION OF THE PLENARY SPEAKER**
I Shapiro and T Schaer

5:15 P.M.  **PLENARY LECTURE:** Disc research: what are the clinical implications?
Gunnar Andersson, M.D.

5:55 – 6:05 P.M.  **DISCUSSION**

7:00 – 9:30 P.M.  **OPTIONAL NETWORKING DINNER**
**Historic City Tavern Restaurant** – 138 South 2nd Street at Walnut Street, Philadelphia, PA 19106

FRIDAY, NOVEMBER 8, 2013

SYMPOSIUM 4

TISSUE ENGINEERING AND REGENERATIVE MEDICINE I
Moderated by L Smith and D Purmessur

8:00 A.M.  **S4.1: Invited Talk:** Mechanobiology of cell-matrix interactions in the nucleus pulposus
L Setton, Ph.D., Duke University, Durham, USA

8:20 A.M.  **S4.2: Invited Talk:** Link N peptide and human intervertebral disc repair: What’s new?
F Mwale, Ph.D., McGill University, Montreal, Canada

8:40 A.M.  **4.3:** Translation of a nanofibrous disc-like angle ply structure for intervertebral disc replacement in a small animal model
J Martin, M.S., University of Pennsylvania, Philadelphia, USA

8:50 A.M.  **S4.4:** Mesenchymal stem cells encapsulated poly(trimethylene carbonate) implants for annulus fibrosus defect repair – An organ culture study under dynamic load
Z Li, Ph.D., AO Research Institute Davos, Switzerland

9:00 A.M.  **S4.5:** The anti-inflammatory response of human mesenchymal stem cells when co-cultured with degenerate nucleus pulposus cells in an inflammatory microenvironment
S Richardson, Ph.D., The University of Manchester, UK

9:10 A.M.  **S4.6:** Evaluation of in vivo function of tissue engineered intervertebral discs made with human mesenchymal stem cells
K Hudson, B.S., Cornell University, Ithaca, NY, USA

9:20 A.M.  **DISCUSSION**

9:35 A.M.  **NETWORKING BREAK**
TISSUE ENGINEERING AND REGENERATIVE MEDICINE II
Moderated by N Chahine and L Bonassar

10:00 A.M. **S4.7: Invited Talk**: Multiple roles for mesenchymal stem cells in intervertebral disc regeneration/tissue engineering • J Hoyland, Ph.D., University of Manchester, UK

10:20 A.M. **S4.8: Invited Talk**: Prevention and treatment of intervertebral disc degeneration with bone marrow derived stem (stromal) cells – an in-vivo study in sheep • J Melrose, Ph.D., University of Sydney, Australia

10:40 A.M. **S4.9: Invited Talk**: Migration and fate of mesenchymal stem cells in a rat disc injury model • R Maidhof, Ph.D., Feinstein Institute for Medical Research, NY, USA

10:50 A.M. **S4.10:** Differentiation of mouse induced Pluripotent Stem Cells (iPSCs) into nucleus pulposus-like cells in vitro • J Chen, Ph.D., Duke University, Durham, USA

11:00 – 11:15 A.M. DISCUSSION

11:15 – 11:45 A.M. BUSINESS MEETING • PSRS Organizing Committee

11:50 – 1:30 P.M. LUNCH AND POSTER SESSION III (Hamilton Lobby)

SYMPOSIUM 5

TRANSLATIONAL STUDIES
Moderated by J Lotz and N Vo

1:30 P.M. **S5.1: Invited Talk**: Diabetes, diet, and disc degeneration • J Iatridis, Ph.D., Icahn School of Medicine at Mount Sinai, NY, USA

1:50 P.M. **S5.2: Invited Talk**: Human annulus cells and nerve cells: In vivo and in vitro interactions • H Gruber, Ph.D., Carolinas Medical Center, Charlotte, USA

2:10 P.M. **S5.3: Rho-associated coiled kinase (ROCK) inhibition prevents dedifferentiation of nucleus pulposus cells in vitro** • T Nukaga, M.D., Tokai University, Japan

2:20 P.M. **S5.4:** Transient TNFα exposure induces altered biomechanics and a sustained inflammatory environment in a dynamic compression bioreactor system • B Walter, B.S., Icahn School of Medicine at Mount Sinai, NY, USA

2:30 P.M. **S5.5: Effect of type-2 diabetes mellitus on intervertebral disc creep and endplate microarchitecture in rats** • A Fields, Ph.D., University of California San Francisco, USA

2:40 – 2:55 P.M. DISCUSSION

2:55 – 3:10 P.M. BREAK

3:10 – 4:00 P.M. PSRS LIFETIME RESEARCH ACHIEVEMENT AWARD AND LECTURE
Grand unified theory of disc degeneration and back pain • Irving M. Shapiro, Ph.D.

SYMPOSIUM 6

HOT AND LATE BREAKING TOPICS
Moderated by R Kandel and J Chen

4:05 P.M. **S6.1: The role of diabetes type I in intervertebral disc degeneration** • F Russo, M.D., University of Pittsburgh, USA

4:15 P.M. **S6.2:** Degenerating and painful intervertebral discs secrete pro-inflammatory and pro-nociceptive factors that stimulate PC12 cells and mouse DRG neurons • E Krock, B.S., McGill University, Canada

4:25 P.M. **S6.3: Identification of novel annulus fibrosus (AF) cell phenotypic markers and their use in identifying mesenchymal stem cell differentiation to an AF-like cell** • M Ablett, Ph.D., The University of Manchester, UK

4:35 P.M. **S6.4: Deep sequencing of notochord-derived cells during embryonic formation of the nucleus pulposus: Preliminary findings** • L Smith, Ph.D., University of Pennsylvania, Philadelphia, USA

4:45 P.M. **S6.5: Mesoscale characterizations of annular transamellar cross bridges** • SK Han, Ph.D., University of Maryland, USA

4:55 P.M. DISCUSSION

5:10 P.M. AWARDS CEREMONY (Oral and Poster Awards for Young Investigators) • Presented by the PSRS Organizers

5:40 P.M. MEETING ADJOURNED
## MECHANISMS OF DISC DEGENERATION

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<td>Priya Patel, Courtney Brooks, Cheryle Séguin</td>
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<td>Chondroitin Sulfate Secreted from Intervertebral Disc Derived Notochordal Cells Inhibits Neurite Outgrowth from Human SH-SY5Y Neuroblastoma Cells and Rat Dorsal Root Ganglion Cells</td>
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<td>Catabolic Effects of Endothelial Cell-Derived Microparticles on Intervertebral Disc Cells</td>
<td>Pedro H.I. Pohl, Thomas Lozito, Thais Cuperman, Hong Joo Moon, Kevin Ngor, Takashi Yurube, Gwendolyn Sowa, Rocky Tuan, James D. Kang, Nam Vo</td>
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<td>Synergistic Pro-inflammatory Effects of TNF-α and High Strain on Human Annulus Fibrosus Cells is Effectively Inhibited by Infliximab</td>
<td>Morakot Likhitpanichkul, Jadry Gruen, Benjamin A. Walter, Andrew C. Hecht</td>
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<td>Padma Madiraju, Lisbet Haglund, Peter J. Roughley, John Antoniou, Fackson Mwale</td>
<td>Lady Davis Institute at the Jewish General Hospital • McGill University</td>
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<td>Inflammation Induces F-actin Redistribution and Alters Aquaporin-1 Expression in Isolated Nucleus Pulposus Cells</td>
<td>Robert Maidhof, Nadeen O. Chahine, The Feinstein Institute for Medical Research</td>
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<td>Hyunchul Kim, Tyler Caspar, Sameer B. Shah, Adam H. Hsieh, University of Maryland</td>
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<td>Mechanism of Proteoglycan Synthesis by Bovine and Human Link N</td>
<td>Sultan Aldebeyan, Laura M. Epure, Michael P. Grant, John Antoniou, Fackson Mwale</td>
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<td>Effect of Link N Treatment on Pain Associated with Intervertebral Disc Degeneration</td>
<td>Padma Madiraju, H. Noorwali, Laura M. Epure, John Antoniou, Fackson Mwale</td>
<td>Lady Davis Institute at the Jewish General Hospital • McGill University</td>
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14. Cytokine Leakage through Annular Fibrosus Tears Causes Low Back Pain Hao Yang, Hao Yang, Hui Liu, Zhaomin Zheng, Zemin Li, Jianru Wang, Bingxue Li, Kuibo Zhang, Wenbin Ding, Hua Wang, Shilabant Rajesh Shrivastava • The First Affiliated Hospital of Sun Yat-sen University


16. Excessive Mechanical Loading of Primary Intervertebral Disc Cells Initiates Secretion of Inflammatory Factors Associated with Disc Degeneration and Pain Derek H. Rosenzweig, Rahul Gawri, Emerson Krock, Jean Ouellett, Laura S Stone, Thomas M Quinn, Lisbet Haglund McGill University


18. Chronic Ingestion of Advanced Glycation End Products Induces Early Degenerative Spinal Structural Changes Svenja Illien-Junger, Young Lu, Sheeraz A. Qureshi, Andrew C. Hecht, Weijing Cai, Helen Vlassara, Gary E. Striker, James C. Iatridis • Icahn School of Medicine at Mount Sinai

19. HIF-1 is Refractory to FIH-1-Mint3 Dependent Activity Regulation in Nucleus Pulposus Cells Yuichiro Hirose, Zariel I. Johnson, Zachary R. Schoepflin, Dessislava Z. Markova, Yoshiaki Toyama, Irving M. Shapiro, Makarand V. Risbud Thomas Jefferson University • Keio University

20. Regulation of Growth Factor Signaling by Extracellular Matrix Components of the Nucleus Pulposus Tissue Robert J. Frawley, Carl Blobel, Matthew Cunningham Weill Cornell Graduate School of Medical Science


22. Unique Regulation of AQP1 and AQP5 Expression by HIF-1 in Nucleus Pulposus Cells Shilpa S. Gogate, Zariel I. Johnson, Dessislava Z. Markova, Irving M. Shapiro, Makarand V. Risbud • Thomas Jefferson University

23. A Novel Protocol for Intervertebral Disc Characterization at a Micro-Scale Level Insaf Hadjab, Laura M. Epure, Michael P. Grant, John Antoniou, L'Hocine Yahia, Fackson Mwale • École Polytechnique de Montréal


25. The Effects of Link N and Bone Marrow-Derived Mesenchymal Stem Cells on the Regeneration of Intervertebral Disc Hong Tian Wang, Fackson Mwale, Peter Roughley, John Antoniou, Lisbet Haglund • Lady Davis Institute for Medical Research Jewish General Hospital • McGill University


27. Differential CD24 Expression in The Human Nucleus Pulposus Reveals Two Functionally Distinct Sub-Populations of Cells Ricardo Rodrigues-Pinto, Guus G.H. van den Akker, Tim J.M. Welting, Jan Willem Voncken, Stephen M. Richardson, Judith A. Hoyland • University of Manchester
28. Gene Expression Profiling of Human Notochordal and Sclerotomal Cells Identifies Hepatocyte Growth Factor as a Putative Notochordal Cell Regulator
Ricardo Rodrigues-Pinto, Leo A.H. Zeef, Andrew Berry, Karen Piper-Hanley, Neil A. Hanley, Stephen M. Richardson, Judith A. Hoyland • University of Manchester

29. The Mechano-Response of Human Nucleus Pulposus Cells is Pericellular Matrix- and pH-Dependent
Hamish T.J. Gilbert, Nathan Hodson, Judith A. Hoyland University of Manchester

30. GDF6 Restores a Non-Degenerate Phenotype and Drives Extracellular Matrix Production in Degenerate Human NP Cells
Louise E. Clarke, Stephen M. Richardson, Judith A. Hoyland University of Manchester

31. Nutrient Deprivation Modulates Cellular Autophagy, Apoptosis, Senescence, and Extracellular Matrix Metabolism in Intervertebral Disc Annulus Fibrosus Cells
Takashi Yurube, Robert A. Hartman, Pedro H. I. Pohl, Nam V. Vo, James D. Kang, Gwendolyn A. Sowa • University of Pittsburgh

32. Laminin and Collagen Differentially Regulate Cell Cluster Formation and Cellular Biosynthesis for Nucleus Pulposus Cells of the Intervertebral Disc
Priscilla Y. Hwang, Aubrey T. Francisco, Liufang Jing, William J. Richardson, Jun Chen, Lori A. Setton • Duke University

33. CCN2 Secreted from Notochord-Derived Cells Regulates Intervertebral Disc Development and Protects from Age-Related Disc Degeneration
Jake M. Bedore, Wei Sha, Matthew R. McCann, Shangxi Liu, Andrew Leask, Cheryle Séguin • The University of Western Ontario, Canada

34. Chondroadherin Fragmentation as a Biochemical Marker for Early Stage Disc Degeneration
Bashar G. Alkhatib, Patrik Önnerfjord, Rahul Gawri, Jean Ouellet, Peter Jarzem, Dick Heinegård, John Mort, Peter Roughley, Fackson Mwale, Lisbet Haglund • McGill University

36. HIF-1α is Essential for the Development of the Nucleus Pulposus
Christophe Merceron, Laura Mangiavini, Tremika LeShan Wilson, Alexander Robling, Karl Jepsen, Irving M. Shapiro, Makarand V. Risbud, Ernestina Schipani • University of Michigan Medical School • Thomas Jefferson University

BIOMECHANICS AND IMAGING

37. In Situ Calcium Signaling in Fiber-Reinforced Tissues is Strain Dependent
Woojin M. Han, Dawn M. Elliott, Robert Mauck, Randall Duncan University of Pennsylvania • University of Delaware

38. Variation of Thoracic Pedicle Dimensions in Normal and AIS Pediatric Subjects
James R. Peters, Charanya Chandrasekaran, Sriram Balasubramanian • Drexel University

39. Finite Element Analysis of Angled Cracks and Stress Concentration in Annulus Fibrosus
John M. Peloquin, Dawn M. Elliott University of Pennsylvania • University of Delaware

40. Torsional Biomechanics of Lumbar Segmental Motion in Cases of Lumbosacral Transitional Vertebrae
Hidetoshi Nojiri, Alejandro A. Espinoza Orias, Howard S. An, Gunnar B.J. Andersson, Nozomu Inoue • Rush University Medical Center

41. Development and Validation of a Lumbar Disc Finite Element Model for Impact Mechanical Response Analysis
David Jamison, Christopher Massey, Michele Marcolongo Drexel University

42. Dynamic Compressive Loading May be Required In-Vitro to Mimic In-Vivo Cervical Spine Kinematics
Kevin M. Bell, Richard Debski, Gwen Sowa, James Kang, Scott Tashman • University of Pittsburgh

43. Shear Modulus of the Human Nucleus Pulposus Measured Using MR Elastography Correlates with Directly Measured Mechanical Properties
Daniel H. Cortes, John F. DeLucca, Jeremy F. Magland, Alexander C. Wright, Dawn M. Elliott • University of Delaware

44. Differences in Destabilizing Effects of Posterior Spinal Releases versus Discectomy on Full Thoracic Spine Biomechanics
Kevin M. Bell, Cheng Wang, James Kang, Patrick Bosch University of Pittsburgh
TISSUE ENGINEERING AND REGENERATIVE MEDICINE

51. Versican Expression by Inner Annulus Fibrosus Cells and Outer Annulus Fibrosus Cells is Mechanosensitive
Jonathan Iu, J. Paul Santerre, Rita A. Kandel
University of Toronto

52. Insulin-Mimetic Local Therapeutic Adjuncts for Enhancing Spinal Fusion in a Rat Model
John D. Koerner, Michael Vives, Sheldon Lin, Saad Chaudhary, Eric Breitbart, Paul Chirichella, Linda Uko • Thomas Jefferson University • Rothman Institute • University of Medicine and Dentistry of New Jersey

53. GDF6 Drives Discogenic Differentiation of Human Mesenchymal Stem Cells Resulting in a Proteoglycan Rich Extracellular Matrix
Louise E. Clarke, James C. McConnell, Michael J. Sherratt, Stephen M. Richardson, Judith A. Hoyland • University of Manchester

54. Molecular Engineering of the Intervertebral Disc Tissue with Biomimetic Aggrecan
Katsiaryna Prudnikova, Edward Vresilovic, Michele Marcolongo
Drexel University

55. In Vitro Repair of Annulus Fibrosus Defects Using Injectable Riboflavin-Crosslinked Collagen Gels
Brandon Borde, Peter Grunert, Roger Härtl, Lawrence Bonassar
Cornell University

56. Mechanical Testing of Canine-Sized Alginate/Collagen Tissue-Engineered Intervertebral Discs
Jorge A. Mojica-Santiago, Peter Grunert, Roger Hartl, Lawrence J. Bonassar • Cornell University

57. Bioperformance of an Osteoconductive Ceramic in an Ovine Lumbar Model
Zosia E. Zawacki, Thomas P. Schae, Hala Zreiqat
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45. Development of a Finite Element Model Template of the Pediatric Thoracic Spine and Ribcage
Prasannaah Hadagali, Sriram Balasubramanian
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46. Ex-Vivo Flexion/Extension Mechanobiology in Functional Spinal Units: Effect of Cycle Number
Robert A. Hartman, Kevin Ngo, James D. Kang, Gwendolyn A. Sowa • University of Pittsburgh

47. Influence of Biochemical Composition on Tensile Properties in Human Endplate Cartilage
Aaron J. Fields, David Rodriguez, Kaitlyn Gary, Ellen C. Liebenberg, Jeffrey C. Lotz • University of California, San Francisco

48. A Microscale Computational Model of the Intervertebral Disc Based on Micro Anatomy of the Collagen Fibers
Ovidiu Ciobanu, Laura Epure, Insaf Hadjab
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49. Effect of Degeneration on Compressive Properties of the Human Cartilage Endplate
John F. DeLuca, Daniel H. Cortes, Randall L. Duncan, Dawn M. Elliott • University of Delaware

50. Mechanical Parallels for a Camelid Cervical Spine Model of Lumbar Disc Degeneration
Dean K. Stolworthy, R. Amy Fullwood, Tyler Merrell, Laura Bridgewater, Anton E. Bowden • Brigham Young University

58. Annular Repair Using High Density Collagen Gel; An In Vivo Study
Peter Grunert, Brandon H. Borde, Katherine D. Hudson, Lawrence J. Bonnasar, Roger Härtl • Weill Cornell Medical College

59. A Brachyury Responsive Transactivation Assay for Quantifying the Molecular Phenotype of Human Nucleus Pulposus Cells in Vitro
Funding for this conference was made possible (in part) by (1 R13AR065339-01) from National Institute Of Arthritis And Musculoskeletal And Skin Diseases (NIAMS) and all co-funding support provided by the National Institute of Child Health and Human Development (NICHD). The views expressed in written conference materials or publications and by speakers and moderators do not necessarily reflect the official policies of the Department of Health and Human Services; nor does mention by trade names, commercial practices, or organizations imply endorsement by the U.S. Government.