The Institute for Engineering in Medicine

ANNUAL CONFERENCE & RETREAT

November 6th 2017
McNamara Alumni Center
Dear Colleagues,

We welcome you to the 5th Annual Institute for Engineering in Medicine (IEM) Conference and Retreat. As you know IEM is an interdisciplinary research organization aimed at advancing engineering solutions to medical and health problems by fostering collaborations between engineering and biomedical faculty at the University of Minnesota, and between University faculty and industrial colleagues. The mission of IEM is to seek innovative engineering solutions to tomorrow’s medicine and health care, through organized interdisciplinary and multidisciplinary research.

We have the privilege to represent more than 272 IEM faculty members from 63 academic departments and divisions on campus. Here at the conference and retreat we have registrants representing research efforts from these faculty members, their students and collaborators. These efforts are broken into five thematic areas including: (1) Cardiovascular Engineering, (2) Cellular and Molecular Bioengineering (3) Medical and Biological Imaging, (4) Medical Devices, and (5) Neuroengineering.

The event will begin with a networking lunch that will include Plenary Keynote Talks from members of industry. Immediately following the lunch talks, and new this year, will be a Collaboration Session at which IEM Member faculty will proactively work with one another to initiate or further develop biomedical research through collaborations between health sciences and engineering participants and form teams of collaborators responding to federal and industry funding opportunities. From mid-afternoon, there will be a poster and networking session that will highlight the research of IEM faculty members and their groups.

Throughout the day, the event is designed to offer rich opportunities to learn about cutting edge research, develop collaborations, and also learn more about how to responsively apply for IEM seed grants and other internal funding and support mechanisms at the University of Minnesota. We hope that you enjoy the event and look forward to your continued interest and support. Please contact us at iem@umn.edu with ideas that can improve what we do. Together, we will make a difference in tomorrow’s medicine and healthcare through engineering innovation.

Sincerely,

John Bischof, Ph.D.
Interim Director
Institute for Engineering in Medicine

David Odde, Ph.D.
Associate Director for Development
Institute for Engineering in Medicine
The Institute for Engineering in Medicine is an interdisciplinary organization that creates and supports research collaborations between engineers, scientists, and medical professionals at the University of Minnesota, and provides research and partnership opportunities to the wider medical industry. With over 200 affiliated researchers representing 46 departments across the Twin Cities campus, five affiliated research centers, and laboratories, IEM provides University faculty, students, and external partners with world-class resources to drive innovation in medicine and to find solutions for the great medical challenges.

IEM hosts six research centers and organizes its members’ research into five themes. Most IEM members are from departments in the University’s Academic Health Center or College of Science and Engineering. As an organization dedicated to building partnerships with a wide variety of medical, clinical, and engineering professionals, IEM highly values the involvement of scientific and industrial advisors from outside the University.
11:30 am    Buffet Lunch

11:45–12:00 pm    Welcome Remarks
Tucker W. LeBien, Ph.D.
Vice Dean for Research, Medical School
Associate Vice President for Research,
Academic Health Center

Mos Kaveh, Ph.D.
Associate Dean for Research and Planning,
College of Science and Engineering

Moderator: John Bischof, Ph.D.
Interim Director,
Institute for Engineering in Medicine

12:00–12:10 pm    IEM Industrial Fellows Induction
Moderator: John Bischof, Ph.D.
Interim Director,
Institute for Engineering in Medicine

Moderator: Paul Iaizzo, Ph.D.
Associate Director for Education & Outreach,
Institute for Engineering in Medicine
Director, Visible Heart Laboratory

12:10–1:30 pm    Distinguished Plenary Talks

*Distinguished Plenary Talks

An Approach to University Collaboration in Engineered Biomaterials Through 3Ms Corporate Research Laboratory

Greg Anderson
Vice President, Corporate Research Lab
3M Company

Moderator: Christy Haynes, Ph.D.
Associate Department Head of Chemistry
Theme Co-Chair, Medical Devices
Institute for Engineering in Medicine

Translation Through Early Stage Collaboration

David M. Knapp, Ph.D.
Vice President of Corporate Research
Boston Scientific

Moderator: David Odde, Ph.D.
Associate Director for Development,
Theme Co-Chair, Cellular and Molecular Bioengineering
Institute for Engineering in Medicine

Marrying the Best of Industry with the Best of Academia to Enable Breakthrough Science, Technologies, and Commercialization

Sebastian Eriksson Giwa, Ph.D.
Cofounder of Elevian, Sylvatica Biotech,
Ossium Health, and the Organ Preservation Alliance

Moderator: John Bischof, Ph.D.
Interim Director,
Institute for Engineering in Medicine

1:30–3:30 pm    Collaborative Session*
Coffee and Snacks Provided

1:30–2:30 pm    Student Career Panel**

3:00–4:30 pm    Poster Session

4:30–5:00 pm    Poster Awards Announcement
David Odde, Ph.D.
Associate Director for Development,
Institute for Engineering in Medicine
Professor of Biomedical Engineering

*Collaboration Tables will be available beyond 3:30 pm for those not attending the Poster Session.

**Tables will be hosted by IEM faculty, UM staff and local industry participants to engage in free-form Q+A and collaborative discussions on these topics.
GENERAL INFORMATION

CONNECTING TO WI-FI
Network: U of M Guest
Access: Please enter your email address.

MCNAMARA ALUMNI CENTER
200 SE Oak St, Minneapolis, MN 55455
GREG ANDERSON
Vice President, Corporate Research Lab
3M Company

At the center of 3M lies the Corporate Research Laboratories (CRL). This group is interdisciplinary by design and partners with Business Group Laboratories to deploy new technologies and capabilities through the commercialization of new products. CRL is the steward for 3M’s technology platforms and is leading efforts to sponsor research programs with Universities and external entities. One of the focused areas of research is engineered biomaterials. Sponsored research programs are critical for engineered biomaterials in order to better understand biological systems and how these materials trigger a defined biological response. Applications such as biopharma purification, wound healing, sterilization, re-mineralization, etc. require unique engineered biomaterials and an eco-system that helps us understand the efficacy of these materials in their directed application. All of these important applications benefit from the CRL model within 3M as will be further introduced in this talk.

Greg Anderson is the Vice President of 3M’s Corporate Research Lab. The Corporate Research Lab is responsible for development and deployment of new technology across the global 3M R&D organization.

Greg has a M.B.A. in Marketing from the University of St. Thomas, M.S. in Organic Chemistry from the University of Minnesota, and a B.S. in chemistry from Hamline University in St. Paul MN.

SEBASTIAN ERIKKSSON GIWA, PHD, MBA
Co-Founder of Elevian, Sylvatica Biotech, Ossium Health and the Organ Preservation Alliance

In many ways, the strengths of industry are exactly the weaknesses of academia and vice versa. By creating new structures that leverage the best of both academia and industry, larger scale problems can be tackled with significant resources in a way that leads to i) breakthrough science, ii) rapid technological translation and high odds of commercialization. In this talk we’ll explore roadmaps for such structures based on concrete past examples and future initiatives in the works.

Sebastian will draw from experience from biotech companies Sylvatica Biotech, Ossium Health, and Elevian Inc as well as from the non-profit Organ Preservation Alliance - all four that he co-founded and was/is a leader of.

Prior experience includes investing and research at leading hedge fund, Bridgewater Associates, consulting and research at Bain and Goldman Sachs and serving two terms as the President of the National Youth Council of Sweden. Sebastian holds a PhD in Economics (conducted at SSE, Harvard and MIT) and an MBA from Harvard where he graduated with High Distinction and was named a Baker Scholar.

DAVID KNAPP, PHD
Vice President of Corporate Research, Boston Scientific

David Knapp is a leader in the area of Medical Device Development and Exploratory Research working to treat unmet clinical needs for 20 years. Dave’s current focus as Vice President of Corporate Research at Boston Scientific is on developing new solutions and fostering growth in White Space areas of the company and developing novel technical platforms that cut across all Boston Scientific Divisions. He is passionate about coordinating open collaborative efforts including developing relationships with external institutions and connecting functions to drive meaningful innovation. Dave also serves as a Board Member on the Boston Scientific Foundation and is a member of the Boston Scientific Health Advisory Panel. He holds a B.S. in Chemical Engineering from University of Michigan and a Ph.D. in Chemical Engineering from University of Minnesota where he is a Fellow of the Institute for Engineering in Medicine.
SAVE THE DATE

MN NEUROMODULATION SYMPOSIUM

April 12 – 13, 2018

You may have received an email message earlier that the Minnesota Neuromodulation Symposium would take a break in 2018.

After receiving feedback from members of the neuromodulation research community and others, the Symposium’s Co-chairs and Planning Committee enthusiastically reconsidered that decision – hope to see you here in Minneapolis at the Symposium next April!

Symposium Planning Committee:

Timothy Ebner, MD, PhD*
Matthew Johnson, PhD
Hubert Lim, PhD
Gregory Molnar, PhD*

Tay Netoff, PhD
Jerrold Vitek, MD, PhD*

*Co-chairs

General Questions:

neuromod@umn.edu
(612) 624-8483

Potential Sponsors:

Greg Molnar, PhD
gfmolnar@umn.edu
612-801-0307
CARDOVASCULAR ENGINEERING

CA 1 Polymer gels for delivering adeno viral vectors to cardiac muscle
Jeanette Caronia, Dept. of Biomedical Engineering, UMN; Daniel Sorensen, Dept. of Genetics, Cell Bio & Development, UMN; Jop van Berlo, Dept. of Medicine/Cardiology, UMN; Samira Azarin, Dept. of Chemical Engineering and Material Science, UMN

CA 2 A High-Throughput Platform to Assess Endothelial Permeability Using Collagen Microtissues
Alexandra L. Crampton, Dept. of Biomedical Engineering, UMN; Katherine A. Cummins, Dept. of Biomedical Engineering, UMN; David K. Wood, Dept. of Biomedical Engineering, UMN

CA 3 Cryopreservation of Artery and Heart Valves Using Nanowarming
Zhe Gao, Dept. of Mechanical Engineering, UMN; Zonghu Han, Dept. of Mechanical Engineering, UMN

CA 4 The Effects of Capacitance and Conductance on Blood Pressure in the Arterial System
Shanen Kizilski, Dept. of Mechanical Engineering, UMN; Omid Amili, Dept. of Aerospace Engineering and Mechanics, UMN; Filippo Coletti, Dept. of Aerospace Engineering and Mechanics, UMN; Rumi Faizer, Dept. of Surgery, UMN; Victor Barocas, Dept. of Biomedical Engineering, UMN

CA 5 Failure Behavior of Human Ascending Thoracic Aortic Aneurysms: The Importance of Shear Stress
Christopher E. Korenczuk, Dept. of Biomedical Engineering, UMN; Rohit Y. Dhume, Dept. of Mechanical Engineering, UMN; Collen M. Witzenburg, Dept. of Mechanical Engineering, UMN; Victor H. Barocas, Dept. of Biomedical Engineering, UMN

CA 6 Role of Protein Loss and Denaturation in Determining Outcomes of Heating, Cryotherapy and Irreversible Electroporation on Cardiomyocytes
Priyatanu Roy, Dept of Mechanical Engineering, UMN; Feng Liu, Dept of Mechanical Engineering, UMN; Qi Shao, Dept of Mechanical Engineering, UMN; Chunlan Jiang, Dept of Mechanical Engineering, UMN; Jeonghwan Choi, Dept of Engineering, East Carolina University; Connie Chung, Dept of Mechanical Engineering, UMN; Dushyant Mehra, Dept of Mechanical Engineering, UMN; John C Bischof, Dept of Mechanical Engineering, UMN; Victor Barocas, Dept of Biomedical Engineering, Institute for Engineering in Medicine, UMN

CA 7 Localization of Origins of Premature Ventricular Contraction by Means of Convolutional Neural Network from 12-lead ECG
Ting Yang, Dept. of Biomedical Engineering, UMN; Long Yu, Dept. of Biomedical Engineering, UMN; Qi Jin, Shanghai Ruijin Hospital, Shanghai; Lijun Wu, Shanghai Ruijin Hospital, Shanghai; Bin He, Dept. of Biomedical Engineering, UMN

CA 8 Outcomes of Heating, Cryotherapy and Irreversible Electroporation on Cardiomyocytes
Alexandra L. Crampton, Dept. of Biomedical Engineering, UMN; Katherine A. Cummins, Dept. of Biomedical Engineering, UMN; David K. Wood, Dept. of Biomedical Engineering, UMN

CELLULAR & MOLECULAR BIOENGINEERING

CMB 1 Emergent Transport Properties of Molecular Motor Ensemble Affected by Single Motor Mutations
Shreyas Bhaban, Electrical Engineering, UMN; Donatello Materassi, Electrical Engineering, University of Tennessee, Knoxville; Mingang Li, Molecular and Cellular Biology, UMN; Thomas Hays, Molecular and Cellular Biology, UMN; Murti Salapaka, Electrical Engineering, UMN

CMB 2 In Vitro Model For Tauopathy and Traumatic Brain Injury
Nicholas J. Braun, Dept. of Biomedical Engineering, UMN; Patrick W. Alford, Dept. of Biomedical Engineering, UMN; Dezh Liao, Dept. of Neuroscience, UMN

CMB 3 A Microfluidic Platform to Probe the Role of Pericellular Matrix in Metastatic Extravasation and Invasion of Breast Cancer Epithelial Cells
Marie-Elena Brett, Department of Biomedical Engineering, UMN; Heather E. Bomberger, Department of Biomedical Engineering, UMN; Geneva R. Doak, Department of Biomedical Engineering, UMN; Matthew A. Price, Department of Laboratory Medicine and Pathology, UMN; James B. McCarthy, Department of Laboratory Medicine and Pathology, UMN; and David K. Wood, Department of Biomedical Engineering, UMN

CMB 4 Programming of Tumor Protective Tissue Resident Memory CD8 T cells
Brandon Burbach, Center for Immunology, UMN; Stephen O’Flanagan, Center for Immunology, UMN; Katharine Young, Center for Immunology, UMN; Lalit Beaura, Center for Immunology, UMN; Christine Nelson, Center for Immunology, UMN; Qi Shao, Dept. of Mechanical Engineering, UMN; Francisco Pelaez, Dept. of Chemical Engineering and Materials Science, UMN; John Bischof, Dept. of Mechanical Engineering, UMN; Samira Azarin, Dept. of Chemical Engineering and Materials Science, UMN; Dave Masopust, Center for Immunology, UMN; Yoji Shimizu, Center for Immunology, UMN

CMB 5 Directing Reversible Cell-Cell Interactions with Evolved Fibronectin Domains
Clifford M. Csizmar, Dept. of Medical Chemistry, UMN; Jacob R. Petersburg, Dept. of Medical Chemistry, UMN; Lawrence A. Stern, Dept. of Chemical Engineering and Material Science, UMN; Benjamin J. Hackel, Dept. of Chemical Engineering and Material Science; Carston R. Wagner, Dept. of Medicinal Chemistry, UMN

CMB 6 ECM-Based Droplets for Three-Dimensional Cell Culture and Analysis
Katherine A. Cummins, Dept. of Biomedical Engineering, UMN; Alexandra L. Crampton, Dept. of Biomedical Engineering, UMN; David K. Wood, Dept. of Biomedical Engineering, UMN

CMB 7 Effect of Network Architecture on its Fatigue Behavior: A Comparative Study on Simulated Networks
Rohit Y. Dhume, Dept. of Mechanical Engineering, UMN; Victor H. Barocas, Dept. of Biomedical Engineering, UMN

CMB 8 Tracheal Cartilage-Derived Extracellular Matrix Methacrylamine for 3D Bioprinting
Zachary Gallagher, Dept. of Biomedical Engineering, UMN; Daniel Sorby, Dept. of Pediatrics, UMN; Angela Panoskaltsis-Mortari PhD, Dept. of Pediatrics, UMN
CMB 9  
Mucoadhesive Wafers Composed of Binary Polymer Blends for Sublingual Delivery and Preservation of Protein Vaccine  
Samuel M. Hanson, Dept. of Biomedical Engineering, UMN; Shaibala Singh, MD Anderson Cancer Center; Anthony Tabet, Dept. of Biomedical Engineering; Jagannadha K. Sastry, MD Anderson Cancer Center; Michael Barry, Mayo Clinic; Chun Wang, Dept. of Biomedical Engineering, UMN

CMB 10  
Computational Modeling of Tubulin: Tubulin Interaction: Molecular Dynamics and Brownian Dynamics  
Mahye Hemmat, Dept. of Mechanical Engineering, UMN; David J. Odde, Dept. of Biomedical Engineering, UMN

CMB 11  
Effect of Slow Freezing in Protein Vitrification Solutions  
Sampreeti Jena; Alptekin Aksan, Dept. of Mechanical Engineering, UMN

CMB 12  
Cell membrane protection by block copolymers: Effect of molecular architecture  
Mihee Kim, Department of Chemical Engineering and Materials Science, UMN; Karen J. Haman, Department of Chemical Engineering and Materials Science, UMN; Evelyne M. Houang, Department of Integrative Biology and Physiology, UMN; Wenjia Zhang, Department of Chemical Engineering and Materials Science, UMN; Demetris Yannopoulos, Department of Medicine, Cardiovascular Division, UMN; Joseph M. Metzger, Department of Integrative Biology and Physiology, UMN; Frank S. Bates, Department of Chemical Engineering and Materials Science, UMN; Benjamin J. Hackel, Department of Chemical Engineering and Materials Science, UMN

CMB 13  
Silica Gel Encapsulation of Ovarian Cancer Cells to Investigate Dormancy and Drug-resistance  
Tiffany Lam, Dept. of Chemical Engineering and Materials Science, UMN; Julian Preciado, Dept. of Biomedical Engineering, UMN; Alptekin Aksan, Dept. of Mechanical Engineering, UMN; Samira Azarin, Dept. of Chemical Engineering and Materials Science, UMN

CMB 14  
A facile in vitro platform to study cancer cell dormancy under hypoxic microenvironments using CoCl2  
Hak Rae Lee, Dept. of Chemical Engineering and Materials Science, UMN; Faith Leslie, Dept. of Chemical Engineering and Materials Science, UMN; Samira M. Azarin, Dept. of Chemical Engineering and Materials Science, UMN

CMB 15  
Optimizing Cryopreservation Outcomes of Human Induced Pluripotent Stem Cell Aggregates Using Inhibitor-Free Solution and Controlled Rate Freezing  
Rui Li, Dept. of Biomedical Engineering; Guanglin Yu, Dept. of Mechanical Engineering; Allison Hubel, Dept. of Mechanical Engineering

CMB 16  
Biopreservation Core Resource  
Allison Hubel, Amy P.N. Skubits, Alptekin Aksan

CMB 17  
Multimodality Imaging of Glioma Cells Dynamics on Organotypic Slice Culture  
Chao J. Liu, Dept. of Biomedical Engineering, UMN; Ghaidan Shamsan, Dept. of Biomedical Engineering, UMN; Taner Akkin, Dept. of Biomedical Engineering, UMN; and David J. Odde, Dept. of Biomedical Engineering, UMN

CMB 18  
Engineering Ligands against Cell Membrane Targets using Yeast Surface Display  
Patrick S. Lown, Dept. of Chemical Engineering and Materials Science, UMN; Lawrence A. Stern, T Cell Therapeutics Research Laboratory, City of Hope; Ryan Wong, Dept. of Chemical Engineering and Materials Science, UMN; Benjamin J. Hackel, Dept. of Chemical Engineering and Materials Science, UMN

CMB 19  
Blastocyst Complementation to Generate Oligodendrocytes  
Zachary D Miller, Joseph P Voth; Walter C Low; Ann M Parr (all Dept. of Neurosurgery, UMN)

CMB 20  
A Microfluidic In Vitro Model of The Blood-Brain Barrier  
Pedram Motallebnejad, Dept. of Chemical Engineering and Material Science, UMN; Sarah Swisher, Dept. of Electrical and Computer Engineering, UMN; Samira Azarin, Dept. of Chemical Engineering and Material Science, UMN

CMB 21  
In vitro Osmotic Swelling of the Periodontal Ligament  
David S. Nedrelow, Dept. of Biomedical Engineering, UMN; Theresa A. Thurston, College of Chemical, Biological and Environmental Engineering, OSU; Kishore V. Damodaran UMN School of Dentistry; Victor H. Barocas, Dept. of Biomedical Engineering, UMN.

CMB 22  
Exosome Enrichment in Blood Biopsies via Radio-Frequency Identification (RFID) Nanowire Tags  
Zohreh Nemati, Department of Electrical and Computer Engineering, UMN; Kelly Makielski, Animal Cancer Care and Research Program, UMN; Daniel Shore, Department of Electrical and Computer Engineering, UMN; Wen Zhou, Department of Electrical and Computer Engineering, UMN; Alison Donnelly, Animal Cancer Care and Research Program, UMN; Rhonda Franklin, Department of Electrical and Computer Engineering, UMN; Bethanie Stadler, Department of Electrical and Computer Engineering, UMN; Jaime Modiano, Animal Cancer Care and Research Program, UMN

CMB 23  
Quantifying Tumor Specific Immunological Responses to Optimize Focal Energy-based In Situ Tumor Vaccination  
Stephen O’Flanagan, Center for Immunology, UMN; Brandon Burbach, Center for Immunology, UMN; Yoji Shimizu, Center for immunology, UMN; Francisco Pelayez, Dept. of Chemical Engineering & Materials Science, UMN; Tiffany Lam, Dept. of Chemical Engineering & Materials Science, UMN; Samira Azarin, Dept. of Chemical Engineering & Materials Science, UMN; Qi Shao, Dept. of Mechanical Engineering, UMN; John Bischof, Dept. of Mechanical Engineering, UMN

CMB 24  
Synthetic Surfaces for the Combination of Cationic Charge Moieties and Cell Adhesion Peptides  
Kevin Ortiz-Rivera, Dept. of Biomedical Engineering, UMN; Chun Wang, Dept. of Biomedical Engineering, UMN; Wei-Shou Hu, Dept. of Chemical Engineering and Materials Science, UMN

CMB 25  
Understanding and Modeling Molecules Acting in Concert to Improve Post-Thaw Recovery  
Chia-Hsin Pi, Dept. of Mechanical Engineering, UMN; Guanglin Yu, Dept. of Mechanical Engineering, UMN; Allison Hubel, Dept. of Mechanical Engineering, UMN
POSTERS

CMB 26 Microtubule-based control of motor-clutch system mechanics in glioma cell migration
Louis S. Prah, Dept. of Biomedical Engineering, UMN; Patrick F. Bangasser, Dept. of Biomedical Engineering, UMN; Mahya Hemmat, Dept. of Biomedical Engineering, UMN; Steven S. Rosenfeld, Dept. of Medical Oncology, Mayo Clinic; David J. Odde, Dept. of Biomedical Engineering, UMN

CMB 27 Nucleotide-Gold Nanoparticles Conjugates for Rapid PCR-free Detection of DNA Based on Nanoaggregation-mediated Chemiluminescence
Olga Saiapina, Dept. of Bioproducts and Biosystems Engineering, UMN; Renu Singh, Dept. of Bioproducts and Biosystems Engineering, UMN; Alexandra Feltmeyer, USDA Forest Service, Northern Research Station, St. Paul, MN; Jennifer Juzwik, USDA Forest Service, Northern Research Station, St. Paul, MN; Brett Arenz, Dept. of Plant Pathology, UMN; Abdennour Abbas, Dept. of Bioproducts and Biosystems Engineering, UMN

CMB 28 Spontaneous glioma mouse models reveal subtype specific cell dynamics
Haynes, Dept. of Chemistry, UMN; Kang Xiong-Hang, Dept. of Chemistry, UMN; Christy L. Haynes, Dept. of Chemistry

CMB 29 Getting in Shape and Swimming —Roles of Cortical Forces and Membrane Heterogeneity in Eukaryotic Cells
Hao Wu, School of Mathematics, UMN; Marco Avila Ponce de Leon, School of Mathematics, UMN; Hans Othmer, School of Mathematics, UMN

CMB 30 Exploring platelets response to malaria at the single cell level
Kang Xiong-Hang, Dept. of Chemistry, UMN; Christy L. Haynes, Dept. of Chemistry

CMB 31 Improving Localization of AMP Delivery By Engineering Pathogen-Binding Commensal Bacteria
Elizabeth Zudock, Dept. of Chemical Engineering and Materials Science, UMN; Seth Ritter, Dept. of Chemical Engineering and Materials Science, UMN; Benjamin Hackel, Dept. of Chemical Engineering and Materials Science, UMN

MEDICAL & BIOLOGICAL IMAGING

MBI 1 Reduced Medial Frontal Positivity Precedes Task Errors and Explains Poor Performance in ADHD
Scott J. Burwell, Department of Psychiatry, UMN; Scott Makeig, Swartz Center for Computational Neuroscience, UCSD; William G. Iacono, Department of Psychology, UMN; Stephen M. Malone, Department of Psychology, UMN

MBI 2 Function-specific and Enhanced Brain Structural Connectivity Mapping via Joint Modeling of Diffusion and Functional MRI
Shu-Hsien Chu, Dept. of Electrical and Computer Engineering, UMN; Keshab K. Parhi, Dept. of Electrical and Computer Engineering, UMN; Christophe Lenglet, Center for Magnetic Resonance Research, UMN

MBI 3 Classification of Major Depressive Disorder with Diffusion MRI
Shu-Hsien Chu, Dept. of Electrical and Computer Engineering, UMN; Christophe Lenglet, Center for Magnetic Resonance Research, UMN; Mindy Westlund Schreiner, Dept. of Psychology, UMN; Bonnie Klimes-Dougan, Dept. of Psychology, UMN; Kathryn Cullen, Dept. of Psychiatry, UMN; Keshab K. Parhi, Dept. of Electrical and Computer Engineering, UMN

MBI 4 Non-Invasive Assessment of Disc Degeneration utilizing Quantitative MRI
Mary H Foltz, Dept. of Rehabilitation Medicine, UMN; Craig C Kage, Dept. of Rehabilitation Medicine, UMN; Casey P Johnson, Dept. of Radiology, UMN; Arin M Ellingson, Dept. of Rehabilitation Medicine, UMN

MBI 5 Feasibility of Quantitative T2* MRI to Assess Disc Health Following Corrective Fusion Surgery; Porcine Study
Mary H Foltz, Dept. of Rehabilitation Medicine, UMN; Robert M O’Leary, Division of Physical Therapy, UMN; Nicholas L Rudolph, Division of Physical Therapy, UMN; Diana S Reader, Division of Physical Therapy, UMN; Krista A Schiltter, Division of Physical Therapy, UMN; David W Polly, Dept. of Orthopaedic Surgery, UMN; Arin M Ellingson, Dept. of Rehabilitation Medicine, UMN

MBI 6 Algorithm for Semi-Automatic Segmentation of Hip Acetabular Cartilage Applied to Patients with Femoroacetabular Impingement
Casey P. Johnson, Dept. of Radiology, UMN; Joost Mulders, Consultant, Costa Mesa, CA; Douglas Martin, Dept. of Radiology, UMN; Patrick M. Morgan, Dept. of Orthopaedic Surgery, UMN; Julta M. Ellermann, Dept. of Radiology, UMN

MBI 7 Validation of Biplane Fluoroscopy for Cervical Spine Kinematics
Craig Kage, Dept. of Rehabilitation Medicine, UMN; Mhosen Akbari-Shandiz, Dept. of Physical Medicine and Rehabilitation, Mayo Clinic; Rebekah L. Lawrence, Dept. of Rehabilitation Medicine, UMN; Hana Boudlali, Dept. of Biomedical Engineering, UMN; Mary Foltz, Dept. of Rehabilitation Medicine, UMN; Arin M. Ellingson, Dept. of Rehabilitation Medicine, UMN; and David Odde, Dept. of Biomedical Engineering, UMN

MBI 8 Development of a Peptide-based 19F MRI Imaging Agent
Steve Kirberger, Sofia Maliteva, and William Pomerantz, Dept. of Chemistry, UMN
MBI 9  Sensing Abiotic Factors in MRI via Perfluorocarbon-Loaded Mesoporous Silica Nanoparticles
A.L. Lee, Dept. of Chemistry, UMN; C.T. Gee, Dept. of Chemistry, UMN; H.L. Ring, Dept. of Chemistry, UMN; B.P. Weegman, Dept. of Radiology CMRR, UMN; S.A. Einstein, Dept. of Radiology CMRR, UMN; M. Garwood, Dept. of Radiology CMRR, UMN; C.L. Haynes, Dept. of Chemistry, UMN; W.C.K. Pomerantz, Dept. of Chemistry, UMN

MBI 10 Three-Dimensional Mechanical Behavior of the Ovine Carotid Artery Bifurcation Evaluated through High Resolution Ultrasound
Ryan R. Mahutga, Dept. of Biomedical Engineering, UMN; John P. Carruth, Dept. of Biomedical Engineering, UMN; Victor H. Barocas, Dept. of Biomedical Engineering, UMN

MBI 11 Development of a Live Cell Microscopy Platform for Quantifying Ovarian Cancer Cell Migration
Rory Manion, Dept. of Lab Medicine and Pathology, UMN; Patrick Bangasser, Dept. of Biomedical Engineering, UMN; Kristin L.M. Boylan, Dept. of Lab Medicine and Pathology, UMN; David Odde, Dept. of Biomedical Engineering, UMN; Amy P.N. Skubitz, Dept. of Biomedical Engineering, UMN

MBI 12 Comparison of Methods for High Spatial-Resolution Breast Diffusion Imaging
Jessica A McKay, Dept. of Biomedical Engineering, UMN; Steen Moeller, Dept. of Radiology, UMN; Sudhir Ramanna, Dept. of Radiology, UMN; Edward J Auerbach, Dept. of Radiology, UMN; Gregory J Metzger, Dept. of Radiology, UMN; Michael T Nelson, Dept. of Radiology, UMN; Kamil Ugurbil, Dept. of Radiology, UMN; Essa Yacoub, Dept. of Radiology, UMN; and Patrick J Bolan, Dept. of Radiology, UMN

MBI 13 Assessment of Neurodegeneration in Brain and Cervical Spine of People with ALS using Diffusion MRI
Pramod Pisharady, CMRR, Department of Radiology, UMN; David Walk, Department of Neurology, UMN; Gaurav Guliani, Department of Neurology, UMN; Georgios Manousakis, Department of Neurology, UMN; Christophe Lenglet, CMRR, Department of Radiology, UMN

MBI 14 A Sparse Bayesian Learning Algorithm for White Matter Parameter Estimation from Compressed Multi-shell Diffusion MRI
Pramod Pisharady, CMRR, Department of Radiology, UMN; Stamatios Sotiropoulos, Centre for Functional MRI of the Brain (FMRIB), University of Oxford, Sir Peter Manseld Imaging Centre, University of Nottingham; Guillermo Sapiro, Electrical and Computer Engineering, Duke University; Christophe Lenglet, CMRR, Department of Radiology, UMN

MBI 15 Application of Novel Analysis Approaches for Atrial Fibrillation using Clinical Intracardiac Electrograms
Vasant Ravikumar, Dept of Electrical Engineering UMN; Siva K Mulpuru, Division of Cardiovascular Diseases, Mayo Clinic; Elena G Tolkachova, Dept of Biomedical Engineering, UMN

MBI 16 Magnetic Resonance Quantification of Iron Oxide Nanoparticles within Cryopreserved Tissues

MBI 17 Information theoretic approaches for brain network analysis
Bhaskar Sen, EE, UMN; Keshab K. Parhi, EE, UMN

MBI 18 Single Element Photoacoustic Imaging for Procedure Guidance and Monitoring
Supriya Thathachary, Dept. of Biomedical Engineering, UMN; Shai Ashkenazi, Dept. of Biomedical Engineering, UMN

MBI 19 Tissue clearing and unbiased image analysis shows the cross talk between MuSC and blood vessel endothelial cell
Mayank Verma, Stem Cell Institute; Bhavani Sai Rohit Murkonda, Stem Cell Institute; Yoko Asakura, Stem Cell Institute; Atsushi Asakura, Stem Cell Institute. University of Minnesota Medical School

MBI 20 Quantification of pain-related gait parameters in mouse model with sickle cell disease
Ying Wang, Dept. of Medicine, UMN; Fei Peng, Dept. of Medicine, UMN; Madhusudan Tennakoon, College of Science and Engineering, UMN; Saad Bedros, College of Science and Engineering; Kalpna Gupta, Dept. of Medicine, UMN

MBI 21 3D modeling and visualization of human cadaver organs for clinical and educational applications
Jorge Zhingre Sanchez, Department of Biomedical Engineering; Mikayle Holm, Department of Biomedical Engineering; Erik Gaasedelen, Department of Bioinformatics and Computational Biology; Paul Iaizzo, Department of Biomedical Engineering
MEDICAL DEVICES

MD 1 Effect of Duty Cycle on the Efficacy of Vagus Nerve Stimulation Therapy in Hypertensive Rats
Elizabeth M. Annoni, Dept. of Biomedical Engineering, UMN; Duty Van Helden, Dept. of Integrative Biology and Physiology, UMN; Imam Libbus, LivaNova PLC; Bruce H. KenKnight, LivaNova PLC; John W. Osborn, Dept. of Integrative Biology and Physiology, UMN; Elena G. Tolkacheva, Dept. of Biomedical Engineering, UMN

MD 2 Non-invasive blood glucose monitoring using near infrared spectroscopy
Vinod kumar Avulapati, Department of Electrical Engineering; Shanthi Prince, SRM University, India

MD 3 Biodegradable, Liquid-filled, Spherical Capsules with Pre-determined Burst Times
Krutika Harish Jain, Department of Pharmaceutics, UMN; Ronald A. Siegel, Department of Pharmaceutics and Biomedical Engineering, UMN

MD 4 Utilization of 3D Printing and Virtual Reality to Train Physicians on Lead Extraction Procedures
Mikayle A Holm, Dept. of Biomedical Engineering, UMN; Paul A laizzo, Dept. of Surgery, UMN

MD 5 Muscle Powered Walking Exoskeleton for People with Spinal Cord Injury
Vikram Katti, Dept. of Mechanical Engineering, UMN; William Durfee, Dept. of Mechanical Engineering, UMN

MD 6 Anatomical 2D/3D Shape-Matching in Virtual Reality: A User Interface for Quantifying Joint Kinematics with Radiographic Imaging
Kyungyoon Kim, Dept. of Computer Science and Engineering, UMN; Rebekah L. Lawrence, Dept. of Rehabilitation Medicine, UMN; Nikkii Kyllonen, Dept. of Computer Science and Engineering, UMN; Paula M. Ludewig, Dept. of Rehabilitation Medicine, UMN; Arin M. Ellingson, Dept. of Rehabilitation Medicine, UMN; Daniel F. Keefe, Dept. of Computer Science and Engineering, UMN

MD 7 Using Virtual Patients for Studying Thoracic Volume Variations in Scheuerman’s Kyphosis Symptom
Po-Chih Lee, Dept. of Mechanical Engineering, UMN; Charles G.T. Ledonio, Dept. of Orthopaedic Surgery, UMN; Arthur G. Erdman, Dept. of Mechanical Engineering, UMN; David W. Polly, Dept. of Orthopaedic Surgery, UMN

MD 8 3D Reconstruction and Analysis of Epicardial Adipose on the Human Heart
Alex Maltson, Dept. of Biomedical Engineering, UMN; Susan Sun, Dept. of Biomedical Engineering, UMN; Traci Jones, Dept. of Biomedical Engineering, UMN; Paul laizzo, Dept. of Surgery, UMN

MD 9 4D Engineering in vitro Metastatic Models via Guided Cell Migration
Fanben Meng, Department of Mechanical Engineering, UMN; Carolyn Meyer, Department of Pediatrics and Medicine, UMN; Angela Panoskalsis-Mortari, Department of Pediatrics and Medicine, UMN; Michael McAlpine, Department of Mechanical Engineering, UMN

MD 10 Anatomic Evaluation of Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) Catheter Deployment
Zachary D. Miller, Eliza R. Pelrine, Jillian V. Johnson, Gerald Weber (College of Science and Engineering, UMN); Peter Kernahan, Brent Bauman, Victor Vakayil, James V. Harmon (all other authors are Dept of Surgery, UMN)

MD 11 VR for Health: Patient-Specific Virtual Reality Environments for Mindfulness-Based Healing
Daniel F. Keefe, Dept. of Computer Science, UMN; Gert Bronfort, Center for Spirituality and Healing, UMN; Roni Evans, Center for Spirituality and Healing, UMN; Alex Haley, Center for Spirituality and Healing, UMN; Joseph Jolton, Minneapolis College of Art and Design; Francis J. Keefe, Dept. of Psychology and Neuroscience, Duke; Lana Yarosh, Dept. of Computer Science, UMN; Anna Tarberko, Minneapolis College of Art and Design; Jung Nam, Dept. of Computer Science, UMN; Linda Hanson, Center for Spirituality and Healing, UMN; Haiwei Ma, Dept. of Computer Science, UMN

MD 12 A Fluorescent enterobactin analogue for the rapid and selective detection of bacteria
Pailloux, S. L., Department of Chemistry, UMN; Joaqui Joaqui, M. A., Department of Chemistry, UMN; Armstrong-Pavlik, F., Department of Chemistry, UMN; Karau, M. J., Department of Laboratory Medicine and Pathology, Mayo Clinic; Heath Brown, Department of Chemistry, UMN; Livezey, N., Department of Chemistry, UMN; Greenwood, K. E., Department of Laboratory Medicine and Pathology, Mayo Clinic; Patel, R., Department of Laboratory Medicine and Pathology, Mayo Clinic; Pierre, V. C., Department of Chemistry, UMN

MD 13 Biomaterial Scaffolds for Non-Invasive Focal Hyperthermia as a Potential Tool to Ablate Metastatic Cancer Cells
Francisco Pelaeez, Dept. of Chemical Engineering and Material Science, UMN; Navid Manuchehrabadi, Dept. of Mechanical Engineering, UMN; Priyatawu Roy, Dept. of Mechanical Engineering, UMN; Harishankar Natesan, Dept. of Mechanical Engineering, UMN; Yiru Wang, Dept. of Mechanical Engineering, UMN; Emilacacela Racila, Dept. of Laboratory Medicine and Pathology, Mayo Clinic; Heather Fong, Dept. of Chemical Engineering and Material Science, UMN; Kevin Zeng, Dept. of Chemical Engineering and Material Science, UMN; Abby Silbaugh, College of Biological Sciences, UMN; John C Bischof, Dept. of Mechanical Engineering, UMN; Samira M. Azarin, Dept. of Chemical Engineering and Material Science, UMN

MD 14 Cancer Antigen Release and Presentation Depend on Focal Therapy Conditions
Qi Shao, Dept. of Mechanical Engineering, UMN

MD 15 A GMR Handheld Platform for One-Step and Rapid Biomarker Detection
Diqing Su, Dept. of Chemical Engineering and Materials Science, UMN; Kai Wu, Department of Electrical and Computer Engineering, UMN; Venkatramana D. Krishna, Dept. of Veterinary Population Medicine, College of Veterinary Medicine, UMN; Todd Klein, Department of Electrical and Computer Engineering, UMN; Andres M. Perez, Dept. of Veterinary Population Medicine, College of Veterinary Medicine, UMN; Jian-Ping Wang, Dept. of Electrical and Computer Engineering, UMN.
MD 16  Cerebellar tDCS Applied During Motor Training Modulates Corticospinal Excitability
RLS Summers, Department of Rehabilitation Medicine, UMN and Program in Physical Therapy, Department of Rehabilitation Medicine, UMN; M Chen, Institute for Engineering in Medicine and Department of Psychiatry, UMN; A Hatch, Program in Physical Therapy, Department of Rehabilitation Medicine, UMN and School of Health and Rehabilitation Sciences, Department of Physical Therapy, MGH Institute of Health Professions.

MD 17  A completely biological “off-the-shelf” arteriovenous graft that recellularizes in non-human primate model
Zeeshan H. Syedian, Department of Biomedical Engineering, UMN; Melanie L. Graham, Preclinical Research Center, UMN; Ty B. Dunn, Department of Surgery UMN; Timothy O’Brien, Department of Veterinary Population Medicine, UMN; Sandra L. Johnson, Department of Biomedical Engineering, UMN; Robert J. Schumacher, Center for Translational Medicine, UMN; Robert T. Tranquillo, Department of Mechanical Engineering, UMN

MD 18  The role of nanoparticle design in determining analytical performance of lateral flow immunoassays
Li Zhan, Dept. of Mechanical Engineering, UMN; Shuangzhuang Guo, Dept. of Mechanical Engineering, UMN; Fayi Song, Institution of Biomaterials & Biomedical Engineering & Terrence Donnelly Center for Cellular and Biomolecular Research, University of Toronto; Yan Gong, Feng Xu, The Key Laboratory of Biomedical Information Engineering of Ministry of Education, School of Life Science and Technology, Bioinspired Engineering and Biomechanics Center (BEBC), Xi’an Jiaotong University; David R. Boulware, Department of Medicine, UMN; Michael C. McAlpine, Dept. of Mechanical Engineering, UMN; Warren C. W. Chan, Institution of Biomechanics & Biomedical Engineering & Terrence Donnelly Center for Cellular and Biomolecular Research, University of Toronto; and John C. Bischof, Dept. of Mechanical Engineering, UMN

NE 1  Modulation of Motor Cortical Spiking Activity during Thalamic DBS
Edward M. Bello, Dept. of Biomedical Engineering, UMN; Filippo Agnesi, Dept. of Biomedical Engineering, UMN; Yizi Xiao, Dept. of Biomedical Engineering, UMN; Matthew D. Johnson, Dept. of Biomedical Engineering, UMN

NE 2  Online seizure prediction using long-term iEEG records
Hsiang-Han Chen, Bioinformatics and Computational Biology, UMN; Han-Tai Shiao, Dept. of Electrical and Computer Engineering, UMN; Vladimir Cherkassky, Dept. of Electrical and Computer Engineering, UMN

NE 3  A particle-swarm optimization algorithm for predicting deep brain stimulation settings that improve parkinsonian motor signs
A. Doyle, Dept. of Neuroscience, UMN; S. Zhang, Dept. of Biomedical Engineering, UMN; E. Peña, Dept. of Biomedical Engineering; M. Yeatts, Dept. of Biomedical Engineering; M. Johnson, Dept. of Biomedical Engineering

NE 4  A 0.0094mm^2/Channel Time-Based Beat Frequency ADC for In-situ Neural Recording
Luke Everson, Dept. of Electrical and Computer Engineering, UMN; Somnath Kundu, Dept. of Electrical and Computer Engineering, UMN; Gang Chen, Dept. of Neuroscience, UMN; Zhi Yang, Dept. of Biomedical Engineering, UMN; Timothy J. Ebner, Dept. of Neurosciences, UMN; Chris H. Kim, Dept. of Electrical and Computer Engineering, UMN

NE 5  Brain Windows: Digitally Generated 3D Cranial Windows for Pan Cortical Neural Interfacing
L Ghanbari, Dept. of Mechanical Engineering, UMN; Carter R E, Dept. of Neuroscience, UMN; Rynes M, Dept. of Biomedical Engineering, UMN; Dominguez J, Dept. of Mechanical Engineering, UMN; Nahom M, Dept. of Neuroscience, UMN; Hu J J, Dept. of Biomedical Engineering, UMN; Shull G, Dept. of Biomedical Engineering, UMN; Ebner T J, Dept. of Neuroscience, UMN; Kodandaramaiah S B, Dept. of Mechanical Engineering, UMN; Laroque M, Dept. of Biomedical Engineering, UMN

NE 6  Reinforcement Learning for Closed Loop DBS in a Computational Model of Parkinson’s Disease
Logan Grado, Dept of Biomedical Engineering, Matthew Johnson, Dept of Biomedical Engineering, Theoden Netoff, Dept of Biomedical Engineering

NE 7  Increased Therapeutic Window for Narrow Pulse Width Deep Brain Stimulation
J. Krieg*, Dept of Biomedical Engineering, UMN; L.K. Wilmerding**, Dept of Biomedical Engineering, UMN; A Doyle, Dept. of Neuroscience, UMN; S. Zhang, PhD. Department of Biomedical Engineering; M. Johnson, PhD, Department of Biomedical Engineering

NE 8  Evaluating Simplified Surfaces for Modeling Tissue Heterogeneity in Finite Element Models of Deep Brain Stimulation
Michael Livanos, Edgar Peña, Dr. Mathew Johnson, Department of Biomedical Engineering
### NE 9
**Achieving Super-Resolution with Redundant Sensing for Biomedical Sensors**
Diu Khue Luu; Anh Tuan Nguyen; and Zhi Yang, Dept. of Biomedical Engineering, UMN

### NE 10
**Discovery of novel biomarkers for Schizophrenia using graph theoretic measures**
Pantea Moghimi, Department of Biomedical Engineering; Kelvin O. Lim, Department of Psychiatry; Theoden I. Netoff, Department of Biomedical Engineering

### NE 11
**A Low-Noise, Wireless Data Acquisition System for Neural Recording Applications**
Jian Xu; Anh Tuan Nguyen; Wenfeng Zhao; Hongsun Guo; Tong Wu; Hubert Lim; and Zhi Yang, Dept. of Biomedical Engineering, UMN

### NE 12
**Photoresponsive Hydrogels for Understanding the Mechanism of Brain Cancer Metastasis**
Keun-Young Park, Dept. of Chemistry, UMN; David J. Odde, Dept. of Biomedical Engineering, UMN*; Mark D. Distefano, Dept. of Chemistry, UMN*

### NE 13
**Utilizing Zika Virus in Oncolytic Medulloblastoma Treatment**
Clairice Pearce, Dept. of Neurosurgery, UMN; Maple L. Shiao, Dept. of Neurosurgery, UMN; Walter C. Low, Dept. of Neurosurgery, UMN

### NE 14
**Multi-objective particle swarm optimization with subject-specific models facilitate spatially targeted programming in subthalamic nucleus deep brain stimulation**
Edgar Peña, Simeng Zhang, Remi Patriat, Noam Harel, Matthew Johnson

### NE 15
**Towards fMRI Mapping of Optogenetic Cerebellar Seizure Treatments**
Thomas Richner, Dept. of Biomedical Engineering & Neuroscience, Corey Cruttenden, Dept. of Mechanical Engineering, Wilson Yu, Dept. of Neuroscience, Hannes Wiesner, Dept. of Radiology, Mahdi Ahmadi, Dept. of Mechanical Engineering, Wei Zhu, Dept. of Radiology, Xiao-Hong Zhu, Dept. of Radiology, Zhi Yang, Dept. of Biomedical Engineering, Rajesh Rajamani, Dept. of Mechanical Engineering, Wei Chen, Dept. of Biomedical Engineering & Radiology, Esther Krook-Magnuson, Dept. of Neuroscience

### NE 16
**Combining tDCS with Cognitive Training for Treatment of Memory Dysfunction in Epilepsy**
Abhrajeeet V. Roy, Dept. of Psychiatry, UMN; Elias Boroda, Dept. of Neuroscience, UMN; Eric Waldron, Rehabilitation Medicine, UMN; Kelvin O. Lim, Dept. of Psychiatry, UMN; Thomas R. Henry, Dept. of Neurology, UMN

### NE 17
**Principles of Computer Numerical Control Applied to Small Research Animal Surgical Procedures**
Mathew Rynes, Dept. of Biomedical Engineering; Leila Ghanbari, Dept. of Mechanical Engineering; Gregory Johnson, Dept. of Mechanical Engineering; Jia Hu, Dept. of Biomedical Engineering; Micheal Laroque, Dept. of Mechanical Engineering; Daniel S Schulman, Dept. of Mechanical Engineering; Nahom Mossazghi, Dept. of Neuroscience; Gabriella Shull, Dept. of Biomedical Engineering; Judith Dominguez, Dept. of Mechanical Engineering; Suhasa Kodandaramiah, Dept. of Mechanical Engineering

### NE 18
**Vibrotactile Discrimination of Simple and Complex Waveforms**
Tiffany Senkow, Dept. of Biomedical Engineering, UMN; Brianna Morales, Dept. of Biomedical Engineering, UTSA; Victor Barocas, Dept. of Biomedical Engineering, UMN

### NE 19
**Image Guided Robot for Microinjection into Single Cells in Organotypic Slices of Mouse Telencephalon**
Gabriella Shull, Dept. of Biomedical Engineering, UMN; Christiane Hoffener, Max Planck Institute for Cell and Molecular Biology; Wieland Huttner, Max Planck Institute for Cell and Molecular Biology; Elena Taverna, Max Planck Institute for Cell and Molecular Biology; Suhasa Kodandaramiah, Dept. of Mechanical Engineering, UMN

### NE 20
**Advanced Stimulation Patterns to Increase Therapeutic Windows for Deep Brain Stimulation Applications**
Julia Slopsema, Dept. of Biomedical Engineering, UMN; Lauri Lehto, Center for Magnetic Resonance Research, UMN; Shalom Michaeli, Center for Magnetic Resonance Research, UMN; Matthew Johnson, Dept. of Biomedical Engineering, UMN

### NE 21
**Evaluating the Zika Virus for its Ability to Infect Human GBM6 and U87 Malignant Gliomas**
Nikolas G. Toman, Dept. of Neurosurgery, UMN; Maple L. Shiao, Dept. of Neurosurgery, UMN; Joseph Voth, Dept. of Neurosurgery, UMN; Georgette Danczyk, Dept. of Neurosurgery, UMN; Walter C. Low, Dept. of Neurosurgery, UMN