CURRICULUM VITAE

Richard J. McMurtrey MD, MSc

Academics

MD – Doctor of Medicine and Surgery with Highest Honors (AOA) – University of Colorado School of Medicine.
NIH research fellowship grant studying molecular signaling pathways for memory formation and neuroprotection.

MSc – Master of Science in Biomedical Engineering with Distinction – University of Oxford – Department of Engineering Science. Thesis research in the area of tissue engineering, biomechanics, stem cells, & regenerative medicine.

BS – Bachelor of Science in Neuroscience with University Honors (Top 1%) – Brigham Young University.
Thesis research in the area of neuroacoustic processing and neural networks.

Director – Alpine Spine & Orthopedics Institute
Director of clinical care for orthopedics, sports medicine, spine, brain, nerve & pain disorders, as well as wilderness, high altitude, & critical care medicine. Director of research for image-guided minimally-invasive regenerative interventions, including the use of stem cells, peptides, proteins, biomaterials, & biologic signaling agents to repair and reconstruct injured and damaged tissues, particularly for orthopedic, neural, & spinal pathologies and conditions.

Fellowship Experience – University of Oxford
Oxford University Hospitals, Oxford Institute of Biomedical Engineering, Oxford Department of Engineering Science, Oxford Orthopaedic Engineering Centre, Nuffield Department of Orthopaedics, Rheumatology, and Musculoskeletal Sciences [Orthopaedics & Sports Medicine]

Resident Physician – University of Virginia
Primary on-call neurosurgery resident for OR, ER, ICU, and general patients, including neuro-trauma, neuro-oncology, neuro-endocrine, spine, trauma, and pediatric neurosurgery specialty services. Primary operative experience in numerous surgical interventions and techniques. Primary resident for all critical care services including ER, trauma surgery, intensive care [trauma-ICU, neuro-ICU, surgical-ICU, cardiovascular-ICU, pediatric-ICU, neonatal-ICU], general surgery, pediatric surgery, anesthesia and interventional pain management services.

Medical Student – University of Colorado
Sub-Internships at Denver General County Medical Center, University Hospital, and Denver Children's Hospital in general surgery, trauma surgery, orthopedics, intensive care, neurosurgery, pediatric neurosurgery, neurology, and interventional radiology (in addition to core rotations).

Adjunct Professor in Neuroscience – Brigham Young University (BYU)
Professor for senior neuroscience 481 courses synthesizing theory, problem-solving, and laboratory techniques, including modules in neuroanatomy, neurohistology and tissue staining, autonomic physiology, electrophysiology and electroencephalography, neuronal membrane physics and mathematical programming, microscopy techniques and theory, medical device instrumentation and biosignal processing, biostatistics and bioinformatics, as well as neuroimaging and MRI physics.

Passed the American Board of Neurological Surgery and the American Board of Surgery Written Examinations.
Licensed for Independent Practice of Medicine and Surgery in Colorado, Utah, & Virginia.
Clinical Research, PHRP, and ICH/GCP Certifications.
Completed all U.S. Medical Licensing Examinations (95-97%ile)
MCAT (97%ile), GRE (99%ile), ACT (99%ile), AP English/Calculus (5/5)

Research Grants & Awards

Distinguished at the University of Oxford as one of the top innovators in the Oxbridge Biotech Roundtable.

Awarded the Oxford Skolkovo Innovation prize, supported by the University of Oxford and the Skolkovo Foundation—first place amongst several finalists.

Qualified Therapeutic Discovery Program Grant from the Department of Health and Human Services for translating basic science research into clinical applications.

Hamilton Medical Research Award from the University of Colorado School of Medicine for outstanding research in the field of neurological disease.

Awarded the ARCS Research Scholarship twice as a medical student.

NIH T32 Research Training Fellowship studying neuronal CaMKII signaling mechanisms. Mentor: K. Ulrich Bayer.

Research grant from the Honors Department and Office of Research and Creative Arts (ORCA). Mentors: S.C. Steffensen & D.E. Fleming.

Research Engineering and Apprenticeship Program (REAP) Grant in Applied Physics. Mentor: Dr. Carl E. Patton, Department of Physics – Colorado State University.

Four year full-tuition academic scholarship to BYU.

Awarded the Rensselaer medal and scholarship for outstanding achievement in mathematics and science.

Publications & Presentations

McMurtrey RJ. "Image-Guided Fibrin Patching and Stem Cell Anchoring in Minimally-Invasive Spine Interventions: Regenerative Repair of Spinal Disorders." *World Conference on Stem Cells and Regenerative Medicine*, Paris, France, 2023.

McMurtrey RJ. "Novel Regenerative Interventions for Osteoarthritis: An Early Clinical Review of Image-Guided Intra-Articular and Extra-Articular Delivery of New Orthobiologic and Pharmacologic Agents for Cartilage Repair." *Tissue Engineering & Regenerative Medicine International Conference*, Paris, France, 2022.

McMurtrey RJ. "Elements of Organoid Design." *Organoids and Mini-Organs*. University of Edinburgh, Elsevier Academic Press, London, United Kingdom: 2018.

McMurtrey RJ. "Roles of Diffusion Dynamics and Molecular Concentration Gradients in Cellular Differentiation and Three-Dimensional Tissue Development." *Stem Cells and Development* 2017; 26(18):1293-1303. PMID: 28707964 arXiv 1707.08543

McMurtrey RJ. "Multi-Compartmental Biomaterial Scaffolds for Patterning Neural Tissue Organoids in Models of Neurodevelopment and Tissue Regeneration." *J. Tissue Engineering* 2016; 7:1-8. PMID: 27766141 arXiv:1610.02543

McMurtrey RJ. "Analytic Models of Oxygen and Nutrient Diffusion, Metabolism Dynamics, and Architecture Optimization in Three-Dimensional Tissue Constructs with Applications and Insights in Cerebral Organoids." *Tissue Engineering* 2016; 22(3):221-249. PMID: 26650970 arXiv1512.06475

McMurtrey RJ. "Novel Advancements in Three-Dimensional Neural Tissue Engineering and Regenerative Medicine." *Neural Regeneration Research*. 2015; 10(3):352-354. PMID: 25878573 arXiv1504.00698

McMurtrey RJ. "Patterned and Functionalized Nanofiber Scaffolds in 3-Dimensional Hydrogel Constructs Enhance Neurite Outgrowth and Directional Control." *J. Neural Engineering* 11 (2014) 066009. PMID: 25358624 arXiv1501.01338

McMurtrey RJ. "Novel 3-Dimensional Hydrogel Constructs with Patterned and Functionalized Nanofiber Scaffolding for Enhanced Neurite Outgrowth and Directional Control." *World Stem Cell Summit*, San Diego, CA 2013.

McMurtrey RJ. "The Effects of Patterned and Functionalized Nanofiber Scaffolds on Neurite Outgrowth and Guidance in 3-dimensional Hydrogels." Thesis for the Degree of Master of Science in Biomedical Engineering with Distinction, Department of Engineering, University of Oxford.

McMurtrey RJ. "A Novel Biomolecular Interface for Suppression of Astrogliosis with Neural Implants." (*In*

Process, extension of McMurtrey R.J. "Decorin and Gliosis and Related System and Method." U.S. Patent App 12,701,603.)

McMurtrey RJ; Zuo Z. "Isoflurane Preconditioning and Postconditioning in Rat Hippocampal Neurons." *Brain Research* 2010; 1358:184-90. PMID: 20709037

McMurtrey RJ; Zuo Z. "Cell Signaling Pathways in Preconditioning and Postconditioning of Rat Hippocampal Neurons." *American Society for Anesthesiologists*, San Diego, CA 2010.

McMurtrey RJ. "Microanatomy, Macroanatomy, and Embryology of the Hippocampus." Department of Neurological Surgery Conference Presentation, 2009, Charlottesville, VA.

McMurtrey RJ; Vest R; Bayer KU. "Modulation of Calcium/Calmodulin Protein Kinase II (CaMKII) Protects against Ischemic Neuronal Cell Death." *Journal of Investigative Medicine,* Vol. 56 (1), 00-00, Jan 2008.

McMurtrey RJ. "The Role of CaMKII in CNS Trauma and Excitotoxic Injury." Presentations for the UCHSC and University of Virginia (UVA) Departments of Neurosurgery, 2008.

McMurtrey RJ; Vest R; Bayer KU. "The Role of Calcium/Calmodulin Protein Kinase II (CaMKII) in Oxygen/ Glucose Deprivation**.**" *Western Student Medical Research Forum* 2008, Carmel, CA.

McMurtrey RJ; Bayer KU. "Alternative Splicing of Calcium/Calmodulin Protein Kinase II (CaMKII) Affects Subcellular Localization and Dendritic Arborization." *Journal of Investigative Medicine* Vol. 54, (1) #177, Jan 2006.

McMurtrey RJ; Bayer KU. "Alternative Splicing of Calcium/Calmodulin Protein Kinase II (CaMKII) Affects Subcellular Localization and Dendritic Arborization—with Sequence Analysis of Functional Regions." *Western Student Medical Research Forum* 2006, Carmel, CA.

O'leary H; Filbin ME; McMurtrey RJ; Lasda E; Davies K; Bayer KU. "Alternative Splicing Modulates Cytoskeletal Association of the Neuronal CaMKIIβ." (Department of Pharmacology and Program in Neurosciences) *Society for Neuroscience* 2006.

McMurtrey RJ. "Psychiatric Sequelae of Traumatic Brain Injury." *UCHSC NeuroPsychiatry Conference* 2006.

McMurtrey RJ. "A Novel Role of Alternative Splicing in Neuronal Plasticity." *UCHSC University Research Conference*, 2006.

Escobar GA; McMurtrey RJ; Hedges J; Moore JB. "Large Spontaneous Unilateral Adrenal Hemorrhage in Pre-eclampsia: Case Report and Clinical Image:" Institution: Denver Health Medical Center/University of Colorado Health Sciences Center.

McMurtrey RJ. NIH T32 Research Training Fellowship Report and Summary, 2005 (NIHMS Manuscript 64900).

McMurtrey RJ; Fleming DE. "Effects of Harmony and Dissonance with Two-tone Narrow and Wide Range Frequencies on Auditory Evoked Potentials," *Journal of Undergraduate Research and Creative Activities* (JUG) 2002.

McMurtrey RJ. The Effects of Harmony and Dissonance with Two-tone Narrow- and Wide- Range Frequencies on Auditory Evoked Potentials—with Proposed Neural Mechanisms of Tone Perception. University Honors Thesis AS 36 .B752 M34646 2004. (66 pp.)

Srivastava AK; Hurben MJ; Wittenauer MA; Kabos P; Patton CE; Ramesh R; Dorsey PC; Chrisey DB. "Angle Dependence of the Ferromagnetic Resonance Linewidth and Two Magnon Losses in Pulsed Laser Deposited Films of Yttrium Iron Garnett, MnZn Ferrite, and NiZn Ferrite," *Journal of Applied Physics*, Vol. 85.11, June 1999. (U.S. Army Research Engineering and Apprenticeship Program.)

Intellectual Property

McMurtrey RJ. "Biochemically Functionalized Tissue Constructs with Patterned Three-Dimensional Architecture." U.S. Patent App 62,077,207.
McMurtrey RJ. "Artificial Composite Neural Tissue Construct." U.S. Patent App 29,499,603, D789538.
McMurtrey RJ. "Patterned and Functionalized Composite Constructs for Neural Tissue Engineering." U.S. Patent App 14,461,325.
McMurtrey RJ. "Composition and Method for Achieving Rehydration and Improved Performance in Endurance Exercise." U.S. Patent App 13,103,105.
McMurtrey RJ. "Decorin and Gliosis and Related System and Method." U.S. Patent App 12,701,603.

Reviewer for Academic Journals

Scientific Reports (Nature Publishing Group)
Biophysics Reviews (Institute of Physics Publishing)
Tissue Engineering (Tissue Engineering and Regenerative Medicine International Society - Mary Ann Liebert Pub.)
Journal of Biomedical Materials Research (Society for Biomaterials - John Wiley & Sons Pub.)
Journal of the Royal Society Interface (The Royal Society Publishing)
Neural Regeneration Research (Lippincott Williams & Wilkins)

Engineering Skills

Completed all graduate courses offered in Biomedical Engineering at the University of Oxford Department of Engineering Science with highest distinction in both my thesis work and engineering and mathematics examinations including biomechanics, fluid mechanics, ultrasonics, quantitative physiology, device instrumentation, informatics, nuclear and magnetic resonance imaging physics, image processing, tissue engineering, and MATLAB modeling of numerous complex applications of ordinary and partial differential equations. For my thesis work I designed new forms of 3D nano-patterned biomaterial constructs for stem cell growth and differentiation which showed new capabilities in creating 3D neural tissue using patterned molecular signaling cues that guided stem cell differentiation, promoted neurite outgrowth, and controlled neurite direction during development. I also developed novel neural interfaces and created 3D models of complex molecular diffusion and biomechanical signaling phenomena as well as new methods of microscopy imaging analysis for 3D tissue constructs. This work forged essential advancements in 3D tissue engineering capabilities and provides many new applications and directions for future tissue regeneration research.

Computer Skills

Expertise in MATLAB programming (including ODEs, PDEs, Modeling & Analysis – completed Oxford Matlab course), Sigmastat and several other bioinformatics statistics programs (completed advanced statistics and epidemiology courses), Microsoft Office Suite software and Adobe Creative Suite software.

University Adjunct Professor & Professional Consulting Experience

Neurological & Orthopedic Surgery	Critical Care, Trauma, & Wilderness Medicine
Tissue Engineering & Biomaterials	Tissue Interfaces
Medical Device Instrumentation	Imaging (MRI, PET, CT, Ultrasound)
Neurobiology & Neurodevelopment	Biophysics
Neuroanatomy & Neurohistology	Quantitative Physiology
Stem Cell Biology	Neural Modeling
Regenerative Medicine	Molecular Biology

Languages

Latin (1st place in the Yengich Latin I translation competition amongst several universities)
Hebrew (intermediate level)
Greek (intermediate level)
Russian (basic level)
Spanish (advanced level)

Extracurricular Activities and Accomplishments

I enjoy exploring the outdoors and utilizing my knowledge and skills in wilderness medicine, high-altitude medicine, remote critical care and trauma. I have extensive experience in rock and ice climbing at grades up to 5.13 sport/5.12 trad/WI6/M10/Grade V, including climbing routes like the Diamond of Longs Peak (*D7*, *Yellow Wall*, etc.), completing the entire *Cirque of the Towers* traverse, summiting the Grand Teton via the *Direct Petzoldt* and *Exum* ridges, climbing one of the longest sport routes (*Squawstruck*), climbing test-pieces like Rainbow Wall's *Original Route*, *Levitation 29*, and *Resolution Arete* at Red Rock Canyon, completing several alpine ice and mixed climbs (e.g., *Stairway to Heaven* in Utah, *Mixed Master* in Canada), and many other alpine and expedition medicine experiences. I love trail running through the mountains and currently hold the 35+ age division record in the Utah Valley 10K, and I also played rugby at the intercollegiate and professional club levels (flanker and wing positions). I am always intrigued by the physiologic mechanics that enable extraordinary athletic performance, with many interesting questions still remaining to be explored. When I was younger I also played concert piano, including some of my favorite works by Rachmaninoff and Beethoven, and I hope to return to playing and composing more someday when I have the time, especially because the interactions of artistic brilliance, acoustical physics, and auditory neural processing still fascinate me. I am also a somewhat obsessive collector of books, especially of historical works in science, literature, mountaineering, and photography, and one of my own microscopy photographs of neurons was displayed at the "Art in Science" exhibit at the Denver Museum of Nature and Science.

Research Statement

With the current limitations in therapies for so many diseases and conditions, there is a greater need than ever to engineer new approaches and find more effective therapies. Innovative advancements are most likely to come from those who think outside the box and who have a range of skills and perspectives across disciplines, and I hope to be at the forefront of that discovery, advancing novel solutions to the vast array of unresolved problems in medicine and surgery. With my creativity, knowledge, devotion, and talents, I hope to make many meaningful contributions and advancements in tissue engineering using several regenerative stem cell mechanisms and novel biochemical signaling pathways to repair or replace damaged and diseased tissue, synthesizing biochemical and biomechanical tissue remodeling with minimally-invasive interventions.

Tissue engineering holds incredible potential to restore functional capabilities to damaged tissue. My current research focuses on methods of understanding and reconstructing functional tissue, which incorporates several fascinating fields, including molecular and developmental biology, biochemistry, biomechanics, and biomaterials, all of which necessitate not just a deep understanding of biologic, physiologic, and medical principles, but also of physics, engineering, and mathematics. Regenerative approaches to tissue injury and disease will require a synthesis of many innovative ideas in order to guide functional restoration, and my approaches include 1) construction of 3-dimensional tissue cultures with patterned and functionalized bioactive biomaterial scaffolding designs for guidance of cell differentiation and replication of unique anatomical structures, identities, and functions; 2) refining the processing, implantation, differentiation, and integration of stem cells using unique signaling factors; 3) imaging structure and activity in 3D tissue constructs; 4) researching signaling pathways and mechanisms of tissue injury, cell death, and protective therapeutic interventions; 5) development of novel tissue interfaces, including new biomolecular approaches that may improve the biocompatibility, function, and duration of synthetic tissue implants, constructs, devices; and 6) modeling of diffusion processes, morphogenic gradients, and signaling mechanisms involved in tissue regeneration, repair, and remodeling. In addition, my work examines mechanisms of neuroprotection and neuromodulation, which holds potential for novel therapeutic interventions in traumatic brain injury, spinal cord injury, stroke, and neurodegenerative diseases. These will all be essential components in the advancement of therapeutic interventions that will usher in novel therapeutics and significant improvement in functional recovery over the next decade, especially with applications to neurological conditions of neurons and glial cells as well as orthopedic conditions of bone, muscle, nerve, tendon, ligament, labrum, disc, cartilage, and meniscus injuries. This approach synthesizes many techniques and technologies used in the fields of neurosurgery, orthopedic surgery, critical care, and interventional pain management to effectively forge a new field of "interventional regenerative medicine" using image-guided minimally-invasive interventions with a variety of orthobiologic agents that may include cellular, molecular, and/or biomaterial agents for specific targeted repair effects, which can all be applied in the categories of neurosurgery, orthopedics, critical care, sports medicine, and pain management.