MIZZOU JOINT RESTORATION PORTFOLIO

Technology Management
& Industry Relations
University of Missouri

YOUR CONTACT FOR MIZZOU **LIFE SCIENCES** INNOVATIONS

Staff in the MU Office of Technology Management & Industry Relations (OTMIR) life sciences Intellectual Property Licensing Unit evaluate inventions, negotiate agreements, file patents and arrange legal and business development assistance for inventors and industry partners who work in biological sciences, plant sciences, agriculture, natural resources, veterinary medicine and other fields.

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SAM BISH

SENIOR LICENSING & BUSINESS DEVELOPMENT ASSOCIATE

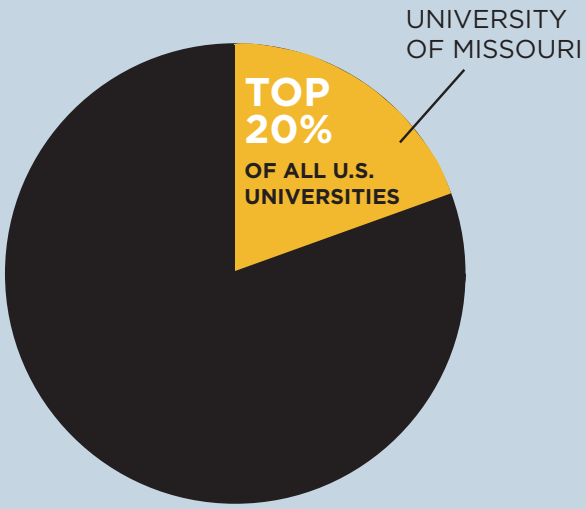
Sam Bish has more than 10 years of technology transfer experience. Before joining OTMIR, Bish was a senior licensing and patenting manager in the cancer branch of the Office of Technology Transfer at the National Institutes of Health (NIH) in Maryland. Before working for NIH, Sam was a technology transfer specialist in the Technology Transfer Center of the National Cancer Institute, also in Maryland. He is a member of the Association of University Technology Managers and has been a guest columnist for Bio Careers, a professional service for life scientists with doctorates or medical degrees.

Sam earned his bachelor's degree in microbiology from Duquesne University in Pittsburgh, Pa., and his doctorate in cell biology and molecular genetics from the University of Maryland in College Park.

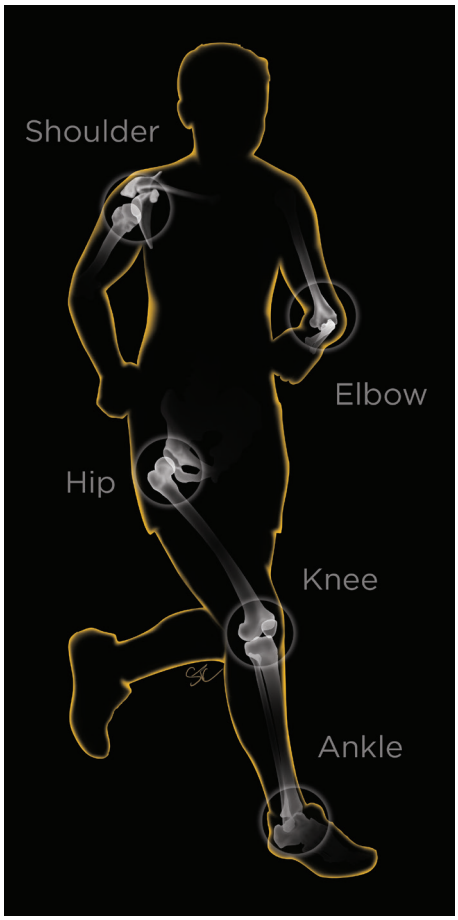
DID YOU KNOW?

The University of Missouri System is consistently in the top 20 percent of higher education institutions nationally for total income received from licensed inventions.

In the last five years, the university has generated $50.98 million in income from more than 169 different technology licenses (FY13-17).



Source: Ranking based on 2017 Milken Institute "Concept to Commercialization" ranking and annual U.S. Licensing Activity Surveys conducted by the Association of University Technology Managers



NOVEL **SURGICAL TOOLS, TECHNIQUES** AND **IMPLANTS** FOR **JOINT RESTORATION**

MU researchers in the **Thompson Laboratory for Regenerative Orthopaedics** have developed innovative technologies for procedures to treat patients with problems affecting their knees, shoulders, hips, ankles, spine and other joints.

Their breakthroughs facilitate **more precise and accurate joint restoration surgery** through the development of customized instrumentation systems, implants and techniques. This customization affords patients the opportunity for more functional outcomes by enabling surgeons to expand their treatment toolbox and overcome the limitations of other technologies.

The University of Missouri is developing breakthrough innovations in joint restoration to preserve patient function and quality of life.

Patients with articular cartilage defects and other bone-cartilage problems are seeking **better treatment options**. Today's standard-of-care techniques are limited by defect size, location and geometry; instrumentation for precise and accurate surgical implantation; and capabilities for restoring joint motion and function. Because of this, patients are often relegated to lifestyle changes that diminish their activities and quality of life.

The Thompson Laboratory for Regenerative Orthopaedics is the **world's largest comprehensive orthopaedic research center** housed within a stand-alone orthopaedic hospital. The center, located in the Missouri Orthopaedic Institute, has a robust team of engineers, physicians, molecular biologists, anatomists, pathologists and veterinarians who collaborate and are able to more efficiently translate their discoveries in the lab to their animal and human patients.

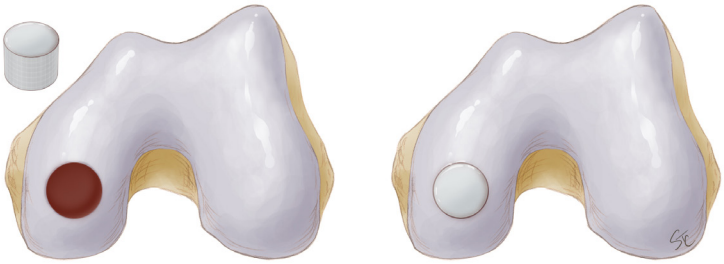
Visit **thompsonlab.missouri.edu** to take a 360-degree virtual tour.

AVAILABLE FOR LICENSING & FURTHER DEVELOPMENT

MU TOOLS AND TECHNIQUES

HYBRID SYNTHETIC-BIOLOGIC JOINT ARTHROPLASTY SYSTEMS

Innovation: This invention comprises a group of related implants, instruments and techniques that provide a variety of options for performing joint replacement and resurfacing surgeries. The implants will be composed of both synthetic and biologic components. These hybrid implants are designed to optimize long-term success in joint replacement and resurfacing surgery of all major joints by combining the advantages of synthetic and biologic arthroplasty techniques while minimizing their disadvantages.



Cylindrical implant for focal defect restoration

Background: More than 7 million Americans have had knee or hip replacement surgeries, according to a Mayo Clinic study. And the Centers for Disease Control and Prevention estimates that well over 1 million hip and knee replacements are performed annually. The demand for such procedures is expected to increase exponentially in the coming years, based on a projected growth in number of older adults and an increase in sedentary lifestyles. Existing implants for artificial joint replacements are not capable of withstanding forces from a variety of real-life activities and cannot be tailored to an individual patient's needs.

Anatomic (patella) implant for full surface restoration

Applications:
- Treatment for focal cartilage defects of the hip, knee, ankle, elbow and shoulder
- Partial and complete hemi-arthroplasties
- Total joint arthroplasty of the knee, shoulder, hip, ankle, elbow, wrist, TMJ, fingers and toes for trauma or arthritis

Advantages:
- Designed to optimize long-term success in joint replacement and resurfacing surgery by using biologic implants rather than metal and plastic
- Restores damaged and degenerating joints with living tissue that will incorporate into the patient's body and maximize function

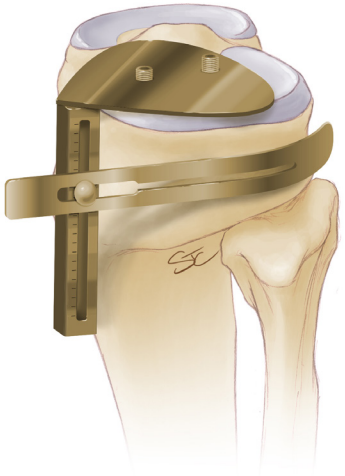
State of development: Prototype completed and successfully implanted in animals showing short-term safety and efficacy; optimizations to pursue regulatory approval are ongoing.
Patent status: U.S. and foreign patents issued
Inventors: James L. Cook, Clark T. Hung, Gerard Ateshian and Eric Lima

DEVICE AND TECHNIQUE FOR TIBIAL PLATEAU ALLOGRAFTING WITH OR WITHOUT ATTACHED MENISCUS

Innovation: MU's invention includes the surgical instrumentation and method for creating custom anatomic osteochondral allografts (OCA) to treat damaged areas of the tibial plateau and meniscus. Our revolutionary instrumentation allows for contouring of grafts to the patient's anatomy and precise preparation of the recipient site for an OCA of complex geometry, rather than simple cylindrical grafts as currently performed.

Background: Between 600,000 and 900,000 patients in the U.S. undergo surgical treatment for articular defects resulting from osteochondritis dessicans, injury, trauma and osteoarthritis. Currently, only a small percentage of surgical procedures use allografts because of their limitations. Though osteochondral allograft tissues are available for transplantation of tibial plateau with or without meniscus, use of standard cylindrical grafts is not amenable to treatment of tibial plateau. As such, many patients are not offered biologic joint restoration options or may have suboptimal outcomes after OCA transplantation because of the inability to comprehensively and effectively address the problems in their knees. These issues result in limited use of donor tissues, graft failures and/or progression of disease, mainly due to the the non-patient-specific geometry of a standard cylindrical OCA. MU's technology is predicted to overcome each of the pitfalls of current OCA procedures, which will improve outcomes and increase the number of patients who can be effectively treated with OCA.

Applications:
- Human or veterinary orthopaedic surgery
- Treats tibial plateau defects with or without meniscal deficiency



Tibial plateau resection guide

Advantages:
- Personalized allografts to match a patient's joint geometry
- Precise removal and replacement of damaged cartilage and meniscus
- Patient-specific grafting for optimal fit and function
- Increased graft stability and comprehensive treatment of defects
- Improved outcomes for patients

State of development: Completion of prototype; canine model testing ongoing
Patent status: Patent pending
Inventors: Ferris M. Pfeiffer, James L. Cook and James P. Stannard

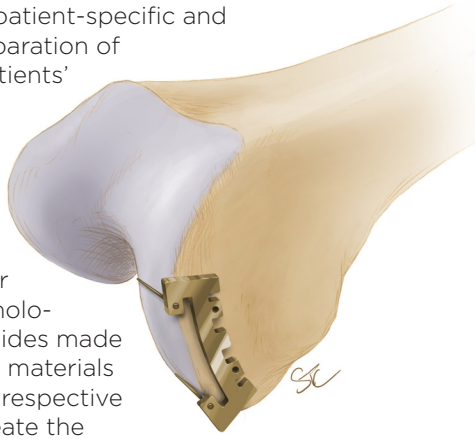
Portfolio art by Stacy Turpin Cheavens

AVAILABLE FOR LICENSING & FURTHER DEVELOPMENT

MU TOOLS AND TECHNOLGIES

NEW SURGICAL INSTRUMENTATION AND TECHNIQUES FOR PATIENT-SPECIFIC OSTEOCHONDRAL ALLOGRAFTS

Innovation: These unique surgical instrumentation systems allow for accurate, patient-specific and defect-specific preparation of recipient sites in patients' knees, ankles, hips, shoulders and elbows, as well as creation of the corresponding osteochondral allograft from donor tissues. These technologies use surgical guides made from medical grade materials that contour to the respective joint surfaces to create the anatomy-specific recipient site, followed by instrumentation of the donor tissue to create a precisely matched OCA for transplantation. As such, they have the potential to revolutionize joint surgery by allowing for precise, anatomical biologic joint restoration; increasing the use of organ donor tissue; and improving outcomes for patients with these common, debilitating problems.



PATIENT-SPECIFIC OCA RESECTON GUIDE ON LATERAL FEMORAL CONDYLE

Background: Young, active patients with extensive damage to their articular cartilage have few treatment options that allow them to return to highly functional activities. Current standard-of-care techniques do not optimally address these types of problems due to limitations in surgical site access, effective instrumentation, and stable implantation of anatomical restorations that return joint function. Total and partial joint replacements using synthetic materials also do not allow return to these activities and have a limited lifespan. Younger, active patients want options that provide more optimal outcomes. OCA transplantation is a proven and growing treatment option for these patients. MU's technological advances in this area provide the potential to address the limitations of OCA transplantation so that more patients can pursue this treatment option.

Applications:
- Human and veterinary orthopaedic surgery

Advantages:
- Patient-specific, anatomic-based creation and implantation of osteochondral allograft transplants
- Contoured to fit a variety of articular surfaces for application to major joints
- Same system prepares recipient site and donor OCA
- Allows for restoration of joint function

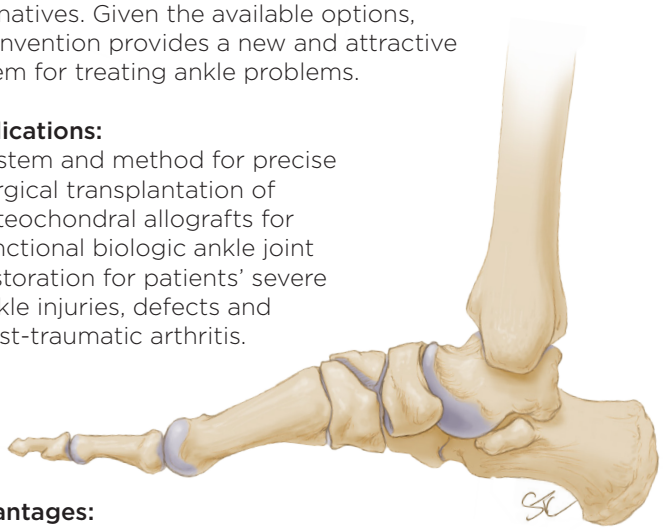
State of development: Completion of prototype; ongoing preclinical testing
Patent status: Patent pending
Inventors: Ferris M. Pfeiffer, James L. Cook and James P. Stannard

OSTEOCHONDRAL ALLOGRAFTS FOR THE ANKLE

Innovation: This invention provides a system and method for precise surgical transplantation of osteochondral allografts for functional biologic ankle joint restoration. Our surgical instrumentation system can be used to create the recipient site and matched donor OCA for patient-specific biologic total ankle replacement. The technology provides an alternative to current standard-of-care procedures, such as fusion or artificial replacements, that can return patients suffering from severe ankle injuries, defects and post-traumatic arthritis to highly functional activity.

Background: The ankle joint is the most commonly injured joint in the body. Ankle fractures occur in cases of high-energy trauma, such as motor vehicle, extreme sports and cycling accidents, and those of low-energy trauma, such as falls, athletic events and other repetitive impact activities. Patients with debilitating ankle problems are usually younger than those with debilitating knee or hip problems. The longer projected life span combined with a substantial decrease in health-related quality of life, underscores the profound effect that ankle trauma and osteoarthritis have on patient disability. Total ankle replacements using metal and plastic implants have not resulted in consistently successful outcomes, and options such as ankle fusion or amputation are not functional alternatives. Given the available options, this invention provides a new and attractive system for treating ankle problems.

Applications:
- System and method for precise surgical transplantation of osteochondral allografts for functional biologic ankle joint restoration for patients' severe ankle injuries, defects and post-traumatic arthritis.



Advantages:
- First osteochondral allograft instrumentation system available for the ankle
- Same system allows for recipient site preparation and creation of matched donor OCAs for transplantation
- Provides an alternative to ankle fusion, artificial replacements or amputation, which can allow for highly functional outcomes

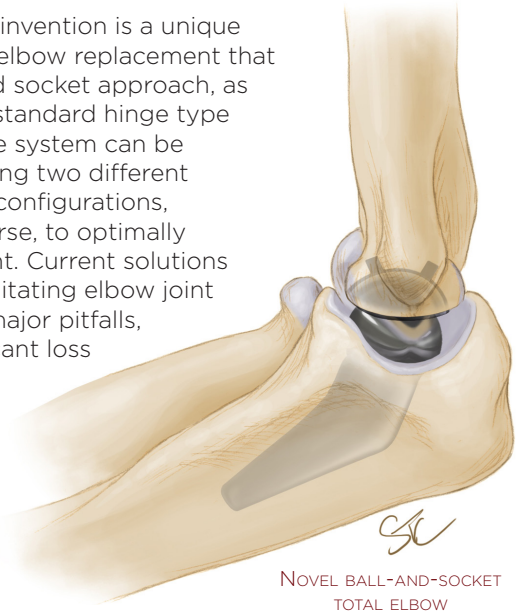
State of development: Functional prototype developed; testing on human cadavers ongoing
Patent status: Under evaluation
Inventors: Ferris M. Pfeiffer, James L. Cook and James P. Stannard

AVAILABLE FOR LICENSING & FURTHER DEVELOPMENT

MU TOOLS AND TECHNOLGIES

NOVEL TOTAL ELBOW REPLACEMENT SYSTEM

Innovation: This invention is a unique system for total elbow replacement that utilizes a ball and socket approach, as opposed to the standard hinge type replacement. The system can be implemented using two different ball-and-socket configurations, standard or reverse, to optimally treat each patient. Current solutions for treating debilitating elbow joint problems have major pitfalls, including significant loss of function with elbow joint fusion and high failure rates for standard hinge joint replacements. This novel system, which fully addresses these issues, is designed to provide improved safety, function and longevity for elbow joint replacements compared to current treatment methods.



NOVEL BALL-AND-SOCKET TOTAL ELBOW ARTHROPLASTY SYSTEM

Background: Total elbow arthroplasty is a surgical procedure included in the total joint replacement market. As the general population ages, the number of arthritis cases and elbow fractures will rise, which creates a need for additional elbow replacement procedures. Although symptomatic arthritis of the elbow is less frequently diagnosed than in joints such as the knee or hip, the physical impairment of someone with arthritis in the elbow can be just as severe, greatly hindering a person's ability to work, enjoy recreational activities and even perform activities of daily living.

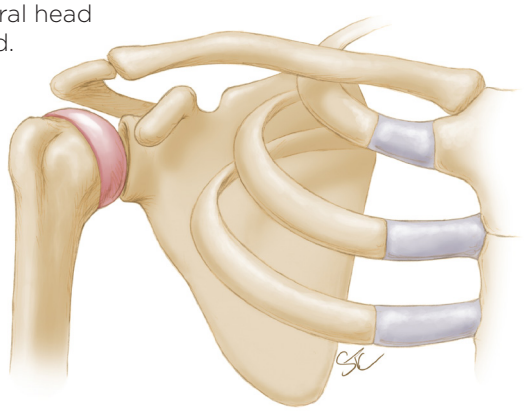
Application:
- Total elbow replacement

Advantages:
- Modular system with standard and reverse configurations allows patient- and disease-specific approaches to treatment
- Ball-and-socket type configurations
- Unique design restores complete range of motion to the elbow
- Surgical technique and instrumentation allow for greater post-operative stability than standard replacements

State of development: Ongoing; prototype developed
Patent status: Patent pending
Inventors: James L. Cook, Trent Guess and Matthew Smith

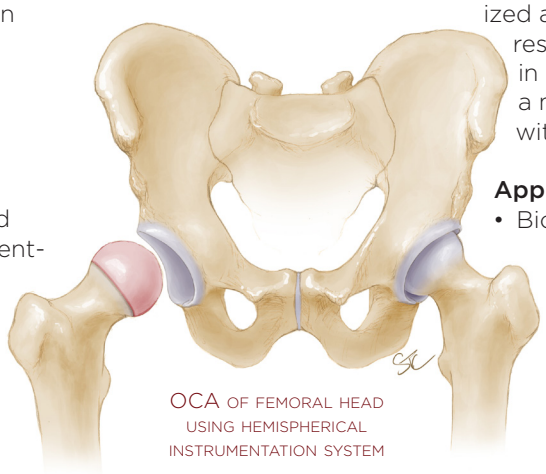
OSTEOCHONDRAL ALLOGRAFT INSTRUMENTATION SYSTEM FOR HEMISPHERICAL JOINT REPLACEMENT

Innovation: This unique system addresses an unmet need in osteochondral allograft transplantation surgery. It provides instrumentation and methodology for creating a recipient site and matched donor OCA for hemispherical articular surfaces, such as the femoral head and humeral head. The instrumentation produces matching multitiered donor and recipient components that allow for complete resurfacing using press-fit fixation. This enables the surgeon to follow the principles of successful osteochondral allograft transplantation for this unique anatomical geometry. This invention has distinct advantages over surgical approaches that use plug allografts or artificial joint replacements.



OCA OF HUMERAL HEAD USING HEMISPHERICAL INSTRUMENTATION SYSTEM

Background: Current methods of joint replacement use artificial materials that wear down over time and often need to be replaced or adjusted after 10 years. Biological joint replacements are believed to have greater longevity and allow for a more active lifestyle than artificial joint replacements. No instrumentation exists for biological replacement of hemispherical joint surfaces, such as the ball portion of the ball-and-socket hip and shoulder joints. This technology is designed to allow for whole joint resurfacing in a standardized and repeatable manner that may be able to restore joint function for longer than 15 years in patients, while also enabling them to enjoy a more active lifestyle compared to recipients with artificial joints.



OCA OF FEMORAL HEAD USING HEMISPHERICAL INSTRUMENTATION SYSTEM

Applications:
- Biological replacement of hip and shoulder joint

Advantages:
- Provides instrumentation and methodology for recipient site and matched donor OCA preparation for press-fit fixation
- Allows for complete resurfacing of hemispherical articular surfaces
- Allows for biologic joint resurfacing, which provides a more natural joint with potential for higher level function than artificial joint replacements

State of development: Ongoing; early prototype design
Patent status: Under evaluation
Inventors: James L. Cook and Matthew J. Smith

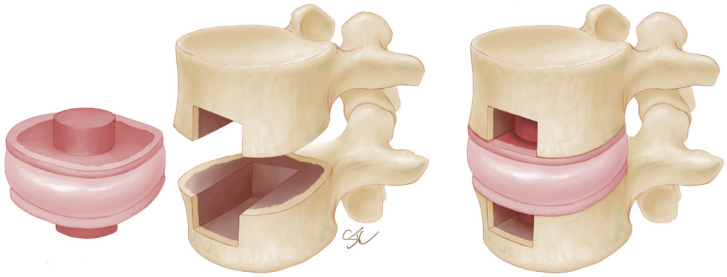
AVAILABLE FOR LICENSING & FURTHER DEVELOPMENT

MU TOOLS AND TECHNOLGIES

NOVEL INTERVERTEBRAL DISC REPLACEMENT SYSTEM

Innovation: This spinal disc replacement system uses novel instrumentation and methodology for implanting complete intervertebral disc (IVD) allografts or artificial replacements at any disc space in humans or companion animals. The system utilizes size-matched instrumentation for recipient (patient) bone used for implantation of pre-manufactured artifical disc replacements or creation of allograft transplants. This technology is designed to create a precise press fit in the patient's spine while protecting the surrounding soft tissues, such as blood vessels, nerve roots and the spinal cord. This system could improve the safety and success rate of disc replacement surgeries compared to currently available options.

Background: Back and neck pain are two common health complaints in medical practice. Lifestyle changes, an aging population and obesity are the primary reasons for rising incidence of degenerative spine disorders. Spinal fusion is the most common surgical procedure used to treat degenerative disc disease. However, advancements in artificial disc replacement surgeries are creating a shift from fusion to disc replacements, which enable better rotational and translational movements, higher patient function, lower risk for adjacent disc disease, and improved quality of life.



Intervertebral allograft transplantation using MU's novel method

Applications:
- Intervertebral disc replacement in humans or animals

Advantages:
- Surgical technique and instrumentation allow for improved efficacy and safety for disc replacement surgery
- Precise geometric fit of artificial or allograft disc replacement to patient recipient site
- Can be adapted for both humans and companion animals

State of development: Ongoing; prototypes developed for canine and human applications
Patent status: Under evaluation
Inventors: James L. Cook and James T. Stannard

Members of the Thompson Laboratory for Regenerative Orthopaedics team, led by Dr. James Cook and Dr. James Stannard, have accomplished a great deal during the past 20 years, but they are dedicated to continually improving delivery of care in orthopaedics through patient-based discovery and application of technological advancements.

When Cook, who began his career designing orthopaedic solutions for companion animals, joined forces with MU Orthopaedic Surgery Chairman, Stannard, they knew their unique partnership, resources and research team could truly make a difference for human patients, too.

In addition to developing the innovations in this portfolio, the Thompson Lab team invented, patented and licensed MOPS℠, an award-winning bone-and-cartilage preservation system that is revolutionizing osteochondral allograft tissue banking and transplantation. MOPS more than doubles the storage life of osteochondral tissues and preserves them at a higher quality level than other systems, which results in far less waste and improved outcomes for patients.

"It took our team more than seven years of rigorous scientific research to find and patent a new way to preserve donor tissue," Cook says, "but it has certainly been worth all the hard work in terms of what it means to donor families and the initial results we are seeing in patients."

Today, the lab's diverse, multidisciplinary researchers continue to focus on finding better solutions to common orthopaedic problems, including advancements in biomarkers for arthritis, methods for improving bone health and healing, optimized ligament repair techniques, and better postoperative rehabilitation methods and techniques, among others.

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