

Costs and Research Funding Public and Private Sources

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Research is the foundation for advancement in the field of biologic reconstruction in the knee. Perhaps, more than in any other specialty, the potential for development of and demand for new treatment paradigms, procedures, and products is extremely high. There continues to be a large segment of the population affected by cartilage pathology in the knee. However, there also continues to be a relative deficiency of widely available and affordable treatment options. The development of some of these newer options is frequently prohibitively expensive. Thus, delivery of safe and effective articular cartilage repair technologies to the public is currently a significant issue within orthopedic surgery, sports medicine, and regenerative medicine.

The investigation of articular cartilage repair techniques in the knee takes a minimum study size of 250 to 300 individuals with a study result that is not only statistically significant, but clinically important, over the current gold standard microfracture, just to get a product to the US Food and Drug Administration.¹ This would cost a company a minimum of 30 to 50 million US dollars before they can even sell their first product to hospitals and surgeons. This cumbersome process makes it incredibly costly and not without significant financial risk to deliver a product to market. Unfortunately, 2 recent products being used in high-quality clinical trials both in the United States (Cartilage Autograft Implantation System [CAIS], DePuy Mitek) and Italy (Hyalograft C, Hyaff 11, Anika Therapeutics, Inc) have been withdrawn from the market owing to cost, despite significant improvements in validated patient-reported clinical outcomes. However, without research in new technologies such as these,

advancements and improvements are severely limited. Thus, continued funding of research is essential to the development of the field and improved outcomes for patients.

There are 2 main types of research: clinical and basic science. There are multiple different divisions within each of these categories and multiple different sources of potential funding available within each division. Generally, these can be broken down into public and private sources and also local vs national and international. Requirements and funding levels vary based on the source and the project proposal. It is important to first define the project objective(s) and then search for a funding source that aligns with those goals.

Regardless of the funding source, the presence of a financial conflict of interest disclosure in research publications and funding may confound outcome interpretation in the eyes of peers, the public, and policy-makers. In certain centers and for certain projects, combining sources of funding, including private industry, is necessary to support research. It has been shown that the level of evidence of industry-funded research is lower than nonindustry-funded research or investigations funded by government or public sources.² Further, presentations by authors with financial conflicts of interest present have been more likely to describe positive findings.³ However, it has also been shown that the proportion of financially supported disclosed studies with negative outcomes (studies that find no difference in outcome between intervention and control groups) has also significantly increased.⁴ In a recent systematic review, there was a significant increase in the number of studies that adequately

TABLE 25-1. US REGIONAL MEDICAL SOCIETIES AND SOURCES OF FUNDING ASSOCIATED WITH EACH

SOCIETY	WEBSITE	GRANTS, AWARDS, SOURCES OF FINANCIAL SUPPORT
Western Orthopaedic Association	www.woa-assn.org	<ul style="list-style-type: none"> • Annual meeting awards (young investigator, resident/fellow, poster, eponymous)
Eastern Orthopaedic Association	www.eoa-assn.org	<ul style="list-style-type: none"> • Eastern Orthopaedic Education Foundation • Annual meeting awards (EOA/OREF resident/fellow travel, Ranawat, Founders')
Mid-America Orthopaedic Association	www.maoa.org	<ul style="list-style-type: none"> • MAOA Education and Research Fund • MAOA Endowment Fund • Annual meeting awards (physician-in-training, multipurpose resident, poster, travelling fellowship, education grants for new-in-practice physicians and senior residents)
Southern Orthopaedic Association	www.soaassn.org	<ul style="list-style-type: none"> • SOA Educational Program • SOA President's Fund • Annual meeting awards (resident/fellow, eponymous)

reported either the presence or absence of a financial conflict of interest, reflecting journal editors' and study authors' recognition of the impact that these conflicts may have on study outcomes.⁵

PUBLIC SOURCES

Public sources of funding include, but are not limited to, government agencies and universities. These can then be divided into local, state, regional, national, and international opportunities.

Local/State/Regional

- University grants—Grant funding sources are frequently available in universities and colleges to support research. These can be excellent opportunities to obtain seed funding for a project. Each grant has different sources and requirements. Contact the research or grant department at your university.
- Local, state, regional medical societies—Grant funding sources are available from medical societies to which clinicians and researchers may belong (Table 25-1). These opportunities are available to practicing clinicians, researchers, clinician-scientists, students, residents, fellows, and other trainees.

National/International

- National Institutes of Health (NIH) and National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS) (www.niams.nih.gov)—This is the most well-known funding source. It is also the funding source with the highest amount of available support. There are multiple different grants available and a variety of pathways (Table 25-2). Application submission, review, and revision (Figure 25-1) can be a long process and requires a significant amount of “preapplication” work that often includes early preliminary data. Specifically, NIAMS has a cartilage and connective tissue program designed to support advancement in these fields. This is an excellent resource for scientists focused on these areas.⁶ For residents, fellows, and practicing orthopedic surgeons in the first 3 years of practice, the American Academy of Orthopaedic Surgeons (AAOS)/Orthopaedic Research and Education Foundation (OREF)/Orthopaedic Research Society (ORS) Clinician Scholar Development Program (CSDP)⁷ is an annual program designed for orthopedic surgeons interested in pursuing a career as a clinician scientist who are involved in obtaining public and private research funding.
- National Science Foundation (NSF) (www.nsf.gov/funding)—This is a federal program that funds research and education in science and engineering. This source of financial support sponsors research at

NIH RESEARCH PROJECT GRANT PROGRAM (R01)	<ul style="list-style-type: none"> • Used to support a discrete, specified, circumscribed research project • NIH's most commonly used grant program • No specific dollar limit unless specified in FOA • Advance permission required for \$500,000 or more (direct costs) in any year • Generally awarded for 3 to 5 years • All ICs use
NIH SMALL GRANT PROGRAM (R03)	<ul style="list-style-type: none"> • Provides limited funding for a short period of time to support a variety of types of projects, including: <ul style="list-style-type: none"> ◦ Pilot or feasibility studies, collection of preliminary data, secondary analysis of existing data ◦ Small, self-contained research projects ◦ Development of new research technology • Limited to 2 years of funding • Direct costs generally up to \$50,000 per year • Not renewable • Used by more than half of the NIH ICs
<p>FOA, funding opportunity announcements; IC, institutes and centers; NIH, National Institutes of Health. Reprinted with permission from http://grants.nih.gov/grants/funding/funding_program.htm#Resource</p>	

all levels of education and academia (colleges, universities, grade and high schools, and science and research organizations). The Foundation funds approximately one-fourth of academic institutions' federal support for basic science research in the United States.

PRIVATE SOURCES

Local

- There are often local organizations that provide seed funding for basic projects for investigators at various levels of experience. These sources of funding can be particularly important for clinical studies for the young investigator. Search your local orthopedic organizations for available opportunities.

National/International

- The Arthritis Foundation (www.arthritis.org)—This is a large organization that is very well funded. It directs research funding to the fields of rheumatoid arthritis and osteoarthritis. They have multiple different grants available that can be applied to a wide range of research topics.

- The Arthritis National Research Foundation (www.curearthritis.org)—This is a national organization focused on the improvement of care for people with arthritis.
- OREF (www.oref.org)—This is the best source for orthopedic-related research funding. There is a range of funding sources designed to provide opportunities for every level of investigator (Table 25-3).
- Arthroscopy Association of North America (AANA)—This society focuses on the arthroscopic treatment of cartilage pathology. They have research grants available up to \$25,000.
- The American Orthopaedic Society for Sports Medicine (AOSSM)—This is a large sports medicine organization with significant grant funding available. The grants listed below are specific to cartilage pathology.
 - AOSSM offers a research grant program to fund investigations related to early osteoarthritis and/or prevention of osteoarthritis progression. AOSSM offers a grant for \$50,000 to support either a clinical research investigation or a basic science project.
 - Young investigator grants are also available with funding amounts up to \$50,000.

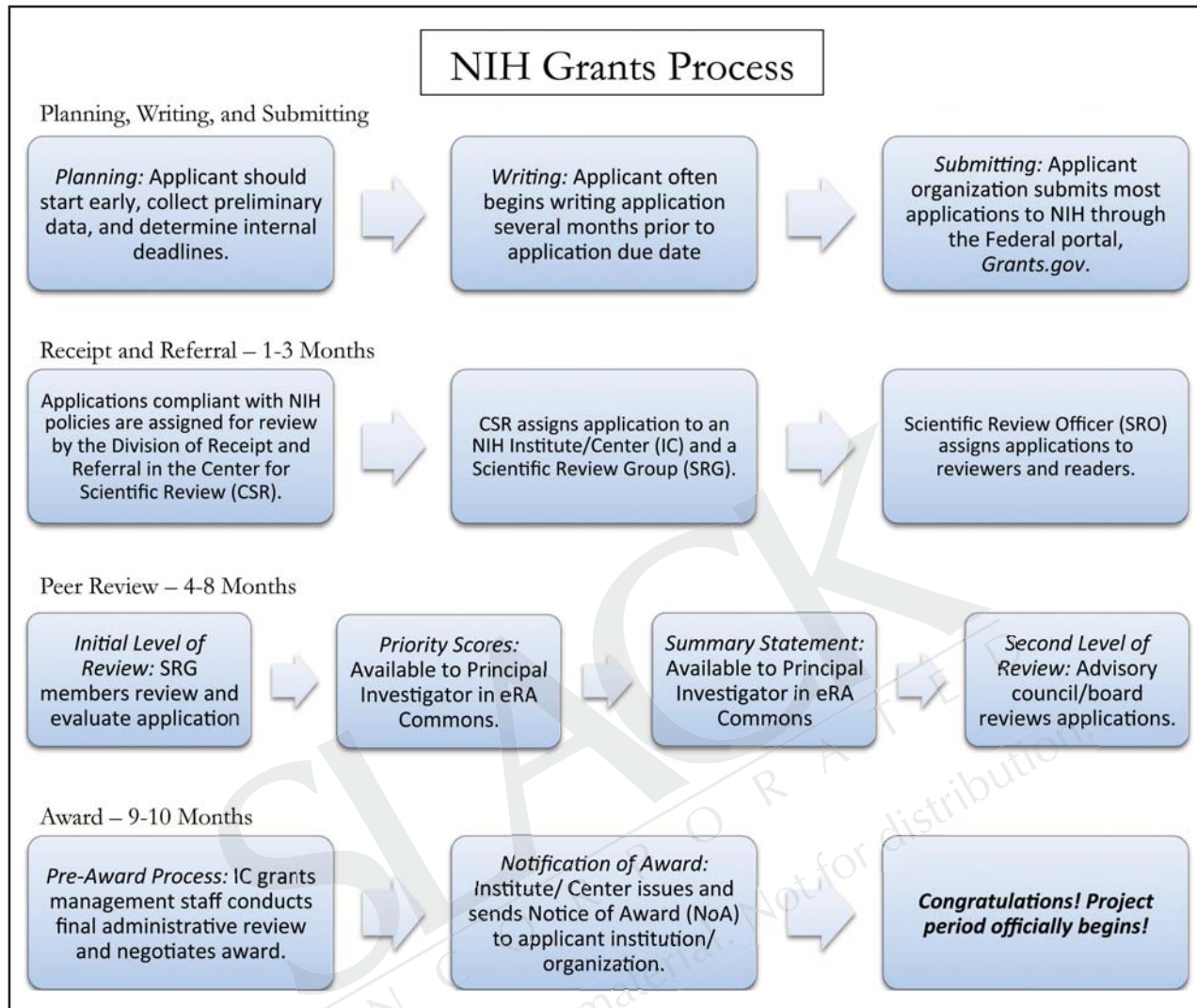


Figure 25-1. Flowchart for the grant application process through the NIH. eRA, electronic Research Administration.

- International Cartilage Repair Society (ICRS)—This society also has access to funding for articular cartilage projects. These include a travelling fellowship and industry cosponsored support.
- Osteoarthritis Research Society International (OARSI)—This society sponsors Clinical Research Awards, Basic Science Research Awards, Lifetime Achievement Awards, Young Investigator Awards, Collaborative Scholarships, and Travelling Fellowships.

INDUSTRY

Private industry companies can represent excellent sources of funding. However, as discussed earlier in this chapter, the researcher must be aware that funding from a company that has a financial stake in the results of a study can bring significant bias into the conclusions. Further,

negative findings that do not demonstrate superiority of a certain product may not be published (publication bias). The best way to search for industry funding is to obtain the contact information of the research department for each specific company. A proposal will then be required for the department to evaluate the research opportunity.

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**TABLE 25-3. GRANTS AVAILABLE THROUGH THE
ORTHOPAEDIC RESEARCH AND EDUCATION FOUNDATION**

GENERAL GRANTS	DESCRIPTION AND ELIGIBILITY REQUIREMENTS	WHO APPLIES
Career Development Grant—\$225,000 grant (\$75,000 per year)	<ul style="list-style-type: none"> Encourages investigators to commit to scientific research. Research may be basic, translational, clinical and/or health services. 	<ul style="list-style-type: none"> Orthopedic surgeon (MD, MBBS) PhDs and DVMs are eligible if affiliated with an orthopedic department Resident/fellow can apply only if he/she is able to demonstrate will begin a staff position at the time the grant commences
Prospective Clinical Research Grant—\$150,000 grant (\$50,000 per year)	<ul style="list-style-type: none"> Promotes clinical research and provides funding for promising prospective studies (studies that occur over the course of time and typically track the outcomes of a group over that time) in the areas of high clinical importance in orthopedic surgery. 	<ul style="list-style-type: none"> PI or Co-PI must be an orthopedic surgeon PhDs and DVMs are eligible if affiliated with an orthopedic department Resident/fellow can apply only if he/she is able to demonstrate will begin a staff position at the time the grant commences
OREF Mentored Clinician-Scientist Grant—\$20,000 grant	<ul style="list-style-type: none"> Promotes the development of new clinician-scientists-in-training to have a long and productive career in academic surgery. Supplements the salary of an orthopedic researcher that has secured an NIH K08 or K23 award (or equivalent mentored research funding). 	<ul style="list-style-type: none"> Orthopedic surgeon Current NIH K-award recipient (or mentoring award from an equivalent funding source)
New Investigator Grant—\$50,000 grant	<ul style="list-style-type: none"> Advances the scientific training of the next orthopedic surgeons by providing seed and start-up funding for promising research projects. Clinical relevance must be clearly noted in the abstract and specific aims, and be obvious from the title and study design. 	<ul style="list-style-type: none"> Residents Fellows Orthopedic surgeons having completed formal training within the past 4 years
ORS/OREF Post-Doctoral Fellowship Grant—\$50,000 grant	<ul style="list-style-type: none"> ORS/OREF Postdoctoral Fellowship Award provides 1 year of support for individuals in a full-time postdoctoral training program. Applicants must be dedicated to an orthopedic-related project and focused on development of a career in orthopedic research. 	<ul style="list-style-type: none"> PhD, MD, DVM, or DO Applicant must be a full member of the ORS at the time of application submission Applicant must have a mentor/advisor who is a full member of ORS at the time of application submission

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TABLE 25-3 (CONTINUED). GRANTS AVAILABLE THROUGH THE ORTHOPAEDIC RESEARCH AND EDUCATION FOUNDATION

GENERAL GRANTS	DESCRIPTION AND ELIGIBILITY REQUIREMENTS	WHO APPLIES
	<ul style="list-style-type: none"> • Applications from trainees who have established a working relationship with an academic orthopedic or musculoskeletal research unit are strongly encouraged. • Applicants must have a minimum of 95% time dedicated to proposed research. 	
Resident Clinician Scientist Training Grant—\$20,000 grant	<ul style="list-style-type: none"> • Prepares residents for a career with research as a major component. • Clinical relevance must be clearly noted in the abstract and specific aim, and be obvious from the title and the study design. • Work should clearly be achievable by the resident as a free-standing project even when it is a part of a larger work, and it should potentially lead to publication with the resident as an author. 	<ul style="list-style-type: none"> • Residents • Fellows
Resident Research Project Grant—\$5,000 grant	<ul style="list-style-type: none"> • Provides funding to residents who are interested in research. • Covers research expenses, but not salary or travel. • Work should clearly be achievable by the resident as a free-standing project even when it is a part of a larger work. • It is expected that recipient will learn to write a competitive research proposal, and will develop a relationship with a mentor who has research experience and has mentored others. 	<ul style="list-style-type: none"> • Residents
Howard Hughes Medical Institute (HHMI)-OREF Medical Research Fellow Grant—\$43,000 grant	<ul style="list-style-type: none"> • HHMI and OREF have partnered to strengthen and expand the nation's pool of physician-scientists, and veterinarian-scientists conducting orthopedic medicine. 	<ul style="list-style-type: none"> • Student in good standing at a medical, dental, or veterinary school in the United States • Student does not have to be a US citizen, but has to be eligible to work with an appropriate visa

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TABLE 25-3 (CONTINUED). GRANTS AVAILABLE THROUGH THE ORTHOPAEDIC RESEARCH AND EDUCATION FOUNDATION

GENERAL GRANTS	DESCRIPTION AND ELIGIBILITY REQUIREMENTS	WHO APPLIES
	<ul style="list-style-type: none"> The program requires students to choose their own mentor; develop a basic, translational, or applied orthopedic research project; and conduct full-time research for 1 full year. 	<ul style="list-style-type: none"> Cannot be enrolled in a combined medical, dental, or veterinary/PhD program (or PhD or ScD program, or have a PhD or ScD in a laboratory-based biological science)
RESEARCH-SPECIFIC GRANTS	DESCRIPTION OF GRANT	WHO APPLIES
Musculoskeletal Tumor Society (MSTS) Clinical Research Grant in Orthopaedic Oncology—\$100,000 grant (directed program)	<ul style="list-style-type: none"> OREF in partnership with the MSTS offers grants to clinician researchers focused on oncology (cancer). Encourages promising research that will yield clinical outcomes for patients. MSTS clinical research priorities focus on randomized trials. 	<ul style="list-style-type: none"> PI or Co-PI must be an orthopedic surgeon PhDs and DVMs are eligible if affiliated with an orthopedic department and working with an orthopedic surgeon PI or Co-PI must be an MSTS member in good standing
Musculoskeletal Transplant Foundation (MTF) Research Grant—\$98,000 grant (\$49,000 per year) (directed program)	<ul style="list-style-type: none"> OREF in partnership with the MTF offers seed money for new investigators conducting research on biologic skeletal reconstruction, including implants and stem cells. Research may be basic or clinical. Clinical relevance must be clearly noted in the abstract and specific aims, and be obvious from the title and study design. 	<ul style="list-style-type: none"> PI or Co-PI must be an orthopedic surgeon PhDs and DVMs are eligible if affiliated with an orthopedic department and Co-PI is an orthopedic surgeon
OREF/Goldberg Arthritis Research Grant—\$50,000 grant (directed program)	<ul style="list-style-type: none"> Encourages new investigators by providing seed and start-up funding for promising research projects that address issues related to the treatment of arthritis with an emphasis on arthroplasty. Clinical relevance must be clearly noted in the abstract and specific aims, and be obvious from the title and the study design. 	<ul style="list-style-type: none"> PI or Co-PI must be an orthopedic surgeon PhDs and DVMs are eligible if affiliated with an orthopedic department and working with an orthopedic surgeon

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TABLE 25-3 (CONTINUED). GRANTS AVAILABLE THROUGH THE ORTHOPAEDIC RESEARCH AND EDUCATION FOUNDATION

RESEARCH-SPECIFIC GRANTS	DESCRIPTION OF GRANT	WHO APPLIES
OREF/American Shoulder and Elbow Surgeons (ASES)/Rockwood Clinical Research Grant in Shoulder Care—\$50,000 grant (directed program)	<ul style="list-style-type: none"> • OREF, in partnership with ASES and Dr. Charles Rockwood, encourages new investigators to conduct research in the area of shoulder care. • Focus is clinical research. Clinical relevance must be clearly noted in the abstract and specific aims, and be obvious from the title and study design. 	<ul style="list-style-type: none"> • PI or Co-PI must be an orthopedic surgeon • PhDs and DVMs are eligible if affiliated with an orthopedic department and Co-PI is an orthopedic surgeon • PI/Co-PI must be an ASES member
New! Ruth Jackson Orthopaedic Society (RJOS)/OREF/DePuy Research Grant in Women's Musculoskeletal Health Grant—Up to \$15,000 grant (directed program)	<ul style="list-style-type: none"> • OREF, in partnership with the RJOS, encourages new investigators to conduct research that enhances knowledge in the area of women's musculoskeletal health, and our understanding of how gender and diversity differences affect the outcomes of orthopedic procedures. • Research may be basic, translational, clinical, and/or health services. 	<ul style="list-style-type: none"> • PI or Co-PI must be an orthopedic surgeon • PhDs and DVMs are eligible if affiliated with an orthopedic department and working with an orthopedic surgeon

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