Writing a first grant proposal

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A workshop organized by the Society for Leukocyte Biology offered advice to young scientists on how to decipher the grant-submission process of the US National Institutes of Health and compose a clear, compelling and fundable grant.

Fiscal challenges worldwide have restricted the resources available to support research and thus have intensified competition for extramural funding from both government and private agencies. The ramifications of this economic reality are felt most acutely by those least prepared to negotiate the challenges to access funding: graduate students, postdoctoral fellows and junior faculty. Established in 2009 with the charge of enhancing the educational opportunities for members of the Society for Leukocyte Biology (SLB), the Professional Development Committee elected to organize at the 2011 annual SLB meeting an interactive workshop to target the needs of scientists at the initial stages of their careers. The workshop, "Grant Writing

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for Junior Faculty and Postdoctoral Fellows," focused its attention specifically on providing critical information to junior investigators on the present peer-review process of the US National Institutes of Health (NIH), as well as personal perspectives from successful NIH grantees, deferring to another time discussion of non-NIH funding mechanisms.

Planning and organization
Julian Gomez-Cambronero and members of the Professional Development Committee invested nearly an entire year in planning the format and content of the workshop, as this was a new initiative for SLB. The workshop was widely advertised through the *Journal of Leukocyte Biology* (the SLB's journal), the SLB newsletter *i*-SLB and the SLB website, and all registered SLB meeting attendees were given the opportunity to participate in the workshop on a first-come, first-served basis. To provide both a formal presentation of a predetermined body of information and an opportunity for addressing individual concerns and questions in an informal setting, the Professional Development Committee elected to use a format with two complementary components: an initial didactic presentation followed by small-group roundtable sessions with individual discussion facilitators, all of whom contributed to this commentary. The workshop facilitators were members of SLB with a proven track record of NIH funding, service on NIH study sections and experience mentoring people in their own laboratories as well as hiring and advising junior faculty. To optimize the opportunity for attendees to interact one on one with workshop facilitators, organizers limited attendance to 45 participants, and maximum capacity was reached more than a month in advance of the conference.

Given the results of a survey questionnaire distributed to registrants 1 week before the date of the workshop, the composition of the group was diverse, including undergraduate students (4%), graduate students (29%), postdoctoral fellows (38%), assistant professors (21%) and other (8%). From the write-in section on the questionnaire, included to define the priorities of registrants, the topics of greatest interest to the workshop attendees were also varied, with the most common objectives being to learn the basic principles of grant writing, to obtain tips for creating a more effective proposal, to gain insight in the mechanics of the review process and to ascertain what reviewers seek in evaluating the merits of a grant application. The results of the pre-workshop survey were provided to the facilitators, as was a comprehensive list of potential topics for discussion (**Table 1**).

The event
The inaugural workshop was held on 23 September 2011 in Kansas City, Kansas, and began with a didactic presentation by Julian Gomez-Cambronero (http://leukocytebiology.org/PDFS/e0/e02ba5f9-467f-42c5-a3b1-83123e2d5221.pdf) that described the NIH procedures for grant submission and provided tips for grant preparation (discussed below). He also defined the spirit of the session, indicating that although none of the participating facilitators claimed to have infallible insight into successful grant writing, each wished to share his or her perspective, tacitly acknowledging the observation by the American humorist Will Rogers that "good judgment comes from experience, and a lot of that comes from bad judgment." Overall, the take-home messages of the workshop were relevant both to the grant application process itself and to the optimal style and content of the successful

Table 1 Topics for roundtable discussions

Topic 1	Grant mechanisms (R21 versus R01 versus foundation grants)
Topic 2	Preparation: when to start; the importance of getting feedback; consulting with other scientist(s) and with NIH program officials; writing and rewriting; editing and re-editing
Topic 3	What to include in the Biographical Sketch and the Abstract
Topic 4	What to include in the Environment section to support the research (equipment); letters from collaborators
Topic 5	Grantsmanship: – Understand the importance of the Significance section – Limit Specific Aims to one page (will not count toward the total of twelve pages) – Know how much preliminary data to include – Ensure the application reads as a whole story with parallel and sequential specific aims; avoid the 'domino effect' (that is, do not have dependent aims whereby aim 2 depends on the success of aim 1) – Include a section for each aim that describes expected results, alternative approaches (a plan if the unexpected occurs) and potential pitfalls – Remember the audience (too many applicants write to only experts in their fields and lose those on the fringe) – Do not bury the reviewers in data
Topic 6	Understand what happens at an NIH study section, critiques, the five criteria for scoring and the overall score (not the average of scores for the five criteria); New Investigator status is taken into consideration; and the study section wants you to succeed
Topic 7	The big decision: resubmit your "Not Discussed" application or start over from scratch?

proposal. What follows is a distillation of the advice provided to novice applicants for funding from the NIH.

The process

The array of grant types and their designations can intimidate and confuse the uninitiated. For the most part, researchers will pursue at this stage of their career individual National Research Service Award grants (for example, F30, F31 and F32) and Career Development Award grants. Project grants such as R21 grants (Exploratory/Developmental Grant applications) and R01 grants (Investigator-Initiated Research Project Grant applications) serve different purposes, fund at different amounts and for a longer duration than those pertinent to the immediate goals of young scientists. Strategic planning to take full advantage of the many resources available for assistance is needed. Seeking the advice of mentors, peers and investigators who have been successful in obtaining support from the NIH is recommended. Contacting institutional grants and contract offices, professional or scientific societies and participation in grant-writing workshops can only help. Information on the NIH and Center for Scientific Review websites (**Table 2**) includes data on active and previously funded grants through the NIH Research Portfolio Online Reporting Tools website (RePORT). NIH personnel are advocates, not adversaries, in the funding process and are committed to the support of excellent science. To that end,

NIH Scientific Review Officers are particularly helpful in the presubmission process, whereas Program Officers can provide helpful information on the critiques after the grant application has been reviewed.

Peer review is the guiding principle by which proposals are judged. The online video "Mock study section: Peer Review Revealed" (http://www.csr.nih.gov/Video/Video.asp) produced by the Center for Scientific Review at NIH provides a clearer view of how the important work of the study sections is executed. The timeline for submission, study section review, council review and initiation of funding should be learned. Young scientists must become familiar with the nine-point scoring system. Although it is disheartening for novice and veteran alike to have an application assigned the non-numerical 'score' of "Not Discussed," it is essential to appreciate that over 50% of applications receive that designation and that it reflects more the limited resources than the inherent quality of the proposal. Although applications judged "Not Discussed" do not receive a numerical impact or priority score, individual criterion scores and written critiques are provided that can be very helpful in preparing a revision or new proposal.

Reviewers judge and score each application by five separate criteria: significance, investigator(s), innovation, approach and environment. In addition, the proposal will be given an overall impact score. The distinction between 'impact' and 'significance' needs to be recognized. The overall impact is not a sixth

review criterion, nor is it the arithmetic mean of the scores for the scored review criteria. It is the integration of the five core review criteria plus an assessment of the likelihood for the project to exert a powerful influence on a research field. Conversely, significance is one of the five evaluation criteria and is evaluated in the context of the research field relevant to the proposal. In short, 'impact' might be considered what the sponsor gets for its money at the end of the project (hopefully the field will have been pushed forward), whereas 'significance' is the reviewers' collective perception of whether the project and ideas proposed merit doing and are relevant. Consequently, it is important to provide the reviewers with a grand perspective of the proposed work and its potential effect, 'painting the big picture' rather than applying excessive attention to technical details. It is useful to remember that reviewers consider multiple factors in judging the merits of a proposal, including the balance between the technical aspects and feasibility of proposed experiments versus the innovative nature of the methodology or findings. An application may prove successful if it is "highly significant, but somewhat risky," provided the reviewers believe that the value of the information gained outweighs the technical uncertainty. In fact, reviewers might perceive an application as potentially transformative to the field even if only part of the project were to succeed.

The proposal

Reviewers do not expect lyrical prose in a grant application but do require that proposals be written in clear and grammatically correct English. If by circumstance or aptitude young researchers are not facile at written composition, they should seek assistance. Confusing writing and sloppy grammar will alienate reviewers quickly and irreversibly. Critical input from colleagues provides an effective means with which to identify and then correct confusing content and style. Repeated editing and rewriting are prerequisites for a clear proposal.

Reviewers often form a strong impression of the merits of a grant application by reading the Specific Aims section, so it is imperative to craft a compelling and clear statement of the short-term goals of the project. Researchers should design a feasible experimental approach that addresses a specific problem that will advance the scientific field of interest, perhaps by challenging existing paradigms or standards of clinical practice, addressing a critical barrier to progress in the field or setting the foundation necessary for the development of new technology. The grant should be written to explain the problem that will be attacked and its importance and how its solution will advance the

field or translate into a clinical improvement. Researchers must remember that the reviewers are excellent scientists but are not necessarily well versed in the nuances of the chosen area. A young researcher should avoid 'writing to the expert' and should instead focus on presenting a clear rationale that a knowledgeable reader lacking particular expertise can understand and appreciate. Grant writers should avoid the use of excessive abbreviations; communicating in 'code' is effective only when the reader can decipher the jargon used (that is, when the reviewer is also an expert). The reader should not be forced to refer repeatedly to a long list of novel and unconventional abbreviations created to save space; annoying the reviewer with 'gobbledygook' is not a tactic likely to yield a funded proposal.

The personal statement in the Biographical Sketch section should briefly describe the specific experience and qualifications that make the researcher particularly well suited to undertake the proposed project. As this section is limited to 15 publications, selection of those publications that are relevant to the topic of the grant proposal and that demonstrate technical or theoretical expertise relevant to the work is prudent. Objective demonstration of appropriate experience and training to accomplish the proposed objectives will allay concerns reviewers may have about early-stage or new investigators and can provide a record of productivity that has advanced the field for more senior applicants. In the same way, the inclusion of preliminary data should illustrate the rationale for the proposal, support the scientific validity of the assertions underpinning the rationale and, just as importantly, demonstrate both the feasibility of the approaches and the researcher's ability to undertake the proposed experiments. As these data will be scrutinized critically, the inclusion of appropriate controls and statistical analysis of the data is essential. Citation of a researcher's own work is an efficient way of achieving these goals while sparing valuable space, given the page limitations. Researchers who lack personal experience in an area or with an approach need to enlist appropriate collaborators both to provide essential or additional expertise to assist with the work and should demonstrate the recruitment of necessary input by including a letter of support for the proposal. Acknowledgment of a researcher's own limitations gives the reviewer confidence that the researcher will be equally circumspect when meeting unexpected challenges in the laboratory.

Small-group roundtable discussions

With the advice presented above fresh in the minds of attendees, participants divided into small groups for the second phase of the workshop, the roundtable discussions. As a complement to the formal presentation, the small groups provided a venue in which to emphasize important points, clarify any confusion arising from earlier comments and provide attendees an opportunity to ask questions and obtain feedback from established investigators in an informal setting. The discussions in each small group were driven by the topics raised by participants in each of the individual groups. With the exception of those junior faculty who had already submitted grants, participants distributed randomly into groups of five to six people, each with a facilitator. In the small groups, attendees were enthusiastic and engaged and asked thoughtful questions. Because the individual facilitators used the participants' questions to initiate and direct the discussion, the specific content varied among the groups. Some groups focused mainly on the different types of NIH grants available, the

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organizational structure of the NIH staff and the review process, whereas others found discussion of the process of grant writing most interesting. One theme recognized by many discussion leaders was the need by the participants for a better understanding of the NIH and its review process.

Reflections and plans

A survey distributed to attendees at the conclusion of the session confirmed the facilitators' impression that the workshop was favorably received. Participants appreciated the didactic presentation, although they suggested it be abbreviated; they thought that the small-group sessions were excellent and the facilitators were well prepared; and they indicated that the overall experience was very informative. They acquired 'know-how' and many tips that they had not received at their own institutions and felt that the workshop encouraged them to prepare their own applications. For more senior attendees, the content of the workshop provided less novelty but was useful in reinforcing important information.

Given the positive feedback from the attendees and the interest that exceeded the capacity of the session, the inaugural workshop was judged a success in meeting the needs of the younger members of the SLB just beginning their scientific careers. However, we recognize that improvements in the organization and implementation of future sessions are needed. In the future, the pre-workshop survey will include an opportunity for attendees to pose one question that they feel must be answered in the workshop, which will provide the organizers guidance in selecting the content of the didactic presentation. In addition, any websites containing helpful information, courses or manuals applicable to the preparation of

Table 2 Grant-writing tips and essential NIH links

The NIH Office of Extramural Research	http://www.grants.nih.gov
Grants already funded	http://projectreporter.nih.gov/reporter.cfm
Correct forms	http://grants.nih.gov/grants/forms.htm
Writing tips for new investigators	http://www.nigms.nih.gov/Research/Application/Tips.htm
	http://www.niaid.nih.gov/researchfunding/grant/Pages/newpiguide.aspx
General guide for grant types	http://grants.nih.gov/grants/guide/index.html
Enhanced peer review	http://grants.nih.gov/grants/guide/notice-files/not-od-09-025.html
NIH scoring system table	http://enhancing-peer-review.nih.gov/scoring&reviewchanges.html
Human subjects	http://grants.nih.gov/grants/policy/hs/index.htm
Vertebrate animals	http://grants.nih.gov/grants/olaw/olaw.htm
SF424 guidelines for submission	http://grants.nih.gov/grants/funding/424/index.htm
Checklist for new investigators	http://www.niaid.nih.gov/researchfunding/grant/checklists/pages/checknewpi.aspx
Grant-writing tips	http://grants.nih.gov/grants/grant_tips.htm

grants will be provided in handouts to attendees. To optimally address specific concerns of attendees at different stages of their academic career, the organizers will arrange the small groups accordingly, clustering graduate students, postdoctoral fellows or junior faculty in separate groups. Given that many of the issues of interest relate to the NIH organization and procedures, either a Scientific Review Officer or a Program Officer will be included when NIH funding is the focal point of the workshop. In addition to providing pertinent factual information, participation by a member of the NIH establishment would foster the idea that young investigators can and should interact with these people as a matter of course.

Concluding remarks

Given the results of the post-workshop survey, informal feedback from attendees and the general impression of the workshop facilitators, we believe "Grant Writing for Junior Faculty and Postdoctoral Fellows" was a successful initial step in meeting some of the needs of the junior members of the SLB. As the workshop facilitators, we will use feedback from the participants of this inaugural workshop to direct our design of future events to improve the educational experience of those scientists who represent the future.

COMPETING FINANCIAL INTERESTS
The authors declare no competing financial interests.

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Erratum: Writing a first grant proposal

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In the version of this article initially published, the first author's surname was incorrect and e-mail address was missing. The correct name is "Gomez-Cambronero"; the e-mail address is julian.cambronero@wright.edu. The error has been corrected in the HTML and PDF versions of the article.