Education

Writing an effective National Institutes of Health (NIH) budget: How to get the money for your science

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ABSTRACT

In the scheme of developing an application for funding from any federal or foundation source, it is reasonable to place significant attention on the science. However, it is also imperative to remember that your budget is what will provide the resources to make sure you can complete your proposed investigations and, as such, deserves appropriate consideration. In the competitive arena of extramural funding, funding agencies are incentivized to ensure that the funds committed to research will yield maximum impact. A well-thought-out budget demonstrates to the funding agency 2 key factors: (1) that you understand the needs of the project and (2) you have a realistic expectation of the project costs. When these 2 things are communicated to the funding agency, in addition to the significance of your science, it is more likely that you will receive the budget you request. Herein, we put forth the fundamentals for preparing your budget and the nuances that may help you not only be in compliance but also improve your chances of success. This article will discuss issues to consider when designing a budget for large research grants, using the NIH R&R Budget as a prototype.

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Introduction

In the process of generating an application for a major funding opportunity, particularly National Institutes of Health (NIH) research grant applications, most investigators rationally spend the bulk of their time refining the research plan. However, investigators should be careful not to neglect a critical piece of their overall application, which is the budget and budget justification. While the research plan is what will determine the priority of the project for funding, the budget and justification contain the funding ask that will be evaluated and awarded at the discretion of the agency council or board. Therefore, it is critical to effectively communicate that the proposed costs for the project are both realistic and rational, based on the research approach. Here, we will discuss fundamental considerations when crafting a budget, using the NIH Modular and Research & Related (R&R) budgets as templates, and

provide tips and tricks to improve your chance of receiving full funding for your project.

How do funding agencies determine funding levels?

First, it is important to understand how funding decisions are made at the agency level. For most funding agencies, including the NIH, a panel of expert reviewers will provide initial commentary on the significance of the proposed research and whether or not it should be considered for funding, as well as recommendations for the funding level. The final funding decision, however, is made by a board or council representing the overall interests of the funding agency, taking into consideration the recommendations of the reviewers, the Program Officer, and the specific funding priorities of the agency.[1–3] When crafting a budget, the key advice is to ask for what you need. Some investigators, particularly at early stages, feel that they must limit themselves to a smaller budget, perhaps because they believe that a funding agency will not be willing to take a larger risk on an unproven investigator. However, this is certainly not the case. Funding agencies are excited to support excellent science, and if you can show that you have a strong idea, are capable, and your request is commensurate with your project

Table I
Elements of a detailed (R&R) budget

Category	Subcategory	Comments/examples
Personnel		Separate by senior/key personnel and other personnel
Equipment		Includes any durable equipment purchase over $5,000
Travel		Separate costs for domestic and foreign travel—foreign requires additional justification
Participant/trainee costs		Not relevant for most NIH grant budgets, except training grants
Other direct costs		
(NIH predefined subcategories)	Materials & supplies	General laboratory supplies, culture reagents, standard assays, etc
	Publication costs	Color figures, open access
	Consultant services	Consultant fees
	ADP/computer services	Supercomputer usage, software licensing
	Subawards/consortium/contractual costs	Total of all subawards, including IDC (although IDC does not count against the DC total for NIH grants)
	Equipment or facility rental/user fees	Core facility and shared equipment time, usage
	Alterations and renovations	Not relevant for research grants
(Examples of PI-defined subcategories, limit 3)	Animal work	Purchase, housing, manipulation of animals
	Human subject costs	Human tissue processing, storage; patient incentives
	-Omics analysis	Sample preparation and analysis for sequencing or other big data-generating projects

ADP, automated data processing; *DC,* direct costs; *IDC,* indirect costs; *NIH,* National Institutes of Health; *PI,* principal investigator; *R&R,* Research and Related.

needs, your likelihood of funding will not be impacted by the size of the budget requested.[4]

Read carefully

Although investigators should ask for what they need for a given project, each grant opportunity and funding agency will have different limitations on specific budget items and overall project costs. Most smaller research grants are fairly straightforward, as budgets are highly limited and the allowable spending categories are clearly laid out. However, larger research grants (R01-series and similar) provide more leeway but also pose new challenges for allocating resources. Regardless of the funding mechanism, it is essential the investigator read the funding opportunity carefully and enlist support from their sponsored programs or research management officers. The importance of planning your application well in advance and establishing an open, 2-way method of communication with your grant's office cannot be overstated. Investigators should review the sponsor submission guidelines with their grant office at least 45 days before the due date and ask your grant office to create a checklist, timeline, and arrange frequent "check in" meetings to ensure you are on schedule.

Proposal submission process

When discussing the proposal submission guidelines with your grant's office inquire about the internal proposal submission workflow, approval process, and turnaround time. Most institutions have a web-based electronic workflow that will seamlessly route your grant application from the department to the grant office for review and approval. In addition, your institution may have a proposal deadline policy mandating, for example, the final, ready-to-submit version of the application must be received by the grants office at least 3 business days before the sponsor deadline. Having a finalized budget is critical at this juncture, as this is what will be most heavily scrutinized by institutional approvers and making major budgetary changes after departmental approval may delay your application. If there is an internal deadline policy, it's important to adhere to it because if you miss the deadline your application may not get submitted to the sponsor.

Part I: Drafting your budget

When crafting a research budget, resources will need to be allocated appropriately to the broad categories of Personnel and Other Costs. Personnel includes all investigators and support staff who will be contributing effort to the completion of the research, while Other Costs includes all of the physical resources needed to actually perform the research, as well as funds for participants/trainees and travel costs. These categories are summarized in Table I, organized according to the detailed (R&R) budget form used by the NIH; however, the discussion herein will detail budget categories in the order of their impact on the investigator's overall research budget for planning purposes.

1. Personnel

Personnel costs typically constitute most of a research budget, especially for projects primarily involving computational analysis. The challenge for many researchers is deciding how much to allocate toward personnel costs, while preserving sufficient funds for the material costs of the research and defining the effort of key collaborators and staff. For investigators involved in wet lab research, a suggested starting point is 60% for salary support and 40% for research costs, although this can commonly increase to 80% salary and 20% other costs.[4] However, this should be adjusted as appropriate for the needs of the research—for example, projects without significant physical resource needs may allocate as much as 90% of the budget to personnel support.

Personnel supported by the research budget should include all investigators and staff who will be contributing effort toward the completion of the research project. Typically, this will include the principal investigator (PI), coinvestigators at the PI's institution or external collaborators, and other personnel, such as postdoctoral fellows, research staff, and predoctoral students tasked with performing the proposed experiments. The challenge many investigators face in this situation is how to delineate effort for each of these contributors.

The PI should, of course, contribute enough professional effort to the project to effectively oversee its completion.[4] Factors to consider when delineating professional effort include (1) minimum effort requirements from the grant mechanism or institutions, (2) career level of the PI, and (3) the type of grant (foundation versus

government). Many institutions require a minimum effort for PIs, typically at least 5% of their professional effort. For surgeon-scientists, this can be especially challenging, as their effort is split between the clinic, research, and administrative demands, reducing the total effort that can be contributed to research. Early-stage investigators (ESI) may invest significantly more effort, especially on their primary, funded research project, than established investigators. One recommendation for an ESI is to commit at least 25% effort to your primary research grant.[4] On the other hand, it can be tempting for ESIs to maximize their effort on a single primary research grant; however, a rule of thumb is to have no more than 50% (unless otherwise specified) on a single grant to leave room for other opportunities.

Other key personnel should provide effort in keeping with their role on the project. Again, many institutions have lower limits for serving as a coinvestigator with salary on a grant, typically 2%. This brings up a common practice of having "token effort" for some well-established coinvestigators on a grant. Typically, these investigators are very senior and highly respected in their area of specialty and agree to lend their expertise in an advisory role to ensure the completion of the project. While these investigators are not directly involved in the conduct of the research, providing some salary in the form of 1% to 2% professional effort can be a way to show their commitment to the project, which can reflect positively in the grant review.

A final word of caution regarding the drafting of your personnel budget is to be aware of salary caps.[5,6] NIH salary caps are set by Congressional law through appropriations acts, which are updated annually.[5,7] Many granting organizations follow the NIH guidelines for salary caps; although many designate their own or do not allow salary as part of the grant award. Surgeon-scientists' salaries will almost invariably exceed these salary caps, which implies cost sharing, i.e., the institution or department must make up the difference of the investigator's salary for the effort on the research project. Many departments guarantee investigators' salaries, regardless of funding; however, this practice is not universal, and some departments require specific documentation to ensure that investigator salaries can be maintained, despite their effort being underfunded. By contrast, some institutions view cost sharing as an opportunity to maximize their investigators' research budgets by allowing investigators to request salary for less than their dedicated effort (e.g., an investigator with 10% effort on the grant requests only 2% of salary support) and making up the difference in salary (cost sharing) at the institutional level. Investigators should discuss their departments' and institutions' expectations and policies with their department chairs and sponsored programs offices and enlist the help of department administrators to complete any documentation needed.

2. Subawards

The second major cost in most grant applications comes from subawards, when allowed and used. This includes both direct and indirect costs to be provided to the secondary institution, which count as part of the primary institution's total direct costs. Subawards can sometimes be construed by investigators as being less economical, as they increase the total cost of the project significantly and can create logistical issues, such as sharing of data and samples; however, supporting key collaborations with subawards can, in fact, strengthen an application. In cases where subawards are used to support research completion at collaborating institutions, 2 key steps should be followed. First, determine whether the opportunity sets a limit on total costs and then determine what percentage you can release to the collaborator. Second, start discussions with collaborators early to ensure sufficient time for the

subaward institution to prepare and provide an approved budget for submission to the prime institution. When applying to most NIH opportunities, you are allowed to exclude the subaward's indirect costs and only count their direct costs toward the limit on direct costs. NIH adds the indirect charges for both prime and subawards in such a way to ensure researchers at different institutions have the same amount of direct costs to use for research regardless of their federally negotiated rates. The indirect costs from the subaward, therefore, do not count against the total direct cost limit, even though the total amount of direct and indirect costs are listed as part of "Consortium Costs" on the project budget. This becomes especially important when determining whether a project qualifies for a "modular" budget (less than $250,000 per year in direct costs). For example, if a subaward institution is requesting $25,000 in direct costs, then the prime institution is left with $225,000 in direct costs, instead of that amount less the indirect costs for the subaward. However, it is important to note that other government agencies and foundations may require consortium indirect costs to be counted as part of the total direct costs, thus reducing the total budget available to the prime institution. Be sure to read carefully and enlist the help of your sponsored programs office to clarify these accounting requirements.

3. Other Direct Costs

For almost all application budgets, the previously discussed information on personnel and subaward costs will be relevant; however, accounting of other project costs ("Other Direct Costs") can vary significantly based on the level of funding and agency. Most notably for NIH-funded grants, there is far less detail requested for modular budgets than for "detailed" budgets (direct costs of over $250,000 per year).[8] In the case of modular budgets, funding is requested in "modules" of $25,000, and no itemized cost information is needed (Figure). Detailed budgets, on the other hand, require a more significant level of itemization, although this is still limited to broad budget categories. Some examples include equipment, publication costs, travel, animal purchasing/housing, patient/human subjects costs (for clinical or human subjects research), and general lab supplies. If you have graduate students funded by the grant, this may also include costs for tuition remission. It should be noted that modular budgets do significantly reduce the administrative burden for the investigator during the grant submission process, which can preserve additional time for refining the science. Additionally, there is much more flexibility in how the funds from a modular budget can be spent, since funds are not allocated to specific line items. However, many projects will require more resources than what is available through a modular budget, and with rising labor costs, investigators will increasingly see more of their research budgets being dominated by personnel costs. In this case, investigators should consider using a detailed budget and enlist maximum assistance from their department and grants administration to reduce the burden of budget preparation as much as possible. It is also important to note that there is an upper limit of $500,000 per year in direct costs for detailed budgets. Budgets over this amount must request special permission from the funding institute 6 weeks before submitting an application. But again, requesting what is necessary for the project will not negatively affect your chances of being awarded the grant.

Equipment

The definition of equipment adopted by most funding agencies comes from the NIH grants policy statement,[9] which defines equipment as durable devices lasting more than 1 year and costing more than $5,000. Costs for durable equipment are often front-loaded in the first year of a project budget. Note that equipment

Fig 1. PHS 389 modular budget form (reproduced from "General Instructions for NIH and Other PHS Agencies, Forms Version F Series," released Oct 16, 2020). *F&A,* facilities and administrative; *NIH,* National Institutes of Health; *OMB,* Office of Management and Budget; *PHS,* Public Health Service; *POC,* point of contact.

costs are excluded when calculating the indirect costs and are only part of the direct costs portion. This budget category is especially important to consider for new investigators building out their labs or investigators looking to expand their laboratory's in-house capabilities. In both cases, however, equipment supplements may also be a potential alternative option. Equipment supplements are used by some funding institutes to allow investigators who have been awarded research grants to request additional funds to purchase new equipment in support of the funded project. These are especially useful for equipment that is not essential to the performance of the project but would significantly increase the throughput, reproducibility, and/or rigor of the proposed experiments. These supplement requests are exclusively reviewed by an internal committee at the funding institute and therefore have a much higher rate of success than competitive grant applications, making them an excellent alternative way to add capacity-building equipment without sacrificing your research budget.

Travel

Many departments supply investigators with discretionary funds that can offset the cost of travel to domestic and international conferences to present their research; however, this benefit is not universal nor is it always permissive, particularly in the case of international travel. Budgeting funds for travel, particularly if international travel is required for a critical conference or the conduct of the research, can reduce the burden on limited discretionary funds and allow the investigator to support trainee travel to a greater degree.

Human/clinical studies

Another major cost category for those doing human subjects research is the costs associated with the handling of patient samples and care of patients (clinical studies). For human research studies, it is important to account for the costs related to the collection and storage of human tissue samples, if relevant to the research. Costs in this category may also include patient incentives for participation or print materials for the study. For clinical studies involving the care of patients as part of the research, costs directly related to patient care need to be separated into their own subcategory. It is important to get accurate estimates of patient care costs, thus investigators should consult with their research accounting or clinical accounting administrators to provide these cost estimates.

Animal work

For labs doing in vivo testing with animals, this subcategory can easily be a dominant driver of the final research budget. This category should be carefully calculated from the animal number estimates, experimental timeline, and need for additional facilities, such as surgical suites and other equipment or facilities to perform the work. Most animal facilities regularly publish per diem rates for the care of animals and fee schedules for the use of other equipment and facilities.

Institutional resources/fee-for-service facilities and equipment

Investigators should also consider using institutional resources whenever possible. For example, instead of hiring a research technician and ordering supplies for a specific experiment, your institution may have a core research facility you can use to conduct the same experiment for a fraction of the cost. Likewise, before adding an expensive piece of equipment to your budget, it is possible the equipment already exists at your institution that you may be able to access on a fee basis. Fees for core facility and equipment usage can be requested specifically under the Other Direct Cost subcategory. Contact your grants office and ask them for an inventory of equipment and list of available Core Facilities.

Other supply categories

Other supply categories are available in the detailed budget form or can be defined by the investigator as appropriate to the research project. For example, studies proposing genetic sequencing or proteomics research may require a subcategory for materials or core facility costs to analyze those samples, or highly computational projects may include a category for software licenses or fees for supercomputer access. Finally, most researchers will include a "Materials and Supplies" subcategory, which is typically

an estimated annual cost for laboratory consumables expected to be used in the research, including cell culture supplies, biological assay reagents, and other standard laboratory supplies. These subcategories are up to the discretion of the investigator and serve to demonstrate to the reviewers that sufficient funds have been set aside for critical material components and resources to ensure the completion of the research.

4. Indirect Costs

Surgeons at academic institutions are likely to have a sponsored programs office that can assist with calculating indirect costs for their budget, assuming the investigator has provided all the budget categories discussed above. However, it can be useful to know how these costs are calculated, in case this level of support is not available. Indirect costs are a fraction of the total project budget that is provided on top of the direct cost budget to the PI's institution, usually between 50% and 80% of the total direct costs. Indirect costs, or facilities and administrative costs (also simply referred to as "F&A"), are used by the institution to maintain research facilities and administrative support for the research mission and therefore must be requested at the appropriate rate. Some institutions may even have variable rates for different performance sites (e.g., work being done at affiliate sites versus the main campus) or for work involving certain core facilities (e.g., animal housing facilities). Indirect rates are set through a negotiation between the institution and the federal government, typically the Department of Health and Human Services.[10] These rates are regularly renegotiated, so investigators should work closely with their sponsored programs office to ensure that they are using the correct rate (or rates) based on the work being performed and the location. It is also important to be aware of the specific limitations of the funding mechanism, as many funding mechanisms or agencies set lower caps for indirect rates or do not allow for indirect costs to be requested at all. For example, NIH institutional research training grants and career development awards have a fixed facilities and administrative rate of 8%. Make sure to provide this information to your sponsored programs representatives so they are aware of the award limitations when assisting you with your budget.

Part II: Justifying your budget

Once you have a complete budget with good estimates of all your project costs, the next step is to document your cost justifications. This step is crucial to ensuring that you get your budget request, particularly if you are using a detailed budget. As a reminder, while the budget is not a score-driving issue, the scientific review panel is allowed to make recommendations regarding your budget.[3] If these experts feel that the requested personnel or materials support is overinflated, they may recommend a reduction in the award budget. Fortunately, the budget justification has no page limit requirement, so use the space to be as detailed and articulate as possible to prevent potential cuts to your requested budget.

Personnel justification

Budget justifications are typically organized in a parallel fashion to the budget itself. Nearly all grant mechanisms will require a personnel justification. For each person named in the budget, a short paragraph is recommended to (briefly) explain their expertise, role in the project (PI, coinvestigator, research staff, etc), their specific responsibilities, and their effort on the project. It is important to remember not to repeat information from the

biosketch here; a brief statement about the person's expertise is sufficient, and emphasis should be placed on their roles and responsibilities on the project. This helps to differentiate what each person is contributing to the project to avoid the appearance of overlap and to justify the total time they will need to dedicate to complete their part of the research. Every effort should be made to identify project personnel before the grant submission; however, it is frequently the case that certain positions, such as technicians or research coordinators, may not be recruited yet. In this case, the position title should still be listed in the justification, with a description of the expertise this person will need to have and what their project responsibilities will be when hired.

Other direct costs justification

In some cases, such as for modular NIH budgets, additional justification beyond personnel is not required. However, for detailed NIH budgets and some foundation awards, a justification for how you estimated the costs of primary budget categories is needed. In addition to an explanation of how you arrived at various estimates, you may also want to provide quotes for certain items, particularly equipment. Many times, costs in different budget categories will vary year-to-year; therefore, it can be helpful to include a table showing the year-by-year changes and describe why these costs are expected to change, given the timeline of the project performance.

Many institutions also include standard language describing how fringe and indirect rates are calculated. This can be important if the institution has different indirect rates for different affiliate performance sites or for research that uses specific facilities (e.g., animal facilities).

Other collaborators

In many cases, investigators will have additional collaborators who contribute to the project but do not commit effort or draw salary. While these investigators should not be listed in the budget or justification, their contributions can be documented through letters of support and biosketches. Letters of support from these collaborators should clearly state the importance of the project, their role, their expertise in the field, and how their involvement will help you achieve the goals of the project. These individuals can also be listed in the Senior/Key Personnel form as an "Other Significant Contributor" and their biosketch included in the application.[11]

Part III: Final words

Crafting a well thought out budget can help ensure that you get the funds needed for your research, should your project be chosen for funding. Some of the top tips for approaching this important aspect of your application have been summarized in Table II. While this is logically one of the later steps in your grant application (you need to have a good handle on your approach before estimating the

Table II
Top tips for budgeting.

1. Ask for what you need
2. Discuss your budget with your department and sponsored programs EARLY
3. Pay attention to limitations and unallowable costs in the opportunity instructions
4. Provide effort in keeping with personnel roles and contributions
5. Have early discussions with collaborators regarding effort, salary, and letters of support
6. Properly justify all items in your budget, as requested

project cost), it should not be left to the last minute, especially if your project includes subawards to other institutions. Make sure to have budget discussions often and early with any collaborators providing significant effort on the project and ask for help from your institutional sponsored programs office or department to prepare the budget form. Finally, a word to new investigators: ask for the budget you need to achieve the specific aims of the project. There can be a temptation to request a lower budget thinking that it will increase your likelihood of funding; however, remember that the budget is never a score-driving factor. You will not be penalized by asking for the budget required for the project. Using the tips and advice presented here, we hope that surgeon-scientists will be able to confidently approach this sometimes confusing and daunting aspect of grant preparation and be empowered to create well-justified budgets that will fully support their research efforts.

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Conflict of interest/Disclosure

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