The State of Federal Research Funding in Genetics as Reflected by Members of the Genetics Society of America

Jasper Rine^{*,1} and Adam P. Fagen[†]

^{*}President, Genetics Society of America, Professor of Genetics, Genomics and Development, Department of Molecular and Cellular Biology, University of California, Berkeley, California 94720, and [†]Executive Director, Genetics Society of America, Bethesda, Maryland 20814

ABSTRACT Scientific progress runs on the intellect, curiosity, and passion of its practitioners fueled by the research dollars of its sponsors. The concern over research funding in biology in general and genetics in particular led us to survey the membership of the Genetics Society of America for information about the federal support of genetics at the level of individual principal investigators. The results paint a mosaic of circumstances—some good, others not so good—that describes some of our present challenges with sufficient detail to suggest useful steps that could address the challenges.

KEYWORDS grants; funding gaps; intellectual capital; NIH; NSF

THE generous federal support of the research enterprise in the United States is relatively new, having its genesis at the end of World War II (Bush 1945). With the exception of the stimulus package of 2008, the budget of the National Institutes of Health (NIH) has been essentially flat at about \$30 billion per year since 2003, though that budget is estimated to have lost almost 25% of its 2003 buying power because it has not kept up with the increasing cost of research (<http://nexus.od.nih.gov/all/2013/09/24/one-nation-in-support-of-biomedical-research/>). The smaller National Science Foundation (NSF) budget at \$7.3 billion (http://www.nsf.gov/about/congress/114/highlights/cu15_0109.jsp) has tracked that of the NIH. There is much discussion in all fields of science about the current funding status of individual scientists, often fueled by anecdote. Graduate students and postdocs are making decisions on career paths based on their observations of their local environment, such as the outcomes of the grant applications of their mentors and the experiences of their peers. Articles in the popular press and commentaries in *Science* and *Nature*

usually lack the granularity necessary to understand the broader funding picture in specific fields. A recent report of systematic flaws in biomedical research (Alberts *et al.* 2014) closes with a specific request:

We therefore encourage academic institutions, scientific societies, funding organizations, and other interested parties to organize discussions, national and regional, with a wide range of relevant constituencies.

For such a discussion to be productive, scientists need access to timely data on important issues in their own fields. Thus, we undertook a survey of the membership of the Genetics Society of America (GSA) to understand better the current funding situation in our field. Although there are other important issues to consider, funding so dominates the discussion and our collective vision of the future that we chose that as our focus.

With the intent of targeting principal investigators (PIs) and career staff scientists, the questionnaire was emailed to GSA members in the United States who are categorized as “regular members” (*i.e.*, not students or postdocs). Although graduate and postdoctoral fellowships can make an important contribution to a laboratory’s funding, in most cases they would be inadequate to support a vigorous research program. To the extent possible, we identified responses of active PIs, which typically was straightforward because of their answers to certain questions. The questionnaire

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¹Corresponding author: Department of Molecular and Cellular Biology, 374A Stanley Hall, University of California, Berkeley, California 94720. E-mail: jrine@berkeley.edu

included 11 multiple-choice questions designed to give a snapshot of a respondent's current position in the field and current funding and information on the trend in funding status (the survey instrument is included in the supporting information, [File S1](#)). The twelfth question invited comment on whatever was foremost on the respondents' minds. The questionnaire was sent out in early October 2014, with one reminder midway in the 1-month response period. We received nearly 700 responses, typically 500 to 525 responses to each question. While our coverage was substantial, we acknowledge possible sampling biases in the data set.

As with any survey containing multiple-choice items, there are many ways to parse the data into individual subsets of respondents conditioned on specific responses to particular questions. The results presented here are a broad analysis of the data that will likely inspire readers to further analyze the data in additional ways. The summary data for the first 11 questions are available as [File S2](#).

The Demography of PIs in the GSA and Sources of Funding

The age of the PIs responding to the poll was what one might expect for a successful and established field that continues to attract new people: 54.3% have been PIs for less than 15 years, 45.7% for more than 15 years. Among the newer PIs, 21.2% were in their first 5 years, 17.8% between 6 and 10 years, and 15.3% between 11 and 15 years as a PI.

The predominant funders of GSA PIs responding to the questionnaire are the NIH (72% of respondents) and the NSF (30% of respondents) (Figure 1). These PIs also have secured research funding from a wide range of sources, including the Department of Agriculture, the Department of Energy, the Department of Defense, state and local governments, and a variety of private sources.

Most of the GSA PI respondents have active federal research funding: 39.0% have one grant, 24.3% have two, and 10.9% have three or more. Although the sizes of grants vary and the funding needed in different fields varies, it is certainly encouraging that 74.2% of the PIs have funding. However, 25.8% have no current federal funding supporting their research. We find it alarming that a full quarter of the GSA PIs currently have no grant support from the primary funders in their field. A typical new assistant professor of genetics has had over a million dollars invested in his or her training when you add up undergraduate, graduate school, and postdoctoral experiences. Having 25.8% of practicing PIs lack the fuel to power their research is a troubling lack of return on an otherwise significant investment. For those who indicate having no current grant, 28.5% have been a PI for less than 5 years (presumably including people who have not yet submitted their first proposal), 12.4% have been a PI for 5–10 years, 15.3% have been a PI for 11–15 years, and 27.7% for 15 years or longer. The remaining 16.1% report that they are not currently a PI.

The Funding Level per PI Varies Widely

The modular R01 grant from the NIH was set at \$250,000 per year, not including overhead, in 1999 (<http://grants.nih.gov/grants/guide/notice-files/not98-178.html>). Across-the-board funding cuts have often reduced this to around \$180,000, and increases in salaries and expenses have further eroded its buying power. The NSF does not have anything equivalent to a modular grant, but the comparable awards in the various areas of genetics are typically smaller. Some members of the GSA are well funded: 7.2% report receiving over \$500,000 per year, and 13.4% receive \$300,000–\$500,000 per year (Figure 2). The \$150,000–\$300,000 per year range, which brackets the original size of the modular R01 grant, covers 29.1% of the PIs. Thus, fully half of PIs surveyed have less than \$150,000 per year for their research programs. The \$75,000–\$150,000 range accounts for 17% of PIs, leaving 33.2% of PIs with \$75,000 or less of research funding per year. In addition, 25.8% have no funding at all.

Recent Funding Trends Varied but Were Substantially Worse for More than Half of PIs

We asked how PIs' present funding situation compared with what it was 5 and 10 years ago, respectively, adjusting for the number of PIs with fewer than 10 years of experience. For 9.4 and 11.6%, the funding situation was reported to be substantially better than it was 5 and 10 years ago, respectively. For 37.4 and 26.4%, the funding situation was about the same as it was 5 and 10 years ago. That is, for a sizable minority of PIs, the funding situation was about the same or somewhat better than it had been. However, most PIs reported that their funding situation was substantially worse than it was 5 (53.2%) and 10 (62%) years ago.

Disruptions in the Continuity of Funding Were Common

A research team takes years to build and needs stable funding to be sustained. Hence, breaks in funding can have a strong negative impact on a PI's research effectiveness for years to come, even after funding is restored. We focused on significant gaps in federal research funding in recent years. Of note, only 41.8% of the PIs who have held that position for 5 years or more had no significant gap in research funding; 9.2% reported a gap of 2 years, and an additional 12.1% reported a gap of 3 or more years. Gaps in funding are even more striking for those who have been PIs for between 5 and 10 years ($N = 93$). For those PIs, only 25% have had continuous federal funding; 26.3% had a 1-year funding gap during the last 5 years, 17.5% had a 2-year gap during the last 5 years, and 12.5% had a 3-year gap during the last 5 years.

Figure 1 Sources of extramural grant support for survey respondents. Red bars indicate those who receive any amount of funding from that source; purple bars indicate the average percentage of grant support for PIs who receive funding from that source.

Efforts to regain funding from federal sources diminish after researchers experienced a funding gap, and the bigger the gap, the more precipitous was the decline in efforts to restore funding. Among the respondents who presently lack federal grant support, the majority (69.5%) have submitted an application within the last year. But the probability of resubmission then drops steadily: 9.1% submitted an application in the last 2 years, 5.2% in the last 3 years, 4.5% in the last 5 years, and a full 11.7% last submitted an application more than 5 years ago.

Impact on PI Salary and Career

Gaps in research funding have far-ranging consequences, including the ability of some PIs to cover their own salaries. Salary-support practices differ widely among institutions, ranging from full 12-month salaries to PIs being obligated to raise most of their salaries from grants. A sizable fraction of GSA PIs are heavily dependent on grants to pay themselves (Figure 3). A fortunate 16.9% of PIs have a full 12 months of salary support, and another 43.7% are expected to raise 30% or less of their salaries from grants (assuming that they want to pay themselves a full salary, and who wouldn't?). In contrast, 31% are expected to cover between 30 and 75% of their salaries, and 8.3% are expected to raise more than 75% of their salaries. We suspect that the percentage of researchers expected to raise funds for their own salaries is far higher for disciplines with a more substantial fraction of PIs based in medical schools.

When asked about the consequence of losing federal grant support for a single grant cycle, 9.2% reported that they would have to close their laboratories, 40.9% could survive one unfunded cycle, and the remaining 50% would have to adapt in various ways (File S2).

Lessons

Despite the limitations of self-reporting surveys that cover a subset of the population of interest, this survey provides an interesting snapshot of matters directly affecting PI members of the GSA and their research staffs. Importantly, how can this information be used productively, and how could it be misused or abused? The greatest utility in these data are likely their ability to guide the message to young scientists about what a career in genetics research will look like and to inform faculty, deans, and other university officials about how their faculty members are faring relative to others. We offer a few suggestions regarding how these data might be used.

The flat NIH budget in recent years, with its eroding buying power, and similar trends in funding from other agencies affecting geneticists have made recent years difficult, as this survey illustrates. Although there is a great deal of uncertainty about future funding trends, there is an interesting development on the horizon known as the 21st Century Cures Act (<http://energycommerce.house.gov/cures>). This bill is working its way through the House of Representatives, and should it be successful, it would bring approximately a 5% increase to the NIH's base budget per year for the next 5 years, as well as an additional \$2 billion per year for innovation. Although there are many important details to be worked out, action on this bill is a welcome change from the funding climate of recent years. Moreover, a recent editorial from a former Speaker of the House calling for a doubling of the NIH budget (http://www.nytimes.com/2015/04/22/opinion/double-the-nih-budget.html?_r=0) has helped the conversation on the need for restoring the nation's investment in research. Together these developments offer a welcome measure of optimism that the future will be better than the recent past for research.

Figure 2 Percentage of laboratories with indicated level of annual federal research funding. Figures reflect the total amount of annual direct costs.

A good fraction of our PIs described their present funding situation as about the same as or better than it was 5 (46.8%) or 10 (38%) years ago. The clear message is that many PIs have successful careers with research support that allows them to make fundamental discoveries, though most probably would prefer a higher level of funding. Our members have shown entrepreneurial creativity in identifying a broad range of funding sources. We believe that this message needs wider circulation so that others will also be inspired to seek funding from unconventional sources.

The equally clear message is that we live in a time when many perfectly capable PIs will experience gaps in their funding. Know that you are in good company if you find yourself with a funding lapse. These gaps reflect more about our collective research ecosystem than they do about individual laboratories, with many deserving grant applicants unable to be supported. If necessary, the findings in this survey may help your chair or dean to have a more quantitative sense of how much the world is different from his or her rose-tinted recollection of yesteryear. Clearly, institutions need to develop resources and practices that protect the substantial investment society has made in its highly trained scientists.

The other striking observation is the rapidity with which attempts to restore federal grant support falls off as a function of the length of the gap in funding. Perhaps these PIs find other nonfederal sources of funding. Perhaps those unable to support their research shift their focus to teaching or administration. Perhaps they stop trying amid the toll of accumulating discouragement. The key action item these data prompt is the need for rapid engagement of helpful colleagues in the preparation of a resubmission for anyone who encounters a gap. Many departments have formal mentoring programs to help junior faculty secure their first

Figure 3 Percent of institutional salary support for GSA PIs.

grants. Perhaps we need to expand these efforts to benefit all colleagues who experience a significant loss of funding.

Undesirable uses of these data would include decreasing the number of searches for new faculty in genetics in response to funding travails. It would be a shame for a student or postdoc trained in genetics to look at the statistics and run the other way. There is more money available now for genetics research than there has ever been, and the scientific questions to be answered have never been more interesting or approachable. Research institutions must formulate an accurate understanding of the problems young investigators face and a resolve to find solutions. Those solutions will be harder to find at the institutions offering the least committed salary support.

There will be no single way to create a more stable research ecosystem. Data such as those presented here help us to perceive the problems and measure their magnitude so that we might enable adjustments. Perhaps institutions can find stability by investing more heavily in their areas of excellence to bolster competitiveness in that area. It takes a million dollars or more to set up a new junior faculty member at many research institutions, and that cost should be balanced against the cost of not sustaining existing junior, midcareer, and senior faculty who suffer a funding gap. While we clearly need to ensure that there are opportunities to bring in new expertise and junior colleagues, slight adjustments in the pace of replacement, perhaps enabled by adjustments in the teaching loads of existing faculty, can contribute a measure of stability.

We are all in this together. Despite the many differences in individual situations, there is some comfort in our collective acknowledgment of the problems we face. We encourage the members of our society to join the conversation and bring in others. The GSA blog *Genes to Genomes* (<http://genestogenomes.org>) is one way to rapidly discuss ideas about how we can best serve the interests of our members and our community.

Acknowledgments

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Files S1-S2

Available for download at www.genetics.org/lookup/suppl/doi:10.1534/genetics.115.179523/-/DC1

File S1 Survey questions

File S2 Summary results