OPINION

We need to improve the welfare of life science trainees

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As the COVID-19 pandemic continues to sweep across the globe, the media and the general public are turning to biomedical scientists in hopes of quick remedies. And while terms such as "contact tracing," "convalescent plasma," and "PCR testing" become part of our daily vocabulary, a new spotlight has been shone on the importance of academic scientists in the fight for human healthcare and well-being. Yet, for years, few have acknowledged the lack of appreciation experienced by science's primary workforce: graduate students and postdoctoral fellows.

Indeed, to anticipate and prevent the next pandemic, biomedical science must provide its labor force with the backing and respect it deserves. More vigorous aid of academic science would infuse trainees with much needed assistance that could lead to novel ideas and solutions for the fight against human diseases, including COVID-19. In light of this devastating health crisis as well as some very unfavorable

Many scientist trainees in academia strive in vain for a sustainable career path. Their plight is well known, and yet trainees still struggle with poor living and working conditions. It's a plight made worse by the pandemic and recently implemented immigration restrictions. Image credit: Dave Cutler (artist).

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recent changes in immigration policies, we must address the persistent challenges across academia and envision a future in which institutions and governments fully recognize the value of a life science trainee.

In 2009, I moved to the United States as a young and perhaps naïve Italian undergraduate student looking for an excellent education and a better future. When I enrolled in a Ph.D. program in biomedical sciences, little did I know just how undervalued a graduate student would be—and how much self-sacrifice would be required. On realizing that most of the fellows in training shared my same tormented condition, reality soon crushed my dreams.

I later discovered that the neglect of scientist trainees in academia was not a new concern. And yet, the conditions have not substantially improved. Although oft discussed among peers, the poor working condition of life science trainees is frequently branded as a taboo subject. Everyone knows the circumstances, but no real, lasting actions have been taken to correct the status quo.

A quick refresher: The yearly stipend of a biomedical Ph.D. student in the United States averages $30,000, with only a few schools disbursing stipends that barely exceed poverty thresholds. Pursuing a doctorate in life science routinely requires 12-hour shifts (often including weekends) and an average of 6 years. Thus, students often enter early adulthood with lots of uncertainty. Struggling to pay for their shared apartment and unable to save for future milestones (*e.g.*, buying a house, having children, investing in their retirement), students let themselves envision a future in which their sacrifices will pay off. But the next "academic step" will again disappoint, as the life of a postdoc often isn't much better. Stipends are relatively low, and these highly educated, skilled individuals are forced to scrimp and save. I have witnessed many senior postdocs in their mid-to-late 30s gleefully smuggle out entire boxes of pizza at the end of a seminar—a trophy to showcase to their lab members for dinner. And yes, dinner most often takes place in the lab's break room!

In a sense, the inequities of the system fall even more heavily on postdoctoral fellows, who are more apt to be supporting families as well as more likely to experience poverty, anxiety, and depression (1). Postdoctoral fellowships can help nurture careers; but with an annual salary of about $50,000, the perils of life science postdocs can also last well after the completion of their training (2, 3). Still, postdoctoral training remains a needed stepping stone for academic positions in the life sciences; students would be wise to consider making career plans early in their Ph.D. studies. And graduate schools should offer courses that explore various career paths for students seeking life science job positions, helping them see the advantages and disadvantages of postdocs and other early-career moves.

Importantly, all life scientists in academia are regarded as "trainees" for the duration of their research work [*i.e.*, from the beginning of their Ph.D. studies to the completion of their postdoctoral fellowships—an estimated 11–12 years of combined training (4)], hence the long-standing debate over whether trainees should be treated as employees and thus compensated accordingly. With more intense competition for academic positions and higher demands to publish more comprehensive, nearly "encyclopedic" articles, the perils that scientist trainees experience have profound consequences on their welfare.

They also pose relatively novel challenges. For instance, the average price of an undergraduate degree has skyrocketed 161% since 1987 [adjusted for inflation (5, 6)], forcing many students into graduate school with an estimated $50,000 to $100,000 in student loans. Moreover, rent in several cities in the United States has dramatically soared without a commensurate increase in salaries. Rent in Boston, New York City, and San Francisco—three important university hubs—is up as much as 70% since 2010 (7, 8).

COVID-19 Complications

In recent months, the COVID-19 pandemic has complicated career prospects and further exacerbated financial inequalities (9, 10), making it nearly impossible for some trainees to pay off their loans while meeting their monthly rent. This effectively weeds out those individuals who cannot commit to a long-term, low-paying education program such as a biomedical sciences Ph.D. By excluding prospective scientists because of their financial status or ability to meet their monthly bills, universities are neglecting a plethora of talented, motivated, and passionate students who could have made tremendous contributions to the advancement of biomedicine, an especially important pursuit during a health crisis. Furthermore, increased financial stability would not only translate into more inclusive and accessible career options for people hailing from diverse backgrounds, but it would also provide a more dignified and sustainable lifestyle that boosts productivity and efficiency in the work setting, allowing for faster discoveries and disease treatments.

Complicating matters, international trainees, who account for a significant portion of the research workforce in the United States, are ineligible for most benefits, federal grants, or side jobs but are often regarded as residents for tax purposes. Following a recent executive order suspending new work visas, international scientists faced even more uncertainty regarding their future prospects. Between January and May, the number of visas issued to highly skilled foreign workers plummeted by more than 90%, and officials now predict that the U.S. State Department will see an 82% reduction in visa applications through 2021 (11, 12). Yet, heads of leading American biomedical research laboratories advocate for more immigrant scientists to join the U.S. research workforce (13, 14) and strongly opposed the suspension of new work visa in the form of a petition which has currently reached more than 3,300 signatories (15). Remarkably, a recent Twitter trend, ignited by President Trump's visa ban and spread via the hashtag #immigrantscience, reveals how U.S. research labs would be

decimated—a scenario starkly illustrated by removing international trainees from their group photos, including those who are at the forefront of COVID-19 research.

Unfortunately, the plight of this army of scientists arises from a difficult decision that trainees are forced to make. They must choose between performing the science that they love, and a more stable, financially secure, and dignified life. Soon, the decision to pursue their passion for science mutates into a self-imposed acceptance of the status quo, as trainees keep reinforcing their mantra: "One day these sacrifices will pay off." But will they really? With the number of trained biomedical scientists on the rise, and the number of available principal investigator positions in academia remaining stagnant (16), postdocs are left to compete for prey like ravenous sharks. Lacking a salary that matches their position and facing limited recognition for their roles, postdocs hoping to find a job in academia frantically pursue first-author publications in high-impact journals. But with greater competition comes a greater temptation to cut corners, which may contribute to the reproducibility crisis some have documented (17–19).

Owing to the paucity in tenure-track positions, early-career scientists in life science are increasingly turning to alternative career options outside academia. With the expansion of the biotechnology and pharmaceutical sectors over the last few decades, talented trainees swiftly abandon their dreams of becoming principal investigators. Higher salaries, paid overtime, retirement plans, and stock options are just a few of the benefits that many trainees experience when transitioning from academia to industry. This flow of trainees into the private sector reduces the talent pool available to academic institutions in the long term. Some scientists will welcome this path. But the fact remains that basic research represents a pillar of academic science and a cornerstone of medical applications—including COVID-19 diagnostics, therapeutics, and vaccines sold by private pharmaceutical companies.

Since the late 1940s, higher educational attainment in the United States has steadily increased, currently hitting an all-time high of 35% of the population who have completed four years of college or more. Since then, numerous generations, including my own, have been brought up believing that higher education is a means to achieve a brighter future. I can still remember adults telling my younger self: "You need to study if you want to do well in life." But despite achieving the culmination of my academic growth, higher education in science did not correlate with a better quality of life. In fact, to train in academia, we are asked to put our lives aside and to commit to sacrifices that will eventually offer a path to a satisfying career. But although we believe those same sacrifices to be indispensable for the enrichment of our future prospects, we forfeit our possibility for a more dignified present. Yet, graduate students and postdocs are the vital engine of academic science and are among the people the world relies on to guard against the threat of a deadly virus. To change the status quo, universities and policymakers need to take action.

Room for Improvement

Trainees must first initiate a discussion with their institutions' leaders. And these leaders should appreciate that the highest level of education should not require dire conditions. It is not alright to raise a family in a studio apartment; it is not dignified to be worked to exhaustion without overtime benefits; it is not acceptable to be undervalued. Institutions need to acknowledge the importance of their workforce and reexamine how they distribute funds. They should mitigate the enormous disparities between trainers' and trainees' salaries and offer wages that support a better quality of life. And although an increase in stipends and salaries across academic institutions would provide much needed support for the well-being of trainees, a combination of external funding options would enable faster and more flexible solutions. Manufacturers, biotech, and pharmaceutical companies can help via collaborations and sponsorships that can better account for local differences in stipends and costs of living. Similarly, nongovernmental sources (such as private, nonprofit organizations and philanthropic foundations) should partner with academic institutions to facilitate financial support and provide more flexibility to international students and people from diverse backgrounds. American institutions could learn from the European model of graduate-level education, which sets the length of a Ph.D. training at 3 years to incentivize students to swiftly pursue their career paths, while reducing the duration of their financial stress.

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Of course, a reform that provides increased financial support must also entail a greater sense of responsibility. Although infusing more money into academic research is an important investment for the well-being of humankind, trainees must always remember their obligation to society, by striving for excellence and justifying the relevance and importance of their work for the benefit of the general public.

Ideally, institutions will ally with trainees to ensure that governments take serious action. With $2.4 trillion spent to combat the U.S. coronavirus emergency (20) and a projected $8 trillion reduction in GDP through 2030 (21), the $40 billion the National Institutes of Health (NIH) invests yearly on medical research (22) appears modest. Although proactively spending money for the prevention of a possible—but not certain—health

threat has always been a point of contention in the political forum, the current pandemic has certainly highlighted the need for allocating a higher budget to biomedical research—an investment that is undoubtedly well worth its return. Ironically, the U.S. military budgeted $686 billion for 2019 (23), ostensibly to fight threats to the nation, whilst an invisible enemy was marching undetected. Increasing the annual NIH spending would finally breathe new life into the welfare of training scientists. And with improved welfare comes higher productivity and better science, which will be helpful for the prevention of a future pandemic at a fraction of the cost—and more importantly, at a fraction of the lives lost. It is time to give science's primary workforce the attention it deserves.

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