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FRONT MATTER

Title

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Short title: LGBTQ+ realities in biology

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Abstract

While scientific environments have been described as unwelcoming to the LGBGQ+ community, and fields like physics have systematically documented these challenges, the climate in biology workplaces has not been assessed. We conducted the largest survey to date of LGBTQ+ experiences in biology, including 1419 biologists across five professional societies, with 486 identifying as LGBTQ+. Trans and gender non-conforming (TGNC) biologists reported lower belonging and morale within the workplace, professional societies, and the biology community compared to cis, straight biologists. They also reported being less comfortable with the climate of various professional biology environments. While LGBTQ+ biologists report that their workplaces are moderately inclusive, over 20% of all LGBTQ+ biologists and nearly 40% of TGNC biologists experience exclusionary behavior at work. This landmark survey provides the first comprehensive analysis of the LGBTQ+ climate in biology, revealing specific challenges faced by TGNC scientists and identifying interventions to enhance inclusivity for scientists.

Teaser

Climate study for LGBTQ+ biologists highlights exclusion of trans and gender nonconforming scientists.

MAIN TEXT

Introduction

Individuals who identify as lesbian, gay, bisexual, transgender, queer/questioning plus (LGBTQ+) have historically encountered discrimination and hostile environments in science, technology, engineering, and mathematics (STEM) fields (*1–3*). The unwelcoming nature of the STEM community is attributed to the pervasive cisheteronormativity (*4–6*) and the cultivation of an apolitical culture that sidelines diversity issues (*2*, *7*, *8*). Specifically, LGBTQ+ individuals have previously described a spectrum of negative experiences in STEM environments. For example, physicists have reported experiencing discrimination due to their LGBTQ+ identities (*9*), LGBTQ+ environmental scientists reported being disrespected by their peers (*10*), and LGBTQ+ STEM professionals reported being devalued by their colleagues and socially excluded (*2*). Further, LGBTQ+ scientists are likely underrepresented and underserved in STEM (*11–13*), yet some scientific organizations do not consider LGBTQ+ individuals to be members of an underrepresented group (*14*).

There have been some efforts to systematically assess the experiences of LGBTQ+ individuals in professional STEM environments. These studies primarily surveyed individuals across STEM disciplines (*15*, *16*), with the most recent large-scale study in 2021 finding that LGBTQ+ STEM professionals experience career limitations, harassment, and professional devaluation to a greater extent than their non-LGBTQ+ peers (*2*). Discipline-specific assessments are rare, with the 2016 LGBT+ Climate in Physics Report (*17*) being a notable exception. This study of 324 LGBT+ physicists concluded that the climate experienced by LGBT+ physicists was highly variable. Social norms often established expectations for physicists to conceal their queer identities and many scientists reported feeling isolated and experienced or observed exclusionary behaviors toward LGBTQ+ individuals in the workplace. Considering the cultural differences among STEM fields (*18*) and varying efforts to create inclusive environments (*19–21*), there is a pressing need for additional, discipline-specific evaluations of LGBTQ+ climate.

The life sciences provide a particularly important context in which to assess the LGBTQ+ climate, given the potential intersection of biology content and the LGBTQ+ identity. Many biologists regularly encounter pervasive myths regarding the biology of attraction, biology of gender, genetics, reproduction, hormones, and sexuality, and may be expected to teach content that has been historically influenced by binary and cisheteronormative thought (*19*, *22–24*). Interview studies have found that some LGBTQ+ undergraduates (*25*) and graduates (*26*) describe biology classrooms and graduate programs as unwelcoming and unaccepting spaces and some LGBTQ+ biology professors highlight the potential for negative repercussions if they were to reveal their identity within their department (*27*). The intersection between content and LGBTQ+ identities uniquely positions the biology community to lead changes to make STEM more inclusive. Yet, no large-scale studies have specifically probed the experiences of LGBTQ+ biologists as it relates to their work environments and professional societies.

The experiences of trans and gender non-conforming (TGNC) biologists (*28*) are particularly important to understand, given that TGNC individuals encounter more extreme harassment, discrimination, and violence than their cis LGBQ counterparts (*29*, *30*). In biology, there are unique ways in which the TGNC identity intersects with biology curriculum; namely, gender is often discussed in ways that erase or marginalize non-cisnormative identities (*24*, *28*, *31*, *32*). An interview study of TGNC biology students revealed that biology can be implicitly exclusionary and negatively affects their sense of belonging, career preparation, and interest in biology content (*31*). However, there is a paucity of research that considers gender beyond the binary (*33*), particularly when studying the experiences of biologists (*28*).

To date, no large-scale study has compared the experiences of cis LGBQ biologists, TGNC biologists, and non-LGBTQ+ biologists, nor documented the climate of biology environments for cis LGBQ and TGNC biologists. To address this gap, we surveyed 1419 biologists across five professional societies, 486 of whom identify as LGBTQ+ (Table S1), capturing identities across the spectrum including 153 TGNC biologists. We aimed to assess: 1. To what extent does the belonging, morale, and comfort of LGBTQ+ and non-LGBTQ+ biologists differ? 2. How inclusive are biology workplaces for LGBTQ+ individuals? 3. To what extent do LGBTQ+ biologists experience discrimination? 4. To what extent are LGBTQ+ individuals out in different biology environments? 5. What recommendations do LGBTQ+ biologists have for creating more inclusive biology environments? When answering our research questions, our large sample size enabled us to

answer these research questions with unprecedented depth by distinguishing between the unique experiences of cis LGBQ and TGNC biologists.

Results

In reporting the results, we include any participant who indicated that they were a part of the LGBTQ+ community as "LGBTQ+." In analyses, we considered cisgender LGBQ biologists separately from TGNC biologists. The "cis LGBQ" group includes any participant who selected an orientation identity (e.g., lesbian, gay, bisexual) and reported that they are cisgender. The "TGNC" group includes individuals who did not select that they are cisgender, such as participants who selected agender, genderqueer, gender nonbinary, or transgender. Individuals within the TGNC group may also hold orientation identities. This distinction allows us to identify unique challenges faced by different members of the LGBTQ+ community.

TGNC biologists report lower belonging, morale, and comfort with climate across a variety of professional contexts.

Compared to cisgender straight biologists, and controlling for race, professional position, and geographic location, TGNC biologists reported lower sense of belonging and morale across professional contexts including their workplace (belonging: $\beta = -1.00$, $p < .0001$; morale: $\beta = -0.71$, $p = .004$), within the field of biology (belonging: $\beta = -1.05$, $p < .0001$; morale: $\beta = -1.02$, $p < .0001$), and in their professional societies (belonging: $\beta = -1.08$, $p = .0002$; morale: $\beta = -0.93$, $p = .0002$). TGNC individuals also perceived less comfortable climates on campus ($\beta = -0.84$, $p < .0001$; Fig. 1B), in their departments ($\beta = -0.58$, $p = .002$), and as students ($\beta = -1.28$, $p = .0003$) compared to cisgender straight participants.

Cisgender LGBQ biologists reported lower feelings of morale in their professional societies ($\beta = -0.50$, $p = .004$), compared to cisgender straight biologists, controlling for gender, race, professional position, and geographic location. There were no significant differences in feelings of belonging and morale within the workplace or field of biology and no significant differences in comfort with climate across contexts between cisgender LGBQ and straight cisgender biologists. Full results from both sets of regressions are available in tables S2 and S3.

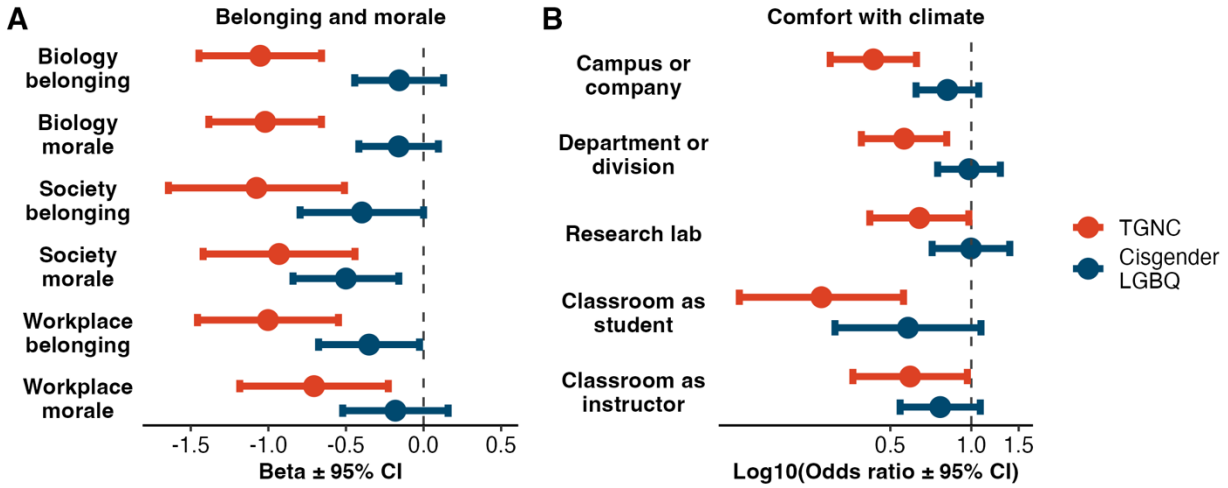

Fig. 1. Forest plot of regression results from: (**A**) linear regressions of sense of belonging and

feelings of morale in the biology community, professional societies, and workplace; and (**B**) ordinal regressions for comfort with climate across five common contexts. TGNC participants are represented in red and cisgender LGBQ participants in blue. Points and confidence intervals to the left of the vertical dashed line indicate that the represented group expressed a lower score on the respective outcome relative to the reference group (which for all models is cisgender straight biologists). Confidence intervals which do not cross the vertical dashed line are statistically significant.

Biology workplaces show mixed levels of LGBTQ+ inclusion and exclusion.

The LGBTQ+ workplace climate scale consists of two factors: LGBTQ+ inclusion and LGBTQ+ exclusion. Of the individual items that comprise the inclusion factor (listed in Fig. 2), over half the participants agreed with most statements indicating inclusive workplace environments. However, less than half of the participants agreed that "Non-LGBTQ+ employees are comfortable engaging in LGBTQ+ friendly humor with LGBTQ+ employees," "Employee LGBTQ+ identity does not seem to be an issue," and "Coworkers are as likely to ask nice, interested questions about LGBTQ+ relationships as they are about non-LGBTQ+ relationships." The 5-point scale measuring LGBTQ+ climate inclusion ranged from 1, strongly disagree to 5, strongly agree, with higher scores indicating greater perceived inclusivity. The average score across all items for all LGBTQ+ participants was 3.5. Cisgender LGBQ participants had a mean score of 3.6, while TGNC participants' mean score was 3.4. When controlling for race, professional position, and geographic location, TGNC participants reported significantly lower inclusion compared to cis LGBQ participants ($\beta = -0.21$, $p = .005$).

Of the individual items that comprise the exclusion factor (listed in Fig. 2), over half of participants disagreed with most statements suggesting relatively inclusive workplace environments. However, less than half of participants disagreed that "Employees are expected to not act 'too gay'," and "Coworkers make comments that seem to indicate a lack of awareness of LGBTQ+ issues." The 5-point scale measuring LGBTQ+ climate inclusion ranged from 1, strongly disagree to 5, strongly agree, where lower scores indicate greater perceived inclusivity. The average score for all items among all LGBTQ+ participants was 2.5 out of 5, Cisgender LGBQ participants averaged 2.4, and TGNC participants reported an average of 2.6. When controlling for race, professional position, and geographic location, TGNC biologists reported higher exclusivity scores than cis LGBQ biologists ($\beta = 0.16$, $p = .06$). The distribution of responses for LGBTQ+ inclusion and exclusion climates across all participants is shown in Fig. 2 and full results from both regressions in table S4.

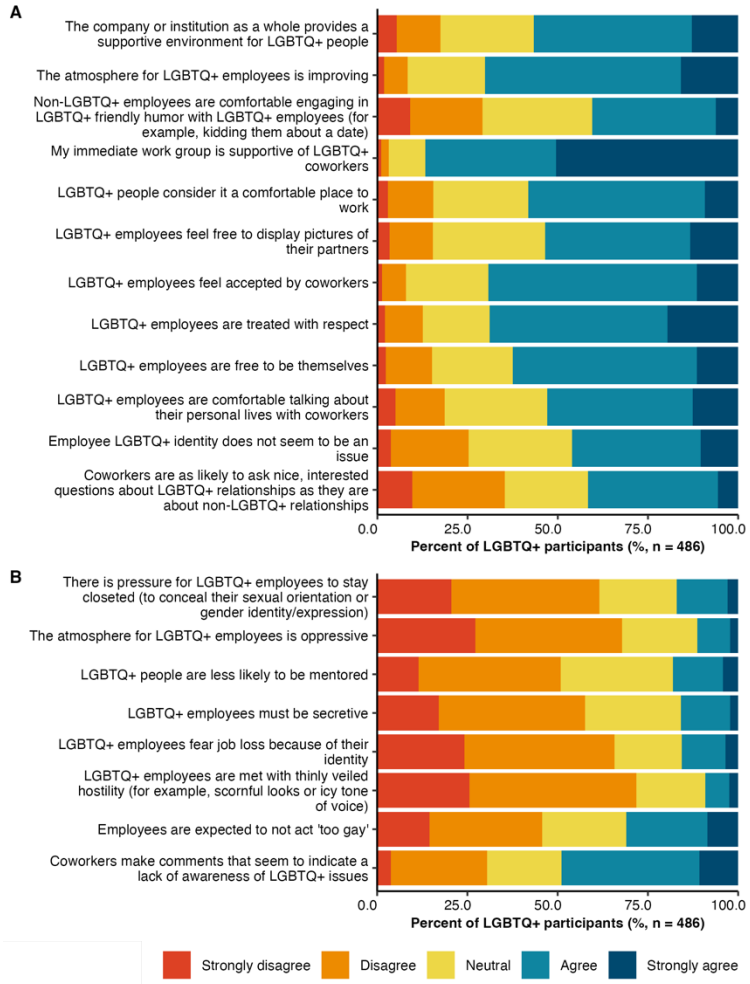

Fig. 2. Distribution of responses from LGBTQ+ participants for the: **(A)** 12 positively worded LGBTQ+ inclusion items; and **(B)** 8 negatively worded LGBTQ+ exclusion items assessing department/workplace climate.

Over 20% of all LGBTQ+ biologists experience exclusionary behavior at work.

The contrast between moderate workplace inclusivity ratings and the actual experiences of LGBTQ+ participants is striking: 21.2% of all LGBTQ+ participants personally experienced intimidating, offensive, and/or hostile conduct due to their LGBTQ+ identity, which interfered with their ability to work or learn in their department or workplace within the past year. Additionally, 38.5% observed or were made aware of such conduct directed toward others. Over forty percent (43.6%) personally experienced exclusionary, intimidating, offensive and/or hostile conduct outside of their department or workplace because of their LGBTQ+ identity within the past year.

When examining the experiences of TGNC biologists specifically, we found that nearly 40% experienced exclusionary behavior at work and over 50% experienced it outside of work (Fig. 3). When controlling for race, professional position, and geographic location, TGNC biologists were significantly more likely to report experiencing exclusionary behavior at work (odds ratio (OR) = 3.73, $p < .0001$) and outside of work (OR = 2.67, $p < .0001$) compared to cis LGBQ biologists. Full regression results are available in table S5.

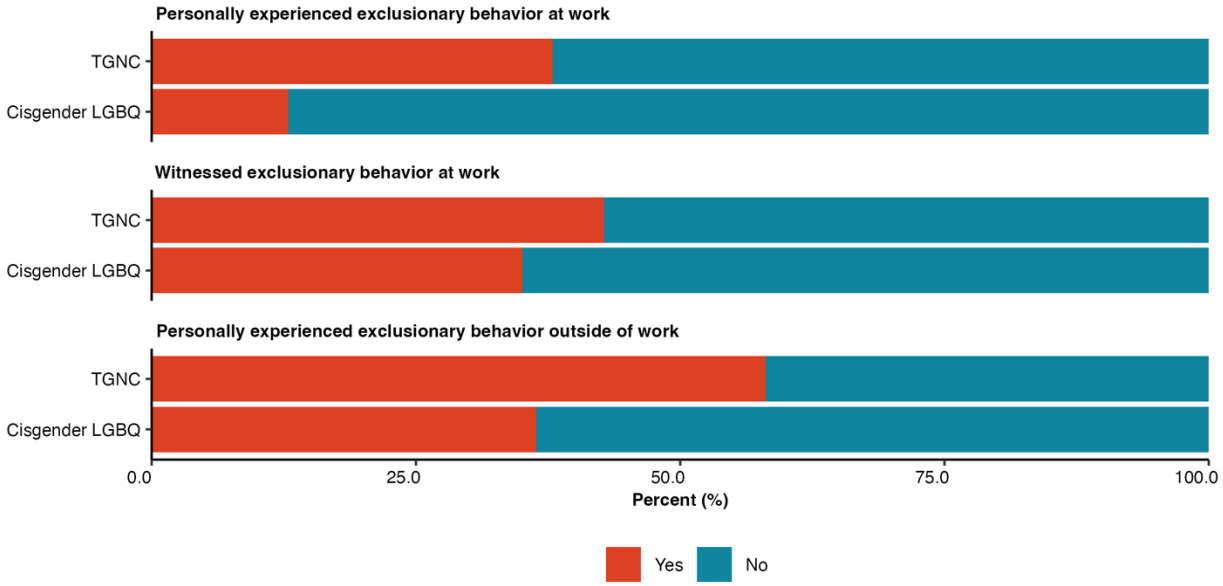

Fig. 3. Distribution of responses from TGNC and cisgender LGBQ participants for whether they have (**A**) experienced exclusionary behavior at work, **(B)** witnessed exclusionary behavior at work, or **(C)** experienced exclusionary behavior outside of work.

LGBTQ+ participants perceive moderate discrimination in biology.

LGBTQ+ participants reported an average score of 3.2 out of 7 on the scale measuring discrimination against LGBTQ+ individuals in biology, where lower scores indicate greater discrimination in biology. When disaggregated by identity category, cisgender LGBQ participants scored an average of 3.5, while TGNC participants scored an average of 2.6. When controlling for race, professional position, and geographic location, TGNC participants perceived significantly more discrimination compared to cis LGBQ participants (β = -0.88, p < .0001). The distribution of responses across all LGBTQ+ participants is illustrated in Fig. 4 and full regression results in table S6.

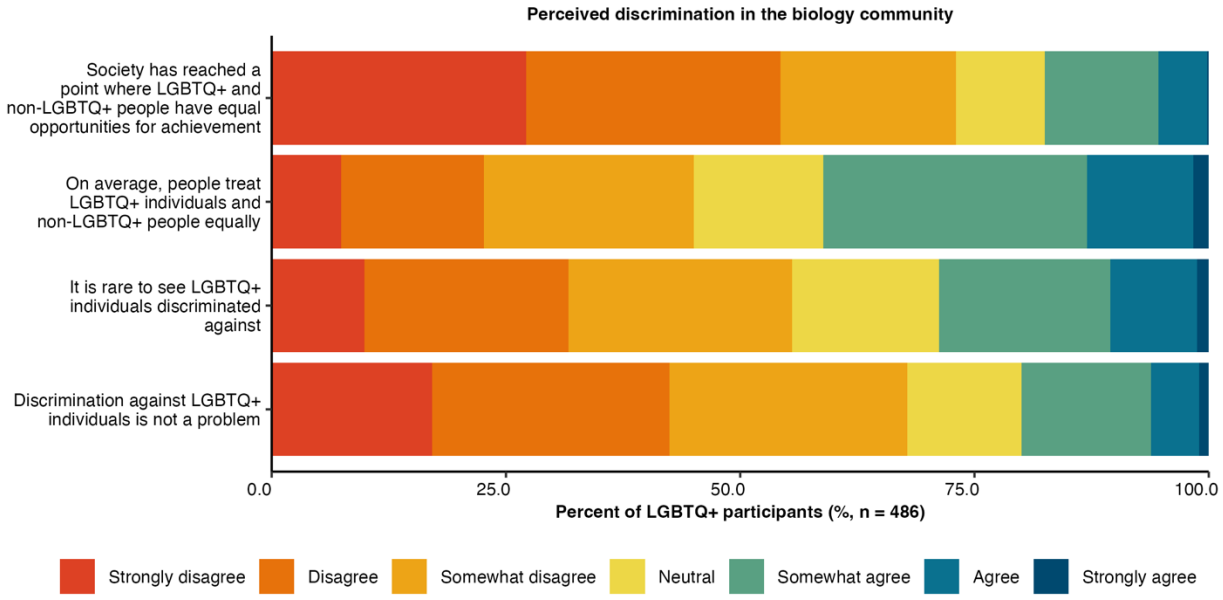

Fig. 4. Distribution of responses from LGBTQ+ participants for the four indicated items assessing discrimination against LGBTQ+ individuals in biology.

LGBTQ+ biologists are somewhat open about their identities to coworkers, but few are out to undergraduates.

Over half of all LGBTQ+ participants were out to most people across an array of professional and personal contexts. Within professional contexts, participants were most likely to be out to postdocs or graduate students in their research groups (67.7%). Of the participants teaching graduate courses, 55.1% were out to graduate students in the course they teach and 16.2% were not. To coworkers or colleagues, 50.6% were out to all, while 5.4% were not to any. LGBTQ+ biologists were least out to undergraduates in their courses; 23.7% were not out to any undergraduates (Fig. 5A). Most LGBTQ+ biologists who were out to all coworkers or colleagues felt comfortable or very comfortable with their department climate (Fig. 5B).

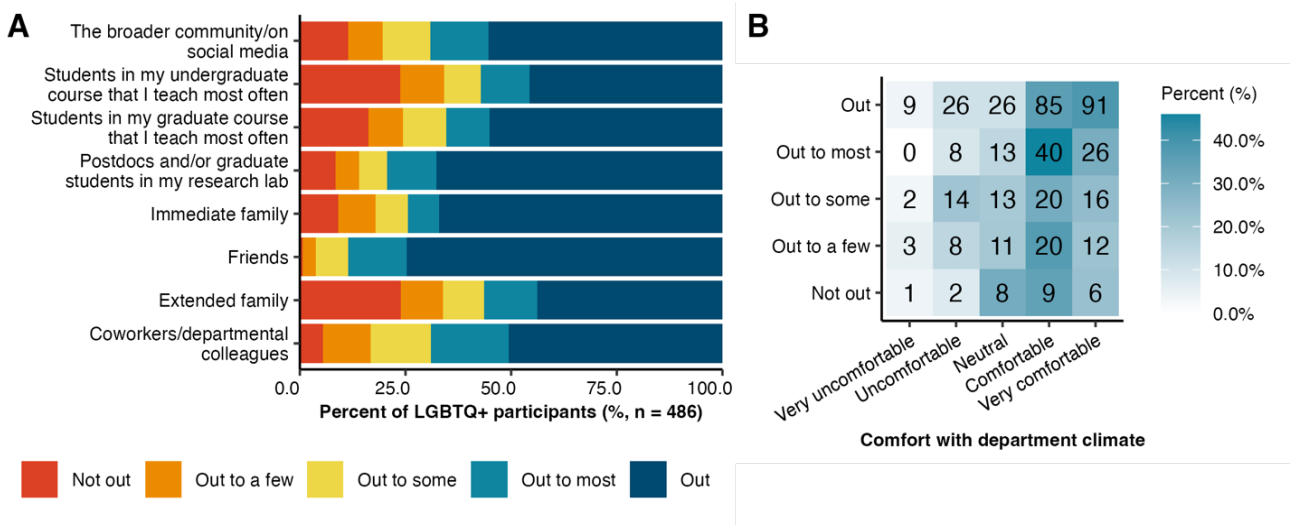

Fig. 5. Distribution of responses from LGBTQ+ participants for **(A)** the degree to which they were out about their LGBTQ+ identities in various contexts, and **(B)** how outness to coworkers was related to comfort in the department/division. The numbers on the heatmap refer to the number of participants represented in that square (e.g., n=9 participants reported being very uncomfortable in their department and were out). The shade of the square represents the percent of LGBTQ+ participants represented per degree of outness (i.e., each row).

LGBTQ+ biologists recommend increased institutional and social support

Participants were asked how their workplaces or professional societies could be more inclusive of LGBTQ+ employees and members. The three most common recommendations included: 1) communicating institutional support by speaking out for LGBTQ+ individuals, addressing LGBTQ-related issues directly, and using inclusive language (23.4%); 2) creating affinity groups or programming for LGBTQ+ individuals (16.4%); and 3) increasing LGBTQ+ visibility and representation (15.8%). Notably, many participants emphasized the need to raise awareness of issues facing TGNC biologists, such as ensuring access to gender-neutral bathrooms and using correct pronouns and names (13.4%). The full descriptions of these suggestions, including frequencies, are detailed in table S7.

Discussion

This study revealed remarkable differences between the experiences of cis LGBQ and TGNC individuals in biology, highlighting the need to disaggregate identities when examining the experiences of LGBTQ+ scientists. While cis LGBQ and non-LGBTQ+ biologists reported similar belonging and morale in the workplace and biology community, and similar comfort with the climate across a variety of professional contexts, TGNC biologists consistently reported lower belonging, morale, and climate than their straight and cis peers. Compared with data from 2021 showing that LGBTQ+ scientists are more likely to report career limitations and professional devaluation than non-LGBTQ+ scientists (*2*), the current data suggest that the increased public acceptance of orientation identities (*34*) combined with specific recommendations and efforts to increase inclusion among LGBTQ+ biologists (*19*, *35–37*) may have resulted in an increase in belonging, comfort, and morale among LGBQ biologists; however, such efforts have fallen short of closing belonging, morale, and comfort gaps for their TGNC counterparts.

These gaps are unsurprising considering the overwhelming anti-TGNC legislation introduced within the U.S. in the past few years (*38*), and that the majority of research on queer biologists has been dominated by the experiences of cis LGBQ participants (*25–27*). However, recent studies are beginning to explicitly examine the experiences of TGNC people in biology, particularly undergraduates (*31*), and there is increased documentation of efforts to reform biology curriculum to be more inclusive of students with queer genders (*24*, *39*). While these efforts are less likely to impact the experiences of practicing scientists, future evaluations are needed to assess whether they are effective in promoting inclusion of rising TGNC biologists.

The current study found that LGBTQ+ biologists are relatively open about their identities across contexts, and much more likely to be out than in prior years. Over half of LGBTQ+ biologists were out to all their colleagues, compared to only a third of 60 LGBTQ+ biologists in a 2019 study (*27*). While participants in the current study were least open about their identity in their undergraduate courses, with 24% not being out to any students, this is a vast improvement from the 2019 study where 65% of biologists were not out to any undergraduates. The rise in LGBTQ+ biologists coming out to undergraduates is encouraging, given recent research highlighting that most students in biology courses benefit from LGBTQ+ visibility and representation among scientists, regardless of whether they hold an LGBTQ+ identity (*40*, *41*). While this progress is promising, the fact that nearly a quarter of LGBTQ+ biologists are not out to any undergraduates indicates ongoing challenges.

Given that over 20% of all LGBTQ+ participants and nearly 40% of TGNC participants experience intimidating, offensive, and/or hostile behavior at work due to their identity, there is an immediate need for workplaces and professional environments to evaluate their internal climates and work toward change as the biology community aims to become more diverse and inclusive. Recommendations from the LGBTQ+ participants are presented in Table S7 and include communicating institutional support for LGBTQ+ individuals and increasing programming to create more inclusive workplace environments. Employers interested in adopting these recommendations should explore resources, such as the Safe Zone Project (thesafezoneproject.com (*42*)), which provides curricula, activities and other resources for LGBTQ+ education sessions, and the Human Resources Campaign Establishing an Allies/Safe Zone Program (hrc.org/resources/establishing-an-allies-safe-

zone-program (*43*)), which provides a step-by-step guide to establishing an LGBTQ+ ally program to make the culture of a workplace more inclusive of LGBTQ+ people.

The findings of this study point to critical areas of future research, particularly examining the intersectional experiences of individuals who hold specific identities within the LGBTQ+ umbrella and those who hold other marginalized identities. Great variation still exists among individuals within the subgroups of the LGBTQ+ community (*44*, *45*). The current study provides foundational insight into the current challenges experienced by cis LGBQ and TGNC biologists and invites the biology community to embrace the participant-generated recommendations in hopes that we can move toward a future where all biologists, regardless of their sexual orientation or gender identity, can thrive and contribute fully to the scientific enterprise.

Materials and Methods

Experimental design

To answer our research questions, we developed a survey with closed-ended and open-ended questions. A full copy of the survey questions is provided in Supplementary Materials.

Sense of belonging and feelings of morale.

We adapted the Course Cohesion Scale (*46*) to measure sense of belonging and feelings of morale associated with the biology community as well as participants' professional societies and workplaces. The Course Cohesion Scale consists of two subscales – sense of belonging and feelings of morale – which each include 3 items (*46*). Participants respond on an 11-point Likert scale from strongly disagree (0) to strongly agree (10). We created aggregate scores for biology, professional society, and workplace sense of belonging and feelings of morale by calculating the mean of the three items. In our sample, we had excellent internal consistency for workplace sense of belonging (Cronbach's $\alpha = 0.96$), workplace feelings of morale (Cronbach's $\alpha = 0.93$), biology sense of belonging (Cronbach's $\alpha = 0.96$), biology feelings of morale (Cronbach's $\alpha = 0.91$), society sense of belonging (Cronbach's $\alpha = 0.93$-0.97), and society feelings of morale (Cronbach's $\alpha = 0.90$-0.93).

Climate comfort.

We assessed comfort with climate across professional and academic contexts using a single item per context. This item has previously been used in a LGBTQ+ climate survey from APS (*47*). Specifically, participants used a 5-point Likert scale from very uncomfortable to very comfortable to rate how comfortable they were with the climate in 1) their campus or company, 2) department or division, 3) research lab or group, 4) classroom where they are an instructor, and 5) classroom where they are a student.

Demographic questions.

Participants then answered a series of demographic questions with regard to their gender, race/ethnicity, LGBTQ+ identity, current professional position (e.g., graduate student, university faculty), and current region of residence.

LGBTQ-specific questions.

Participants who identified as a part of the LGBTQ+ community were asked a series of questions. First, we measured perceived bias against LGBTQ+ individuals in science by

modifying a scale previously developed to assess bias against religious individuals in science (*48*). Participants rated four items on a scale from strongly disagree (1) to strongly agree (7). We created an aggregate score by taking the average of the four items. Our sample demonstrated good internal consistency (Cronbach's $\alpha = 0.90$).

Then, LGBTQ+ participants rated 20 items based on how well they described the atmosphere for LGBTQ+ employees at their workplace. These items have previously been used in a LGBTQ+ climate survey from APS (*9*, *47*) and include 12 positively-worded inclusive climate items and 8 negatively-worded exclusion climate items. We created aggregate scores for both the inclusive climate and exclusive climate measures by taking the mean of the respective items. We found excellent internal consistency for these measures in our sample for both inclusion (Cronbach's $\alpha = 0.93$) and exclusion (Cronbach's $\alpha = 0.91$).

To determine the extent to which LGBTQ+ participants are open in various contexts, they used a 5-point scale from not out (1) to out (5) to describe the extent to which they typically revealed their LGBTQ+ identity to: friends, immediate family, extended family, coworkers, research group, graduate courses, undergraduate courses, and broader community. Participants had the option to select N/A if they did not interact with a particular group of individuals (e.g., they do not teach graduate courses).

Using a series of questions previously used in LGBTQ+ climate surveys in science (*47*), we assessed whether participants had experienced and/or witnessed LGBTQ+ exclusionary behavior. The survey concluded with two open-ended questions for participants to describe any ways in which their professional society and workplace could make them feel more included as an LGBTQ+ individual.

Recruitment and distribution

To understand how the experiences of LGBTQ+ biologists compare to those of straight cis biologists, we aimed to recruit both LGBTQ+ and non-LGBTQ+ participants. Recruitment was initiated by the American Society of Cell Biology (ASCB) LGBTQ+ Committee. In summer 2023, ASCB leadership invited 5 societies to participate in helping to recruit biologists within their respective communities for this study. In addition to ASCB, 4 professional societies agreed to send out the study recruitment to their membership: Biophysical Society (BPS), Genetics Society of America (GSA), International Society for STEM Cell Research (ISSCR), and the Society for the Advancement of Biology Education Research (SABER). A snowball sampling approach was also used; the media teams from each community were encouraged to also use social media outlets to recruit any biologists interested in participating in the survey. Social media posts often encouraged biologists to invite other biologists to participate. The survey was open from June 1 to July 31 of 2023.

Statistical analysis

We conducted all quantitative analyses in R (*49*). We report the percent of participants who selected a particular response for single-item measures and summarize responses by reporting the means for multi-item scales. For all outcomes, we report overall descriptive statistics for LGBTQ+ participants and then disaggregate the responses between TGNC participants and cisgender LGBQ participants in order to respect the differences in experiences for biologists across the LGBTQ+ spectrum. For all regression analyses, the reference group is cisgender straight participants. The specific analyses are organized by research question:

1. To what extent does the belonging, morale, and comfort of LGBTQ+ and non-LGBTQ+ biologists differ?

To assess the extent to which LGBTQ+ individuals differ from non-LGBTQ+ individuals with regard to sense of belonging and feelings of morale across their professional societies, the biology community, and their workplace, we ran linear regressions using the stats package (*49*). We ran one set of regressions for orientation (cis LGBQ biologists compared to cisgender straight biologists) and another for gender (comparing TGNC biologists to cisgender straight biologists). For orientation, our predictors included whether the participant reported an LGBQ orientation identity (0/1), binary gender (cisgender man/cisgender woman), race (Asian, Latine, white, or other), professional position (university faculty, university staff, student, or outside of academia), and region (Midwest US, Northeast US, Southeast US, Southwest US, Western US, or outside of the US). We omitted participants who did not identify as cisgender in order to focus this analysis on the differences between cisgender biologists with or without LGBTQ+ orientation identities. Our reference groups were not reporting an LGBTQ+ orientation identity, man, white, outside of academia, and outside of the US. In our models examining the experiences of participants with LGBTQ+ gender identities, we modeled each of the outcomes by gender (TGNC/cisgender straight), race (Asian, Latine, white, other), professional position (university faculty, university staff, student, or outside of academia), and region (Midwest US, Northeast US, Southeast US, Southwest US, Western US, or outside of the US). Of note, cisgender LGBQ participants were not included in these analyses. Our reference groups were cisgender, white, outside of academia, and outside of the US. For the models assessing professional society sense of belonging and feelings of morale, we also included professional society as a predictor. In presenting the results, we have anonymized the society names and do not interpret any significant differences. If an individual was a member of multiple participating societies, they responded to these items for each society and each entry was included in the model. Thus, we included a random effect of participant to account for multiple responses from participants who were members of multiple societies. To account for multiple hypothesis testing across these six regressions, we used Bonferroni corrections and used 0.008 (0.05/6) as the *p*-value threshold.

Similarly, to assess the differences in experiences between LGBTQ+ and non-LGBTQ+ individuals with regard to their workplace climate, we ran two sets of ordinal regressions using the ordinal package (*50*). The two models had the same sets of predictors as described for the linear models above, with the outcome being participants' responses to the question regarding how comfortable they are with the climate in various professional contexts (campus, department, lab, as a student, as an instructor). We again used Bonferroni corrections to account for multiple hypothesis testing and 0.01 (0.05/5) was the *p*-value threshold.

We calculated the variance inflation factor (VIF) for both sets of predictors using the car package (*51*), which indicated that there were no issues with multicollinearity among the predictors. Assumptions of linearity, homoscedasticity, and normality were checked and met for all linear regressions and proportional odds assumption was met for the ordinal regressions (*52*).

2. How inclusive are biology workplaces for LGBTQ individuals?

We calculated the average score across the 12 positively worded items assessing LGBTQ+ inclusion and the average score across the 8 negatively worded LGBTQ+ items assessing exclusion. We also calculated these average scores for cisgender LGBQ participants as well as TGNC participants. We assessed potential statistically significant differences between TGNC participants and cisgender LGBQ participants using linear regressions for the inclusion and exclusion scales while controlling for race, professional position, and region.

3. To what extent do LGBTQ+ biologists experience discrimination?

We assessed the percentage of TGNC individuals who personally experienced exclusionary behavior at work, personally witnessed exclusionary behavior at work, and personally experienced exclusionary behavior outside of work. This analysis was repeated for cis LGBQ individuals. We used binary logistic regression analyses to determine whether TGNC participants and cis LGBQ participants differed in their experiences with exclusionary behaviors while controlling for race, professional position, and region in the regressions pertaining to the workplace and race and region in the regression of experiencing exclusionary behavior outside of work. In reporting the results of the logistic regressions, we use the odds ratio (OR) to describe effect size. OR is calculated by exponentiating the β coefficient from the model output.

4. To what extent are LGBTQ+ individuals out in different biology environments?

We calculated the percentages of all LGBTQ+ participants who were out in relation to eight circumstances. If a circumstance did not apply to an individual, they could select "N/A." Percentages were calculated by dividing by the number of individuals who indicated the circumstance was applicable to them.

5. What recommendations do LGBTQ+ biologists have for creating more inclusive biology environments?

To describe the recommendations participants had for making their professional societies and workplaces more inclusive for LGBTQ+ individuals, we used open-coding methods (*53*). Due to the parallel structure of the questions, we developed one codebook to analyze the responses. Two researchers (C.A.B. and P.B.B.) individually reviewed different randomly selected subsets of 10% of the responses and took analytic notes on themes that emerged from the text. Then, the researchers met to compare their codes and developed a preliminary codebook which included all of the themes that the researchers identified and ensured that all of the themes were distinct from each other. Then, one researcher (P.B.B.) tested the preliminary codebook on a randomly selected subset of 10% of the responses. Through this process, we ensured that no new codes were present in the responses and that our codebook was complete. The two researchers then independently coded the same subset of 15% of the responses using the codebook. Upon comparing their codes, they achieved excellent interrater reliability (Cohen's K = 0.88) as evidence of the validity of the codebook. One researcher (P.B.B.) then coded all responses using the codebook. We report the percent of participants who included each theme in their response as well as example quotes for the two prompts in table S7.

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Science Advances
AAAS

Supplementary Materials for

Barriers to belonging: Exclusion and discrimination for LGBTQ+ biologists

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This PDF file includes:

Supplementary Text
Tables S1 to S7
Data S1 to S2

Supplementary Text

Copy of survey questions

Please select which of the following professional societies you are associated with. You do not have to be an active member to be associated with a particular society.

- American Society of Cell Biology (ASCB)
- Biophysical Society (BPS)
- Genetics Society of America (GSA)
- International Society for Stem Cell Research (ISSCR)
- Society for the Advancement of Biology Education Research (SABER)
- I am not currently associated with any of the above societies

Based on society(ies) selected in previous question:
Please answer the following questions about **the [society] community.** *Answered on a scale from 0 (strongly disagree) to 10 (strongly agree)*

1. I feel a sense of belonging to [society]
2. I feel that I am a member of the [society] community
3. I see myself as part of the [society] community
4. I am enthusiastic about [society]
5. I am happy to be associated with [society]
6. [Society] is one of the best professional societies

Please answer the following questions about **your department or workplace.** *Answered on a scale from 0 (strongly disagree) to 10 (strongly agree)*

1. I feel a sense of belonging to my workplace
2. I feel that I am a member of my workplace community
3. I see myself as part of my workplace community
4. I am enthusiastic about where I work
5. I am happy to be at my place of work
6. I am at one of the best places to work

What subdiscipline(s) of biology do you work within?

- Anatomy
- Biochemistry
- Bioinformatics
- Biophysics
- Biotechnology
- Botany
- Cell biology
- Developmental biology
- Discipline-based education (DBER)
- Ecology
- Embryology
- Entomology
- Genetics
- Immunology
- Marine biology
- Microbiology
- Molecular biology
- Molecular genetics
- Mycology
- Neuroscience
- Parasitology
- Pathology
- Physiology
- Systems biology
- Zoology
- Other, please describe
- I do not identify as working within a sub-discipline of biology *sent to end of survey*

Please answer the following questions about **the broader biology community.** The broader biology community includes everyone you know in biology. *Answered on a scale from 0 (strongly disagree) to 10 (strongly agree)*

1. I feel a sense of belonging to the biology community
2. I feel that I am a member of the biology community
3. I see myself as part of the biology community
4. I am enthusiastic about the biology community
5. I am happy to be associated with the biology community
6. The biology community is one of the best scientific communities

Climate is defined as the "current attitudes, behaviors, and standards held by faculty, staff, and students concerning access for, inclusion of, and level of respect for individual and group needs, abilities and potential" (APS, 2015).

Overall how comfortable are you with the climate in the following areas? *Answered on a scale from very uncomfortable (1) to very comfortable (5), with the option to select N/A does not apply to me*

1. Campus or company
2. Department or division
3. Research lab or group
4. Classroom where I am an instructor
5. Classroom where I am a student

Next, we ask a series of demographic questions to better understand the identities of those in the biology community. You are always welcome to skip questions or decline to state if you would rather not answer.

I most closely identify as

- Woman
- Man
- Nonbinary or genderfluid
- Agender
- A gender that is not listed _____
- Decline to state

I most closely identify as

- American Indian or Alaska Native
- Asian
- Black or African American
- Hispanic, Latin*, or Spanish origin
- Pacific Islander
- White
- More than one race/ethnicity
- Other (please describe) _____
- Decline to state

Do you identify as a member of the LGBTQ+ community?

- Yes
- No
- Decline to state

If yes: Please select the word or words that best describe your LGBTQ+ identities referring to sexuality and/or romantic attraction.

- Lesbian or Gay
- Bisexual
- Queer as it relates to my sexuality
- Asexual/aromantic
- Pansexual
- Questioning
- An identity not listed, please describe _____
- Straight or I do not identify within the LGBTQ+ community as it relates to my sexuality or romantic attraction
- Decline to state

Please select the word or words that best describe your LGBTQ+ identities referring to gender identity.

- Transgender man
- Transgender woman
- Gender-queer or gender non-binary
- Agender
- Questioning
- A gender that is not listed, please describe _____
- Cis-gender or I do not identify within the LGBTQ+ community as it relates to my gender identity
- Decline to state

I most closely identify as

- An undergraduate student
- A graduate student
- A postdoctoral scholar
- An assistant professor
- An associate professor
- A full professor
- A lecture or instructor
- A non-tenure track faculty member or research staff
- Employed in a government position
- Employed in an industry position
- Other, please describe _____
- Decline to state

What type of academic institution do you identify with?

- I do not work at an academic institution
- R1 doctoral university
- R2 doctoral university
- R3 doctoral university
- Master's college or university
- Baccalaureate college or university
- Associates college or community college
- Tribal college or university
- Decline to state

In which country do you currently reside? *Dropdown selection*

If in the USA: Where do you currently reside?

- Western US
- Southwestern US
- Southeastern US
- Northeastern US
- Midwestern US
- Decline to state

If identify as LGBTQ+: The following questions are intended to assess how inclusive the biology community is of LGBTQ+ individuals. Please answer the following questions about your experience. If you prefer not to answer, you may skip any questions.

Answered on a scale from strongly disagree (1) to strongly agree (7)

1. Discrimination against LGBTQ+ individuals is not a problem in the biology community
2. It is rare to see LGBTQ+ individuals discriminated against in the biology community
3. On average, people in the biology community treat LGBTQ+ individuals and non-LGBTQ+ people equally
4. Society has reached a point where LGBTQ+ and non-LGBTQ+ people have equal opportunities for achievement in the biology community

Please rate the following items according to how well they describe the atmosphere for employees who identify within the LGBTQ+ community in your department/workplace. *Answered on a scale from strongly disagree (1) to strongly agree (5)*

1. LGBTQ+ employees are treated with respect
2. LGBTQ+ employees must be secretive
3. Coworkers are as likely to ask nice, interested questions about LGBTQ+ relationships as they are about non-LGBTQ+ relationships
4. LGBTQ+ people consider it a comfortable place to work
5. Non-LGBTQ+ employees are comfortable engaging in LGBTQ+ friendly humor with LGBTQ+ employees (for example, kidding them about a date)
6. The atmosphere for LGBTQ+ employees is oppressive
7. LGBTQ+ employees feel accepted by coworkers
8. Coworkers make comments that seem to indicate a lack of awareness of LGBTQ+ issues
9. Employees are expected to not act "too gay”
10. LGBTQ+ employees fear job loss because of their identity
11. My immediate work group is supportive of LGBTQ+ coworkers
12. LGBTQ+ employees are comfortable talking about their personal lives with coworkers
13. There is pressure for LGBTQ+ employees to stay closeted (to conceal their sexual orientation or gender identity/expression)
14. Employee LGBTQ+ identity does not seem to be an issue
15. LGBTQ+ employees are met with thinly veiled hostility (for example, scornful looks or icy tone of voice)
16. The company or institution as a whole provides a supportive environment for LGBTQ+ people
17. LGBTQ+ employees are free to be themselves
18. LGBTQ+ people are less likely to be mentored
19. LGBTQ+ employees feel free to display pictures of their partners
20. The atmosphere for LGBTQ+ employees is improving

To what extent do you typically reveal your LGBTQ+ identity in the following contexts. *Answered on a scale from not out (1) to out (5) with the option to select N/A I do not interact with these individuals*

1. Friends
2. Immediate family
3. Extended family
4. Coworkers/departmental colleagues
5. To postdocs and/or graduate students in my research lab
6. To students in my graduate course that I teach most often
7. To students in my undergraduate course that I teach most often
8. To the broader community/on social media

Within the past year, have **you personally** experienced any exclusionary (e.g., shunned, ignored), intimidating, offensive and/or hostile conduct (harassing behavior) because of your LGBTQ+ identity that has interfered with your ability to work or learn on your department or workplace?

- Yes
- No
- Decline to state

Within the past year, have you observed or personally been made aware of any conduct directed **toward a person or group of people on campus or at your department or workplace** that you believe has created an exclusionary (e.g. shunned, ignored), intimidating, offensive, and/or hostile (harassing) working or learning environment because of their LGBTQ+ identity?

- Yes
- No
- Decline to state

Within the past year, have **you personally** experienced any exclusionary (e.g., shunned, ignored), intimidating, offensive and/or hostile conduct (harassing behavior) **outside of your department or workplace** because of your LGBTQ+ identity?

- Yes
- No
- Decline to state

What, if anything, could your respective **professional society/societies** do to make you feel more included as an LGBTQ+ individual? *Open-ended*

What, if anything, could your **workplace** do to make you feel more included as an LGBTQ+ individual? *Open-ended*

Table S1.

	Demographic	Percent (n)
Gender	Woman	47.0 (667)
	Man	41.3 (586)
	Non-Binary Or Gender Fluid	5.1 (72)
	Agender	0.9 (13)
	A Gender That Is Not Listed	0.8 (11)
	Decline To State	4.9 (70)
Race/ ethnicity	White	64.5 (915)
	Asian	11.5 (163)
	Hispanic, Latin*, Or Spanish Origin	8.2 (116)
	More Than One Race/Ethnicity	3.7 (53)
	Identity(ies) Not Listed	3.4 (48)
	Black Or African American	2.6 (37)
	American Indian Or Alaska Native	0.6 (8)
	Pacific Islander	0.1 (2)
	Decline To State	5.4 (77)
LGBTQ+	No	58.3 (827)
	Yes	34.2 (486)
	Decline To State	7.5 (106)
LGBTQ+ identity group	Cisgender LGBQ	22.1 (313)
	Trans, nonbinary, genderfluid, or genderqueer (TGNC)	10.8 (153)
	Decline To State	1.4 (20)
LGBTQ+ gender identity (can select >1)	Agender	1.3 (19)
	Gender-queer or gender non-binary	7.8 (111)
	Questioning	1.8 (26)
	Transgender man	1.3 (18)
	Transgender woman	0.7 (10)
	A gender not listed	1.3 (18)
	Decline to state	0.8 (11)

LGBTQ+ orientation identity (can select >1)	Asexual or aromantic	2.7 (38)
	Bisexual	9.7 137)
	Lesbian or gay	18.9 (268)
	Pansexual	3.5 (49)
	Queer	10.5 (149)
	Questioning	0.4 (6)
	An identity not listed	0.6 (9)
	Decline to state	0.2 (3)
Geographic location	Outside of US	22.1 (314)
	Northeast US	19.7 (280)
	Midwest US	15.4 (219)
	West US	14.7 (209)
	Southeast US	12.8 (181)
	Southwest US	5.6 (80)
	Decline to state	9.6 (136)
Professional position	University faculty	49.9 (708)
	University staff, lecturer, or postdoc	20.4 (290)
	University undergrad or grad student	15.3 (217)
	Position outside of academia (e.g., govt. or industry, nonprofit)	11.0 (156)
	Decline to state	3.4 (48)
Society (can select >1)	ASCB	416
	BPS	172
	GSA	353
	ISSCR	162
	SABER	176
	None	375

Participant demographic characteristics.

Table S2.

Outcome	Predictor	beta	SE	p-value
Workplace sense of belonging	(Intercept)	8.018	0.267	**0.000**
	Cis LGBQ (yes)	-0.351	0.166	0.034
	Gender (cis woman)	-0.194	0.144	0.178
	Race (Asian)	-0.081	0.232	0.726
	Race (Latinx)	-0.277	0.261	0.290
	Race (other)	-0.015	0.239	0.950
	Position (faculty)	-0.064	0.235	0.784
	Position (university staff)	-0.500	0.262	0.057
	Position (student)	-0.334	0.290	0.250
	Region (Midwest US)	-0.422	0.225	0.061
	Region (NE US)	0.049	0.214	0.819
	Region (SE US)	0.142	0.237	0.549
	Region (SW US)	-0.251	0.321	0.435
	Region (West US)	0.281	0.230	0.222
Workplace feelings of morale	(Intercept)	7.685	0.279	**0.000**
	Cis LGBQ (yes)	-0.181	0.173	0.295
	Gender (cis woman)	-0.313	0.150	0.037
	Race (Asian)	0.011	0.242	0.965
	Race (Latinx)	-0.048	0.273	0.859
	Race (other)	0.062	0.250	0.805
	Position (faculty)	-0.436	0.245	0.075
	Position (university staff)	-0.289	0.274	0.291
	Position (student)	-0.521	0.303	0.086
	Region (Midwest US)	-0.770	0.235	**0.001**
	Region (NE US)	-0.164	0.223	0.464
	Region (SE US)	-0.042	0.247	0.866
	Region (SW US)	-0.277	0.336	0.409
	Region (West US)	0.527	0.240	0.028
Biology sense of belonging	(Intercept)	7.722	0.236	**0.000**
	Cis LGBQ (yes)	-0.157	0.146	0.282
	Gender (cis woman)	-0.255	0.126	0.044
	Race (Asian)	0.099	0.204	0.627
	Race (Latinx)	0.231	0.229	0.313
	Race (other)	-0.055	0.210	0.795
	Position (faculty)	0.122	0.207	0.554
	Position (university staff)	-0.091	0.231	0.694
	Position (student)	-0.332	0.255	0.194
	Region (Midwest US)	-0.215	0.198	0.278
	Region (NE US)	-0.121	0.188	0.518
	Region (SE US)	-0.040	0.208	0.846
	Region (SW US)	-0.339	0.282	0.230
	Region (West US)	0.083	0.202	0.681
Biology feelings of morale	(Intercept)	7.729	0.212	**0.000**
	Cis LGBQ (yes)	-0.161	0.131	0.220
	Gender (cis woman)	-0.133	0.113	0.241

	Race (Asian)	0.033	0.182	0.857
	Race (Latinx)	0.018	0.205	0.932
	Race (other)	0.160	0.188	0.396
	Position (faculty)	0.107	0.185	0.565
	Position (university staff)	-0.034	0.207	0.868
	Position (student)	0.208	0.229	0.362
	Region (Midwest US)	-0.228	0.177	0.199
	Region (NE US)	0.075	0.168	0.657
	Region (SE US)	0.229	0.186	0.219
	Region (SW US)	-0.190	0.253	0.452
	Region (West US)	0.342	0.181	0.059
Workplace sense of belonging	(Intercept)	8.026	0.290	**0.000**
	TGNC (yes)	-1.002	0.232	**0.000**
	Race (Asian)	-0.095	0.241	0.694
	Race (Latinx)	-0.238	0.305	0.436
	Race (other)	-0.014	0.248	0.954
	Position (faculty)	-0.366	0.264	0.166
	Position (university staff)	-0.795	0.300	0.008
	Position (student)	-0.306	0.334	0.359
	Region (Midwest US)	-0.261	0.249	0.295
	Region (NE US)	0.317	0.234	0.176
	Region (SE US)	0.303	0.277	0.274
	Region (SW US)	-0.221	0.372	0.553
	Region (West US)	0.385	0.255	0.131
Workplace feelings of morale	(Intercept)	7.534	0.306	**0.000**
	TGNC (yes)	-0.706	0.244	**0.004**
	Race (Asian)	-0.035	0.254	0.891
	Race (Latinx)	-0.109	0.322	0.736
	Race (other)	0.146	0.262	0.578
	Position (faculty)	-0.577	0.278	0.038
	Position (university staff)	-0.390	0.316	0.217
	Position (student)	-0.277	0.352	0.431
	Region (Midwest US)	-0.597	0.262	0.023
	Region (NE US)	0.118	0.246	0.632
	Region (SE US)	-0.010	0.292	0.974
	Region (SW US)	-0.348	0.392	0.375
	Region (West US)	0.359	0.269	0.183
Biology sense of belonging	(Intercept)	7.522	0.254	**0.000**
	TGNC (yes)	-1.052	0.201	**0.000**
	Race (Asian)	0.253	0.209	0.227
	Race (Latinx)	0.235	0.264	0.373
	Race (other)	-0.115	0.216	0.593
	Position (faculty)	-0.105	0.231	0.648
	Position (university staff)	-0.234	0.261	0.370
	Position (student)	-0.325	0.291	0.264
	Region (Midwest US)	-0.016	0.216	0.940
	Region (NE US)	0.397	0.203	0.051
	Region (SE US)	0.325	0.241	0.177
	Region (SW US)	-0.493	0.321	0.125
	Region (West US)	0.197	0.222	0.375

Biology feelings of morale	(Intercept)	7.644	0.233	**0.000**
	TGNC (yes)	-1.021	0.185	**0.000**
	Race (Asian)	0.174	0.192	0.366
	Race (Latinx)	-0.012	0.242	0.960
	Race (other)	-0.016	0.198	0.938
	Position (faculty)	-0.091	0.212	0.668
	Position (university staff)	-0.282	0.240	0.241
	Position (student)	0.145	0.267	0.587
	Region (Midwest US)	-0.073	0.199	0.713
	Region (NE US)	0.515	0.187	**0.006**
	Region (SE US)	0.592	0.221	**0.008**
	Region (SW US)	-0.233	0.295	0.430
	Region (West US)	0.417	0.204	0.041
Society sense of belonging	(Intercept)	6.963	0.311	**0.000**
	Cis LGBQ (yes)	-0.398	0.203	0.050
	Gender (cis woman)	-0.354	0.138	0.011
	Race (Asian)	0.158	0.213	0.457
	Race (Latinx)	-0.011	0.259	0.966
	Race (other)	-0.168	0.219	0.443
	Society B	0.860	0.220	**0.000**
	Society C	0.371	0.176	0.035
	Society D	-0.276	0.240	0.251
	Society E	0.103	0.227	0.652
	Position (faculty)	0.055	0.245	0.822
	Position (university staff)	-0.166	0.276	0.549
	Position (student)	0.065	0.334	0.845
	Region (Midwest US)	0.259	0.230	0.261
	Region (NE US)	0.272	0.213	0.202
	Region (SE US)	0.517	0.246	0.036
	Region (SW US)	0.266	0.322	0.408
	Region (West US)	0.340	0.234	0.146
Society feelings of morale	(Intercept)	7.859	0.266	**0.000**
	Cis LGBQ (yes)	-0.500	0.174	**0.004**
	Gender (cis woman)	-0.080	0.118	0.501
	Race (Asian)	0.032	0.182	0.862
	Race (Latinx)	-0.088	0.222	0.692
	Race (other)	-0.021	0.187	0.912
	Society B	0.317	0.188	0.092
	Society C	-0.006	0.151	0.968
	Society D	-0.176	0.206	0.392
	Society E	-0.080	0.195	0.680
	Position (faculty)	0.044	0.210	0.835
	Position (university staff)	0.026	0.237	0.913
	Position (student)	0.019	0.286	0.947
	Region (Midwest US)	-0.053	0.197	0.787
	Region (NE US)	0.134	0.183	0.463
	Region (SE US)	0.316	0.211	0.135
	Region (SW US)	0.213	0.276	0.440
	Region (West US)	0.115	0.200	0.566
Society sense of belonging	(Intercept)	6.628	0.313	**0.000**

	TGNC (yes)	-1.077	0.289	**0.000**
	Race (Asian)	0.168	0.210	0.424
	Race (Latinx)	0.057	0.288	0.842
	Race (other)	-0.249	0.223	0.266
	Society B	0.918	0.223	**0.000**
	Society C	0.379	0.180	0.036
	Society D	-0.179	0.248	0.472
	Society E	0.204	0.239	0.393
	Position (faculty)	0.172	0.256	0.502
	Position (university staff)	-0.130	0.291	0.654
	Position (student)	0.116	0.363	0.749
	Region (Midwest US)	0.271	0.230	0.241
	Region (NE US)	0.447	0.215	0.038
	Region (SE US)	0.518	0.258	0.045
	Region (SW US)	0.263	0.342	0.442
	Region (West US)	0.200	0.235	0.396
Society feelings of morale	(Intercept)	7.674	0.270	**0.000**
	TGNC (yes)	-0.931	0.250	**0.000**
	Race (Asian)	0.053	0.181	0.770
	Race (Latinx)	0.036	0.249	0.886
	Race (other)	-0.021	0.193	0.915
	Society B	0.413	0.192	0.032
	Society C	0.025	0.155	0.873
	Society D	-0.064	0.214	0.764
	Society E	-0.003	0.206	0.989
	Position (faculty)	0.112	0.220	0.613
	Position (university staff)	-0.018	0.251	0.942
	Position (student)	0.041	0.313	0.896
	Region (Midwest US)	-0.064	0.199	0.749
	Region (NE US)	0.332	0.186	0.074
	Region (SE US)	0.297	0.223	0.182
	Region (SW US)	0.201	0.295	0.496
	Region (West US)	0.126	0.203	0.533

Results from linear regressions for sense of belonging and feelings of morale in the workplace, biology community, and professional societies. Reference groups are straight, cisgender, white, outside of academia, outside of the US, and Society A. Bold text represents statistical significance after Bonferroni corrections.

Table S3.

Context	Predictor	beta	SE	OR	p-value
Campus	Cis LGBQ (yes)	-0.205	0.137	0.815	0.135
	Gender (cis woman)	-0.320	0.120	0.726	**0.008**
	Race (Asian)	-0.153	0.192	0.858	0.427
	Race (Latinx)	-0.066	0.213	0.937	0.758
	Race (other)	-0.358	0.199	0.699	0.072
	Position (faculty)	-0.480	0.240	0.619	0.046
	Position (university staff)	-0.493	0.258	0.611	0.056
	Position (student)	-0.367	0.274	0.693	0.181
	Region (Midwest US)	-0.001	0.185	0.999	0.996
	Region (NE US)	0.392	0.179	1.479	0.028
	Region (SE US)	0.123	0.194	1.131	0.526
	Region (SW US)	-0.225	0.263	0.798	0.392
	Region (West US)	0.583	0.195	1.791	**0.003**
Department	Cis LGBQ (yes)	-0.020	0.137	0.980	0.885
	Gender (cis woman)	-0.247	0.121	0.781	0.041
	Race (Asian)	-0.181	0.194	0.835	0.351
	Race (Latinx)	-0.167	0.214	0.846	0.435
	Race (other)	-0.450	0.199	0.638	0.024
	Position (faculty)	-0.389	0.244	0.677	0.110
	Position (university staff)	-0.761	0.259	0.467	**0.003**
	Position (student)	-0.691	0.276	0.501	0.012
	Region (Midwest US)	0.199	0.186	1.220	0.285
	Region (NE US)	0.419	0.178	1.521	0.018
	Region (SE US)	0.487	0.197	1.627	0.014
	Region (SW US)	-0.284	0.261	0.753	0.277
	Region (West US)	0.408	0.194	1.503	0.036
Lab	Cis LGBQ (yes)	-0.003	0.170	0.997	0.985
	Gender (cis woman)	-0.174	0.150	0.840	0.245
	Race (Asian)	-0.602	0.218	0.548	**0.006**
	Race (Latinx)	-0.409	0.252	0.664	0.104
	Race (other)	-0.333	0.247	0.717	0.178
	Position (faculty)	0.628	0.283	1.874	0.027
	Position (university staff)	-0.330	0.295	0.719	0.264
	Position (student)	-0.332	0.313	0.718	0.289
	Region (Midwest US)	0.353	0.225	1.424	0.117
	Region (NE US)	0.674	0.219	1.962	**0.002**
	Region (SE US)	0.748	0.245	2.113	**0.002**
	Region (SW US)	0.451	0.324	1.570	0.165
	Region (West US)	0.650	0.240	1.915	**0.007**
Teaching	Cis LGBQ (yes)	-0.266	0.175	0.766	0.128
	Gender (cis woman)	-0.397	0.151	0.673	**0.009**
	Race (Asian)	-0.802	0.243	0.449	**0.001**
	Race (Latinx)	-0.157	0.281	0.855	0.577
	Race (other)	-0.459	0.254	0.632	0.070
	Position (faculty)	1.194	0.556	3.301	0.032
	Position (university staff)	0.622	0.573	1.862	0.278

	Position (student)	0.689	0.585	1.991	0.239
	Region (Midwest US)	0.621	0.240	1.861	**0.010**
	Region (NE US)	0.703	0.226	2.021	**0.002**
	Region (SE US)	0.468	0.237	1.597	0.048
	Region (SW US)	0.547	0.339	1.728	0.107
	Region (West US)	0.804	0.255	2.235	**0.002**
Student	Cis LGBQ (yes)	-0.542	0.319	0.581	0.089
	Gender (cis woman)	-0.581	0.288	0.559	0.044
	Race (Asian)	-0.714	0.411	0.490	0.082
	Race (Latinx)	0.772	0.437	2.164	0.077
	Race (other)	-0.851	0.451	0.427	0.059
	Position (faculty)	-0.081	0.696	0.922	0.907
	Position (university staff)	-0.844	0.694	0.430	0.224
	Position (student)	-0.345	0.665	0.708	0.604
	Region (Midwest US)	0.987	0.437	2.684	0.024
	Region (NE US)	1.447	0.541	4.251	**0.007**
	Region (SE US)	1.241	0.422	3.457	**0.003**
	Region (SW US)	1.526	0.744	4.602	0.040
	Region (West US)	0.798	0.425	2.221	0.060
Campus	TGNC (yes)	-0.839	0.188	0.432	**0.000**
	Race (Asian)	-0.128	0.194	0.880	0.510
	Race (Latinx)	0.078	0.244	1.081	0.748
	Race (other)	-0.127	0.202	0.881	0.531
	Position (faculty)	-0.552	0.270	0.576	0.041
	Position (university staff)	-0.523	0.290	0.593	0.071
	Position (student)	-0.261	0.313	0.770	0.404
	Region (Midwest US)	0.138	0.199	1.148	0.488
	Region (NE US)	0.570	0.189	1.769	**0.003**
	Region (SE US)	0.391	0.226	1.478	0.084
	Region (SW US)	-0.249	0.303	0.780	0.412
	Region (West US)	0.514	0.208	1.672	0.014
Department	TGNC (yes)	-0.576	0.186	0.562	**0.002**
	Race (Asian)	-0.174	0.196	0.841	0.375
	Race (Latinx)	-0.145	0.241	0.865	0.549
	Race (other)	-0.349	0.203	0.705	0.086
	Position (faculty)	-0.451	0.281	0.637	0.109
	Position (university staff)	-0.805	0.299	0.447	**0.007**
	Position (student)	-0.631	0.321	0.532	0.049
	Region (Midwest US)	0.328	0.202	1.388	0.105
	Region (NE US)	0.506	0.188	1.659	**0.007**
	Region (SE US)	0.560	0.227	1.751	0.013
	Region (SW US)	-0.191	0.297	0.827	0.521
	Region (West US)	0.294	0.210	1.342	0.161
Lab	TGNC (yes)	-0.445	0.216	0.641	0.040
	Race (Asian)	-0.719	0.219	0.487	**0.001**
	Race (Latinx)	-0.540	0.281	0.583	0.055
	Race (other)	-0.158	0.255	0.854	0.536
	Position (faculty)	0.592	0.321	1.807	0.065
	Position (university staff)	-0.173	0.340	0.841	0.610

	Position (student)	0.081	0.363	1.084	0.824
	Region (Midwest US)	0.368	0.245	1.444	0.133
	Region (NE US)	0.761	0.232	2.141	**0.001**
	Region (SE US)	0.794	0.289	2.213	**0.006**
	Region (SW US)	-0.047	0.355	0.954	0.894
	Region (West US)	0.436	0.250	1.546	0.081
Teaching	TGNC (yes)	-0.524	0.250	0.592	0.036
	Race (Asian)	-0.717	0.246	0.488	**0.004**
	Race (Latinx)	-0.051	0.324	0.950	0.874
	Race (other)	-0.501	0.248	0.606	0.044
	Position (faculty)	1.089	0.692	2.972	0.115
	Position (university staff)	0.466	0.713	1.593	0.514
	Position (student)	0.743	0.732	2.101	0.310
	Region (Midwest US)	0.494	0.261	1.639	0.058
	Region (NE US)	0.723	0.235	2.061	**0.002**
	Region (SE US)	0.435	0.269	1.544	0.106
	Region (SW US)	0.411	0.385	1.509	0.285
	Region (West US)	0.699	0.271	2.012	**0.010**
Student	TGNC (yes)	-1.283	0.358	0.277	**0.000**
	Race (Asian)	-0.489	0.394	0.613	0.215
	Race (Latinx)	0.462	0.537	1.587	0.390
	Race (other)	-0.601	0.423	0.548	0.156
	Position (faculty)	-0.423	0.917	0.655	0.645
	Position (university staff)	-0.842	0.945	0.431	0.373
	Position (student)	-0.423	0.918	0.655	0.645
	Region (Midwest US)	0.228	0.488	1.256	0.640
	Region (NE US)	0.782	0.434	2.187	0.071
	Region (SE US)	2.158	0.681	8.655	**0.002**
	Region (SW US)	1.103	0.717	3.013	0.124
	Region (West US)	0.345	0.460	1.412	0.454

Results from ordinal regressions for climate across professional and academic contexts. Reference groups are straight, cisgender, white, outside of academia, and outside of the US. Bold text represents statistical significance after Bonferroni corrections.

Table S4.

Outcome	Predictor	beta	SE	p-value
LGBTQ+ climate inclusion	(Intercept)	3.607	0.111	**0.000**
	TGNC (vs cis LGBQ)	-0.211	0.074	**0.005**
	Race (Asian)	0.000	0.146	1.000
	Race (Latinx)	-0.074	0.117	0.527
	Race (other)	-0.303	0.122	**0.014**
	Position (faculty)	0.052	0.112	0.645
	Position (university staff)	0.036	0.116	0.754
	Position (student)	-0.004	0.112	0.969
	Region (Midwest US)	0.046	0.110	0.675
	Region (NE US)	0.043	0.103	0.678
	Region (SE US)	0.005	0.114	0.967
	Region (SW US)	-0.009	0.142	0.948
	Region (West US)	0.062	0.105	0.556
LGBTQ+ climate exclusion	(Intercept)	2.390	0.127	**0.000**
	TGNC (vs cis LGBQ)	0.162	0.085	0.058
	Race (Asian)	0.094	0.168	0.577
	Race (Latinx)	0.087	0.134	0.516
	Race (other)	0.321	0.140	**0.023**
	Position (faculty)	-0.098	0.129	0.448
	Position (university staff)	-0.044	0.132	0.740
	Position (student)	0.107	0.128	0.406
	Region (Midwest US)	0.015	0.126	0.904
	Region (NE US)	-0.025	0.118	0.830
	Region (SE US)	0.009	0.130	0.944
	Region (SW US)	0.095	0.163	0.559
	Region (West US)	-0.016	0.120	0.896

Results from linear regressions for workplace inclusion and exclusion. Reference groups are cisgender LGBQ, white, outside of academia, and outside of the US. Bold text represents statistical significance.

Table S5.

Outcome	Predictor	beta	SE	OR	p-value
Experienced exclusionary behavior at work	(Intercept)	-1.822	0.414	0.162	**0.000**
	TGNC (vs cis LGBQ)	1.319	0.256	3.738	**0.000**
	Race (Asian)	-0.090	0.551	0.914	0.871
	Race (Latinx)	-0.002	0.439	0.998	0.997
	Race (other)	0.679	0.394	1.971	0.085
	Position (faculty)	-0.315	0.423	0.730	0.456
	Position (university staff)	-0.143	0.423	0.867	0.735
	Position (student)	0.072	0.397	1.075	0.856
	Region (Midwest US)	0.338	0.387	1.402	0.382
	Region (NE US)	-0.162	0.384	0.851	0.674
	Region (SE US)	-0.102	0.440	0.903	0.816
	Region (SW US)	0.079	0.514	1.083	0.877
	Region (West US)	-0.148	0.397	0.863	0.710
Witnessed exclusionary behavior at work	(Intercept)	-0.895	0.339	0.409	**0.008**
	TGNC (vs cis LGBQ)	0.301	0.224	1.351	0.178
	Race (Asian)	-0.187	0.487	0.829	0.701
	Race (Latinx)	0.147	0.352	1.158	0.676
	Race (other)	0.430	0.364	1.537	0.238
	Position (faculty)	-0.323	0.345	0.724	0.349
	Position (university staff)	-0.079	0.349	0.924	0.822
	Position (student)	0.350	0.332	1.418	0.293
	Region (Midwest US)	0.558	0.326	1.748	0.087
	Region (NE US)	0.214	0.318	1.239	0.501
	Region (SE US)	0.670	0.337	1.954	**0.047**
	Region (SW US)	0.370	0.423	1.448	0.382
	Region (West US)	-0.203	0.332	0.816	0.540
Experienced exclusionary behavior outside of work	(Intercept)	-0.487	0.214	0.614	**0.023**
	TGNC (vs cis LGBQ)	0.973	0.217	2.646	**0.000**
	Race (Asian)	-0.220	0.448	0.803	0.624
	Race (Latinx)	-0.171	0.349	0.843	0.624
	Race (other)	-0.132	0.366	0.877	0.720
	Region (Midwest US)	-0.079	0.318	0.924	0.803
	Region (NE US)	-0.342	0.307	0.710	0.265
	Region (SE US)	0.165	0.331	1.180	0.617
	Region (SW US)	0.085	0.422	1.088	0.841
	Region (West US)	-0.061	0.305	0.941	0.842

Results from logistic regressions for exclusionary behavior. Reference groups are cisgender LGBQ, white, outside of academia, and outside of the US. Bold text represents statistical significance.

Table S6.

Predictor	beta	SE	p-value
(Intercept)	3.587	0.197	**0.000**
TGNC (vs cis LGBQ)	-0.879	0.132	**0.000**
Race (Asian)	0.313	0.261	0.230
Race (Latinx)	-0.401	0.209	0.055
Race (other)	-0.379	0.218	0.083
Position (faculty)	0.324	0.200	0.106
Position (university staff)	0.183	0.206	0.374
Position (student)	0.174	0.200	0.383
Region (Midwest US)	-0.192	0.196	0.328
Region (NE US)	-0.295	0.183	0.108
Region (SE US)	-0.207	0.203	0.309
Region (SW US)	-0.232	0.253	0.360
Region (West US)	-0.345	0.186	0.064

Results from linear regressions for perceived discrimination. Reference groups are cisgender LGBQ, white, outside of academia, and outside of the US. Bold text represents statistical significance.

Table S7.

Theme	Description	% (n)	Example quote - professional society	Example quote - workplace
Communicate institutional support	Participant describes that their workplace or society could speak out in support of LGBTQ+ individuals (including by honoring their scientific achievements), spread awareness, address LGBTQ+ issues head-on, use inclusive and careful language, and avoid an apolitical stance.	23.4 (126)	Participant 1444: Speak out in favor of LGBTQ+ people. Give a platform to LGBTQ+ members.	Participant 609: Take a stance against the state policies. Stop being quiet about these laws affecting healthcare for LGBTQ individuals and women. Their silence is being read as support.
Social support/ Mentoring	Participant describes that their workplace or society could increase social support and mentoring for LGBTQ+ individuals by having meet-up groups, affinity groups, and programming specifically for LGBTQ+ people.	16.4 (88)	Participant 1321: Organize queer events (meet-ups, happy hours, symposia) at conferences and encourage attendance by all.	Participant 1251: The thing I would most appreciate is access to identity-specific mentorship-professional guidance from more senior LGBTQ+ researchers about how to navigate life as an out scientist.
Increase visibility/ representation	Participant describes that their workplace or society could increase LGBTQ+ visibility and representation through pride flags, celebrating pride, and having LGBTQ+ individuals in leadership positions.	15.8 (85)	Participant 1567: I think promoting and celebrating LGBTQI+ visibility. I feel a real problem is simply a lack of role models because by and large LGBTQI+ people are not publicly visible.	Participant 621: Provide more visibility of LGBTQ+ research community.

Programming	Participant describes that their workplace or society could support and train others on how to be inclusive to LGBTQ+ individuals through programming, sensitivity training, and talks by LGBTQ+ individuals.	13.9 (75)	Participant 2016: Conferences could host workshop and conversations about how to be more inclusive in our research labs, teaching roles (especially with language!), and departmental service positions.	Participant 1321: Implement trainings about bias, gender identity, workplace conduct, and historical bias and exclusion of queer people in science.
Trans/nonbinary awareness	Participant describes that their workplace or society could pay attention to issues affecting transgender and genderqueer individuals, including making gender-neutral bathrooms available and ensuring the correct pronouns and names are used.	13.4 (72)	Participant 1650: Better use of pronouns and preferred names, gender inclusive restrooms at conference, gender and surname options for forms / records.	Participant 1639: I wish that pronouns were more respected. No one really seems to care and I'm constantly misgendered.
Institutional action	Participant describes that their workplace or society could take institutional action to change the cisheteronormative policies including family leave, hiring processes, insurance coverage, spousal hires, and pay equity.	7.2 (39)	Participant 1843: Inclusive award nomination processes. I can not apply for LGBTQ specific awards because that will put a target on my head. To get tenure at an R1, I need to demonstrate the that my work has an impact and awards are one potential mechanism but I don't have a strong advocate at my university who will do so. What does the award nomination and selection process	Participant 1401: Provide expansive health care benefits for LGBTQ+ employees that are well documented and easily accessible. Provide explicit leave for LGBTQ+ people when undergoing healthcare procedures. Provide financial support for fertility services, adoption, and other family-related expenses.

			look like? Can you self nominate? Is the selection process sensitive to differential resources or challenges?	
Accountability for individuals	Participant describes that their workplace or society could curb discrimination and homophobia by improving reporting mechanisms and having consequences for harassment.	5.6 (30)	Participant 1590: Zero tolerance policies. I'm tired of people with harmful views being allowed to continue working or not receive serious repercussions for their words or actions. It makes me feel not seen and invalidates my experiences.	Participant 1212: Sanctions need to be applied when individuals misbehave due to someone's identity/orientation. There have been reports of homophobia/transphobia from faculty members in my department, that were never acknowledged or acted upon. LGBTQIA+ people keep relying on a whisper network to help guide students towards accepting mentors, which may not be available for newly out/questioning individuals.

Financial support	Participant describes that their workplace or society could provide financial support for LGBTQ+ individuals via grants, donations, funding, fellowships, or scholarships.	5.4 (29)	Participant 618: LGBTQ+ students need funding and resources to find success in their respective societies. We need funding to attend events and meetings. We need the societies to incentivize participation in society events with travel support and scholarships.	Participant 1314: Offer grants, fellowships and funding schemes that acknowledge the barriers in sustaining an academic career as a LGBTQI+ individual, and work towards retaining them within the workplace.
Consider regional politics	Participant describes that their workplace or society could avoid hosting events in places with anti-LGBTQ+ legislation or could consider local politics when making the decision of where to hold events.	3.9 (21)	Participant 1225: Consider the locations of annual meetings/conferences and the impact of state and local policies on LGBTQIA+ attendees and their ability to attend a feel safe.	*n/a*
Intersectional DEI measures	Participant describes that their workplace or society could engage in diversity, equity, and inclusion initiatives broadly (not LGBTQ-specific).	3.9 (21)	Participant 1299: Continue to put all EDI [equity, diversity, and inclusion] issues in the forefront, be vocal about allyship and support.	Participant 407: Put more effort towards diversity and inclusion rather than leaving it up to a committee which faces lots of restrictions, and make sure that LGBTQ+ people are a part of the conversation on how this happens.

Collect data	Participant describes that the NSF or other institutions (including their workplace or society) could collect data about LGBTQ+ identities.	1.9 (10)	Participant 1251: I think it is critical to continue to do these types of surveys, and to collect overall demographic information about LGBTQ+ scientists in these societies. We are so often overlooked in surveys and censuses, and this makes it very difficult to quantify the challenges we face and to design strategies to address them.	Participant 1306: Collect data and work to understand how LGBTQ faculty, staff, and students are doing in programs and work.
Diversity	Participant describes that their society or workplace could have more diversity, including hiring a more diverse group.	1.1 (6)	Participant 586: Have more diverse representation.	Participant 1374: Have quite a diversity of hires so we don't feel we were simply hired to improve federal workplace statistics. I'm a human being with real and complex experiences…. not just another number.
Confidentiality	Participant describes that their society or workplace could take care to ensure confidentiality when handling personal data, communicate why it is being collected, and not disclose the LGBTQ+ identities of members to others.	0.7 (4)	Participant 312: [My professional society] revealed people's LGBTQ identity on [a] form to all other authors, which inadvertently outed people. More attention needs to be placed on the confidentiality of this identity.	Participant 1281: Don't spread that information [individuals' LGBTQ+ identity] to others, it is the individual's business to share, no one else's.

Nothing	Participant describes that there is nothing that their workplace or society could do to be more inclusive, either because it is already inclusive or because it lacks the power/authority to do so.	13.4 (72)	Participant 1791: They are doing well. There is a diversity committee with an LGBTQIAA section that is quite active and lots of working groups.	Participant 200: I don't think my workplace, in this very red state, can do much since people are entitled to their opinions.
Participant is unsure	Participant describes that they do not know what their workplace or society could do to be more inclusive of LGBTQ+ individuals.	1.9 (10)	Participant 2015: I'm honestly not sure. It's a scary time everywhere and I don't know what would help right now.	Participant 1278: I am unsure.

Full description, frequencies, and example quotes for each of the themes from suggestions to make workplaces and professional societies more inclusive of LGBTQ+ biologists.

Data S1. (separate file)
De-identified dataset for analyses of all participants.

Data S2. (separate file)
De-identified dataset for analyses of LGBTQ+ participants.