

Graduate Internship/Externship Experiences in NIBIB Funded Graduate Training Programs

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The mission of Dr. Markey's Biomedical Informatics Lab is to develop decision support systems for clinical decision making and scientific discovery. For example, Prof. Markey leads a collaborative, multi-institutional team that is designing a decision support system to help breast cancer survivors understand their likely appearance changes following breast reconstruction and, therefore, enable them to choose a reconstruction strategy that will lead to maximal psychosocial adjustment.

Dr. Markey has been recognized for excellence in research and teaching with awards from organizations such as the American Medical Informatics Association, the American Society for Engineering Education, the American Cancer Society, and the Society for Women's Health Research. She is a Senior Member of both the IEEE and the SPIE. Dr. Markey is the editor of *Physics of Mammographic Imaging* (Taylor and Francis, 2012). This new text gives an overview on the current role and future potential of new alternatives to mammography in the context of clinical need, complementary approaches, and ongoing research.

Graduate Training Program in Imaging Sciences: The Role of Academic Externships

Abstract

Experiential learning opportunities such as internships and externships are an important part of graduate education for many engineering students. Short-term off-campus training experiences can help students see the 'real-world' impact of engineering research and broaden their understanding of their career opportunities. Arguably, internship and externship experiences are particularly valuable for students in interdisciplinary majors, such as biomedical engineering, which cross more traditional fields and career paths. Thus, interdisciplinary graduate training programs, such as those funded by the National Institute of Biomedical Imaging and Bioengineering (NIBIB), sometimes include an internship or externship component as a way to ensure breadth in the educational program. The purpose of this study is to review the graduate summer internship/externship practices of NIBIB funded graduate training programs (i.e., T32 mechanism). Our review is based on a survey of the principal investigators (program directors) of graduate training programs (T32 sites) currently funded by NIBIB. By comparing internship/externship practices across training programs, we hope to enable training program directors to reduce redundancy in developing policies and procedures for internships/externships, improve this experience for graduate trainees, and provide a baseline for internal continuous improvement purposes. For example, the survey results show that most programs have settled on a similar duration for the off-campus training experience (about 6 to 9 weeks), but there is more variation as to when during the trainee's education they participate in the internship/externship (summer after 1st year, 2nd year, etc.). Other factors reviewed include: (a) overall goals for the internship/externship; (b) type of internship/externship host institution (e.g., company, government lab, academic medical center); (c) source of housing and travel financial support for the internship/externship; (d) policies for ownership of intellectual property generated during the internship/externship; and (e) assessment methods used to evaluate the effectiveness of the internship/externship.

Introduction

The investigators lead a biomedical engineering graduate training program in Imaging Science and Informatics, funded by a training grant (T32) from the National Institute of Biomedical Imaging and Bioengineering (NIBIB). This predoctoral program trains comprehensive imaging scientists through coursework and professional development activities in the skills necessary to identify clinically relevant problems to improve the prevention, detection, diagnosis, and treatment of human diseases.

The program requires a summer externship experience to expose trainees to an interdisciplinary research and/or clinical environment outside of their on-campus graduate research and coursework. The off-campus experience adds an important interdisciplinary aspect to their training in clinically translatable research¹. Although little systematic study has been done on the learning outcomes of off-campus experiences for graduate students², undergraduate internships and cooperative experiences have been shown to provide valuable engineering

problem-solving skills³. The additional potential for trainees to develop leadership and collaborative research skills⁴ in an off-campus experience is critical for graduate training programs such as those funded through the T32 mechanism.

Since our program’s beginning in 2009, several procedural challenges have emerged during the externship experiences. Housing needs and doctoral supervisor cooperation are the most common issues encountered in our program. In addition to making adjustments in our externship structure to address these issues, we sought to compare internship/externship practices across similar programs other institutions to identify common best practices and areas for future improvement.

Methods

To study the externship practices of similar training programs at other universities, an adaptive questionnaire was created to collect information (see Figure 1 and Appendix A). The electronic survey was constructed with a web-based survey tool and distributed through email to principal investigators (PIs) of 44 training programs currently funded in the 2013 fiscal year by NIBIB under the T32 mechanism. Based on the public abstracts of the training grants, the 44 grants include 33 predoctoral programs, 4 combined pre- and postdoctoral programs, and 7 postdoctoral programs.

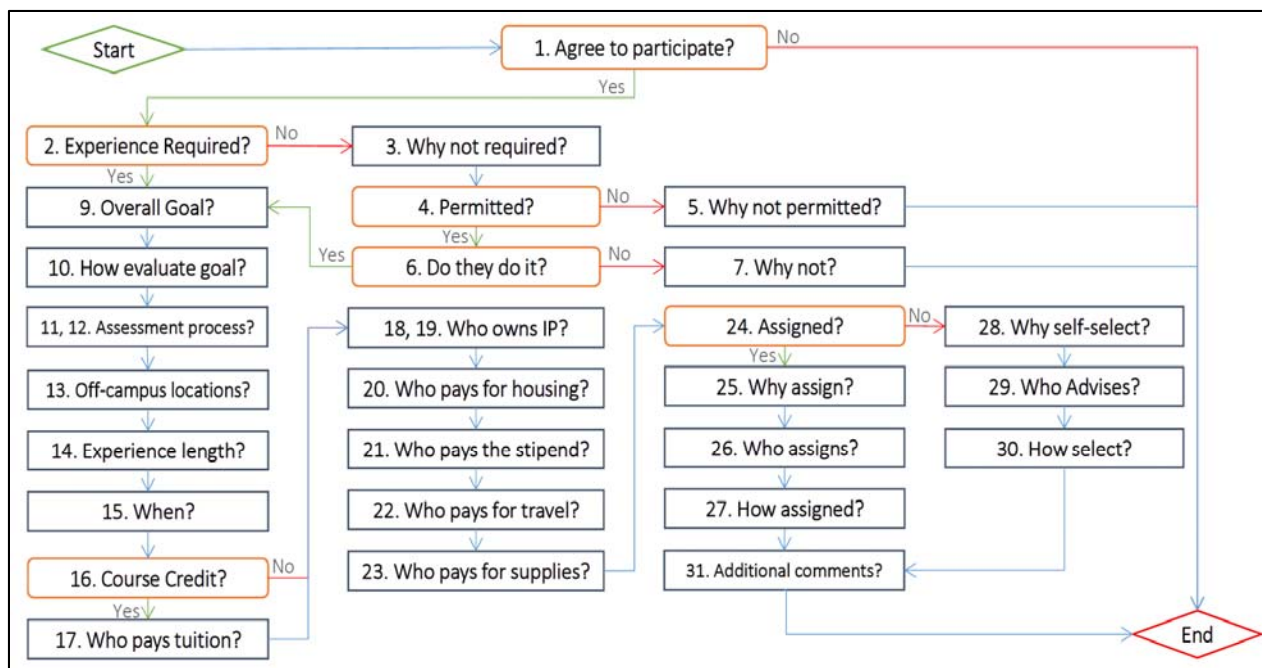


Figure 1. Electronic Questionnaire Sequence.

Our own training site is not included in the survey results; rather, we discuss our experiences in light of the survey data in the discussion section. Survey responses were anonymous in the sense that they were not connected to the participants' email addresses. Participants were asked to complete the electronic questionnaire regarding the structure and common practices of any internship/externship activities in their graduate training programs. The questionnaire asked the PIs if their T32 training grant programs included an off-campus experience, and if so how they address specific procedural issues. These issues include: (a) overall goals for the internship/externship; (b) type of internship/externship host institution (e.g., company, government lab, academic medical center); (c) duration of the internship/externship; (d) source of housing and travel financial support for the internship/externship; (e) policies for ownership of intellectual property generated during the internship/externship; and (f) assessment methods used to evaluate the effectiveness of the internship/externship.

Results

An email requesting participation in this study was sent to 44 principal investigators listed as the point of contact for training programs funded by the NIBIB under the T32 mechanism in fiscal year 2013. A total of 16 people responded to the survey, though 1 declined to participate in the study. Of the 28 who did not respond to the survey, 11% (3/28) verified by email that their T32 funded programs did not include a predoctoral component. Based on the grant abstracts publicly available via NIH RePORTER, we believe that an additional 14% (4/28) did not respond because their programs likewise did not include a predoctoral component. Hence, out of the 37 programs that include a predoctoral component, 41% (15/37) completed the survey.

The majority of programs surveyed do not require an off-campus training experience, i.e., only 20% (3/15) require an internship/externship. Participants cited a variety of reasons why their programs do not require such an experience with emphasis on concerns about an off-campus experience inhibiting students from meeting the existing degree requirements, including both required coursework and dissertation research.

On the other hand, the programs that do not require an off-campus training experience permit trainees to engage in one if they want to do so (12/12 = 100%). Moreover, some students do take advantage of the opportunity to participate in internships/externships despite the fact that these are not required program elements. Specifically, students in 33% (4/12) programs that permit, but do not require, internships/externships choose to take part in them. The reported reasons why students do not choose to participate in optional off-campus training experiences mirror those given for why such experiences are not required elements. Namely, students are concerned about the potential for interference with their dissertation research and they do not foresee the benefits as outweighing the costs in that regard.

Several goals for the off-campus training experience were expressed (N = 7). One motivation was to increase the breadth of the research training. Another expected benefit was 'real-world' experience in settings that are more applied/industrial in nature than the home institution. In addition, the externship/internship was believed to afford new networking opportunities for the trainees.

Based on the responses to the survey questions regarding evaluation procedures (N = 7), current assessments of externship/internship experiences are relatively informal (see Figure 2). One common strategy is to interview the trainee, the trainee’s advisor, and/or the externship/internship supervisor. Another typical approach is to evaluate the experience based on the student’s research deliverables (e.g., paper, presentation).

11. If an assessment is made to determine if the overall goal has been met, what type of assessment is used? Please check all that apply.

Answer	Response	%
Surveys	1	14%
Focus groups	0	0%
Interviews	6	86%
Research deliverable (e.g. paper, presentation, etc.)	3	43%
Other	1	14%

Other
discussion with intern

Figure 2. Question #11 results on assessment methods.

Trainees can have valuable externship/internship experiences in several different settings. For the programs surveyed, 71% (5/7) placed students in government facilities; 57% (4/7) in industry; 29% (2/7) at other universities; and 14% (1/7) in hospitals.

The survey responses indicate that the typical length of the off-campus training experience is approximately 6-9 weeks (5/7 = 71%) (see Figure 3). The length of the experience may be based in part on the fact that it is most commonly scheduled for a summer term (11/14 = 78%). On the other hand, this study found variation as to during which summer term the externship/internship takes place. Survey respondents endorsed the summers after years 1, 2, 3, and 4 of graduate training, with the most typical times being summer after the first year, second year, and third year of study (see Figure 4).

14. What is the typical length of a trainee's off-campus training experience?

Answer	Response	%
< 1 week	2	29%
1 - 3 weeks	0	0%
3 - 6 weeks	0	0%
6 - 9 weeks	5	71%
more than 9 weeks	0	0%
Total	7	100%

Figure 3. Question #14 results on experience length.

15. In which year of fellowship support does the trainee go to their off-campus training experience? If more than one option is available to trainees, please select all that apply.

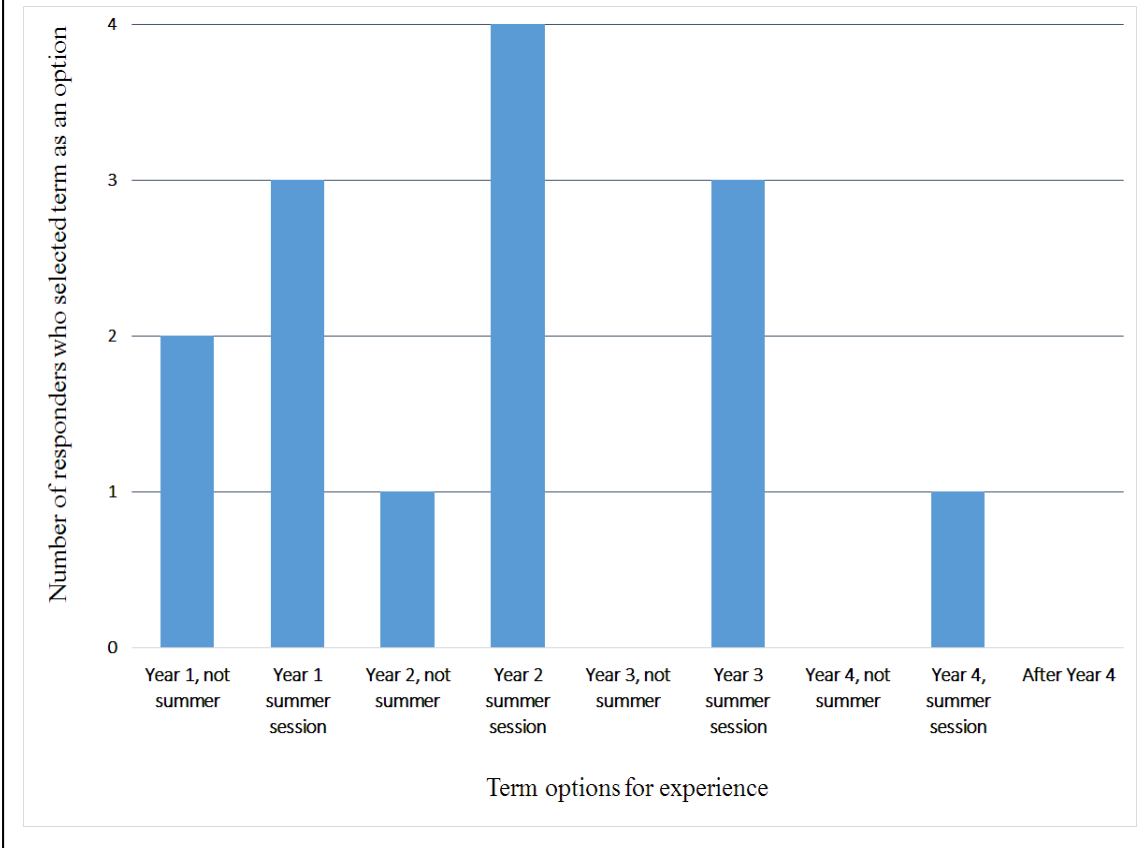


Figure 4. Question #15 results on timing of experience.

Programs can be structured such that course credit is awarded for the off-campus training experience (3/7 = 43%) or such that the externship/internship doesn't yield course credit (4/7 = 57%). Moreover, in the case that course credit is earned, there isn't a uniform approach to paying the associated tuition. The survey responses indicate that tuition is paid by the T32 grant, the student's department, and/or the externship/internship host site.

The training programs reported high variation in ownership of intellectual property associated with work performed by a student during an off-campus training experience (see Figure 5). While the host institution for the externship/internship typically claims some ownership, in some cases it is shared with the trainee and/or the university. Associated comments emphasized that the situation depends on the particulars for each student and his/her externship/internship arrangement and that IP ownership policies appear to be unclear or underdeveloped.

18. If intellectual property (IP) is generated during the off-campus training experience, who owns the IP?

Answer	Response	%
Student owns 100% of IP	0	0%
Your university owns 100% of IP	0	0%
Host institution owns 100% of IP	1	25%
IP is jointly owned between student and your university	0	0%
IP is jointly owned between student and host institution	1	25%
IP is jointly owned between your university and host institution	0	0%
IP is jointly owned between your university, host institution, and student	2	50%
Total	4	100%

Figure 5. Question #18 results on intellectual property ownership.

Costs associated with an off-campus training experience include the trainee’s stipend, housing, travel to host site, and research supplies. Usually the host institution (4/7 = 57%) and/or the T32 grant (4/7 = 57%) provide the trainee’s stipend (see Figure 6). Unless the externship/internship is in close proximity to the trainee’s residence, there are additional expenses related to housing and travel to the host site. While there is variation in addressing the housing cost (see Figure 7), typically the burden is borne at least in part by the trainees. Similarly, trainees must often assume at least some of the costs for traveling to the host site (see Figure 8). On the other hand, research supply expenses are more typically the responsibility of the host site (see Figure 9).

21. Who pays for the trainees' stipend while off-campus? Please check all that apply.

Answer	Response	%
Trainee	0	0%
Trainee's primary advisor(s)	0	0%
Host institution	4	57%
Graduate program	0	0%
T32 grant	4	57%
Other:	1	14%

Figure 6. Question #21 results for stipend source during experience.

Most commonly, programs do not assign an off-campus training experience, but rather allow trainees to self-select (5/7 = 71%). Associated comments on the survey explain that self-selection is used because of the breadth of potential host arrangements and the individualized nature off-campus training experience. Survey respondents reported a range of approaches to helping the trainee select an externship/internship experience, including guidance from their research advisor, a mentor at the host site, the program director, and/or previous trainees.

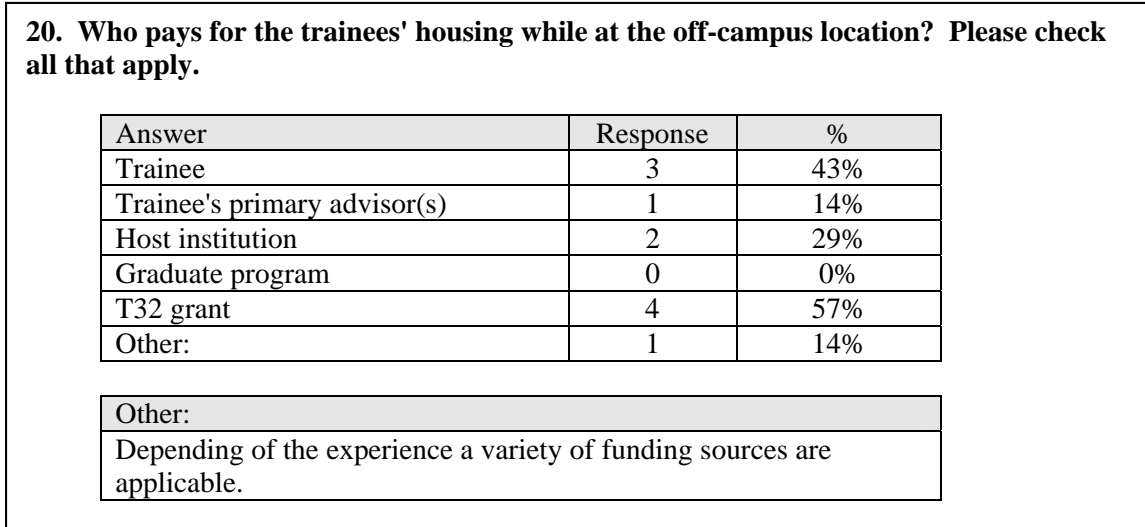


Figure 7. Question #20 results on housing costs.

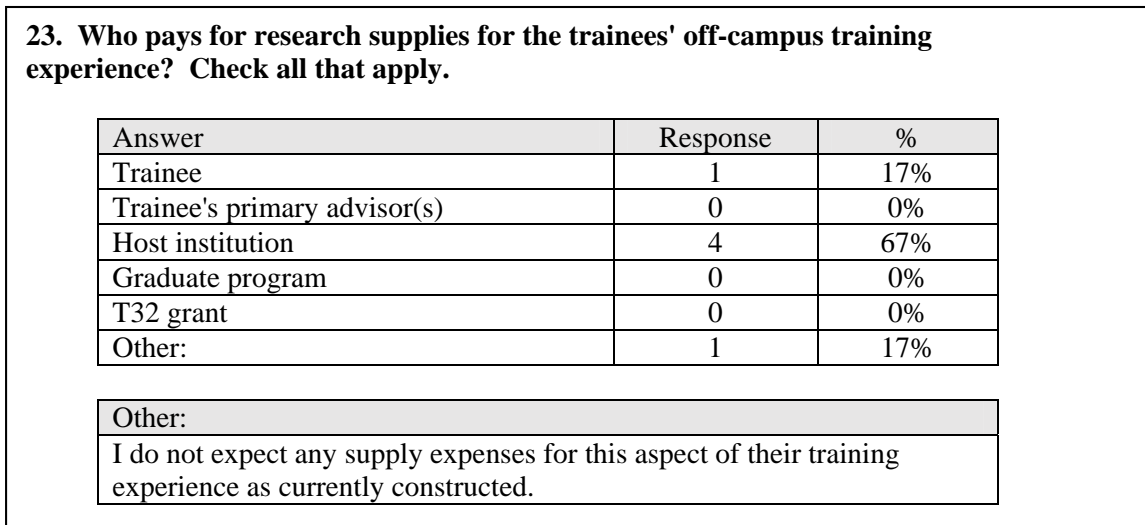


Figure 8. Question #22 results on trainee travel costs.

22. Who pays for the trainees' travel to and from the off-campus location? Check all that apply.

Answer	Response	%
Trainee	3	43%
Trainee's primary advisor(s)	1	14%
Host institution	4	57%
Graduate program	0	0%
T32 grant	3	43%
Other:	1	14%

Other:
As above, the exact source of funding will vary with the training experience and host.

Figure 9. Question #23 results on trainee supplies costs during an off campus experience.

Discussion

Out of the 37 programs that include a predoctoral component, 41% completed the survey, which is within the range of response rates often considered useful for organizational survey methods [5]. 47% of respondents who completed the survey either required an off-campus training experience (N=3) or indicated that their trainees elected to participate in an optional off-campus experience (N=4). However this group of respondents (total N=7) is only 18% of programs with a predoctoral component, and therefore the investigators have recently reminded non-responders of the opportunity to participate in order to obtain as complete of a sample as possible.

There can be substantial logistical challenges to incorporating an externship/internship component into a graduate training program in biomedical engineering or a related field. While there are also numerous potential benefits, it is not clear that they necessarily outweigh the costs. Hence, the majority of graduate training programs funded by the NIBIB under the T32 mechanism do not require an externship/internship. However, the potential for broader experiences and connections in a more applied setting is appealing enough that programs that do not require an off-campus training experience usually permit students to participate if they want to do so and some students do choose to exercise this option. The authors' experience was that making the externship a required component was necessary for its success at our institution, at least when our program was first initiated. However, it is possible that the track record of prior trainees would permit future students and their advisors to make informed decisions about the tradeoff of benefits and costs to the off-campus training even if it were not required.

The majority of programs surveyed employed relatively informal evaluation procedures for the externship/internship experience. Most programs relied upon some form of an interview.

This is consistent with the authors' experience that it is difficult to obtain resources necessary for evaluation and also that it is challenging to assess programs with a modest cohort size. One technique that we find useful that was not discussed by the survey respondents was focus groups. We routinely have a facilitator from outside our program conduct a focus group with our trainees.

In addition to formative evaluation of the internship/externship experiences described in the preceding paragraph, ultimately one would like to have a summative evaluation. In particular, it would be beneficial to have data regarding how the internship/externship experience impacted trainees' postgraduate placements. While this survey did not probe this point, we expect that most programs do not have such information given that they typically reported using rather informal evaluation procedures as described above. In the case of our own program, we do not have data yet on postgraduate placement since we don't yet have graduates (the training grant began in 2009).

Many of the programs surveyed reported that they, and their trainees, are particularly interested in internships in an industry setting to help students gain more 'real-world' experience. This is consistent with the authors' training program as well. The authors' hypothesize that this could be one reason why it is more common to participate in an off-campus training experience after the second year of study rather than at the end of the first year -- it can be more practical to arrange an industry internship when the student is not being paid under the T32 grant and can instead be paid by the industry host site.

There is considerable variation and uncertainty about policy with respect to intellectual property generated as part of an off-campus training experience. This is consistent with the authors' experience. In addition, we note that our trainees to date have demonstrated a high rate of interest in intellectual property and other issues related to entrepreneurship. Hence, we have tried to address this challenge by creating opportunities for students to learn about practical, legal, and ethical issues of intellectual property management.

In conclusion, this analysis suggests that successful incorporation of off-campus training into a graduate level program in biomedical engineering or a related field must be flexible enough to individually address the diverse needs of the trainees. However, some aspects are consistent across programs and it may be helpful for program directors considering adding this element to be aware of them. For example, many programs allow an externship/internship, but do not require it. Also, the externship/internship is typically for 6 to 9 weeks during a summer session, often after the second year of study. In addition, we note that there is also some consistency to the challenges faced. For example, most programs take a relatively informal approach to evaluation, which may make it more difficult to identify and address problems if they arise and to determine the longer-term impact of the internship/externship experience, such as on postgraduate placement. Likewise, there appears to be considerable variation and uncertainty about intellectual property policies that could impact students in off-campus training experiences.

To help the reader derive practical benefit from this paper, we close with a list of what we feel are the key "lessons learned" for implementing a successful internship/externship program:

1. The duration of the internship/externship should be about 8 weeks.
2. A good time for the internship/externship experience is during the summer of the second year.
3. To be successful, the graduate student's supervisor must be engaged in planning the internship/externship experience.
4. All parties must have a clear understanding of the deliverables of the internship/externship experience.
5. Housing and travel expenses must be arranged months in advance and include contributions from the parent and host institutions to carefully comply with training grant travel cost policies.
6. Interviews with students and host faculty are the best tools for assessing individualized program outcomes for each trainee.
7. Clear understanding of the relevant intellectual property policies for each internship/externship experience is important and any conflicts between the policies of the parent and host institution must be resolved early.

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Appendix A

Survey Questions

1. You are invited to participate in a research study, entitled “Graduate Internship/Externship Experiences in NIBIB Funded Graduate Training Programs.” The study is being conducted by [redacted]. The purpose of this research study is to examine the graduate summer internship/externship practices of T32 NIBIB funded graduate training programs. Your participation in the study will contribute to a better understanding of an internship/externship experience overall goals, the type of host institution, the duration, the sources of financial support for student housing and travel, policies for intellectual property ownership, and assessment methods used to evaluate the effectiveness of the training experience.

Your participation in this study is voluntary. You may decline to answer any question and you have the right to withdraw from participation at any time. Withdrawal will not affect your relationship with [redacted] in any way. If you do not want to participate either simply stop participating or close the browser window.

If you have any questions about the study or need to update your email address contact [redacted]. This study has been processed by the [redacted] and the study number is IRB [redacted].

- # Answer
- 1 Agree to Participate
 - 2 Withdraw from Participation

2. Are your trainees required to participate in an off-campus training experience (e.g. internship or externship)?

- # Answer
- 1 Yes
 - 2 No

3. Why do you not require an off-campus training experience?

Text Response

4. If a trainee wanted an off-campus training experience, are they permitted to do so?

- # Answer
- 1 Yes
 - 2 No

5. Why is an optional off-campus training experience not permitted?

Text Response

6. Do the trainees choose to participate in an off-campus training experience when given the option?

- # Answer
- 1 No

2 Yes

7. Why do the trainees choose to not participate in an optional off-campus training experience?

Text Response

[8. Unused number due to question flow logic.]

9. What is the overall goal of the off-campus training experience?

Text Response

10. How do you evaluate whether or not the overall goal has been met?

Text Response

11. If an assessment is made to determine if the overall goal has been met, what type of assessment is used? Please check all that apply.

- | # | Answer |
|---|---|
| 1 | Surveys |
| 2 | Focus groups |
| 3 | Interviews |
| 4 | Research deliverable (e.g. paper, presentation, etc.) |
| 5 | Other |

12. If you have any further comments on the off-campus training experience assessment process, please let us know.

Text Response

13. What type of institutions host your trainees' off-campus training experiences? Please check all that apply.

- | # | Answer |
|---|---------------------|
| 1 | Government facility |
| 2 | University |
| 3 | Hospital |
| 4 | Industrial facility |

14. What is the typical length of a trainee's off-campus training experience?

- | # | Answer |
|---|-------------------|
| 1 | < 1 week |
| 2 | 1 - 3 weeks |
| 4 | 3 - 6 weeks |
| 5 | 6 - 9 weeks |
| 6 | more than 9 weeks |

15. In which year of fellowship support does the trainee go to their off-campus training experience? If more than one option is available to trainees, please select all that apply.

- | # | Answer |
|---|--------------------|
| 1 | Year 1, not summer |

- 2 Year 1 summer session
- 3 Year 2, not summer
- 4 Year 2 summer session
- 5 Year 3, not summer
- 6 Year 3 summer session
- 7 Year 4, not summer
- 8 Year 4, summer session
- 9 After Year 4

16. Is course credit given for the off-campus training experience?

Answer

- 1 Yes
- 2 No

17. Who pays the tuition for any credit(s) received for the off-campus training experience?

Text Response

18. If intellectual property (IP) is generated during the off-campus training experience, who owns the IP?

Answer

- 1 Student owns 100% of IP
- 2 Your university owns 100% of IP
- 3 Host institution owns 100% of IP
- 4 IP is jointly owned between student and your university
- 5 IP is jointly owned between student and host institution
- 6 IP is jointly owned between your university and host institution
- 7 IP is jointly owned between your university, host institution, and student

19. Please provide further comments on IP ownership related to the off-campus training experience, if appropriate:

Text Response

20. Who pays for the trainees' housing while at the off-campus location? Please check all that apply.

Answer

- 1 Trainee
- 2 Trainee's primary advisor(s)
- 3 Host institution
- 4 Graduate program
- 5 T32 grant
- 6 Other:

21. Who pays for the trainees' stipend while off-campus? Please check all that apply.

Answer

- 1 Trainee
- 2 Trainee's primary advisor(s)

- 3 Host institution
- 4 Graduate program
- 5 T32 grant
- 6 Other:

22. Who pays for the trainees' travel to and from the off-campus location? Check all that apply.

- # Answer
- 1 Trainee
- 2 Trainee's primary advisor(s)
- 3 Host institution
- 4 Graduate program
- 5 T32 grant
- 6 Other:

23. Who pays for research supplies for the trainees' off-campus training experience? Check all that apply.

- # Answer
- 1 Trainee
- 2 Trainee's primary advisor(s)
- 3 Host institution
- 4 Graduate program
- 5 T32 grant
- 6 Other:

24. Are trainees assigned an off-campus training experience, or do they self-select their experience?

- # Answer
- 1 Assigned
- 2 Self-selected

25. Why did the program director(s) choose to assign off-campus training experiences for trainees, rather than the trainees self-selecting one?

Text Response

26. Who assigns the student's off-campus training experience?

- # Answer
- 1 Trainee's primary advisor(s)
- 2 T32 program director(s)
- 3 Graduate program director(s)
- 4 Other

27. How is their off-campus training experience assigned?

Text Response

28. Why did the program director(s) choose to have trainees self-select their off-campus training experience, rather than being assigned one?

Text Response

29. Who advises the trainees as they select their off-campus training experience?

Text Response

30. How does the trainee self-select their off-campus training experience?

Text Response

31. Please provide any additional feedback about how off-campus training experiences are used in your program.

Text Response