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REVIEW ARTICLE

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The graduate school guide: How to prepare for the qualifying exam and assemble a thesis/graduate committee

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Abstract

Qualifying exams and thesis committees are crucial components of a PhD candidate's journey. However, many candidates have trouble navigating these milestones and knowing what to expect. This article provides advice on meeting the requirements of the qualifying exam, understanding its format and components, choosing effective preparation strategies, retaking the qualifying exam, if necessary, and selecting a thesis committee, all while maintaining one's mental health. This comprehensive guide addresses components of the graduate school process that are often neglected.

KEYWORDS
dissertation, graduate school, mental health, qualifying exam, STEMM

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1 | INTRODUCTION

As a guide for students in PhD graduate programs, espcially those in the sciences, this article discusses everything from preparing for the qualifying exam to thesis writing and evaluation. A qualifying exam, which may also be called a comprehensive exam or a preliminary exam depending on the specific graduate program, is an important step for PhD students in which they prove they are ready to conduct independent research (Figure 1). In some cases, comprehensive or preliminary exams may be separate, so herein we focus on the "traditional" qualifying exam which includes a written proposal and oral defense. The exam requires students to develop a research proposal to seek approval and feedback from the principal investigator (PI) and committee members before proceeding with the proposed research. The format of the qualifying exam can vary greatly between institutions, and there is little research on what constitutes an effective format (McLaughlin et al., 2023). Here, we seek to provide a generalized overview of the most common format and techniques to succeed in it. This oral "defense" can follow several formats including questions and answers, a "chalk" talk, a PowerPoint presentation, or some combination of these. Moreover, once a student passes their qualifying exam, typically they must then form a thesis or dissertation committee to support them throughout their time in graduate school, or this committee may be chosen before the exam and act as a support network. In either case, many students are unfamiliar with and overwhelmed by selecting a thesis committee or preparing for the committee members' questions. In this detailed guide, we offer advice on meeting the requirements of the qualifying exam, what to expect in the exam, how to advantageously prepare for it, and how to pick the thesis committee members for preparing for eventual thesis defense.

FIGURE 1 Illustration showing PhD student posing for a picture at the end of their journey. In back of her, within her shadow are some of the people that helped her get to her PhD, such as mentors in their thesis/graduate committee.

2 | GETTING TO THE QUALIFYING EXAM

Guides for interviewing to get into a PhD graduate program have previously been written (Ransey et al., 2023), but once they've starting on their journey, these PhD students may find graduate school classes unexpectedly difficult compared with their undergraduate classes. While many undergraduate classes require rote memorization, graduate classes tend to be more discussion and presentation based. As they continue with their graduate classes, students should not feel discouraged by their undergraduate grades or Graduate Record Exam (GRE) scores. GRE scores have no predictive power as to whether a student will pass their qualifying exam (Moneta-Koehler et al., 2017). However, achieving a certain level of success in graduate school can help prepare a student to pass their qualifying exam. Certain strategies, such as metacognition, a growth mindset, and spaced repetition, can help students succeed in the classes leading up to the qualifying exam. Metacognition is an active awareness of one's thinking, learning strategies, and problem-solving approaches that can be applied to optimize studying techniques (Veenman et al., 2006). For example, an individual may set clear and attainable goals, actively monitor their understanding of the material, and practice

self-questioning and regulation to actively maximize learning. A growth mindset is a belief that ability and intelligence can be achieved through effort (Kricorian et al., 2020; Limeri et al., 2020). Spaced repetition is an established technique that involves spacing topics to support memorization, and this technique may be supported by technologies such as adaptive machine learning programs to optimize learning retention (Tabibian et al., 2019). Thus, building these and other necessary skills early in a student's education is important in forming sustainable techniques for the rest of the PhD portion.

3 | WHAT IS THE QUALIFYING EXAM?

Once a student passes their general classes, usually in the first or second year of the PhD program, they need to prepare for their qualifying exam—an entirely new type of challenge. The existing literature provides tips for taking regular examinations (Roberts, 1986), but the main components of the qualifying exam typically have a rigid and unique format, which individuals have likely never dealt with before graduate school and which deviates from that of regular exams. This format depends on the graduate program but tends to include a detailed written component in the form of a research proposal followed by an oral portion where research questions will be asked. While there is variability within fields, in many life science fields, the written proposal for the qualifying exam includes a specific aims page as well as a description of the clinical or basic science significance of the project, overall hypothesis, and background. These details should allow a general scientific audience to understand the relevance of the research while also demonstrating the student's ability to synthesize the pertinent literature and critically reflect on current questions in the field. Generally, qualifying exam committees may be chosen by the student or may be randomly assigned, so the proposal should be written as though a nonexpert might read it. The specific aims page includes two or three aims of the proposed research, and some institutions require additional exploratory aims. Before writing specific aims, student researchers should search open-source online databases to ensure novelty of their proposed work. Specifically, both the National Science Foundation (NSF) and the National Institutes of Health (NIH) have searchable databases like the NSF Award Search and NIH Reporter. Importantly, for PhD graduate students based in the United States (US) and those that are eligible for NIH funding, these specific aims should be independent of one another and should generally follow the NIH format (see https://mmcri.org/deptPages/gc/downloads/Detailed_Guidelines_for_the_NIH_Proposal.pdf; https://grants.nih.gov/grants/how-to-apply-application-guide/format-and-write/write-your-application.htm). Writing a proposal in this manner will help students to format their NIH fellowship applications in the future. However, for international students or those that are not eligible for US federal funding, exceptions can be made to format the application in a style that could be used for a subsequent foundation or private institution grant application. Moreover, these aims should encompass a project that can be completed over the remaining course of study (3–4 years).

A key aspect of the qualifying exam's format is independence. In some programs, a graduate student is typically only allowed to work with their mentor to synthesize ideas for the proposed research. Regardless, students should work independently during the writing process. Additionally, depending on the program, research advisors may have the opportunity to provide comments on the document before submission or other individuals with expertise may be consulted, but the student should do the bulk of the work. Therefore, others in the laboratory, such as postdoctoral fellows and more senior graduate students, can be critical sources of help in the preparation process. Additionally, students can ask within their departments for templates of past qualifying exams (e.g., for the written portion, https://biomed.emory.edu/PROGRAM_SITES/BCDB/resources/quals.html) or grants (e.g., NIH F31 or NSF GRFP applications) to see successful examples. However, there is tremendous variability across institutions, so students should understand the level of independence expected at their individual institution. While students should aim for independence this does not mean they should reject support. Rather, they should use their institutional resources to ensure project proposals are robust and not be afraid to voice concerns of failing, if they feel they are at risk.

4 | PREPARING FOR THE QUALIFYING EXAM

One of the first steps in preparing for the qualifying exam is to determine its length and format, which varies considerably from institution to institution. For example, students will need to determine if the qualifying exam be oral or written or a mix of the two. In many fields, such as psychology, qualifying exams are not standardized. Although nearly all programs have a written component, only 64% include an oral exam (Self et al., 2023). Some programs offer a clear syllabus (https://www.math.harvard.edu/graduate/study-the-qualifying-exam/the-qualifying-exam-syllabus/) or examples of previous qualifying exams (https://www.math.harvard.edu/graduate/study-the-qualifying-exam/some-old-qualifying-exams/), but these are not universal. Additionally, written proposal and oral exam lengths differ even within institutions and departments. It is crucial for students to find out the detailed requirements for their proposal before starting in order to avoid extra work (e.g reformatting). The exam may cover basic information about the courses the student has taken or knowledge they are expected to have to progress in their field, and some institutions require an oral defense of the proposal. Most oral presentations are conducted in person, but they may also be conducted remotely using online communication software. Depending on the format, students should study background information from fields adjacent to the proposal topic, as questions from these fields may come up. Moreover, the topic must be clear. While faculty should not help in the primary writing process, the student should ask their mentor to confirm the topic's clarity and verify it with multiple other people in the program to ensure the interpretations are consistent.

Importantly, these preparatory steps should be seen as an investment in the student's future. In programs where students write

proposals on their own research, qualifying exams can be used as the basis for their external grant applications. The practice that students gain in this stage is often useful for the attainment of future grants, including NIH Predoctoral Fellowships. Therefore, students should invest an adequate amount of time in these preparations.

Graduate students may be able to choose the topic of their research in some programs or labs, but the flexibility of study varies depending on the environment. In some institutions, students are able to use their active research as a basis for proposals, which allows them to adapt the same proposals for external funding opportunities. In other institutions, such as a scientific lab, the proposals must be completely outside of the lab's research topic to ensure independence of thought and to prevent undue influence on the student's writing process by their research mentor. Focusing their work on a topic of interest can help them prepare for the future. However, choosing an off-topic project—for example, in a field slightly outside their interests—can expose the student to new fields that they can weave into their current field to carve out a unique niche as an independent investigator. The topic is ultimately the student's choice, but meetings with the research mentor can help the student consider these options and make a decision. Learning how to write a proposal can be difficult, as scientific writing is very different from traditional formats. Each program has its own requirements for details that should be included, but it is always important in research proposals to provide enough background to the research questions, so their readers can follow. Additional suggested components include experimental controls, alternative approaches if experiments fail, and expected outcomes from each proposed experiment.

At the start of the writing process, a writing accountability group (Spencer, Neikirk, et al., 2022) can help a student stay motivated. Most graduate programs have multiple students preparing to take their qualifying exams, and writing groups allow students to work together in parallel as motivation. In addition to informal student writing groups, many institutions may provide grant writing courses, mock study sections, and the ability to revise and improve proposals during the writing process. Students should check the offerings of their respective institutions. Furthermore, it is easy to allow the proposal to become highly niche as one becomes an expert in the field, yet this can be a hindrance to writing about the proposal. Simplicity should be prioritized to ensure the proposal does not become weighed down with jargon. One should also incorporate background information or experiments that may be relevant to the members of the qualifying exam committee, depending on their field or research specialties. When students begin writing their proposals, they should consider joining peer mentoring groups, which can help them cultivate a sense of identity and aid in their proposal writing process (Cassese & Holman, 2018). Notably, one study indicated that a collaborative editing website shared among graduate students was an effective measure to prepare for the qualifying exam (DiPietro et al., 2010).

The final important step after the oral presentation, if applicable and regardless of its specific format, is choosing the qualifying exam committee members. If students are free to choose their own committees, the student should choose individuals who know them well and can ask relevant probative questions about the specific area of study. One can predict the type of questions they may ask based on their chosen research subject. An additional tool would be to ask students in the lab of committee members to sit in on practice presentations and ask possible questions. One way to do this is to ask the committee members ahead of time if they have specific requirements or requests. It is also possible to contact others in their laboratory, or individuals who have had them on exam committees in the past. However, if a student cannot find this information, even basic information, (e.g. the member's field of study) can help the student prepare. For example, if many committee members are structural biologists, the student should take extra time to consider questions or critiques from the perspective of structural biology.

It is important to note that students must prepare for their committee to ask questions that are both in scope and those that may be out of direct scope. Although the chair of the committee has a responsibility to guide the examination period, any statements, figures, or information that the student provides to the committee are "fair game" for questioning. It is imperative that students fully cite and properly understand any images that are used in the instance that the committee has probative questions.

5 | ORGANIZING NOTES TO STUDY

Organizing notes for the qualifying exam should be set up in such a way that is conducive to effective studying. For example, rather than only flashcards, techniques such as making a custom book can be helpful. Similarly, building an online spreadsheet or document, or database to review all notes quickly can help make rewriting notes more fun and easier to organize. Additionally, notes can also be set up in a way that encourages studying and space repetition. For example, a book can be helpful in setting 10-page increments to study per day, which is an attainable and motivating daily goal. Additionally, small rewards may be written into the notes, such as a reminder to get a small piece of candy or take a rest after every 20 pages of studying. Organizing notes can be helpful in requiring students to critically synthesize information as well as establish fun rewards to motivate studying.

6 | TIME TO STUDY FOR THE BIG DAY

Although the student has been reading manuscripts while preparing the written proposal, it is important to continue reading additional material to prepare for the oral exam. Once the student has obtained the necessary background information, it is time to prepare by holding practice oral exams and practice presentations. Studying for the qualifying exam technically begins on the first day of graduate school and continues until the oral exam. Much of what a student learns in their classes, journal clubs, and lab meeting presentations can be used as preparation. A students should also identify the minimum amount of time required after turning in their written exam before they schedule their oral exams. In some programs, this may be as short as a week, and in others, months. Even if the written portion

is finished, the student should not immediately schedule the qualifying exam but rather allocate time to preparing, depending on their confidence in the subject matter. They should read their proposal line by line and ensure they are confident in the who, what, when, where, and why of the proposal. In other words, the PhD student should be able to accurately explain the literature informing their proposal, their approach, how long the research question has gone unanswered in the field and how long it will take to answer, the collaborations and facilities they will use to study the question, and why it is important to explore this question. Moreover, the student should remember that the qualifying exam committee may not be experts in the field, so they should be able to elaborate on niche concepts and potential points of confusion in the proposal. Studying the proposal is of the utmost importance, it is also important to anticipate what might be asked outside the scope of the proposal. For example, if a PhD student did poorly in a certain class during their graduate studies, the qualifying exam committee may ask questions on that topic to determine if they have improved their understanding. Therefore, students must avoid rehearsing only the topics in which they are strong; they should also consider which topics they are *less* confident about and study those. Additionally, it is important to note that when committee members do not have expertise in the same field, they may focus more on the basics. Therefore, reading through relevant textbook chapters can help students to integrate important topics of study and prepare for the exam.

During this studying process, one's faculty mentor and laboratory are critical resources. As a baseline for studying, students should read any research articles and reviews their mentor recommends to gain a better understanding of the background. Other responsibilities during this period may need to be reduced as much as possible, and it is important to learn how to say "no" during this period of preparation (Hinton et al., 2020). In the months leading up to the qualifying exam, PhD students should practice presenting their aims in laboratory meetings. Beyond these meetings, they should try to practice weekly and encourage individuals from their department to ask difficult questions about the methods, alternative hypotheses, innovation, and alternative approaches or methodology (Table 1). It may also be helpful to have peers from outside of the student's field of research to ask questions, as they often have a different perspective that may foster a new way of thinking. Working together with graduate students across the university or extending the writing accountability groups to oral exam practice groups is an excellent way to prepare for the examination. It is important to be prepared to be "put on the spot" with directed basic and topic-specific research questions during the question-and-answer period. The goal of a qualifying exam is not to critique the project that a student would like to do, but rather to assess their readiness to think critically about their proposal's topic, ask relevant and independent questions, and defend their proposed research to the best of their ability. In all of these practice scenarios, students are free to present in a style that suits them. However, they must eventually tell a clear story that allows the qualifying exam committee to understand the rationale. They should also be ready for criticism, including questions about alternative methods, adjacent fields, differential research topics, and how their study may apply to different models that may arise. In response to all such questions and criticisms, the PhD student should remain logical and respectful. It can help to create a clear and concise system for answering difficult questions. For example, it is okay for the student to admit that a specific question goes beyond the scope of their proposal or that they are unfamiliar with the specific approaches highlighted. However, they should then propose answers based on their knowledge of the field or how the suggestions could potentially be implemented in the study. It could help if reviewers understand the thought process, even if the student in question has not mastered specific content. Additionally, too many responses of, "I don't know," without attempts to think around the problem with prior knowledge can lead to exam failures. Students can reduce nervousness or unease around topics of uncertainty by taking a second to think about the question or by drawing diagrams or pictures to help them outline the answer. If all else fails, ask the questioner to rephrase their question.

TABLE 1 Common questions to expect.

Why did you choose [this method] over [another method]?
You touched on how this topic relates to an adjacent field. How could you better incorporate this field to create a multidisciplinary study?
How does your project contribute to the overall field?
You had difficulty in Cell Biology during your graduate studies. Given that this project relies on *in vitro* studies, how have you improved in these topics?
Are there alternative hypotheses or explanations that could challenge your proposed hypotheses?
How will you ensure proper controls for your projects, and what are potential sources of error in your data collection and analysis methods?
How do seminal papers in the field contribute to your current question?
If using an animal model, why did you choose to use one species over another species or model? (e.g., if you are using mice, why not rats?)
Explain how to do [insert method here].
(If using transgenic models)—How is this transgenic model generated?
What is the basic structure of [x] molecule? (Be prepared to draw and label)
What are the key differences between [x method] and [y method]?

Note: A student should ultimately prepare using their proposal and seek advice from mentors regarding specific questions that may be asked. Nevertheless, this table presents common topics and areas of inquiry.

7 | TAKING THE QUALIFYING EXAM

On the day of the presentation/oral defense, the following aspects should be kept in mind.

The day before:

- Get at least 8 hours of sleep, if possible. This is not the time to pull an all-nighter.
- Eat a nutritious dinner or a smoothie if you are too nervous to eat.

- Review study materials one more time, then try to relax.
- Review all materials and ensure all documents are collected.
- Go to the exam room and get familiar with the layout, placement of lights, location, and so forth.
- If using technology, ensure that you are able to connect to the computer, use the laser pointer, pull up and flip through your presentation slides, and so forth.
- Print out any required forms that must be signed by the committee if necessary. You may also print out your written proposal, though many committee members bring their own copy to the exam.

The day of:

- Ensure reliable transportation is arranged to reach the exam location on time.
- Have a nourishing breakfast.
- Bring several items in case they are needed, including the written proposal, any notes or papers, a notepad, pens, highlighters, a (laser) pointer, and dry-erase markers.
- Bring a timer or stopwatch to stay on pace.
- Arrive at the exam location with ample time; use some of the time to relax and do breathing exercises, if necessary.

During the exam:

- Maintain a positive mindset throughout and be proud regardless of performance.
- Present what you have prepared and avoid assigning tone to the reactions of the qualifying exam committee members.
- Pace yourself and check the timer regularly, though not too frequently.
- Don't be afraid to stop and regain composure during questions and utilize visual tools to improve clarity. It is ok to take a break if you need one.
- You do not have to know everything. It is okay to speculate, so long as you have sound logic (i.e.,—results from your experiments or evidence from the literature) for your guess.
- It is also okay to say that you don't know something—this is often a better strategy than fumbling through an answer and digging yourself into a hole.
- Stay focused and attentive as the committee members speak.
- If you're unsure about a particular question, don't hesitate to ask for clarification or further explanation.

8 | HOW TO REGROUP IF YOU FAIL

It is okay to not pass the qualifying exam; it does not define an individual as a researcher. A student who fails will usually have an opportunity to take the exam again (Table 2). In that case, they can once again follow the advice in this guide, but they should allocate additional time for each stage and focus on specific areas of weakness. The student should also rethink how they study and try new methods. A good way to get started is to ask the qualifying exam committee how to improve. Committees will often provide feedback on students' written or oral presentations, or students can set up individual meetings with their committee members to discuss their weak points and how to address them. Individuals typically pass the exam the second time with proper preparation. A student may get a

TABLE 2 The main outcomes following the qualifying exam and the next steps.

Decision/outcome	Meaning	Next steps
Unanimous fail with no retake	The committee has unanimously decided that the student does not pass the exam, is not permitted to retake the exam, and asked to leave the program.	The student should speak to their faculty mentor and other individuals in their networks. Often, a student may petition to the dean with a strong reason for why they wish to appeal the decision. In other cases, a student may graduate with a master's degree. Additional options outside of dismissal should be discussed with senior faculty at the student' institution.
No pass/fail	The committee has unanimously decided that the student does not pass the exam but is allowed to retake it after a specified period.	After a set period of time, the student is able to retake the exam. The student should revisit in depth what initially was not successful in their study process and reflect on how to prepare and study to ensure they pass the next time. Students must be especially mindful of if their program has a set limit of attempts for qualifying exams.
Conditional pass/pass with reservations	The committee has decided that while the student has mostly met expectations, there are certain deficiencies. This may arise from a unanimous or nonunanimous decision.	The committee will typically specify the deficiency, which may include completing additional coursework, retaking certain parts of the exam, or demonstrating competency in specific areas.
Pass	The committee has unanimously decided the student is ready for candidacy for the doctoral degree because they have met or exceeded expectations of the exam.	Without any further requirements, the student is ready for advancing to candidacy.

Note: While these vary from institution to institution, these outcomes are the most common across many institutions.

third or even a fourth chance, although they may wish to find a new research mentor if these additional attempts are needed.

If a candidate receives a conditional pass, they may need to write a paper or attend a meeting about a specific point of confusion in their proposal. In these cases, the candidate will need to coordinate with their committee and their faculty mentor to ensure that all additional requirements are met in a timely manner to receive a pass on their exam. In some extreme cases, unanimous failure can occur, in which all committee members believe there should not be any further examination. In such rare cases, the student should work with their faculty mentor, department chair, and even program administrators to create a plan of action to improve. The consensus may be that the student should leave the program.

Though the qualifying exam can seem daunting, candidates must remember that it is just one step in a long road that will include other, potentially more challenging hurdles, such as the thesis or dissertation defense. With proper preparation and time management (Murray, Davis, et al., 2022), students can ensure they are prepared to thrive.

9 | MENTAL HEALTH

Because this process can cause stress and burnout, PhD students should make use of support networks, including intentional mentoring from faculty or senior lab members. These mentors may notice a candidate's stress even before they do and may be able to suggest mitigation techniques to prevent total burnout (Shuler et al., 2021). Peer mentoring can be useful; intentional mentors can pair candidates preparing for the qualifying exam with more senior candidates who have taken the exam in the past and can offer expertise. One potentially unfamiliar aspect of these mentorship relationships is that the candidate should be ready to hear constructive criticism and understand that their academic experience does not reflect their accomplishments and worth as an individual. It is crucial to avoid taking constructive criticism as personal insults.

Preparing for a qualifying exam typically takes up most student's time, but they should not neglect other aspects of their life. To maintain a strong work–life balance, students can practice mindfulness (Hölzel et al., 2011) and ensure they manage their time well so that they can keep up with their other responsibilities. One should be especially mindful that other factors including "John Henryism" (i.e., stressors in individuals, with low socioeconomic resources, may cause increased blood pressure) (Fernander et al., 2004) and toxic stress (Rolle et al., 2021), exacerbated by microaggressions (Marshall, Pack, et al., 2021), may further contribute to stress during this period. It is also important not to neglect identity during this time. Students should consider during their writing process to include conversational workshops with other students with shared identities that may focus, for example, on how to express identity across the writing process, which is a major difficulty for students (Fisher et al., 2020). It may be beneficial for students to get involved in interest groups with their peers to widen their network and gain additional perspectives on the graduate student experience.

Finally, PhD students should listen to their minds and bodies. It is important to avoid viewing mental health crises as a reasonable progression of stress while preparing for the exam. These crises should be frankly identified and taken seriously, and candidates should not be afraid to take advantage of school-provided counseling services. Mentors should pay close attention to students and recommend counseling services or time away from the laboratory if needed. In extreme circumstances, students may petition the graduate program, or the relevant support service in the program, to delay the qualifying exam. This is a perfectly normal and common occurrence and may afford the student more time to prepare mentally if they are feeling overwhelmed about the existing exam date.

10 | WHAT IS A THESIS COMMITTEE?

Once the candidate passes their qualifying exam, they officially become a PhD candidate. At this time, they typically need to form a three- to five-member thesis committee, also known as a dissertation committee or supervisory committee. While a dissertation specifically refers to unique and novel concepts and a thesis refers to existing research, here we use them interchangeably as both dissertation and thesis committees serve many of the same primary functions. Additionally, some programs require the formation of a committee before the qualifying exam; those committee members serve as "judges" for the qualifying exam and remain on the thesis committee as students progress to their final defense, in which case all of the advice offered below holds equally true.

The purpose of this committee is to review and evaluate the PhD candidate's research proposal to ensure it is sound, feasible, and aligned with the program's requirements. The committee also ensures the candidate is making notable findings in their field. Similar to a qualifying exam committee, the dissertation committee may include any faculty members with relevant expertise in the student's field of study. The chair of the committee oversees it to ensure that it is effectively run. The candidate and their thesis committee meet regularly so the candidate can share updates on their progression through the program and present their latest work. The thesis committee is often available throughout the candidate's progression through their program to offer their expertise as the candidate's project progresses. Thus, the candidate should feel comfortable contacting their thesis committees outside of their regular meetings, if needed, for additional insight or advice. In the science, technology, engineering, mathematics, and medicine (STEMM) fields in particular, thesis committees often provide access to networks and collaborations that result in opportunities for publishing (Bès et al., 2021).

11 | ASSEMBLING A THESIS COMMITTEE

Candidates should recruit thesis committee members from a wide range of fields, including persons from outside the candidate's field, as they may provide feedback and suggestions for improvement that

the research mentor or those within the field cannot give. It is important to select individuals who can aid the candidate's faculty advisor in mentoring as well as more senior members who may support fellowship submissions to the NIH, particularly if one's own mentor is a junior faculty member. Depending on the institution, the dissertation committee chair may be the candidate's research mentor, or this person may be another professor and their mentor may simply sit on the committee. When selecting a committee chair outside of their department, candidate's should consider well-respected mid-career and senior faculty, such as associate professors or full professors. In many institutions, the committee chair plays a pivotal role in guiding the discourse, ensuring fairness, and moving the process forward as needed, and therefore candidates should choose faculty who are not afraid of controversy and will stand up for the PhD candidate, if necessary. The chair should also have a related academic background to help field guidance that may be relevant versus suggestions that are out of scope. The candidate could also appoint a co-chair, though this role is often unnecessary. In some cases, if the candidate does not have a wide range of mentors, they can ask the PI's recommendation as to which trusted senior faculty members might be willing to head the thesis committee. In all cases, the candidate should confer with their faculty mentor before forming the committee, as their mentor may have insight into how other committee members mesh and/or may suggest alternative members.

It can be tempting to fill the thesis committee with individuals who are experts in the field. However, the committee should contain a mixture of people in and outside of the department as they can be called on for issues with the PI or other, more personal issues in the department environment. This way, each individual can act as a mentor through different mechanisms, creating a diverse mentoring network (Marshall, Brady, et al., 2022; Termini et al., 2021). Professors outside the department can offer a unique angle for tackling issues compared with what is common in the student's field. Furthermore, including a diversity, equity, and inclusion (DEI) officer or another kind of advocate can be advantageous as these individuals offer a distinct perspective that can aid in career development and ensure an equity-focused mindset, especially in clinical projects. Some programs include "Theme Directors" or "Graduate Coordinators" to be involved in qualifying exams and thesis committees. In such cases, these are often nonvoting members who allow for equitable treatment of students and can act as outside mediators for any conflicts that may arise.

Finally, the PhD candidate should avoid choosing thesis committee members who are not able to continue their involvement in the committee for the duration of the candidate's tenure at the university, as their exit may cause unnecessary complications. The committee chair can offer expertise in these matters, but students must remember that politics and interpersonal issues still exist in academia. Therefore, a candidate should have frank conversations with trustworthy individuals in the department about who may impede progress. People to discuss this with may include the faculty mentor, lab members, shadow and casual mentors (Davis-Reyes et al., 2022; Uddin & De Los Reyes, 2021), or other students in their department or program.

Once the candidate selects their thesis committee members, they should approach the individuals in a way that is appropriate for that specific member. For example, explaining the research and providing the necessary information to make a choice in an email can be important. One may offer a formal meeting with the committee chair and PI to ask individuals to join as members of the committee. The candidate may also offer one-on-one meetings with prospective members to broadly discuss the prospective project and how their expertise will be of use as a member of the committee. Many times, faculty from the qualifying exam committee may also become members of the dissertation committee.

It is important to set certain ground rules for the thesis committee early on, including the expected frequency of meetings, level of engagement, and overall research timeline (see Figure 2 for example timeline). However, students must also meet the minimum requirements of their program. These details should be discussed during the first committee meeting, as this is often an opportunity to ensure the committee is harmonious and have the same understanding of what is expected. The PhD candidate should formulate a positive relationship with the primary research advisor, which other works have previously discussed (Tanner, 2002).

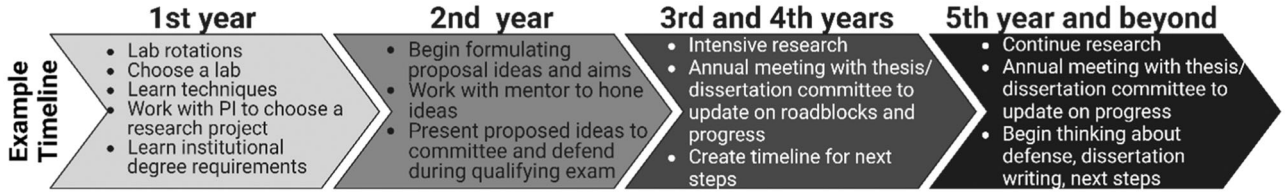

FIGURE 2 Example timeline detailing a student's progress in an institution that holds qualifying exams in Year 2. Many programs allow students to rotate and choose a lab in the second half of their first year. The student will then work with their advisor to define their thesis project and begin performing experiments to exhibit feasibility. In the second year, the student will work with the advisor to choose aims, and the student will write a proposal to send to the committee. The student will then present that project to the committee via digital presentation or "chalk talk" format, and the student will be asked questions about their work and the background material. Once the exam is passed, the student will move on to the next steps and should meet with their committee annually to present updates and challenges before their defense, and acquisition of the PhD.

12 | WHAT TO PRESENT TO THE THESIS COMMITTEE

The thesis committee should meet annually at the very least. In certain scenarios, it can be advantageous to meet with the thesis committee more often, such as every 3 or 6 months. Regular and frequent meetings will help the student establish an overall timeline. As their manuscript nears completion, meetings with the committee can focus on reviewing figures and the final draft to solicit feedback and prepare for potential reviewer comments. It can be beneficial to increase the frequency of meetings toward the end of one's PhD as the committee may be able to offer advice on the next steps or suggest potential employment opportunities.

The PhD candidate should bring all markers of research progress to committee meetings, including published or in-progress manuscripts, manuscript revisions or feedback, grant applications, data in progress, conference attendance, progression on coursework if advanced courses are taken, and awards and honors. A work-in-progress sheet can be used to highlight objectives and any current troubleshooting or experimental design issues the student wishes to discuss. As the meetings typically last only 30–60 minutes, it can be helpful for the student to bring a list of specific questions about getting to the next stages in their research. They should also provide all materials ahead of time to avoid redundancy in discussing published work, which can be a waste of valuable meeting time. Graphics, such as a visual timeline, can help show the progress of the research. It can be useful for students to discuss these things with their faculty mentor before the committee meetings to ensure that they are in lockstep—it does not look good to surprise a faculty mentor with new findings or announcements at a committee meeting!

The committee uses these meetings to monitor the candidate's progress, ensuring that they are making satisfactory progress toward completing their research and writing their thesis. Although the main content of these periodic meetings should focus on the candidate's work and discussing current challenges, it can be useful for them to bring certain documents, such as an individual development plan (Vincent et al., 2015), mentoring map (Davis et al., 2023), social media brand map (Heemstra, 2020), and mentoring contract and laboratory mentoring systems (Marshall, Vue, et al., 2023), as they can show how the mentoring relationship and professional development goals are progressing in addition to the research. These committees, along with evaluating research, may also evaluate other avenues of graduate school development, such as running workshops that may provide training to undergraduates and middle schoolers (Barongan et al., 2023; Marshall, Brady, et al., 2022; Marshall, Neikirk, et al., 2023; Marshall, Palavicino-Maggio, et al., 2022; Marshall, Vue, et al., 2022). Career development is often neglected by these committees, but PhD candidates have the power to redirect the focus and ensure they are making use of this multifaceted mentoring system established for their benefit. For example, the candidate can ask their thesis committee to review their strengths and weaknesses in laboratory skills, interviewing (Ransey et al., 2023), networking (Beasley et al., 2023; Streeter, 2014), writing, leadership (Ruiz et al., 2022), cultural humility and share skills (Foronda, 2020; Murray, Hinton, et al., 2022), and conference presentations, if applicable. Committee meetings can also include networking, and the committee members can help the candidate form and maintain collaborations.

Any meeting should be scheduled at least a month ahead of time unless there is a need for an urgent meeting. Any free online scheduling platform can help large groups find a meeting time that works for everyone. A couple of weeks before the meeting, the candidate should send the committee members all of the relevant materials along with an agenda that specifies how much time should be dedicated to research questions and career development. This lead time ensures members have adequate time to review the documents. Sending out materials again a week beforehand will remind all members to review the material. Candidates should employ time management (Murray, Davis, et al., 2022) of themselves and their committee members when preparing the meeting materials and avoid redundancyby keeping topics simple, clear. Though keeping track of these tasks can be stressful, it is important to remember that committee meetings are less like exams and more akin to planning meetings to help guide the next several months of research. If a candidate does not feel that the meetings are useful, they should work with a faculty mentor to modify the format to make the meetings more productive in formulating a plan.

13 | FORMULATING A PLAN

The candidate should work with the thesis committee to outline a development plan, including any conferences they would like to attend, honors and awards they would like to apply for, manuscripts or capstone projects they aim to finish, and other goals, such as networking or mentoring undergraduates (Vincent et al., 2015). Following a thesis committee meeting, the candidate should craft a plan of action based on what they learned from this committee meeting. The chair typically sends out a written plan, but the student can ensure that no information is missed by recording—or having the PI record—the meeting so they can write meeting minutes after the fact. The candidate should then set a secondary meeting with the PI to discuss the next steps and set goals for what they want to accomplish, including publishing goals, which may include DEI publications, education materials (if applicable), research reviews, and research manuscripts.

PhD candidates should note that contact with members of the committee does not need to be confined to committee meetings. By meeting with committee members individually when the need arises, candidates can maintain strong mentoring relationships and ensure that meetings stay focused on broad updates that are relevant to the entire committee. Such one on one attention may also help the committee member to strengthen a candidate's specific areas of weakness.

Throughout this process, students should remember to embrace the journey. Flexibility is key, and though lofty goals can be good, they should also be realistic and open to change. Although the road to obtaining a PhD can be long and tumultuous, it can also be deeply fulfilling. If a candidate is always waiting to get to the next step, they will miss the middle ground in which so much of life is lived.

14 | HANDLING PROJECT ISSUES

Ideally, candidates will face no issues with their projects. However, research, and the academic career path can be fickle and having a "Plan B" and a "Plan C" can keep candidates on track in case a project goes awry.

Issues can sometimes originate from the committee. The individuals on the committee should not be seen as enemies but rather as teammates. Candidates should avoid conflict and, at the beginning of every meeting, recognize and thank the committee for taking the time to offer input. Bringing coffee, water, or light snacks for the committee can also be helpful, but is not necessary, and these items can also be provided by the faculty mentor. To avoid potential confusion or conflicts during presentations, students should routinely collect positive and negative controls and present them to the committee. If any conversations become hostile or elevated, those topics should be avoided. Having a clear agenda can aid in moving past certain sensitive topics. Sometimes, the student may need to adjust the committee by adding a member for expertise or removing a member who may have a conflict of interest, which can alleviate potential difficulties in the study. The chair of the committee can help the student navigate this process.

Other times, issues may result from the research not progressing as well as the student or committee hoped. These issues might require the candidate to delay graduation but maintain contact with the thesis committee members, who can offer advice and suggest alternative approaches. It is easy to feel that a project is not progressing, especially in the early stages, but this is usually no reason to get discouraged. Once protocols are established, data may accumulate more quickly over time. If things are going very poorly, the candidate should speak with their faculty mentor and the chair of the committee, who may suggest alternative avenues, including a formal report or options such as a terminal master's degree.

15 | THESIS EVALUATION

Past literature has extensively covered tips for writing a thesis (Lunenburg & Irby, 2008), which should incorporate the expertise of the committee. Once the student completes their research and writes their thesis, the committee will evaluate the document. Importantly, this should not be a large source of stress for the PhD candidate if they were able to regularly meet with their committee and accomplish the committee's suggestions regarding the quality of the research, the validity of the findings, and the overall contribution to the field. It is helpful if the student has already written a manuscript or published their research, but this is not always possible in the current peer-review climate. At least two weeks before the evaluation, the student should send the committee all the documents they plan to present. As with the qualifying exam, the student should research the specific format required at their school. The committee may also hold an oral defense in which the student presents and defend their work. Alvarez and Campillo have provided a helpful guide for delivering a PhD defense (Alvarez & Campillo, 2009).

16 | NEXT STEPS

It is important for past students and candidates to continue to utilize the mentoring and network of the thesis committee after it has technically concluded. For example, they may request letters of recommendation for future positions or help finding/applying for postdoctoral positions. Committee expertise may also be leveraged by seeking input on preparation of manuscripts and inviting committee members to participate in other dissemination efforts, as well as keeping them updated on publications, abstracts, posters, and oral presentations. It is important not to neglect the manuscript plan if there is an a priori agreement with committee members. Though this guide has focused on the PhD graduate school, its advice —as well as the difficulties faced and insights gained during the qualifying exam and assembling of these committees—may be invaluable for postdoctoral and later phases, as the same strategies may be applied to effectively form postdoctoral committees. As PhD students continus to progress in their journey, they may further employ previously published guides on navigating the transition to a junior faculty stage (Murray et al., 2022a, 2022b; Spencer, Shuler, et al., 2022).

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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