



**Medical Student Research Program
and the
Yale M.D. Thesis Requirement**

**Guide for Students
and
Faculty Sponsors**

Please read carefully

Yale SCHOOL OF MEDICINE

Prepared by
The Office of Student Research
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OVERVIEW AND HISTORY OF STUDENT RESEARCH AT YALE SCHOOL OF MEDICINE

The Yale System of medical education is designed to foster critical judgment, acquisition of knowledge, and commitment to improving the health of all persons and communities, through the habits of self-education, imagination, and scholarship. Central to these goals is the development of research skills, which enable Yale students to ask and answer questions according to the high standards of ethics and rigor befitting the physician's role in patient care. Presentation of thesis has been one of the requirements for the degree of Doctor of Medicine at Yale for over 180 years. Initially, case reports and reviews of literature predominated, but as the scientific method was established in medicine, the faculty required that dissertations presented be based on original investigation from either laboratory or clinical realms.

The first evidence that the thesis or dissertation was considered a requirement for the degree of Doctor of Medicine is in a statement in the catalog from 1839, which in part reads, "...the candidate must present a dissertation on some subject connected with the medical sciences." Over time the research program has been formalized to include curricular aspects and dedicated time for experiential learning. It culminates in the submission of a written thesis in order to graduate. This requirement has evolved and flourished to its present form and is enthusiastically endorsed by students and faculty as a central component of the "Yale System" of general medical education.

To this day, the Yale School of Medicine continues the tradition of required medical student research, broadly defined as the generation of new knowledge through the generation and/or analysis of data. The creative discipline required to carry out a project and prepare a thesis enables each student to become a physician-scholar, whether their ultimate objective is research, education, clinical practice, administration, advocacy, activism, or other careers. The research experience at YSM teaches students how to critically appraise existing evidence to establish a strong premise for their projects; specify a clear, significant, and innovative research question; collect and analyze data using rigorous methods that adhere to all relevant ethical standards and regulations; and clearly communicate research findings in written, spoken, and digital forms to maximize their impact on communities of interest. As such, the completion of the YSM research program and thesis will enable students to evaluate data critically for the rest of their professional lives.

OFFICE OF STUDENT RESEARCH

The medical student research program is overseen by the Office of Student Research (OSR) and is led by two associate deans, Dr. Sarwat Chaudhry, M.D., and Dr. Erica Herzog, M.D., Ph.D. As OSR exists within the Office of Medical Education, it works collaboratively with the Deputy Dean for Medical Education and leadership within the Education Administration Group (EAG) to develop strategic vision and achieve pedagogical goals. Practically, OSR oversees all aspects of YSM medical student research including, but not limited to: 1) organization of research courses during the MS1 year; 2) guiding students in the process of identifying potential mentors and projects; 3) administration of funding applications and payments; 4) overseeing the approval of research projects; 5) coordination of thesis approval in fulfillment of the partial requirement for the granting of an M.D. degree from YSM; 6) obtaining external support, including from NIH, for student research stipends; and 7) overseeing and

administering the Masters in Health Sciences degree program and 8) providing guidance to students and mentors experiencing challenges in their research.

OSR functions under the direction of Ms. Anne Kellett and two full time support staff, Ms. Kelly Jo Carlson and TBN. OSR is highly accessible to students, mentors, and the YSM community and maintains communication via email in order to facilitate questions related to the medical student research program and thesis requirement. Drs. Chaudhry and Herzog offer weekly office hours during scheduled time blocks (Chaudhry: Wednesdays from 12-1; Herzog: Tuesdays 12-1) or at other times through scheduled appointments. These office hours as an excellent opportunity for 1:1 discussion of research related topics including but not limited to projects, mentors, challenges, and career pathways. Due to current university de-densification regulations, office hours will be conducted primarily via remote format (on zoom or telephone). Appointments for office hours can be made by contacting the OSR staff (see below). Emails to OSR staff and leadership are also welcome. Contact information is as follows.

OSR Address:

367 Cedar Street, Third Floor Harkness Dorm, 310 ESH, 203-785-6633. osr.med@yale.edu

OSR Leadership:

Dr. Sarwat Chaudhry, M.D., Associate Dean of Medical Student Research, Associate Professor of Internal Medicine (General Internal Medicine): sarwat.chaudhry@yale.edu

Dr. Erica Herzog, M.D., Ph.D., Associate Dean of Medical Student Research, Professor of Internal Medicine (Pulmonary, Critical Care, and Sleep Medicine) and Pathology: erica.herzog@yale.edu

OSR Staff:

Ms. Anne Kellett, Associate Director of OSR: anne.kellett@yale.edu

Ms. Kelly Jo Carlson, Senior Administrative Assistant: kellyjo.carlson@yale.edu

Ms. Gabriella Reyes, Project Coordinator: gabriella.reyes@yale.edu

Departmental Thesis Chairs: OSR's mission is executed at the departmental level by "Departmental Thesis Chairs." These individuals serve a critical role in the cultivation and management of YSM's student research enterprise and fulfill myriad roles related to medical student research at YSM. While their title denotes their role in the thesis process, their responsibilities extend to numerous OSR functions including: 1) supporting students in their search for a mentor; 2) provision of feedback on students' proposals for research funding; 3) approval of short term requests before a final review in OSR ([Research Funding](#)); and 4) approval of applications for one-year funding prior to final review in OSR. During the fourth year of medical school, when the student prepares the required thesis, Departmental Thesis Chairs perform critical functions including: 1) communication with students regarding departmental deadlines for thesis submission and review ([Thesis Deadlines](#)); 2) consideration and granting of deadline extensions; 3) coordination of the departmental thesis review and approval process; 4) review and approval of all theses submitted in a given department ([Thesis Preparation and Approval](#)); 5) in very rare cases, nominating a thesis for prize consideration (see below, [Thesis Awards](#)). Given their close working relationship with students, Departmental Thesis Chairs provide invaluable insights to OSR

leadership. Drs. Chaudhry and Herzog meet with and communicate with this group regularly over the course of the academic year. The 2021-2022 Departmental Thesis Chairs are listed in Appendix A.

MEDICAL STUDENT RESEARCH PROGRAM AT YALE

Overview

Students are offered numerous OSR sponsored, research-focused didactics in the preclinical years. Additionally, students have the opportunity to partake of an immersive, full-time research experience during the summer between the first and second years (see [Summer Research](#)) of medical school and during the Advanced Training Period. All are required to write an M.D. thesis during medical school, with the exception of students who have earned a Ph.D. degree in the health sciences before matriculation (see [Formal M.D. Thesis Requirement](#)). A wide choice of subjects for research is available. Students may choose laboratory projects in the basic or translational sciences, or clinical projects in an array of disciplines including, but not limited to: health outcomes; health services; community based participatory research; qualitative; humanities and medicine (including ethics and the history of medicine); sociology; economics; or education research. Four basic requirements apply to all research projects: 1) the subject chosen must address an important question in medicine; (2) the work must pursue a clear, concise aim that can be addressed by new knowledge generated by the student's research; (3) data must be collected and analyzed with the most rigorous methods suited to the research question; (4) the research sponsor must be a full-time faculty member at the School of Medicine. In order to fulfill partial requirements for graduation, the research must be written up in the form of a thesis (see [Required Components and Formatting](#)) and submitted to the Yale Medicine Digital Thesis Library (see [Instructions for Uploading a PDF](#)).

Elements of the Yale Curriculum Favorable for Student Research

Yale's commitment to research as a central component of medical education is reflected by the curriculum and aspects outlined below.

- 1) The long tradition of medical student research at Yale with a M.D. thesis requirement is unique.
- 2) There is an established tradition for Yale faculty to welcome students as colleagues in a community of scientists.
- 3) There is a high student/faculty ratio with only 100-105 students per class and approximately 3000 YSM faculty.
- 4) The curriculum contains fewer hours of scheduled lectures than many leading medical schools in the United States.
- 5) The lack of competition for grades through Yale's use of pass/fail and unsigned examinations in preclinical courses is unique.
- 6) The deep pool of role models and mentors fosters intellectual and professional development of future clinicians and physician scientists in all domains.
- 7) The vast majority of faculty members in both basic science and clinical departments are located within a 6-block medical center campus contiguous with Yale-New Haven Hospital, facilitating students' access to mentors, laboratories, and research groups.
- 8) YSM recruits an outstanding body of students who at the time of matriculation are aware of the expectations for rigorous, reproducible, and creative scholarly work.

For close to two centuries, this system has inspired the careers of numerous Yale Medical Students and continues to do so to this day.

Formal Didactics In preparation for embarking upon the Yale research program, students complete an intake assessment which is used to gauge their experience, interests, competencies, and needs. Students are prepared for their research experience through the “Scientific Inquiry” Course which runs from October through May of the first year. Scientific Inquiry (SI) provides students with practical tools required to perform rigorous, ethical, and responsible research in all domains, and supports the mentor selection process through lectures, workshops, faculty and student panels, and peer mentoring. Embedded within SI is the “Responsible Conduct of Research” (RCR) module, a course that meets federal requirements for education in the ethical and practical aspects of appropriate research conduct that is mandatory for students seeking research funding from OSR. Students are also prepared for scientific rigor through their work in Populations & Methods: The Application of Epidemiology and Biostatistics to Public Health, which offers instruction in study design and statistical methodology during both preclinical years.

Time and Funding Available for Research

1) **Time:** While the culmination of the research program is the medical student thesis, students have the opportunity to participate in research throughout their medical school career. Most students begin research work during the summer following their first year. For example, during the summer of 2021, 77 (of 81) eligible first year medical students either remained in New Haven or worked remotely (due to the COVID-19 pandemic) to conduct mentored research on a wide variety of projects. Students working under the sponsorship of a Yale faculty mentor receive financial support at the level of an NIH pre-doctoral stipend for this time period (see below). Many students continue their research work part-time in the afternoons, evening and weekends during the second year of medical school. Additional blocks of 1-3 months are available in the last half of the third year and into the fourth year during the Advanced Training Period. As the curriculum clinical clerkships run from January of the second year to January of the third year, the Advanced Training Period offers students up to 16 months for research and other activities (sub-internships, interviewing, electives). Students interested in having additional time for research may partake of the fifth year (see below).

As a reminder, the rigorous generation and collection of reproducible data can take many months. Additional time is then required for analysis and the subsequent preparation, submission, revision, and ultimate publication of the thesis and any manuscripts resulting from the project. Therefore, students are encouraged to work with their mentors to develop a realistic timeline for project completion. Please contact Deans Chaudhry or Herzog with questions.

2) **Funding:** Stipends are available to support summer research as well as other periods when full-time research is performed. Students who apply for funding must have completed the Responsible Conduct of Research course during their first year. Stipends are provided at the NIH predoctoral level, which may be adjusted by the federal government at various times throughout the year. “Full time research” is defined as 40 hours per weeks conducted during daytime work hours. Because the stipend is provided to support immersive research work, students may not be enrolled in electives or

subinternships – no matter how small the hourly time commitment -- during their period of stipend support. For graduating students, financial support is not provided for writing the thesis or during the required Capstone course conducted in the spring. Stipends are paid weekly. Due to Yale's financial policy, the first stipend is paid as a paper check regardless of whether the student has set up direct deposit. Because the first stipend payment is mailed, students are encouraged to update their mailing address in the Yale Workday financial management system to avoid delays in receipt. Questions regarding stipends should be directed to OSR.

GENERAL PRINCIPLES OF MEDICAL STUDENT RESEARCH

A close working relationship between the student and faculty research mentor is a major goal of this program and is strongly encouraged. When laboratory research is performed, it is the responsibility of the faculty advisor to provide all necessary space, equipment and supplies, including costs of publication of scientific articles. For non-laboratory investigation, the same commitment to guidance and support is expected, including but not limited to data access, statistical analysis packages, statistical and methodological support, abstract and publication costs, etc. Weekly conferences between student and advisor are encouraged during the course of the research. It is important to note that, where practicable, the research must be designed and specifically performed by the student with the advice of the faculty mentor. Medical students may not solely fulfill research duties expected of a research coordinator or laboratory technician absent of independent scholarly contributions. They may also not work jointly on a research project. If a faculty member chooses to mentor several students concurrently, each student should receive equal support and attention. Specific components of the summer and thesis research programs are offered in the Scientific Inquiry Course and provided in detail below.

Summer Research. The first formal research block occurs in the summer between the first and second years. This 2.5-3-month period is viewed as an immersive experience in which students are fully engaged in mentored research. The overwhelming majority of students partake of this opportunity, details of which are presented on the following pages. First year medical students are prepared for summer research participation through a combination of didactics, attendance at Responsible Conduct sessions, workshops, 1:1 meetings, and peer interactions coordinated by OSR. Similar to the exploratory rotations conducted by Ph.D. students, summer research is viewed as an opportunity to develop a project with the support of a mentor and is not necessarily expected to become the thesis project. Additionally, due to its limited scope and duration, students should not expect to generate sufficient data for a publication during this short period. Students whose summer research has led to a publication typically continue with their mentor throughout subsequent years. Another point to consider is that for some summer research topics, time constraints may necessitate the student working on a project designed by the faculty mentor. In this circumstance, the student should identify a piece of the work which they can lead independently.

Suggested timeline. It is suggested that students start thinking about their summer research during the fall of their first year for several reasons. First, the selection of a topic and mentor is a lengthy process. Second, developing a research question and establishing a protocol requires adequate time and effort. Third, some forms of research -- particularly human oriented work -- have specific regulatory or data needs that can take several months to address. Last, students wishing to compete for external funding may have deadlines preceding the OSR submission deadline by several months. However, while YSM

students are encouraged to start thinking about research shortly after arriving at Yale, they are by no means expected to participate in research until the summer after the MS1 year. In consideration of these factors, the suggested timeline for the vast number of medical students conducting research in New Haven* in the summer following the first year is as follows.

- 1) **September:** Complete the OSR Intake Assessment to provide information regarding experience, knowledge, skills, and goals.
- 2) **October - May:** Attend all Scientific Inquiry and Responsible Conduct of Research course sessions to gain an introduction to the YSM research program and support for developing the summer research project and (in the case of Responsible Conduct of Research) to be eligible for funding.
- 3) **November-February:** Identify 4-6 faculty and meet to discuss possible projects.
- 4) **January-March:** Decide on a faculty mentor and project.
- 5) **Mid-April:** Submit proposal for short-term funding to the Department Thesis Chair for review and signature.
- 6) **Early May:** Submit application approved in Step #6 due to OSR for review and final approval. Applications from students who have not completed the Responsible Conduct of Research sessions will not be approved for funding.
- 7) **June - Sept:** Receive funding and perform research.
- 8) **September:** Conclude summer research project and submit evaluation forms and research summaries to OSR.

*Due to logistical aspects of global health research, students planning to conduct global health research should select a mentor and develop the proposal much sooner (in November and December). Students performing Global Health should also explore the Downs Fellowship Program described below under [Global Health](#). Finally, students wishing to apply for external funding should familiarize themselves with sponsor deadlines and plan their research accordingly. As with all YSM students, completion of the Responsible Conduct of Research sessions is required for students seeking OSR funding for Global Health work. If there are any questions about any part of this timeline, please contact OSR.

[Thesis Research](#). As stated above, many students choose to use the summer research project as the basis for subsequent research and, ultimately, the thesis. An equal proportion choose to pursue a different field of thesis study under the supervision of a different mentor. Either of these tracks is acceptable. Students wishing to embark upon an alternate project for their thesis may identify a mentor using the methods described above. Additionally, students are often inspired by a clinical problem encountered during rotations. In this case, supervising attending physicians may be suitable mentors as long as they are full time Yale faculty.

Thesis research typically begins in earnest during the Advanced Training Period (ATP). Aside from the deadlines related to short term funding and thesis submission, there is no uniform timeline for research conducted during this period. Students are expected to use their skills as adult learners to develop a self directed timeline appropriate for their projects and should remember that data collection can take many

months. Additional time is then required for data analysis, and the preparation, submission, revision, and ultimately publication of the thesis and any manuscripts resulting from the project. Therefore, students are encouraged to work with their mentors to develop a realistic timeline for researching and writing the thesis. Questions and advice regarding research during the ATP can be directed to OSR. The timeline and deadlines for thesis preparation and submission for students graduating in 2022 are presented in the section [Thesis Requirement, Preparation, and Approval Process](#).

IDENTIFYING A MENTOR

In recognition of the fact that each student's research interest is unique, there is no one way to find a project or mentor. The topic of finding a research mentor is introduced in the SI course during the fall of the first year and is supported in numerous ways. Specific aspects of the mentor-mentee relationship are addressed in the first session of the Responsible Conduct of Research series that is required for receipt of research funds. Common methods include use of the Directory of Faculty Research Interests, available at <https://medicine.yale.edu/dfri/>. This directory is searchable using Medical Search Headings (MeSH), by keywords, or by individual faculty names. Another method is by searching the list of PIs and projects maintained by OSR which is available upon request, and by reviewing the database of mentored projects conducted by students in prior years. These lists are updated in real time and contain information regarding projects available to YSM students. Searching the research headings available on departmental and program websites is a method which some students have found very helpful. Search engines are another approach. Other students have found it useful to meet with the thesis chair of the department(s) in which they are considering research to find out about the different research groups working in a given domain. OSR arranges mentor discussion panels throughout the year, as do some student interest groups and departments. Upper year students are another important resource in this search. Mentor searches conducted after the clinical years commonly incorporate role models and experiences gained during clinical rotations.

It is recommended that students perform a preliminary mentor search and select between 4-6 individuals with whom to make preliminary contact. Students should then reach out via email requesting appointments to learn about current research and discuss possible research projects. Students should attend research group meetings and meet with research team members in the absence of the mentor to gain insight into the group's culture, climate, and operations. Medical students may use search engines to assess a given mentor's work and productivity to determine both the alignment of research interests and the likelihood of being able to publish their work. In light of the fact that the mentor is expected to provide financial support for all components of the student's research, depending on the type of research to be pursued, it is highly recommended that students work with a faculty mentor with sufficient extramural support. Therefore, medical students can leverage a federal listing of NIH grant recipients available at the NIH RePORTER website (<http://projectreporter.nih.gov/reporter.cfm>) to evaluate the mentor's funding. To expand the pool of mentors and projects available to students, OSR supports the development of mentoring teams comprised of junior and senior investigators.

Reading the evaluations of former students who have worked with that mentor and speaking with current or former students can be very helpful in making a decision. These evaluations are available in hard copy format in OSR. Finally, the student should then meet again with the chosen faculty member to develop a

proposal for the project. The faculty member should make every effort to orient the student to a practical research question that can be answered within the available time and, to the extent possible, should encourage the student to contribute to the project by formulating an independent and original question.

The Scientific Inquiry Course offers extensive instruction and support for students in their search for a mentor. These include formal didactics, workshops, and speaker panels. Finally, Drs. Chaudhry and Herzog are available to discuss options with individual students either during weekly office hours or at a mutually agreed upon time and location (virtual or in person).

DEVELOPING A MENTORED RESEARCH PROJECT

OSR adheres to the NIH definitions for research and research subcategories, wherein “research” is defined as, “a systematic study directed toward fuller scientific knowledge or understanding of the subject studied.” Most YSM students conduct research that falls into one of the following four categories, presented below alphabetically. If you do not see your area of interest listed, please contact OSR.

Basic/Laboratory Based Research. The NIH defines basic research consistent with the definition of basic research published [here in federal code](#) as, “systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind.” Because medical student research questions are designed to address a specific medical question, these studies may also be termed “laboratory based,” or “experimental,” to reflect their conduct in a scientific laboratory and the performance of experiments that generate quantitative data from biological substances. Hypothesis driven studies aimed at investigating biological processes conducted at the laboratory bench fall under the federal definition of STEM (Science, Technology, Engineering, Math) based, life sciences research as defined here https://www.nsf.gov/about/research_areas.jsp. These projects may involve methods including but not limited to cell culture, animal modeling, human biospecimens, and secondary analysis of large genomic datasets. Due to the significant costs and practical needs associated with laboratory research, students pursuing these studies should select identify mentors with expertise and resources (funding, space, personnel) sufficient to support the proposed work. Summer projects should have appropriate scope and aims to be conducted within the proposed period. Laboratory based projects pursued during the Advanced Training Period are likely to entail more detailed and comprehensive investigations of biological processes. Most students conducting these studies as part of the YSM thesis present their work at national conferences and publish at least one paper, often as first author, in peer reviewed medical journal during their time at Yale.

Clinical Research. The NIH defines clinical research as “a component of medical and health research intended to produce knowledge valuable for understanding human disease, preventing and treating illness, and promoting health.” Clinical Research embraces a continuum of studies involving interactions with patients, diagnostic clinical materials or data, or populations in any of the following categories: (1) disease mechanisms (etiopathogenesis); (2) bi-directional integrative (translational) research; (3) clinical knowledge, detection, diagnosis and natural history of disease; (4) therapeutic interventions including development and clinical trials of drugs, biologics, devices, and instruments; (5) prevention (primary and secondary) and health promotion; (6) behavioral research; (7) health services research,

including outcomes, and cost-effectiveness; (8) epidemiology; and (9) community-based and managed care-based trials. This comprehensive definition can be found in [this reference](#).

Clinical research can be “quantitative,” which uses numerical data to test hypotheses; “qualitative,” which uses non-numeric data to generate hypotheses and a deeper understanding of complex phenomena; or “mixed-methods” which combines qualitative and quantitative approaches, typically in a triangulated fashion, so that insights from the qualitative components inform the quantitative design. As with laboratory-based work, students interested in clinical research should identify mentors with expertise and resources such as funding (if applicable), personnel, infrastructure, access to patient cohorts and data to allow the proposed work. To maximize feasibility, summer projects should be designed with the goal of being completed within the three-month research block. Clinical projects conducted during the Advanced Training Period can be more far reaching and complex. Similar to basic/laboratory projects, students conducting clinical research often present their work at national conferences and publish at least first author paper in a peer reviewed medical journal.

Global Health. Global health research has been defined as “an area of study, research, and practice that places a priority on improving health and achieving equity in health for all people worldwide” according to [evolving definitions](#). The Yale Institute for Global Health (<https://medicine.yale.edu/yigh/>) formed by the Schools of Medicine, Nursing and Public Health at Yale, has a long tradition of providing students opportunities for mentored research in international settings. Practically, while global health is a form of clinical research, it presents a set of unique challenges that may not be immediately evident, including but not limited to: 1) Language and cultural competency, 2) Regulatory approval, 3) Dual mentoring (Yale and local), 4) Resource limitations, 5) Social/infrastructure constraints, 6) Personal safety, 7) Feasibility, and 8) Travel/visa restrictions.

YIGH has developed a Global Health Ethics Program (GHEP), that provides trainings in clinical ethics (led by Professor Tracy Rabin of YSM) and in research ethics (led by Professor Kaveh Khoshnood of YSPH) to Yale health professional students.

Please see link below:

<https://medicine.yale.edu/yigh/students/ghpep/>

We strongly urge medical students pursuing global health research projects to contact Professor Kaveh Khoshnood (Kaveh.Khoshnood@yale.edu) to learn about the pre-departure global health ethics training program before they embark on their research projects.

Yale provides support for global health projects in the form of the Downs Fellowship. In past years, students pursuing research in international settings are strongly recommended to explore the Downs program, which not only provides partial funding for research but offers invaluable logistical and safety training for students. The Downs Fellowship Website is https://publichealth.yale.edu/admissions_alumni/ape/downs/. Due to the on-going COVID-19 pandemic the 2021-2022 Downs program has not been finalized and students may contact the Downs Program Director, Leonard Munstermann, Ph.D., (leonard.munstermann@yale.edu) or the Assistant Director, Ms. Anjuli Bodyk, (anjuli.bodyk@yale.edu) at the Yale School of Public Health. Global health

research is conducted by many students each year and is often the basis for both the thesis and related publications.

Humanities and Medicine. Research in humanities, ethics, history, and related fields provides students with the chance to advance the study of medicine's place in society. Dual mentorship often is particularly appropriate to these topics and enables students to draw upon the rich faculty base available elsewhere in the University. The History of Medicine Department is an outstanding resource for these types of studies. In addition, the Medical Humanities and the Arts Council (<https://medicine.yale.edu/humanities/>) can help students select prospective medical school mentors and identify co-mentors from across the University whose primary faculty appointments are outside of YSM. Each year a small number of YSM students pursue this type of work as the basis for their summer project and/or thesis and publications. Medical students interested in pursuing a humanities-based research project should reach out to OSR.

Medical Education. The YSM Teaching and Learning Center was created in 2012. Their mission includes supporting and enhancing the work of YSM educators in medical education research and scholarship. The TLC is poised to guide medical students to experts in these fields when they are seeking a mentor for their thesis. The TLC faculty understand that medical education research is an important and discrete area of study with numerous and varied topics to investigate and they have the expertise in these unique methodologies, designs and statistical formulations. The TLC has trained and supported hundreds of YSM faculty, residents and students through their educator development programs such as the MHS in Medical Education Pathway Degree Program and the Medical Education Fellowship.

At this link you will find a document published by the [AAMC, Research in Medical Education – A Primer for Medical Students](#). This article published in 2015 outlines some of the opportunities that are open for you to study in this broad and exciting field of research.

Contact the YSM Teaching and Learning Center for more information: tlc@yale.edu.

APPROACH TO DEVELOPING A PROJECT

When the area of investigation has been agreed on by the faculty preceptor, project development begins. Here the student is expected to explore the literature to identify a clear knowledge gap that can be filled by the proposed research and to then formulate an investigative protocol and experimental plan. This step provides a unique opportunity for tutorial instruction in experimental design. All research plans should adhere to high standards of rigor and ethics. In addition, as relevant, projects should adhere to NIH research requirements related to rigor and reproducibility and the appropriate conduct of research, which will be taught in the SI and RCR courses this year. Faculty members who assume responsibility as preceptors should provide the amount of guidance that is necessary in design of the investigation.

Principles that apply to many types of projects

- 1) **Perform a literature search** The goal of the literature search is to understand the current state of a given field and to identify key knowledge gaps that your project may address. The Cushing Whitney Medical Library offers students access to all major databases, with the most commonly used medical database being Medline (also called "PubMed," available here:

<http://www.ncbi.nlm.nih.gov/pubmed/>). PubMed is housed within the National Library of Medicine and uses MeSH headings. OSR recommends that you meet with the Medical Librarian who has been assigned to support you as you begin this process

2) **Specify a Clear Question** Excellent research begins with an excellent research question through literature review and mentor discussions. Ideally, the research question and specific aims should be original and of sufficient significance that any answer is important and will advance the field. Research projects may collect new data or analyze existing data or publications (e.g., meta-analysis). If you and your mentor are unsure as to how your project can ask a question and generate outcome measures, please contact OSR. Below, we have outlined a sequence for developing a quantitative research project. While

we realize these steps do not apply to some forms of qualitative research and projects in the medical humanities, they are intended to illustrate a rigorous approach to developing a research proposal. Certainly, some steps, such as starting with an impactful question, developing a clear study protocol, and plans for data collection and management apply to nearly all types of research.

3) **Frame a hypothesis** In the case of hypothesis driven research, convert the question to a hypothesis by asserting a position. This will lead directly to a consideration of measures, both of exposure and outcome. Because qualitative research is hypothesis generating, this step does not apply for this type of work.

4) **Generate measures of exposure and outcome** This step is facilitated by an additional review of the pertinent literature. How have other researchers defined/measured the exposure and/or outcome? The effort to generate meaningful measures will generally require a return to the question for refinement, and narrowing (i.e., expressing the question in terms of the specific exposure of interest, and the specific outcome anticipated).

5) **Construct an experimental approach and research protocol** How can the specific aim(s) be accomplished? The first requirement is that a comparison be made. Here, too, a search of the literature for methods will be helpful. Choosing the right control group is challenging, and at times subtle. Once the comparison group is selected, the magnitude of expected difference should be estimated as a basis for determining sample size (power calculation).

6) **Revise and refine** In light of the design deemed most appropriate, revise measures of exposure and outcome as required. For example, in a prospective study you can choose how to measure factors of interest, whereas in a retrospective study you will need to rely on measures obtained in the past, or by participant recall.

7) **Develop an analytic plan** When the results of an investigation lend themselves to quantitative analysis, the student should develop a prospective and robust plan for statistical comparison. Personal involvement in the conduct of research will aid the iterative process and support the pedagogical goals of the research experience. Students should be adequately equipped for basic statistical work through the Biostatistics Coursework offered as part of EPH&B. Advanced work may require the aid of a biostatistician for assistance in statistical methodology performed with the support of the mentor. Ideally this support will augment the MS1 and MS2 coursework and will enable the student to learn the value and limitations of statistical analysis as an aid to interpreting the results of an investigation. Drs. Chaudhry and Herzog are also able to answer questions and provide advice if needed. Finally, students may also take advantage of [Yale's Prevention Research Center \(PRC\)](#), located off-campus in Derby. This facility is a resource for students needing assistance with data management and/or statistical analysis, survey development and validation, as well as refinement of clinical study methodology. The PRC data management staff will work with students to perform statistical analysis using a variety of software packages. Referrals can be provided as needed to additional resources available through the computer labs at the Yale Schools of Public Health, and Management. The contact is Dr. Valentine Njike, Assistant Director, Research and Evaluation, at valentine.njike@yalegriffinprc.org.

8) **Determine feasibility** Once your measures are established, determine the appropriate sample size, methods of analysis, and plans for replication. A plan for the generation, collection, and management of data should also be developed. Now is the time to assess feasibility. Specifically, the

following question should be addressed: Can the outcome events be observed and suitably analyzed using the proposed methods in the available time.

9) **Plan for Dissemination to Stakeholders** An additional consideration is how the results will be disseminated to communities of interest. Dissemination to other scientists usually occurs through presentation scientific at meetings and publication in peer reviewed medical journals. Dissemination to patients and community groups may be achieved through meeting with community leaders or providing access to a summary of findings. Students are recommended to consider how their work will impact these groups.

We recognize that research in the humanities will differ from the path outlined above. If you are interested in conducting humanities research, please contact OSR for support with project development.

Additional Considerations

In an effort to ensure that student research projects are conducted in accordance with regulatory and ethical standards and that they are impactful as possible to our patients and other stakeholders, OSR provides guidance in the following areas.

1) **Ethical Conduct** Ethical conduct is central to any research project and should be incorporated into all studies. Instruction in research ethics will be provided in the Responsible Conduct of Research Course throughout the 2021-2022 semesters.

2) **Regulatory Requirements** Most forms of research are subject to regulatory oversight by the university. Laboratory based projects generally require completion of relevant Environmental Health and Safety (EHS) training. Animal research must be approved by the Institutional Animal Care and Use Committee (IACUC) training. Clinical research involving human subjects must be approved by the Human Research Protection Program (HRPP, formally known as Human Investigation Committee) at YSM. The Scientific Inquiry course will review these requirements, all of which are available on the Yale TMS Training and Certification website available here: [Yale TMS Training and Certification website](#). It is the responsibility of the mentor to ensure that students are approved to work on all relevant protocols and to ensure compliance with institutional guidelines, including secure data management and all HIPAA requirements. Discussion of regulatory requirements will be provided in the Responsible Conduct of Research Course throughout the 2021-2022 semesters.

3) **Data access and management** Most research projects are expected to generate some form of data. For projects proposing use of an existing dataset or resource, students should confirm that the dataset is in existence and will be available for use. Students are encouraged to work with their mentor to identify the appropriate method for storage and transfer of datasets. OSR highly recommends students use Yale-approved managed workstations and data encryption methods and/or cloud-based storage systems. As a reminder, google drive is never appropriate for storage of confidential, sensitive, or HIPAA protected data. Furthermore, Yale ITS prohibits the storage of protected health information (PHI) on personal laptops. For more information, see <https://cybersecurity.yale.edu/protectyourdata> and <https://docs.ycrc.yale.edu/data>. As a reminder, the faculty mentor is ultimately responsible for ensuring that all data are securely managed in compliance with relevant local and federal regulations. Data Acquisition and Management will be addressed in the Responsible Conduct of Research Course offered in in Spring 2022.

4) **Joint Projects Are Not Acceptable** A project conducted jointly by two or more students is not acceptable. This does not mean that they may not work on related problems, but each student should have the experience of carrying out an investigation from beginning to end on their own initiative.

5) **Rigor and Reproducibility** The goal of OSR's research program is to educate students in the conduct of ethical research that is both rigorous and reproducible. Rigor is the strict application of methodologies in order to achieve unbiased, well controlled experiments that are analyzed, interpreted, and reported appropriately. Rigor is the cornerstone of reproducibility, which denotes the property of a result being repeated and confirmed by multiple scientists working independently. These facets are considerations in all forms of basic/laboratory based and clinical research. Therefore, OSR requires that all research projects adhere to NIH standards which can be found here: <https://grants.nih.gov/policy/reproducibility/index.htm>. The Scientific Inquiry Course will offer a session on "Rigor and Reproducibility" in Spring 2022. This component is also thematically addressed in numerous sessions of Responsible Conduct of Research. If you and your mentor are unsure as to how the concepts of rigor and reproducibility apply to your particular project, please reach out to OSR.

6) **Sex and Gender** The 1993 NIH Revitalization Act (PL 103-43) included a Clinical Equity Provision requiring that women be considered as participants in NIH-supported clinical research. Implementation guidelines were placed in the Federal Register in 1994 and the most recent policy can be found here: <https://grants.nih.gov/policy/inclusion/women-and-minorities/guidelines.htm>. In 2001 current definitions of sex and gender were developed, with sex as a biological classification and gender as self-representation or sociocultural identification. Discussion of appropriate handling of sex and gender in research will be discussed in the Scientific Inquiry Course in Spring 2022.

7) **Race** The above provision also stipulated that minorities be considered as participants in NIH sponsored studies. Considering this dictum, all clinical research that includes race as an analytic variable should consider the following aspects which will be addressed in the Fall 2021 Scientific Inquiry Course. First, there should be clear explanation of whether race is being included to reflect political categorization, cumulative physiological impact of experiences of interpersonal or structural racism, or as a proxy for genetic ancestry. Second, when race is included in a model, clearly explain the hypothesis or perceived confounding relationship and how a finding of an association or mitigation of the outcome would be interpreted. It is also important to consider the role that racism may have in the findings. Finally, students should consider whether there is any potential for racial bias in participation in the research and its benefits. If you are unsure as to the appropriate consideration of race in your study, please contact OSR.

8) **Authentication of key biological/chemical resources** Projects conducted in the laboratory employ the use of key biological and/or chemical resources to complete the aims. According to current NIH policy, which can be found here: <https://grants.nih.gov/grants/guide/notice-files/NOT-OD-17-068.html>, these entities include but are not limited to: "cell lines, specialty chemicals, antibodies and other biologics...[these resources] 1) may differ from laboratory to laboratory over time; 2) may have qualities and/or qualifications that could influence the research data; and 3) are integral to the proposed research." Consistent with current NIH guidelines, projects must include information regarding the authentication of these entities. Authentication of resources will be discussed in the "Responsible Conduct of Research" Series in Spring 2022.

9) **Additional Considerations** We have attempted to highlight the most relevant considerations in research design and conduct. If you need help with an issue that is not addressed above, OSR will be happy to support you so please reach out with questions.

FUNDING FOR STUDENT RESEARCH

Once the project is ready to submit, the next step is submitting to OSR for funding. Here, the student and mentor should complete and sign the appropriate application form. This form and the proposal document should be sent to the thesis chair of the department in which the mentor holds their primary faculty appointment. The thesis chair submission deadline precedes the OSR deadline by two weeks (see below). The thesis chair will review the application, provide feedback (if needed) and sign the application form. Students should then submit the completed application to OSR. Students are encouraged to do their utmost to meet these deadlines in order to develop the habit of self-accountability that is required of physicians. However, it is recognized that circumstances may arise for the student or mentor that warrant an extension. In this case, students should contact their thesis chair with the request. Please note that applications from students who have not completed Responsible Conduct of Research cannot be considered for funding.

The Office of Student Research provides three types of stipend support for student investigators.

1) **Summer Research** Summer research stipends are awarded specifically to students between the first and second year. Students are required to conduct three months of mentored research. The current amount for 2022 is \$6,459 for a three-month term. Because the NIH typically updates stipend levels early in the year, this amount may be subject to change.

2) **Short-term Research** Short-term stipends are awarded for specific blocks (1-3 months) during the academic year when full-time research is performed during the Advanced Training Period. *Please note that students in their fourth year are not eligible for the short-term research stipend while participating in the Capstone project. The final funding cycle for students in their fourth year is during the months of September through November of the student's expected year of graduation.* These awards are funded at a level of \$2,153 per 4-week block and are supported by a variety of organizations (NIH, private donors, and University funds). Similar to the summer funding, because the NIH typically updates stipend levels early in the year, this amount may be subject to change. Students wishing to receive short term research funding from a Yale-administered fund must complete the Responsible Conduct of Research courses.

3) **One-year Medical Student Research Fellowships** Students choosing to pursue a fully funded fifth year of research are eligible for stipend support provided by OSR. Depending on the source, the stipend value is \$25,836 - \$37,000. As with the short term and summer funding support described above, these stipends derive from numerous sources (NIH, private donors, and University funds). Students considering a fully funded fifth year of research should contact Anne Kellett in the Office of Student Research to discuss the process and obtain information regarding applications for funding. Additional information can be found on OSR's [one-year funding website](#). Students wishing to pursue a one year medical student research fellowship from a Yale-administered fund must complete the Responsible Conduct of Research course series.

Deadlines

1. Summer Research Deadlines. Because these deadlines usually fall amidst other important deadlines and exam dates, students are encouraged to start on their applications early and to plan accordingly. Students who are unable to meet either deadline should contact their Departmental Thesis Chair for an extension.
 - a. April 22, 2022 - Department Thesis Chair
 - b. May 6, 2022 - Office of Student Research
2. Short-term Research Deadlines (2021-2022). Please submit these applications to the Departmental Research Chair two weeks prior to the OSR deadline to allow sufficient time for review and processing. In order to maximize student opportunities for research and minimize the need to submit multiple applications in the same year, we are now offering students the option to submit a single funding application for multiple quarterly funding cycles. If desired, students may include all anticipated dates on a single application. As with all applications, students will be required to confirm their schedule prior to disbursement of funds and to submit quarterly progress reports to ensure continuation of funding. Students must apply prior to the start of their research. No electives, clerkships or vacations may be taken during the research period you are applying for. Students will not be reimbursed for research that was done prior to an application period which was not pre-approved by the Office of Student Research.
 - a. August 6, 2021 – Office of Student Research (Research Sep; Oct; Nov.)
 - b. November 5, 2021 – Office of Student Research (Research Dec; Jan; Feb.)
 - c. February 4, 2022 – Office of Student Research (Research Mar; Apr; May)
 - d. May 6, 2022 – Office of Student Research (Research Jun; Jul, Aug)
3. One year-funding deadlines
 - a. The numerous one-year funding opportunities have varying deadlines which can be found here on the [one year funding section of the OSR website](#). Please contact OSR for more information.
4. External short-term funding
 - a. External sponsors have deadlines occurring throughout the year. External funding websites contain links to numerous funding opportunities. These applications require administrative coordination from OSR to meet Yale’s internal processing deadlines, which generally precede those of the sponsor by up to 7 days. If you are interested in applying for an external funding award, please contact OSR. Additional information can be found [on the OSR website](#).

Research Performed Outside of Yale University Some students wish to conduct in-person research at an institution other than Yale. OSR allows this, but students should be aware of the following.

First year students. There are many reasons why it is preferable for MS1s to conduct their summer research under the mentorship of a Yale faculty member. Close to 3,000 YSM faculty members are qualified to act as mentors. These individuals’ understanding of the Yale system will maximize the student’s opportunity to receive an excellent research education. You also have access to the numerous educational opportunities available to medical students such as APCR and seminars sponsored by OSR and YSM. Remaining on campus for the summer research experience will foster collaboration and

closeness between classmates. Finally, funding in the summer of the first year is provided from training grants and Yale funds. Regulatory and institutional requirements for many of these sources stipulate that work be done with Yale investigators with Yale oversight.

For these reasons, students are advised to begin their work at Yale with a Yale mentor in the summer of the first year. Students performing research at another institution are responsible for obtaining ½ (50%) funding from the other institution. Additionally, for several reasons it is still necessary to have a Yale sponsor before completing the arrangements elsewhere. First, the Yale faculty sponsor (and sponsoring department) will be responsible for approving your application for 50% funding from OSR. Second, in the event that work done elsewhere results in the M.D. thesis, this individual will serve as the local thesis sponsor and will have the thesis reviewed in their department at Yale.

Obtaining funding from another institution: If the investigator at another institution is well funded, they should demonstrate their commitment to you and your project by readily funding half or all of your application. If they are not willing to do so, then you should reconsider. Please note that students conducting their work at an outside institution should not be employed as research technicians or be expected to perform duties normally expected of an employee. Students should recognize that it is greatly preferable to begin the work at Yale in the summer of the first year.

Research at an outside institution done after the first year Students performing research at another institution other than the summer of the first year (3rd, 4th, or 5th year) can receive full stipend funding from the Office of Student Research if the application for research funding is approved by a Yale faculty sponsor who commits to reviewing the thesis and submitting the work in their department. Because these projects often serve as the basis for the thesis, students applying for external funding are highly encouraged to identify a Yale sponsor for their research.

This policy applies to both short-term funding and one-year medical student research fellowships, which for some pullout fifth year programs (Sarnoff, Yale Sponsored, etc.) can also be completed at other institutions.

Considering Yale-based Summer and/or Thesis Research Outside of the Medical School A student may wish to perform research under the supervision of a qualified full-time Yale investigator who does not have a YSM faculty appointment. This type of arrangement is acceptable and requires that a full time YSM faculty member serve as a faculty sponsor. The same regulations concerning the dates of submission and review by the appropriate (Departmental Thesis Chair apply to this situation. In the case of summer projects, the YSM sponsor will be responsible for approving the proposal for funding, serving as the “host” department, and ensuring regulatory approval. In the case of the thesis, the YSM faculty member will be responsible for signing off on applications for funding (if applicable), reviewing the progress of the thesis with the student, reviewing the written thesis, and providing faculty approval. The thesis will be reviewed by the Department Thesis Committee of this faculty member’s department.

Summer Didactics Over the years, students have requested formal summer didactics to support their research work. Several years ago, at the recommendation of students, YSM’s Education Policy and Curriculum Committee (EPCC) established a requirement that students conducting any form of digital research participate in the Applied Principles of Clinical Research Sessions in the summer. With the

exception of those students conducting wet-lab research, all students receiving funding from OSR are required to take APCR as part of their summer research experience.

The Applied Principles of Clinical Research (APCR) seminar series provides applied instruction to students conducting summer clinical research studies in the form of ten 90-minute small group experiential learning modules. The seminar allows for a personalized reflection on their research and the application of first year coursework to their own project. The result is intended to embed a functional understanding of the conduct of research that better prepares them to critique and conduct clinical research.

Students involved in basic/laboratory-based research have the opportunity to receive education in laboratory-based methods at the Intensive Pedagogical Experience (IPE). This course consists of a combination of large group didactics, small group sessions, and moderated presentations tailored to topics of relevance to student projects. Students interested in an 8-12 week intensive course in basic research at the Marine Biological Laboratory in Woods' Hole, MA, should consider partaking of The Jack & Francine Levin Yale-at-MBL Student Research Fellowships Program, which is described here <https://medicine.yale.edu/education/research/summerresearch/>.

ONE YEAR MEDICAL STUDENT RESEARCH FELLOWSHIPS

The School of Medicine offers all students the opportunity to pursue a fifth year of medical school devoted exclusively to research funded by a formal One Year Student Research Fellowship. This Student Research Fellowship Program is facilitated by charging no tuition for the extra year and by the provision of a limited number of stipends that can be paid to students. In 2021, nineteen students will receive full one-year fellowships. These stipends are available on a competitive basis and students are eligible to apply after completion of their clinical rotations. One year fully funded fellowships administered by OSR require a Yale faculty sponsor. Furthermore, because these experiences often serve as the basis for the YSM thesis, students applying for external fellowships through mechanisms other than OSR (NIH, Sarnoff) are strongly encouraged to identify a Yale faculty mentor to serve as their sponsor and local mentor. Separate details and deadlines on these fellowships can be found here <https://medicine.yale.edu/education/research/student/fundingop/oneyearfellowships/>. Currently available funding sources include but are not limited to: YCCI Multidisciplinary Pre-Doctoral Training Program, Sarnoff Foundation, National Institutes of Health, American Heart Association, and Yale sponsored funding. A directory of additional external funding opportunities is maintained on the OSR website. Because these grants are administered through Yale, OSR must invest a significant amount of time and paperwork in preparing these applications. Therefore, students contemplating this form of research support should reach out to Anne Kellett in OSR. Finally, all stipends are paid directly to the student and are considered taxable income. Any questions regarding tax implications should be referred to a qualified tax specialist.

JOINT DEGREE PROGRAMS

[Joint M.D./M.H.S. Degree Program](#) Yale School of Medicine and the Office of Student Research offer a joint degree, the M.D.-Master of Health Science (M.D.-M.H.S). Since its inception in 2006, 229 students have graduated from this program, with 11 currently enrolled. Students enrolled in this program must complete specific coursework and perform research under the guidance of a three-person M.H.S. committee. M.H.S. research also serves as the M.D. thesis and is subject to the M.D. thesis regulations

concerning content, [content, organization](#), and [submission dates](#).

Requirements:

1. Research conducted in the fifth year is the centerpiece of the M.D.-M.H.S. This project serves as the basis for the M.D. thesis and is governed by the regulations concerning content, organization, submission dates, and approval process outlined in section [Formal M.D. Thesis Requirement](#).
2. The student must develop a supervisory team comprised of the project mentor and a two or more-person M.D.-M.H.S. committee that operates similarly to a Ph.D. dissertation committee. This plan and its members must be approved by the Office of Student Research and the M.D.-M.H.S. Advisory Committee.
3. Each pathway requires the completion of specific coursework.
 - a. Clinical research pathway – Courses: IMED 625 Principles of Clinical Research; IMED 645 Introduction to Biostatistics in Clinical Investigation; Sect Ed 501b Responsible Conduct of Research (during M.H.S. year)
 - b. Basic/Laboratory research pathway – Courses: Sect Ed 101 Intensive Pedagogical Experience in Techniques and Strategies for Laboratory Research (or a replacement approved by OSR such as Selected Seminars in CBB 740a Clinical and Translational Informatics, Participation in the Yale-MBL program, or a suitable elective of topical relevance); Sect Ed 501b Responsible Conduct of Research (during M.H.S. year).
 - c. These courses can be taken prior to or during the M.H.S. year.
4. Participation in monthly seminars, journal clubs, Leadership in Biomedicine lectures and dinners, and other announced activities throughout the M.H.S. year.

[Joint M.D./M.P.H. Degree Program](#) For students in the M.D./M.P.H. Program, one thesis satisfies both degree requirements, provided it is approved and carried out under a Yale faculty member of the Department of Epidemiology and Public Health and is in an appropriate subject area. The same regulations concerning content, organization and dates for submission of the M.D. thesis and review by the appropriate departmental committee will apply.

[Joint M.D./J.D. Degree Program](#) The Yale School of Medicine has a formal relationship with the Law School to allow students to seek degrees from both schools. A focused M.D. thesis, answering a significant question of medical relevance and meeting all requirements of the standard M.D. thesis, is required for the M.D. portion of the degree.

[Joint M.D./M.B.A. Degree Program](#) The purpose of the joint-degree program in medicine and management is to develop clinician-managers capable of pursuing careers that balance delivery of patient care with sound management in a changing healthcare environment. The joint-degree program normally requires five years of study and simultaneous award of the degrees of Doctor of Medicine and Master of Business Administration at the conclusion of the five-year period. A focused M.D. thesis, answering a

significant question of medical relevance and meeting all requirements of the standard M.D. thesis, is required for the M.D. portion of the degree.

Joint M.D./M.Div. Degree Program Students who have been admitted to the Yale School of Medicine and are enrolled for the M.D. degree may apply to the Divinity School or admission to a combined program leading to the degrees of Doctor of Medicine and Master of Divinity. The joint program is tailored to the individual interests of students seeking professional education and training in a theological understanding of the self, society, and work; in bioethics; in international health and missions; in hospice or similar patient-care facilities; or in academic work in teaching, counseling and chaplaincy. A focused M.D. thesis, answering a significant question of medical relevance and meeting all requirements of the standard M.D. thesis, is required for the M.D. portion of the degree.

RESPONSIBILITY OF FACULTY MENTORS

Overview. Role modeling and supervision during formative years are critical to success. Therefore, OSR encourages a close working relationship between the student and faculty research mentor. Best practices for mentor-mentee relationships are addressed in the Responsible Conduct of Research Course offered in Fall 2021. Practically, the faculty advisor is responsible for providing the research infrastructure (space, equipment, supplies, data, cohorts, etc.). In order to ensure and support high quality research mentorship, the Yale Center for Clinical Investigation offers formal training which can be found at <https://medicine.yale.edu/ycci/education/mentoring/mentortraining/> based on the curriculum for the Center for the Improvement of Mentored Experiences in Research. In addition, the OSR directs all mentors to the “Optimizing the Practice of Mentoring,” an open source online curriculum offered by the Clinical and Translational Science Institute at the University of Minnesota <https://www.ctsi.umn.edu/education-and-training/mentoring/mentor-training>. OSR is working with YSM to develop guidelines governing the research mentoring of medical students. The below list is not intended to be all inclusive but, rather, presents the most critical responsibilities.

Specific responsibilities of Mentors

1. Faculty members should adhere to high standards of ethical and professional conduct and follow all institutional policies and procedures
2. The faculty mentor should orient the student to a feasible question that can be addressed within the available time. This usually requires multiple meetings with the student, culminating in a project and protocol.
3. The student should develop with the faculty mentor their own project (although others may participate) and should eventually be encouraged by the faculty mentor to be first author on abstracts and publications.
4. The student should not be assigned as a research technician to accomplish someone else’s project in the lab, as a clinical research assistant on a clinical trial, or to duties lacking pedagogical merit.
5. The faculty mentor should invest sufficient time in the student, including weekly meetings to discuss results and, where necessary, help to focus (or refocus) the direction of the project.
6. The faculty mentor is responsible for all research expenses (i.e. space, resources, and facilities) and the supervision of the student’s work

7. The faculty member is responsible for assurance of compliance with all relevant research regulations and data security procedures, as well as for arranging student's research access to the electronic medical record and other data resources.
8. The faculty mentor must review, approve and sign the application for funding prior to submission to the Department Thesis Chair
9. In the case of the medical student thesis, the faculty mentor is the first reviewer and provides the initial approval of the thesis as submitted for graduation. (For more information see "[Thesis Approval Process](#)")
10. The faculty mentor should plan to attend Student Research Day activities which will is currently scheduled for May 10, 2022.

THESIS REQUIREMENT, PREPARATION, AND APPROVAL PROCESS

Formal M.D. Thesis Requirement All students at Yale School of Medicine engage in research and are required to write an M.D. thesis during medical school. The only exceptions are students who have earned a Ph.D. degree in the health sciences before matriculation and students enrolled in Yale's M.D.-Ph.D. program. The YSM M.D. Thesis is under the governance of the YSM Thesis Committee, which meets regularly to recommend policy to the Curriculum Committee for all aspects of the Thesis requirement. Specifically, rules, regulations, and deadlines are established. The Committee also serves as the Thesis Awards Committee, acting as a reviewing body to determine oral presentations at Student Research Day, graduation thesis prizes and guidelines for the awarding of prizes. The 2021-2022 Thesis Committee Roster will be posted in November 2021.

Thesis Preparation and Approval Preparation for thesis submission begins in the fall of the fourth year with the OSR leadership. At this time, the following timeline and practices are reviewed with students. Because thesis approval is a lengthy process involving three levels of review (See Table 1), students are encouraged to manage their time well and start writing their first draft early in the fall semester of their final year of medical school. A suggested timeline is provided below.

First level	Student/Thesis Advisor
Second Level:	Departmental Review and approval
Third Level	OSR review and approval

Table 1. M.D. Thesis review components

August: All students expecting to graduate in May of a given year must, in August of the preceding year, provide OSR with information regarding their thesis title, advisor, and sponsoring department. Students will receive an email from OSR containing a Qualtrics link and should be prepared to provide this information by early September.

August – December: During this time, students should be conducting research and writing their thesis draft. As the semester progresses, activities should shift from the generation and analysis of data to the writing of the actual thesis. Students should do their best to complete the first draft of the thesis by mid-late December. Because students are also involved in the residency application and interview process, they are discouraged from starting new projects at this time.

December – January: This period is devoted to reviewing and editing of thesis draft that is ultimately approved by the faculty mentor and submitted by the student to the Thesis Chair of their sponsoring department. The YSM faculty advisor must also provide a formal letter (or email) to the Department Thesis Chair that includes 1) an explicit statement regarding the originality and significance of the work; 2) explicit information regarding the student’s role in the project; 3) explicit approval of the thesis; 4) an explicit statement regarding whether the thesis is sufficiently extraordinary to warrant consideration for a Thesis Prize (see below). To avoid potential bias in review, the letter must be anonymized by referring to the student by initials only (e.g. “S.C.” instead of “Sarwat Chaudhry”), and gender blinded by using non-binary pronouns (e.g., “their” instead of “she/he”)

January – February: The Departmental Thesis Chair coordinates review of the thesis by at least one external reviewer. An “external reviewer” is defined as an individual who is not directly involved in the project. This individual may be a Yale faculty member internal or external to YSM, or may hold a faculty appointment at an outside institution. This reviewer is strongly urged to meet with the student to discuss their comments and suggestions and is required to provide an anonymized and gender blinded (see above) written critique to the Department Thesis Chair.

February: Changes recommended by the reviewer(s) are then incorporated into the final thesis. The student should then submit the final thesis to the Departmental Thesis Chair, who convenes a committee to 1) evaluate the thesis using the evaluation form shown in Appendix B and to approve the thesis for graduation and 2) nominate selected theses for prize consideration (see [Thesis Awards](#)). The Thesis Chair then provides the student and OSR with written notification that the thesis is approved in partial fulfillment of the YSM graduation requirements.

March-April: Following final approval, students should assemble their thesis as a high-quality PDF and proceed with submission to the YSM Digital Thesis Library via ProQuest (see [Instructions for Uploading a PDF](#)).

Thesis Deadlines for the 2021-2022 Academic Year

Class of 2022 Thesis Deadlines	
Deliverables	Deadline
First draft presented to thesis advisor	Rolling deadline between December 17, 2021 and January 3, 2022 (December 17 th is recommended)
Final draft submitted to Departmental Thesis Chair for review and approval (with anonymized, gender blinded approval letter from faculty advisor)	January 21, 2022
Department Thesis Chair Approvals and Honors nominations due to Office of Student Research	February 25, 2022
Final Thesis (Honors Nominees Only) PDF to Student Research	March 4, 2022
Submission of approved, final version of thesis to the library via ProQuest (all students meeting the above deadlines)	March 11 2022, or within two weeks of receiving Department Thesis Chair Approval and no later than April 22, 2022
Students missing the January 21st deadline <u>will be ineligible for honors, prizes, or <i>Cum Laude</i> at graduation</u> (see below).	

Extensions beyond the above thesis deadlines will be made only for special circumstances and must have the approval of the student's thesis advisor, academic advisor, and the Departmental Thesis Chairperson. Such extensions, if granted, will carry the following ABSOLUTE Class of 2022 Thesis Extension Deadlines.

Class of 2022 Thesis Extension Deadlines	
Deliverables	Deadline
Submission of final draft to Departmental Thesis Chair for review and approval (with approval letter from faculty advisor)	March 25, 2022*
Submission of approved, final version of thesis to medical library via ProQuest	April 22, 2022*
*PLEASE READ CAREFULLY: Any student whose thesis is received after the above Class of 2022 Thesis Extension Deadlines is at risk of not graduating and/or not starting residency on time.	

M.D., Ph.D. students For students enrolled in the combined M.D./Ph.D. Program, the doctoral thesis submitted to and approved by the Graduate School will serve in lieu of the M.D. thesis requirement. Here it is important to note that the Graduate School awards degrees twice a year, in late fall (November or December, depending on the Corporation schedule) and May. In order to guarantee consideration by the appropriate Graduate School Committee on Degrees, the dissertation must be submitted by October 1 for a fall degree, or March 15 for a May degree. To ensure compliance with YSM graduation deadlines, M.D., Ph.D. students should submit their dissertation directly to OSR concomitant with its submission to the graduate school. OSR will convene a committee to review the dissertation. If approved by this committee, OSR will accept the dissertation in lieu of the M.D. thesis. Students will receive formal feedback and have the opportunity to revise the work before receiving final approval. This thesis should then be uploaded into the [Yale M.D. Thesis Library via ProQuest](#). Please contact OSR with any questions regarding this workflow.

THESIS AWARDS

The central role of the medical student thesis is to educate students in the application of rigorous methodologies and creative self-discipline to the asking and answering of a specific question. As such, all students are expected to produce an excellent piece of scholarly work. It is recognized that some theses may be truly exceptional and, as such, merit consideration for a prize at graduation. The basis for this recognition includes the thesis being an outstanding work based on original observations made by the student. Up to 30% of theses in a given department (or more, at the discretion of the Departmental Thesis Chair), maybe submitted for honors. Additionally, many departments recognize outstanding submission with a “Departmental Honors” designation. Copies of the nomination forms and YSM Thesis Committee Score Sheet are included as Appendix Items B, C, and D respectively. Students who believe there may have been bias in the review of their thesis should directly contact OSR to request a formal appeal of the departmental decision.

REQUIRED COMPONENTS AND FORMATTING OF THE FORMAL M.D. THESIS

In general, one topic is appropriate for the thesis, but it is recognized that some students may have performed several projects in parallel under the supervision of their mentor. If the student elects to include more than one study in the thesis, it is recommended that an attempt be made to integrate the topics into one coherent presentation. In rare cases where this goal cannot be achieved, it may be acceptable to divide the results section into different portions (or “chapters”). However, to be consistent with Yale formatting requirements, a thesis may not contain more than one abstract, introduction, statement of purpose, methods, results and discussion section. It is not acceptable to

submit a published or submitted manuscript in lieu of the thesis requirement. The formal thesis is presented as a digital document (PDF) during the graduation year. It must adhere to the following formatting and content requirements. These aspects of research are critical in making the work sound, error-free, and impactful for communities of interest. Recognizing that students may have uncertainty regarding how these guidelines relate to their thesis, OSR will be happy to answer any questions that may arise. Additionally, students may find it useful to consult [reporting guidelines](#) to enhance the quality and transparency of their theses.

Formatting

- 1) **Font:** 10-12-point font should be used.
- 2) **Line spacing:** Body paragraphs and tables should consist of double spaced text. Single spaced text may be used within block quotations, footnotes, and bibliography.
- 3) **Margins:** 1.5-inch margins on the left with one-inch margins on the remaining three sides. These margins apply to text, full-page images and illustrations, and tables.
- 4) **Figures:** Illustrative information, schematics, and representative data should be included as figures. Each panel in a figure should be labeled. Legends should describe each panel in detail in a 9-point font or greater and positioned below the figure to which they refer.
- 5) **Page Numbers:** Each page in the thesis should be numbered except the title page, table of contents, abstract, and acknowledgements. The numbering should start at 1 and be placed either at the top center or at the top right-hand corner at least 1/2 inches from any edge.
- 6) **Minimal page requirement:** Most Yale M.D. theses average 40-80 pages of text. A minimum of 30 pages of text excluding figures, legends, and references is required.

Required Components

- 1) **Title page:** Title should not exceed 100 characters including spaces between words as shown in Appendix Item D.
- 2) **Abstract page:** As described on pages 35-36 and Appendix Item E.
- 3) **Acknowledgements:** Personal and faculty acknowledgements, grant support, departmental support, etc.
- 4) **Table of Contents:** with page numbers for each section.
- 5) **Introduction:** A thorough, complete, detailed, critical review of the literature that contextualizes and cites the work of previous investigators. This section should describe the state of the existing knowledge, provide rationale for the study, identify knowledge gaps, and frame the contribution of the thesis to medicine.
- 6) **Statement of purpose:** Specific hypothesis if appropriate, and specific aims of the thesis.
- 7) **Methods:** Thorough description of valid and rigorous study design.
 - i. **Student Contributions:** Describe in detail exactly which procedures, methods and experiments were conducted by you and which procedures, methods and experiments, generation of data, or production of reagents, were performed by other members of the study team. It is not sufficient to state that this information may be mentioned elsewhere. It must be

summarized here. It is recognized that students may often be completing a portion of a larger work. A statement detailing precisely what was done by the student and what was done by others does not detract from the thesis but is necessary for academic honesty.

- ii. **Ethics Statement:** Include information regarding the ethical conduct of research.
 - iii. **Human Subjects Research:** If relevant, include explicit information regarding Institutional Review Board approval and informed consent. If the study had a waiver of consent, this exception must be clearly stated. Information regarding inclusion of women and minorities as research participants should be included here.
 - iv. **Laboratory Animals:** For studies involving laboratory animals, include an explicit statement regarding study approval from the Institutional Animal Care and Use Committee. Include information regarding the species, strain, sex, and age of laboratory animals in this section as well.
 - v. **Methods Description:** Provide information regarding the materials and methods used in the study. Each method should consist of its subheading and paragraph and be described in detail that is sufficient to allow its replication by an investigator who did not participate in the study.
 - vi. **Statistical Methods:** The last paragraph in this section should present the methods used to derive results. As needed, describe any data preprocessing such as transformation and normalization. Describe how outliers were defined and handled and present descriptive statistics as appropriate. The number of sampled units (ie, “n”) and significance (ie, “P”) should be reported for each statistical comparison. Continuous variables that are normally distributed may be presented as mean \pm standard deviation. Continuous variables that are asymmetrically distributed should be presented as median \pm interquartile range. All statistical tests should be clearly described and include information regarding testing level (alpha) and one- or two-sided comparisons. Corrections for multiple testing should be addressed and reported. Any novel or complex data algorithms should be clearly described and appropriately referenced.
- 8) **Transparent reporting of results:** All primary data related to the thesis topic should be presented. Important data should be highlighted in figures or tables. For ease of review, it is preferred that figures and tables be included in proximity to their callout in the text. Alternately, tables and figures can be presented separately after the discussion but, if possible, it is advantageous to the reader to include these components in the body of the results section, as occurs in research publications.
- 9) **Discussion:** This section presents thorough and detailed interpretation and analysis of data, conclusions drawn, and framing of observations with the larger scientific literature. Limitations should be addressed, as should alternate interpretations and how the thesis may inform future studies in the field. Whenever relevant, a discussion of how the thesis may meaningfully impact communities of interest should be included here. Finally, given the historic disruptions caused by the COVID-19 pandemic, students may insert a

paragraph describing how they approached and responded to the unique research challenges encountered during the 2020-2021 time frame.

- 10) **Figure References and Legends:** Figures must be cited sequentially in the text using Arabic numerals (for example, “Fig. 7”). Provide a short title (in the legend, not on the figure itself), explanation in sufficient detail to make the figure intelligible without reference to the text, and a key to any symbols used.
- 11) **Tables:** All tables should be double-spaced, self-contained and self-explanatory. Provide brief titles and use superscript capital letters starting from A and continuing in alphabetical order for footnotes.
- 12) **References:** We strongly recommend the use of bibliography software such as Endnote for managing the references. References should be formatted according to New England Journal of Medicine Style.

It is acknowledged that theses in the area of medical humanities, ethics, history, and related fields may not obviously adhere to the above requirements. In this case, the thesis will likely replace the “hypothesis” with a “claim” based on evidence gleaned through literary, historical, and ethical research. The first paragraph of the Methods should still contain information about the student’s contribution. The subsequent paragraphs should describe the artistic, literary, or historical databases and methods used to gather the “evidence” presented in support of and contrary to the central claim. The discussion and remaining sections are the same. If you have questions about how to best frame your thesis, please contact OSR.

AVOIDING THE RISK OF COPYRIGHT VIOLATION AND LIABILITY WHEN SUBMITTING YOUR M.D. THESIS

Your M.D. Thesis represents an academic milestone. The protection of your thesis copyright exists from the time your work was created in digital form. Every article, book, or web page you used in conducting research and writing your thesis is also protected by copyright. When you download a single personal copy of a research article or cite a short passage, this scholarship is protected by the legal concept of fair use. A basic understanding of copyright protections and fair use is found at www.copyright.gov. Yale University also provides a guide to copyright protection and fair use: http://ogc.yale.edu/legal_reference/copyright.html.

Section 107 of the U.S. Copyright Law describes how to determine if a particular use of copyrighted material is fair. However, the distinction between what is fair use and what is infringement is not always clear or easily defined. Copying an image from an academic e-journal and citing the source does not substitute for obtaining permission to reproduce the image. Many publishers use www.copyright.com to grant reproduction rights of their articles to authors.

ProQuest/UMI and the Yale Medicine Thesis Digital Library may elect not to distribute your thesis in the absence of evidence that permission or reproduction rights have been secured. Providing evidence of permission or reproduction rights is a student author responsibility. Examples

encountered in M.D. Thesis research that require documentation of reproduction rights include but are not limited to:

- 1) Sections of published survey instruments or questionnaires.
- 2) Complete journal articles or other complete scholarly works [Note: The publisher Elsevier does allow graduate student authors of a journal article prior to graduation to reproduce their article in a thesis].
- 3) Image, graphic, or pictorial works from publications where the author has transferred copyright to the publisher, a common occurrence.

The safest course to avoid a delay in thesis is to avoid using published images without obtaining permission. It is almost always possible to cite a source and expect that readers can find the figure, chart, or image in the published version of the referenced work. Research faculty that transfer copyright to a publisher of their article are no longer the copyright holder and are unable to grant permission for reproduction. To circumvent this issue, the research mentor can offer unpublished images from their group's image collection.

When it is impracticable or prohibitively expensive to obtain permission through the publisher or the Copyright Clearance Center (www.copyright.com), students should avoid using that the material, unless they have obtained a written legal opinion that fair use would apply to the situation. Neither the Office of Student Research nor the Yale Library can supply legal advice on copyright and fair use. If there is any doubt, it is advisable to consult the Yale University Office of the Vice President and General Counsel at 432-4949.

INSTRUCTIONS FOR UPLOADING A PDF VERSION OF A MEDICAL THESIS

Upon receiving notification that the M.D. thesis has been approved as meeting graduation requirements, students should upload the thesis to the Yale Medicine Digital Thesis Library.

Yale Medicine Digital Thesis Library: Starting with the YSM class of 2002, the Cushing/Whitney Medical Library and OSR have collaborated on the Yale Medicine Thesis Digital Library (YMTDL) project, publishing the digitized full text of medical student theses as a durable product of Yale student research efforts. Digital publication of theses ensures access for all scientists to a summary of such work, provides students with a formal citation for their thesis, and demonstrates the exceptional quality of student research and student-faculty cooperation at Yale. In 2006, the digital copy became a graduation requirement. Starting in 2012, alumni of the Yale School of Medicine were invited to participate in the YMTDL project by granting scanning and hosting permission to the Cushing/Whitney Medical Library, which digitized the Library's print copy of their thesis or dissertation.

The Office of Student Research and Yale School of Medicine require that the M.D. thesis be submitted to the YMTDL <https://elischolar.library.yale.edu/ymtdl/>. This submission should be accompanied by a completed "Yale School of Medicine Digital Thesis Depositor's Declaration

Form.” This form can be downloaded from [the OSR website](#) and is included as Appendix F of this document. Instructions on the submission of the digital thesis are as follows.

Submitting a thesis via the ProQuest website:

Logging In: <http://www.etsadmin.com/cgi-bin/student/etd?siteId=323>

The electronic thesis submission process in ProQuest is organized into three major categories: Publishing information, About my dissertation/thesis, and Submission & payment. The system will walk you through the submission process step-by-step.

A few things to note: the ETD Administrator software is a 3rd party product that YSM licenses from ProQuest. Because this vendor is unaffiliated with Yale, OSR and Yale University Libraries do not have control over its policies or processes. The ProQuest Dissertations and Theses Global database is a subscription resource that collects dissertations and theses from multiple countries and a range of academic specialties. This collection is then made available to subscribers. When students choose to make their thesis publicly available, the full-text will appear in this database and users will be able to read, save, and download the text.

EliScholar is a digital platform for scholarly publishing provided by the Yale University Library. While it is supported by third party software, EliScholar is maintained by YUL and offers more flexibility in uploading and managing theses. The option selected for thesis release in the ETD Administrator system will apply to both ProQuest Dissertations and Theses Global and EliScholar. All theses are available to the Yale community (individuals with a NetID and password and users physically present at a library facility on campus) upon publication. A limited release of approved theses to the awarding institution’s user community is common practice.

The steps for thesis submission in the [ETD Administrator](#) system are listed on the right side of the screen. Stepwise instructions are included on the next page.

Submission steps	
Publishing information:	
<input checked="" type="checkbox"/>	Instructions
<input type="checkbox"/>	PQ publishing options
<input type="checkbox"/>	ProQuest agreement
<input type="checkbox"/>	IR publishing options
<input type="checkbox"/>	University agreement
<input type="checkbox"/>	Contact information
About my dissertation/thesis:	
<input type="checkbox"/>	Dissertation/Thesis details
<input type="checkbox"/>	PDF
<input type="checkbox"/>	Supplemental files (optional)
<input type="checkbox"/>	Notes (optional)
Submission & payment:	
<input type="checkbox"/>	Register U.S. Copyright
<input type="checkbox"/>	Order copies
<input type="checkbox"/>	Shipping address
<input type="checkbox"/>	Submit

Publishing Information

This section allows offers options relevant to immediate or delayed worldwide publication through ProQuest Dissertations and Theses Global and EliScholar. This decision will likely be based on whether the student and mentor hold the copyright to all the material in the thesis and have the authority to make it public (copyright may beshared with publishers or other authors). Per YSM policy, the terms for delaying publication are 1, 2, 3 years, or indefinitely. Students will also be prompted to enter their personal information in this section.

Instructions

This step lists the information required to complete the thesis submission process. Read the text, gather the necessary documents, and click continue.

PQ publishing options

This section provides options that dictate whether the thesis is released worldwide immediately, embargoed for 1-3 years, or permanently blocked from public release. When making his decision, students should consider who may have a copyright stake in the work. For example, the research has been previously published, copyright may have been transferred to the publisher or shared with co-authors. Questions regarding potential third party copyrighted material in the thesis should be directed to Lindsay Barnett (lindsay.barnett@yale.edu) at

the Cushing/Whitney Medical Library for assistance.

To make the thesis immediately available for worldwide consumption in ProQuest Dissertations and Theses Global and EliScholar, select *Yes* under “I want my work to be available in ProQuest as soon as it is published.” If the selection is *No*, additional options will become available. ProQuest’s default options are a 1- or 2-year embargo period, but the Office of Student Research allows a 3-year embargo and the option to permanently prevent public release. Students may choose either of these alternatives, by leaving the 1- and 2-year selections blank and entering the preferred choice in the “Note to administrator box.”

Delaying release in ProQuest

I want my work to be available in ProQuest as soon as it is published. *

- Yes
 No - I have patents pending, or another reason why I need to delay access to the full text of my work.

How long would you like to delay the release to ProQuest? * (more info)

- 1 year 2 years

Note to administrator (optional): 200 characters

Do not release worldwide.

[Clear](#)

Reason for delaying release to ProQuest: *

Publication pending with another publisher ▼

Those students choosing an embargo are required to select a reason for delaying the release before saving and proceeding to the next step.

ProQuest agreement

This step requires reading and acceptance of ProQuest’s Traditional Publishing Agreement. The selections in the “PQ publishing options” section will determine how ProQuest exercises their right to reproduce, distribute, and display the thesis. Students must accept this agreement to continue.

University agreement

Here is located a copy of the Yale School of Medicine M.D. Thesis Depositor’s Declaration form. This form should be completed under the direction of the Office of Student Research. Check the box indicating the you have read, understand and agree to the form, then save and continue.

Contact information

Students should enter personal information and associated address(es) here. When all required fields are filled out, save and continue.

About My Dissertation/Thesis

This section allows the entry of descriptive data and uploading of the thesis in PDF format. It also contains options for uploading supplemental files (video, spreadsheets, etc.) and notes. If there is any information that should be communicated to the ProQuest ETD Administrator about the digital thesis, please enter this into the Notes section.

Dissertation/Thesis details

This step involves entry of basic bibliographic details about the thesis as prompted, including title, abstract, degree details, and other information. If a student's specialty is not located in the "Primary Subject Category" dropdown menu, the default choice should be "Medicine [0564]."

Department*:	<input type="text" value="Yale School of Medicine"/>
Primary Subject Category*:	<input type="text" value="Medicine [0564]"/>
Additional Subject Categories:	<input type="text"/>
	<input type="text"/>

Enter all relevant information then save and continue.

PDF

This step involves the actual uploading of the thesis PDF and any documents related to third party copyright permissions through ProQuest's file upload system. Students who received permission from a third party who holds the copyright to portions of their thesis should post those documents here. This is not a required step in the thesis submission process. Students selecting "yes" under "Do you have any copyright permission documents to submit?" will see a file upload box appear.

Do you have any copyright permission documents to submit? *

If copyright permission documents are included in your dissertation/thesis file, you do not need to submit them separately.

Yes No

Add File:

Once necessary files have been uploaded, click save and continue.

Supplemental files (optional)

This optional step allows the submission of supplemental research files that are not part of the PDF uploaded in the previous step. These materials may include spreadsheets, media, datasets, and other types of information. If there are no supplemental files to upload, save and continue to the next step.

Notes (optional)

This space is for the entry of any notes that the ProQuest ETD Administrator should see. These comments are not visible to the Office of Student Research or to the School of Medicine. This section is optional. After entering in any relevant notes, save and continue to the next section.

Submission & Payment

This final section provides options for registering copyright and ordering bound copies of your thesis.


Register U.S. Copyright

This step includes the option to have ProQuest register the thesis with the U.S. Office of Copyright. This is an optional service provided by ProQuest for a \$55 fee; **there is no fee for electronic upload of your thesis.** Using this service represents a personal decision, and no reimbursement from the Office of Student Research or the Cushing/Whitney Medical Library is available. Please note that copyright subsists from the time a work is placed in fixed form and is not dependent upon registration with the U.S. Copyright Office. Authors may register their work with the U.S. Copyright Office personally at any time. Upon doing so, they must certify that no copyright has been previously filed on any version of the thesis and that they are the sole author of the manuscript with no third party claimants to any of the work, to be eligible for this service. After making the appropriate selection, save and continue.

Order copies

The penultimate step is to order bound print thesis copies. This optional service is not required. Upon publication, one bound copy of your thesis will be deposited into the Cushing/Whitney Medical Library's collection. Please note that it can take up to 16 weeks from the point of order to receive bound copies from ProQuest. Copies ordered through ProQuest **cannot be shipped directly to OSR**. Therefore, when choosing to order copies, please complete the subsequent step and enter a shipping address.

Otherwise, this step may be skipped.

A light blue rectangular button with a small square icon to the left of the text "Submit".

The final step is to review all of your choices and submit your thesis. If any steps have been missed or are incomplete, the software will prompt you to finish these steps before submission. While the heading on this step is "Pay for your order," no charges will be generated unless optional services have been selected. The "Submit Dissertation/Thesis" tab completes the process. Students experiencing difficulties with the process or having second thoughts after submission should contact Lindsay Barnett (lindsay.barnett@yale.edu), the ProQuest ETD Administrator for YSM. If Ms. Barnett is not available, please contact OSR staff.

Abstracts of M.D. Theses

A standardized format for the abstract of each M.D. thesis is required (see the following instructions below and the examples provided in Appendix E). This format must be followed for all abstracts published in the Yale Medical Thesis Digital Library. These abstracts will not be reviewed for content. It is the responsibility of the student investigator and the faculty advisor to prepare the abstract. Faculty sponsors provide approval of the abstract when they approve the final version in the bound thesis.

** These instructions for preparing abstracts are to be used for the digital library submission.

1. Abstracts should be formatted with 1.5 inch margins on the left and 1-inch margins on the remaining three sides.
2. Abstracts may be no more than 500 words in length, not including title and author information. The entire abstract, including title page, must be double-spaced and should be no more than one page in length.
3. Titles should be brief, clear and carefully chosen. The title should not exceed 100 characters including spaces between words. Capitalize the entire title, using no abbreviations.
4. Authors' names are to be written in full, omitting degrees. The student author's name shall be first. If the faculty sponsor also qualifies as an author, their name should be last. If the faculty member has been only a sponsor, his or her name should appear in parentheses after the name(s) of other authors as follows: "(Sponsored by...)". Other collaborators

should be listed after the student's name and before the faculty sponsor's name. Immediately following the faculty sponsor's name, designate section (if any), departmental affiliation, institution, city and state (Yale University School of Medicine, New Haven, CT) (see examples).

5. For thesis work performed at another institution, designate the senior author's departmental and institutional affiliation. In parenthesis, indicate the Yale faculty sponsor and institutional affiliation with the phrase: "Sponsored by..." (see examples).
6. Organize the body of abstract as follows:
 - a. A statement of the hypothesis or goals and specific aims of the study.
 - b. A statement of the methods used.
 - c. A summary of the results presented in sufficient detail to support the conclusions. Include actual values with statistics, if appropriate.
 - d. A statement of the conclusions reached.
 - e. Do not use subtitles; e.g., methods, results.
7. Do not include graphs, references to other publications, or acknowledgement of any research grant support. A single short table of results can be used if appropriate.
8. Abbreviations may be used in text only if defined initially by placing them in parenthesis after the full word (or phrase) first appears in the text. Abbreviations may not be introduced in the title.
9. Non-proprietary (generic) names are required the first time a drug is mentioned, written in small letters. Proprietary names are always capitalized, e.g., acetazolamide (Diamox).
10. Completed abstracts must be approved by faculty advisor.

Appendix

Contents:

- A) Departmental Thesis Chairs
- B) Thesis Evaluation Sheet
- C) Thesis Prize Nominee Publications and Presentations Form
- D) YSM Thesis Committee Prize Review Form
- E) YSM M.D. Thesis Title Page Format
- F) ProQuest Abstract Submission Format
- G) Yale School of Medicine Thesis Depositors Declaration

Appendix A. 2020-2021 Departmental Thesis Chairs

<u>Department</u>	<u>Chair</u>
Anesthesiology	Dr. Paul Heerdt
Biomedical Engineering	Dr. Fahmeed Hyder
Cell Biology	Dr. Peter Takizawa
Cellular & Molecular Physiology	Dr. Biff Forbush
Child Study Center	Dr. Andres Martin
Dermatology	Dr. Keith Choate
Emergency Medicine	Dr. Rachel Dreyer
Genetics	Dr. Curt Scharfe
History of Medicine	Dr. Joanna Radin
Immunobiology	Dr. Kevan Herold
Internal Medicine	Drs. Charles Dela Cruz & Lauren Ferrante
Laboratory Medicine	Dr. Ellen Foxman
Molecular Biophysics & Biochemistry	Dr. William Konigsberg
Neurology	Drs. Zachary Corbin & Sourav Ghosh
Neuroscience	Dr. Michael Schwartz
Neurosurgery	Dr. Angeliki Louvi
Ob, Gyn & Reproductive Sciences	Drs. Seth Guller and Shannon Whirledge
Ophthalmology & Visual Science	Dr. Ninani Kombo
Orthopaedics & Rehabilitation	Dr. Jonathan Grauer
Pathology	Dr. Samuel Katz
Pediatrics	Dr. Jeffrey Gruen
Pharmacology	Dr. Daryl Klein
Psychiatry	Dr. Marc Potenza
Radiology & Biomedical Imaging	Dr. Darko Pucar
School of Public Health	Dr. Elizabeth Claus
Surgery	Dr. Peter Gruber (interim)
Therapeutic Radiology	Dr. Shari Damast
Urology	Dr. Isaac Kim

Appendix B: Thesis Evaluation Sheet

To be used by Mentor and Departmental Reviewer

Student Initials:

Reviewer:

Thesis Title:

Faculty Advisor, Primary Department:

Relationship of Departmental Reviewer to Mentor:

Relationship of Departmental Reviewer to Student:

	Excellent (1)	Very Good (2)	Good (3)	Fair (4)	Poor (5)
Significance: expected impact on the field and for improving health and healthcare					
Innovation					
Rigor of prior research					
Methodologic rigor					
Organization and clarity of text					
Presentation of data in tables & figures as relevant					
Interpretation of Data					
Student effort					
Dissemination to communities of interest (publications, presentations, pre-prints, web content, etc)					

I ___do recommend this thesis be considered for a prize.

___do not recommend this thesis be considered for a prize.

Mentor:

If you are recommending this student for a prize, please attach a letter in support of your nomination addressing the criteria above.

Reviewers:

Please comment on two strengths of the thesis.

Please provide up to two suggestions for improvement.

1. Significance

- a. Excellent: Scientific impact will be of great significance.
- b. Very good: Scientific impact will be of moderate significance
- c. Good: Scientific impact will be of modest significance.
- d. Fair: Scientific impact will be of limited significance.
- e. Poor: Scientific impact will be of minimal significance.

2. Innovation

- a. Excellent: Completely new and (clinical or research) paradigm shifting
- b. Very good: Moderately new and (clinical or research) paradigm shifting, some advance over prior work in this area
- c. Good: Modestly innovative (clinical or research), incremental advance over prior work in this area
- d. Fair: Limited innovation (clinical or research), incremental advance over prior work in this area
- e. Poor: Minimal innovation (clinical or research) with no advance over prior work

3. Rigor of Prior Research: concerns the quality and strength of the research cited in the thesis to support the scientific premise.

- a. Excellent: Rigorous discussion of relevant prior research and scholarly work in this field with no omissions. Clearly identifies the gap in knowledge that is being addressed in the thesis.
- b. Very good: Very good discussion of relevant research and scholarly work with minor omissions
- c. Good: Good discussion of relevant research and scholarly work with moderate omissions
- d. Fair: Fairly week discussion of relevant research and scholarly work with major omissions
- e. Poor: Prior research and scholarly work not addressed

4. Methodologic Rigor: the strict application of the scientific method to ensure robust and unbiased experimental design, methodology, analysis, interpretation and reporting of results. Whereas

rigor of the prior research pertains to key supporting data, scientific rigor pertains to the proposed research. Please refer to [reporting guidelines](#) for criteria applicable to a variety of study types.

5. Organization and clarity of text
 - a. Excellent: All sections of thesis are presented in a clear and organized manner
 - b. Very good: All sections of the thesis are clear and well organized with only a few errors
 - c. Good: Some but not all sections of the clear and well organized, text is difficult to read in some but not all sections
 - d. Fair: Most of the thesis is unclear and poorly organized with numerous spelling errors and cut/paste errors
 - e. Poor: Thesis is poorly organized and not clearly written. Numerous cut and paste errors, spelling errors, different fonts throughout

6. Presentation of data in tables & figures as relevant
 - a. Excellent: Tables are exceptionally clear, Figures are well presented with clear and coherent legends
 - b. Very good: Tables are clear, Figures are well presented with clear and coherent legends, minor issues with formatting and legends that require improvement
 - c. Good: Tables are clear, Figures are well presented with clear and coherent legends, moderate issues with formatting and legends that require improvement
 - d. Fair: Tables are unclear, Figures are not clearly presented, legends are not coherent, numerous issues with formatting and legends that require improvement
 - e. Poor: Tables are unclear, Figures are not clearly presented, legends are not coherent, all of them have issues with formatting and legends that require improvement

7. Interpretation of data
 - a. Excellent: Data are exceptionally well interpreted. Findings are not over-stated.
 - b. Very good: Data very well interpreted with minor areas for improvement
 - c. Good: Data are for the most part interpreted appropriately with a moderate number of areas for improvement
 - d. Fair: Data are often inappropriately interpreted with a moderate number of areas for improvement
 - e. Poor: Data interpretation is poorly done and requires complete overhaul

8. Student effort
 - a. Excellent: Student developed the question, designed the study, performed and analyzed the study, and wrote the thesis with no help from mentor's research group aside from scientific mentorship from thesis advisor
 - b. Very good: Student developed the question, designed the study, performed and analyzed the study, and wrote the thesis with a small amount of help from mentor's research group
 - c. Good: Student developed the question, designed the study, performed and analyzed the study, and wrote the thesis with a moderate amount of help from mentor's research group
 - d. Fair: Student developed the question, designed the study, performed and analyzed the study, and wrote the thesis with a large amount of help from mentor's research group

- e. Poor: Student had minimal role in developing the question, designing the study, performing and analyzing the study, and wrote the thesis with a large amount of help from mentor's research group
9. Dissemination to communities of interest. Please note that dissemination is not limited to peer-reviewed publication. Other forms of dissemination include presentations at national / local meetings, sharing findings with communities, and other stakeholders.

Appendix C: Additional Information for Thesis Awards Committee
THESIS PRIZE NOMINEE PUBLICATIONS and PRESENTATIONS

Student Nominee – initials	Department	Advisor	Thesis Chair

1. Has the thesis been published in a peer-reviewed journal? (Please choose): Yes No
 If Yes please attach document giving authors* in order and Journal

2. If the thesis has not yet been published is a publication planned? (Please choose): Yes No

3. If yes, please indicate the status of the publication:
 - a. Manuscript written and under review: (attach document giving authors*in order and Journal) Yes No
 - b. Manuscript draft written but not submitted: (attach document giving authors* in order and Journal planned) Yes No
 - c. Manuscript not started but planned: (attach document giving authors* in planned order and Journal planned) Yes No

4. Has the student presented at a national or regional meeting: (attach a document indicating presentation title, authors*, organization, city, date).
 Yes No

5. Has student disseminated the work in another scholarly format: (attach a document providing details of format*).
 Yes No

Student
Initials:

Signature
Advisor:

Signature
Department Thesis Chair

*Student should be denoted with initials.

Appendix D. YSM Thesis Committee Prize Review Form

Student Initials:	
Thesis Awards Committee Reviewer (Primary):	
Thesis Title:	
Faculty Advisor	
Primary Department:	

Scoring – Use 1 – 5 score with 0.5 divisions. (1 =excellent; 5 = poor)

	Excellent (1)	Very Good (2)	Good (3)	Fair (4)	Poor (5)
Significance: expected impact on the field and for improving health and healthcare					
Innovation					
Rigor of prior research					
Methodologic rigor					
Organization and clarity of text					
Presentation of data in tables & figures as relevant					
Interpretation of Data					
Student effort					
Dissemination to communities of interest (publications, presentations, pre-prints, web content, etc)					

1. Significance

- a. Excellent: Scientific impact will be of great significance
- b. Very good: Scientific impact will be of moderate significance
- c. Good: Scientific impact will be of modest significance
- d. Fair: Scientific impact will be of limited significance
- e. Poor: Scientific impact will be of minimal significance

2. Innovation

- a. Excellent: Completely new and (clinical or research) paradigm shifting
- b. Very good: Moderately new and (clinical or research) paradigm shifting, some advance over prior work in this area

- c. Good: Modestly innovative (clinical or research), incremental advance over prior work in this area
 - d. Fair: Limited innovation (clinical or research), incremental advance over prior work in this area
 - e. Poor: Minimal innovation (clinical or research) with no advance over prior work
3. Rigor of Prior Research: concerns the quality and strength of the research cited in the thesis to support the scientific premise.
- a. Excellent: Rigorous discussion of relevant prior research and scholarly work in this field with no omissions. Clearly identifies the gap in knowledge that is being addressed in the thesis.
 - b. Very good: Very good discussion of relevant research and scholarly work with minor omissions
 - c. Good: Good discussion of relevant research and scholarly work with moderate omissions
 - d. Fair: Fairly weak discussion of relevant research and scholarly work with major omissions
 - e. Poor: Prior research and scholarly work not addressed
4. Methodologic Rigor: the strict application of the scientific method to ensure robust and unbiased experimental design, methodology, analysis, interpretation and reporting of results. Whereas rigor of the prior research pertains to key supporting data, scientific rigor pertains to the proposed research. Please refer to [reporting guidelines](#) for criteria applicable to a variety of study types.
5. Organization and clarity of text
- a. Excellent: All sections of thesis are presented in a clear and organized manner
 - b. Very good: All sections of the thesis are clear and well organized with only a few errors
 - c. Good: Some but not all sections of the clear and well organized, text is difficult to read in some but not all sections
 - d. Fair: Most of the thesis is unclear and poorly organized with numerous spelling errors and cut/paste errors
 - e. Poor: Thesis is poorly organized and not clearly written. Numerous cut and paste errors, spelling errors, different fonts throughout
6. Presentation of data in tables & figures as relevant
- a. Excellent: Tables are exceptionally clear, Figures are well presented with clear and coherent legends
 - b. Very good: Tables are clear, Figures are well presented with clear and coherent legends, minor issues with formatting and legends that require improvement
 - c. Good: Tables are clear, Figures are well presented with clear and coherent legends, moderate issues with formatting and legends that require improvement
 - d. Fair: Tables are unclear, Figures are not clearly presented, legends are not coherent, numerous issues with formatting and legends that require improvement
 - e. Poor: Tables are unclear, Figures are not clearly presented, legends are not coherent, all of them have issues with formatting and legends that require improvement
7. Interpretation of data
- a. Excellent: Data are exceptionally well interpreted. Findings are not over-stated.
 - b. Very good: Data very well interpreted with minor areas for improvement
 - c. Good: Data are for the most part interpreted appropriately with a moderate number of areas for improvement
 - d. Fair: Data are often inappropriately interpreted with a moderate number of areas for improvement
 - e. Poor: Data interpretation is poorly done and requires complete overhaul

8. Student effort

- a. Excellent: Student developed the question, designed the study, performed and analyzed the study, and wrote the thesis with no help from mentor's research group aside from scientific mentorship from thesis advisor
 - b. Very good: Student developed the question, designed the study, performed and analyzed the study, and wrote the thesis with a small amount of help from mentor's research group
 - c. Good: Student developed the question, designed the study, performed and analyzed the study, and wrote the thesis with a moderate amount of help from mentor's research group
 - d. Fair: Student developed the question, designed the study, performed and analyzed the study, and wrote the thesis with a large amount of help from mentor's research group
 - e. Poor: Student had minimal role in developing the question, designing the study, performing and analyzing the study, and wrote the thesis with a large amount of help from mentor's research group
9. Dissemination to communities of interest. Please note that dissemination is not limited to peer-reviewed publication. Other forms of dissemination include presentations at national / local meetings, sharing findings with communities, and other stakeholders.

Appendix E. Thesis Title Page Format

(Full Title of Thesis)

A Thesis Submitted to the Yale University School of Medicine
in Partial Fulfillment of the Requirements for the Degree of Doctor of Medicine

by

(Legal name of author) (Year of degree)

Appendix F: Examples of Abstract Formatting

- 1) Thesis completed under supervision of a YSM Mentor

INCIDENCE OF SUPRAVENTRICULAR ARRHYTHMIAS IN AN AGING POPULATION.

Erica L. Herzog and Sarwat Chaudhry. Section of Cardiology, Department of Internal Medicine, Yale University, School of Medicine, New Haven, CT.

- 2) Thesis completed under supervision of a Yale faculty member who does not hold an appointment at YSM, where the faculty advisor is not a co-author:

ELECTRICAL IMPULSES IN ENGINEERED HEART TISSUE

Erica L. Herzog and Sarwat Chaudhry (School of Engineering, Yale University, New Haven, CT). (Sponsored by Jessica Illuzzi, Department of Obstetrics and Gynecology, Yale University, School of Medicine).

- 3) Thesis completed at an outside institution:

INCIDENCE OF SUPRAVENTRICULAR ARRHYTHMIAS IN AN AGING POPULATION.

Erica L. Herzog and Sarwat Chaudhry. Section of Cardiology, Department of Internal Medicine, St. Elsewhere Hospital, Boston University, Boston, MA. (Sponsored by Jessica Illuzzi, Department of Obstetrics and Gynecology, Yale University, School of Medicine).

Appendix G: MD Thesis Depositor's Declaration

Yale School of Medicine MD Thesis Depositor's Declaration

I hereby grant to the Yale School of Medicine and its agents the non-exclusive license to photocopy, archive and make accessible, under the conditions specified below, my print and electronic thesis, in whole or in part, in all forms of media.

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I agree that the Yale School of Medicine may electronically store, copy or translate my thesis to any medium or format for the purpose of preservation and accessibility. The Yale School of Medicine is not under any obligation to reproduce or display my thesis in the same format in which it was originally deposited.

I retain all other ownership rights to the thesis, including but not limited to the right to use in future works (such as articles and books) all or part of this thesis.

My thesis may be placed in the digital repository with the following status:
(choose one only)

- 1.** Release the entire thesis immediately for access worldwide, in perpetuity.
- 2.** Release the entire work for Yale University access (including on-campus access and remote access) only for 1 year, 2 years, or 3 years. After this time, the work may be accessible worldwide, in perpetuity.
- 3.** Release the entire work for Yale University access (including on-campus access and remote access) only, in perpetuity. I understand that this thesis may be available from any Yale University computer location or authorized remote location.

I understand that descriptions of the thesis will be incorporated into library catalogs or databases. Any request to remove my thesis from the digital library repository shall be submitted in writing to the Director of Student Research. Any such request shall be granted or denied at the sole discretion of the Director, after giving consideration to all factors raised in such request.

I hereby give The Yale School of Medicine the right to make available the thesis in the way described above.

Name of Student Date Signature

For Office of Student Research Date Signature