



**Yale University
School of Medicine**

Medical Student Research Program

and the

Yale M.D. Thesis Requirement



Guide for Students and Faculty Sponsors

**Prepared by
The Office of Student Research
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History of Student Research

The presentation of a dissertation has been one of the requirements for the degree of Doctor of Medicine at Yale for over a century. Initially, case reports and reviews of literature predominated, but as the scientific method found its place in medicine, the faculty required that dissertations presented be based on original investigation either in the laboratory or in the clinic. This experience is considered an important and essential phase of a curriculum which is designed to promote the development of critical judgment, habits of self-education, imagination and scholarship, as well as the acquisition of knowledge and research skills.

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." This requirement remains in effect to the present time, and is enthusiastically endorsed by the faculty as an important component of the "Yale System" of general medical education.

The creative discipline required to carry out a project and prepare a thesis enables each student to become a physician-scholar, whether the ultimate objective is clinical practice, research, teaching, or administration. Yale hopes to produce physicians who can evaluate data quickly and critically as they must do throughout their professional careers.

The M.D. thesis at Yale University teaches a student how to understand the scientific method from the inside, how to design a hypothesis, how to collect and evaluate data and communicate the knowledge to others, and how to think scientifically and critically for the rest of his/her professional life.

To this day, the Yale University School of Medicine has carried on the tradition of required medical student research. This tradition is a hallmark of the Yale system of medical education.

Medical Student Research Program

All students at Yale University School of Medicine engage in research and are required to write an M.D. thesis during medical school, with the exception of students who have a Ph.D. degree in the biological sciences before matriculation. A wide choice of subjects for research is permitted. Students may choose basic laboratory projects or may investigate clinical, translational epidemiologic or sociologic (including medicine and humanities) topics. Publications in the literature may serve as the source of data for research. Two basic requirements apply to all thesis research projects: (1) there must be a specific hypothesis that can be supported or rejected by new data that are generated by the student. Data must be subjected to statistical analysis and results should either confirm or reject the original hypothesis; and (2) the research mentor must be a full-time faculty member at the School of Medicine.

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. If the project is concerned with clinical or epidemiological investigation, the same commitment to guidance and support is expected. Weekly conferences between student and advisor are encouraged during the course of the research. The research must be designed and specifically performed by the student with the advice of the faculty mentor. Students may not work jointly on a research project.

The research is presented as a formal bound thesis during the fourth year or graduation year and must fulfill the following minimal requirements (see page 15 for exact details):

- a. Title Page
- b. Summary (in abstract form)
- c. A critical review and citation of the work of previous investigators
- d. Valid research design
- e. Evidence of mastery of appropriate methodology, including description of what was done by the student and what was done by others
- f. Presentation and analysis of research data, including figures and tables
- g. Conclusions that are supported by the data
- h. A literate presentation
- i. Complete bibliography with full citations

Before the written report is presented to the Office of Student Research and the Thesis Committee, it must be approved in writing by the student's advisor and by a review committee in the department where the work was performed.

An Awards Committee critiques and ranks all student theses submitted for honors by various departments. The highest ranked papers are presented orally at Student Research Day held in May and chaired by the Dean of the School. Most theses are presented as posters at Student Research Day which is widely attended by students and faculty. Thirteen prizes are awarded at graduation for outstanding student research.

Time Available for Research

Practically all students begin research work during the summer following their first year. For example, during the summer of 2007, 84 (of 91) first year medical students remained in New Haven to work with faculty members on a wide variety of projects. Stipends are available to support this summer research and other periods when full-time research is performed. Many students continue their research work in the afternoons, evening and weekends during the second year of medical school. There is an additional eight week block available for student research during the summer before beginning the third year. Additional three month blocks are available in late third year to mid-fourth year for completion of research work. Thus, a total of six to nine months is currently available for research by each Yale student during four years at medical school.

A reminder: We recommend that the actual time devoted to data collection (laboratory or other) be accomplished in a ten-to-sixteen week period or its equivalent in days. Additional time is then needed for planning and literature review, for evaluation of data and final write-up. Stipend support is for full-time periods when students are carrying out the research, but financial support is not provided for writing the thesis.

Yale Curriculum Favorable for Student Research

The Yale curriculum provides an ideal milieu for encouraging research training by students because the curriculum differs in important elements from traditional medical school curricula as follows:

1. The number of scheduled class hours is less than other medical schools in the United States.
2. The lack of competition through unsigned examinations in basic science courses is unique.
3. The M.D. thesis requirement at Yale is unique although the Harvard curriculum and the new curriculum at Duke include a research elective component.

Thus, there is substantial time available for training and independent research by students. There is an established tradition for faculty to encourage students as colleagues in a community of scientists. Finally, Yale Medical School recruits an outstanding body of students who at the time of matriculation are aware of the requirements and expectations for creative scholarly work. This system has spawned a large number of eminent M.D. investigators.

Getting Started

Resources Available

A list of faculty members and their areas of research is available on-line in the World Wide Web. To access the faculty research information use Netscape and open the URL and type <http://info.med.yale.edu/facres/>. You may search by keywords or by individuals listed in each department.

Dr. Forrest, Director of the Office of Student Research, is available to discuss options with individual students by appointment. After deciding upon the area of general interest, the student should check with members of the faculty in both the basic and clinical sciences who are working in that field. After appropriate discussions with several potential mentors, the student should choose the faculty member with whom he/she wishes to work. Although it is not necessary that the idea for the thesis originate with the student, it is necessary that the work be his/her own. The student can work as a member of a group project only if the student's contribution is carried out on an independent basis. Dissertations written jointly by two or more students are not acceptable.

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.

Publications. In planning a project, it should be clear that the prime goals are to ask an important question, formulate a hypothesis, and learn the scientific method and techniques, and not necessarily to publish a paper. Publishing the work, however, is greatly encouraged, and the student should be encouraged by the faculty advisor to write the first draft and to be first author on the manuscript. The faculty member should make every effort to orient the student to a practical problem that can be fulfilled within the available time.

Need for a Hypothesis

Excellent research begins with a clear hypothesis which can be examined by the generation of new data by state-of-the-art techniques. The hypothesis should be original and one which will generate substantial interest by leading investigators in the field when answered. It is not excellent research to investigate a hypothesis which is highly predictable or expected or in which there will be little interest. A review of the literature (meta-analysis) or review of patients' charts may be the source of data used for a thesis. However, the basic requirement still applies. There must be a hypothesis which can be supported or rejected on the basis of data gleaned from the patients' records or published literature. These data should be subjected to statistical analysis, and the results should either confirm or reject the original hypothesis. As with any other thesis, a review of the literature and a section dealing with the interpretation of the data and a discussion of its importance should be included. A literature review cannot be a simple narrative describing the information obtained from these sources.

Literature Review and Protocol Formulation

When the area of investigation has been approved by the faculty preceptor and Departmental Thesis Chairperson, the student is expected to explore the literature and formulate a protocol. This step provides an unusual opportunity for tutorial instruction in experimental design. Faculty members who assume responsibility as preceptors should provide the amount of guidance that is necessary in design of the investigation.

Statistical Analysis

When the results of an investigation lend themselves to statistical analysis, the student should be encouraged to seek the aid of a biostatistician for assistance in statistical methodology. It is hoped that this will enable the student to learn the value and limitations of statistical analysis as an aid to interpreting the results of an investigation. See the list of Secondary Thesis Advisors for clinical epidemiology and clinical research methods.

Research Involving Human Subjects

All research involving human subjects must be approved by the Human Investigation Committee of the School of Medicine. Applications and guidelines are available in the Office of the Chair of the Committee, 47 College Street, Suite 204.

Joint Projects Not Acceptable

Dissertations written jointly by two or more students are 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 his/her own initiative.

Research Done Outside of the Yale Medical School

A student may wish to undertake his/her research project under the supervision of a qualified investigator who is not a member of the faculty of Yale University School of Medicine. **The approval of an outside preceptor will be granted by the Office of Student Research upon receipt of a statement by a full time Yale faculty member acting as sponsor and mentor, in whose area the research work will be done.** The statement should indicate the Yale mentor has approved the preceptor and the facilities available for the research project. The same regulations concerning the dates of submission and review by the appropriate departmental committee will apply to the thesis done outside of the medical school. Specifically, the faculty member will be responsible for reviewing the progress of the thesis with the student, reviewing the written thesis and giving faculty approval. The thesis will be reviewed by the Department Thesis Committee of this faculty member's department.

Ph.D. Thesis in Lieu of Medical School (M.D.) Thesis

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 thesis requirement of the Medical School. 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. **Students planning to submit the dissertation on March 15 for a May degree, however, should make every effort to file the petition by mid-February, so that planning for commencement ceremonies can proceed in a timely fashion. If the Ph.D. has not been completed, a separate M.D. thesis must be submitted to qualify for the M.D. degree.**

One Year Medical Student Research Fellowships:

The School encourages many students to consider a fifth year of medical school and devote it 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 2006-2007, thirty (30) students received full one year fellowships and an additional 20 fifth year students received funding for less than a full year. Stipend levels are approximately \$25,000/year. These stipends will be available on a competitive basis and students in any year are eligible to apply. See separate booklet with details and deadlines on these fellowships.

All stipends are paid directly to the student and are considered taxable income.

Joint M.D.-Master of Health Science Degree

Yale University School of Medicine and the Office of Student Research are pleased to announce that a new joint degree, the MD-Master of Health Science (MD-MHS) was approved by the Yale Corporation in January 2006 and is in place for the 2007-2008 academic year.

There are two pathways to the MD- Master of Health Science degree for medical students. These are a clinical research pathway and a laboratory/translational pathway. The MD-Master of Health Science degree requires a fifth year pull out supported by a fully funded one year medical student research fellowship at Yale (currently Doris Duke Charitable Foundation, Howard Hughes Medical Institute-Yale, Yale NIH T32, NIH-NIDDK, Yale Endowment Fellowships).

The research project in the fifth year is the centerpiece of the MD-Master of Health Science degree program. In addition are the following requirements:

1. The project mentor and a three person thesis committee must be approved by the Office of Student Research and the MD-Master of Health Science Advisory Committee.
2. Additional coursework is required:
 - a. **Clinical research pathway** – Courses: Principles of Clinical Research; Applied Biostatistics; Organization and Leadership; Ethical and Practical Issues in Clinical Investigation (during Masters year)
 - b. **Laboratory/Translational research pathway** – Courses: Intensive Pedagogical Experience in Techniques and Strategies for Laboratory Research or Functional

Genomics in Translational Research; Organization and Leadership; Ethical and Practical Issues in Clinical Investigation(during Masters year)

These courses can be taken prior to the Masters year or during except the Ethical and Practical Issues in Clinical Investigation which must be taken during the Masters year.

3. Participation in monthly seminars, journal clubs, Leadership in Biomedicine lectures and dinners, and other announced activities throughout the Masters year.

M.D./M.P.H. 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 the dates of the M.D. thesis submission and review by the appropriate departmental committee will apply.

Responsibility of Faculty Mentors

To insure a better understanding of the faculty mentor's role, the following suggestions have been made:

- The faculty mentor should make every effort to orient the student to a practical problem that can be addressed within the available time. This usually requires multiple meetings with the student culminating in an application for funding which contains the following elements.
 1. background of the problem being investigated
 2. hypothesis that will be examined
 3. specific aims of the study
 4. methods that will be used including details of the specific design of the study
 5. selected references from the sponsor's work
 6. selected references from others

The faculty mentor must review, approve and sign the application for funding. The application is also reviewed and must be approved for feasibility, hypothesis, study design by the Department Thesis Chair.

- We recommend that the actual time devoted to data collection (laboratory or other) be accomplished in a twelve-to-sixteen period, minimally. Additional time is needed for planning and literature review, for evaluation of data and final write-up. Currently 50% of Yale students elect to spend a fifth year of medical school devoted fully or partially to thesis research.
- The student should not be assigned as a research technician to accomplish someone's project in the lab, including fellows.
- 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.
- The student should develop with the faculty mentor his or her own project (although others may participate) and should eventually be encouraged by the faculty mentor to be first author on abstracts and publications.
- The faculty mentor is responsible for all research expenses (i.e. space, resources, and facilities) and the supervision of the experimental work.
- The faculty mentor is the first reviewer and gives the initial approval of the thesis as submitted for graduation. (For more information see "Thesis Approval Process")
- The faculty mentor should plan to attend Student Research Day activities held in May of each year.

DEVELOPING A CLINICAL RESEARCH PROTOCOL: THE SURVIVAL GUIDE

Opportunities are available for you to pursue a thesis project in either basic or clinical research. Clinical research is less completely “controllable,” and is therefore more subject to potential confounders and sources of bias. However, clinical research offers the advantage of more direct clinical relevance. Whatever topic you choose, you can likely find a qualified advisor in the medical school. But an advisor knowledgeable in your area of interest may or may not have a strong background in research methods. If they do not, you should be prepared to follow a systematic process in the development of your project to be sure the results are what you intend.

Be advised that data do not make a thesis. Without an excellent hypothesis, defined outcome measure(s), and good methodology, collected data cannot lead to meaningful insights. Above all, a good thesis depends on an excellent hypothesis. It is more than coincidence that a “thesis” is derived from the underlying “*hypo*-thesis.”

The following sequence is recommended for the development of a clinical research or epidemiology thesis project. Don’t wait for your advisor to bring up each component; they may never do so. You should be assertive in addressing the following items before you begin the actual research. If you and your advisor are uncertain about or want help with any of the steps below, there are experts in methodology available for consultation (See section on Secondary Thesis Advisors). Be sure to obtain such a consult early. There is little that methods can offer once the data have been collected.

1. Start with a good question. In general, “good” or “excellent” is best defined as a question for which the answer matters either to other researchers in the field, practicing clinicians, or patients. Remember, you will likely do just as much work to answer a question which has “below average” interest to others as you will in answering a question which others will call important.
2. Convert the question to a hypothesis by asserting a position. This will lead directly to a consideration of measures, both of exposure and outcome.
3. Generate measures of exposure and outcome. This step is facilitated by a 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 hypothesis for refinement, and narrowing (i.e., express the hypothesis in terms of the specific exposure of interest, and the specific outcome anticipated).
4. Once a reasonable hypothesis developed, a protocol should be constructed. How can the hypothesis be tested? 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 subtle. Once the comparison group is chosen, the magnitude of expected difference should be estimated, as a basis for determining sample size (power calculation). In clinical research, standard methods include cohort studies (prospective, or retrospective; the randomized controlled clinical trial is a sub-category of the prospective cohort study) that assemble groups on the basis of exposure/intervention, and follow for outcome; and case-control studies that assemble groups on the basis of the outcome and assess for previous exposures. We urge you to use one of the three.

5. In light of the design you deem most appropriate, revise your 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 the subjects' recall.
6. Once your measures are established, determine the appropriate sample size and the methods of analysis. A plan for data collection and management should also be developed. Consultation with a statistician may be helpful at this stage. Now is the time to assess feasibility. Specifically, the following questions should be addressed: Can enough people be obtained for the study? Can the outcome events be observed and suitably analyzed?

The research should only begin after steps 1-6 are dealt with successfully. Again, there are no methods that can transform a vague question and data into a methodologically rigorous study after the fact. Good methods must come first.

The following resources may be of help to you in developing or completing your thesis research:

- Secondary Thesis Advisors

The Yale faculty members list below all have expertise in the methodology of clinical studies, clinical epidemiology and biostatistics. These faculty members have agreed to work with a maximum of two students per year as a secondary thesis advisor. A secondary faculty advisor should become involved on the student's thesis at an early date (preferably in the first few weeks of the project and before any data is collected). The advisors have agreed to meet with students for four sessions at the beginning of the thesis project and an additional four sessions after the data has been gathered. The initial meeting should be attended by both the medical student, the primary thesis advisor and the secondary faculty advisor. The focus will be on developing excellent methodology. Please see the Directory of Faculty Research Interests for more detailed information on the faculty advisors specific areas of interest.

<u>NAME</u>	<u>DEPARTMENT (telephone)</u>
John Concato	Internal Medicine (932-5711, ext. 2993)
Tom Gill	Geriatrics (8-3344)
John Hughes	VA-Internal Med (937-4918)
David Katz	Epidemiology & Public Health (732-1265)
Walter Kernan	Internal Med (8-2984)
Nancy Kim	VA-Internal Med 932-5711 X5371)
Harlan Krumholz	Internal Med (7-1717)
John Leventhal	Pediatrics (8-2468)
Patrick G. O'Connor	Internal Med (8-6532)
Eugene Shapiro	Pediatrics (8-4555)
Richard Schottenfeld	Psychiatry (974-7349)
Mary Tinetti	Geriatrics (8-5238)

Computer facilities for statistical analysis:

Yale's Prevention Research Center (PRC), located off-campus in Derby, is a resource to 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. Contact the PRC at 203-732-1265, or Dr. Valentine Njike, data manager, at valentine.njike@yalegriffinprc.org.

Medical Research in the Humanities and the Arts: A Survival Guide

Each year some students elect to conduct medical research for their M.D. thesis in one or another area of the humanities, social sciences, and the arts (including medical history, medical ethics, medicine and the law, film, photography, medical sociology, medical anthropology, and literature). Like other kinds of student research, the creative discipline required in pursuing the M.D. thesis in these areas helps shape the physician-scholar by cultivating critical judgment, imagination, and scholarship, while developing critical research skills and making an original contribution. At the same time, the challenges involved in research pursued in the archive, library, or field may differ from those encountered in the laboratory.

The Office of Student Research recognizes that distinct methodologies may be required for research conducted at the cutting edge of the humanities, social sciences, and the arts. It is committed to fostering an environment in which students are supported and encouraged to produce work of the highest quality and rigor that is in keeping with the best standards of scholarly research within the discipline in which they are working. Students who wish to pursue medical research projects in the humanities, social sciences, and the arts are eligible to apply for competitive research stipend support. Support from the Office of Student Research is given for student research stipends only, not for the costs of the research itself.

Given the diverse nature of the fields encompassed by the medical humanities and the arts, it is not possible to delineate a single method or approach that suits all projects. Students should work closely with their advisors to gain an understanding of the research methods and forms of analysis best suited to the discipline in which they are pursuing their thesis, or to develop approaches appropriate to interdisciplinary work. All research must attempt to answer a focused question related to medicine that is of interest to other scholars in the field. Research originates with a question, or hypothesis or problem, and requires a clear articulation of a goal and a systematic plan of approach. A starting point is to review critically the research literature on the given question and related areas. It is important to recognize two ways in which rigorous research in the humanities and the arts may differ from exploration in the laboratory and clinical sciences. First, such investigations may be (though by no means always) qualitative, and may not be advanced by statistical analysis. In other cases, studies would be significantly improved by a combination of qualitative and quantitative research methods. Second, while research in these fields must answer an important question related to medicine, the question may not be formulated as a testable hypothesis. Alternative ways of thinking about the aims of a strong research project, informed by the best-practice research norms of different disciplines, are the construction of an evidence-based “argument,” or the production of generalizable knowledge, or (for the arts) the inclusion in the written thesis of material that is thoughtful, important, and makes an innovative contribution.

Sometimes the mentorship needed for a qualitative medical research project is easy to identify. For example, if you were interested in understanding how and why an ill *chicana/o* resident of San Antonio, Texas chooses between consulting a *curandero* and consulting a practitioner of biomedicine, or if you wanted to understand what pediatric residents learn about social and cultural issues during their outpatient experience in a New Haven clinic, you might want guidance from an anthropologist or sociologist in addition to a pediatrician. You would want help from an historian if, starting with an interest in how cultural factors shape responses to “new” diseases, you decided to explore Peruvian responses to cholera in the 1830s, British

responses to HIV/AIDS in the early 1980s, or New York City responses to multi-drug resistant tuberculosis outbreaks in the prison system during the 1990s. If you were interested in the larger cultural meaning of the depiction of women physicians and medical students in late-Victorian novels, or of internship experiences in late-twentieth-century autobiographical and fictional accounts, then probably you would want to seek guidance from mentors in literature and history.

Medical students whose interests have led them to a set of questions about health and culture, medicine and society, may not know which scholarly fields offer the most promising research and analytical tools. If you were interested in a project that would make an innovative contribution to understanding the relationships between poverty and health in New Haven, for example, you might find yourself asking questions about culture that various interpretive methods from the humanities, social sciences, and the arts can help address. Perhaps you want to understand what health and illness mean to HIV-positive mothers and how they make sense of the relationship between health and poverty in managing the lives of their children. Or perhaps you want to understand how information about serving as a paid clinical research subject circulates in the community, and how the role of the healthy research “volunteer” is perceived. Or possibly your interest is in childhood obesity and you decide to explore sports, body image, and cultural esteem among 13 year old girls in an intercity school, or you decide to enlist photography as one medium to explore the nutritional environment of childhood poverty. All of these projects use methods regularly used by scholars in the social sciences, humanities, and the arts. If your research interests involve such questions about health, culture, and society, then we encourage you to contact the Yale Medical Humanities and the Arts Council. We are available to help identify the kinds of guidance best suited to your aims (email john.warner@yale.edu).

Medical students may work with any approved Yale University faculty member on their thesis so long as the work is supervised and sponsored by a full-time School of Medicine faculty member in whose department the thesis will be reviewed. Such dual mentorship often is particularly appropriate to medical research in the humanities and the arts, and enables students to draw upon the rich mentorship resources available elsewhere in the University. The Humanities and the Arts Council can help students identify prospective medical school mentors, but also can help identify co-mentors from across the University whose primary faculty appointments are outside the School of Medicine.

Funding for Student Research

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

- 1) Summer Research
- 2) Short-term Research
- 3) One-year Medical Student Research Fellowships

All programs require a competitive application. Summer research stipends are awarded specifically to students between the first and second year. Short-term stipends are awarded for specific blocks (1-3 months) during the academic year when full-time research is performed and during subsequent summers. These stipends are supported by a variety of organizations (NIH, Howard Hughes Program, private donors, and University funds.)

Required Components of the Formal M.D. Thesis

(In Order for Final Submission of Bound Copy)

Length- 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.

1. **Title** page. - Title should not exceed 100 characters including spaces between words (see details page 19).
2. **Abstract** page, as described, (see details page 21).
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 and relevant review of the literature is required).
6. **Statement of purpose specific hypothesis and specific aims of the thesis.**
7. **Methods – Please Note:** Give details of all methods used. 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 others. 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.

8. **Results** – All primary data related to the thesis topic should be presented with the important data given in figures or tables. If preferred, figures and tables should be included in this section and should be explained in the detail in the text. Tables and figures can be presented separately after the discussion but, if possible, it is advantageous to the reader to include tables in the body of the results section (as in a manuscript). All data should include the number of observations, and mean values \pm S.E.M. or \pm S.D.

9. **Discussion.** (Thorough and detailed interpretation and analysis of data and reference to and analysis of other literature.)
10. **References** – We strongly recommend the use of Endnote for formulating the references. Indicate references in the text by sequential numbers in parentheses (do not use subscript). In the Reference section, list references numbered in the order in which they appear in the text in the format shown below (note that the initials of the authors always follow the surnames, and that there should be no space between more than one initial). Include all authors' names up to 5 authors (use *et al.* after the 5th author) and complete article titles. Indicate articles that are in press following the journal name.

Abbreviate the names of journals according to *Pub Med or BIOSIS Database*. Spell out names of unlisted journals. Supply inclusive page numbers. Submitted manuscripts, manuscripts in preparation, unpublished observations, personal communications, and preliminary report citations must appear parenthetically in the text. They should not appear in the Reference section. See examples below:

Journal style guides and Endnote style files for the *Journal of Clinical Investigation* and *New England Journal of Medicine* – are also acceptable.

Journal Articles

1. Yalow, R.S., and Berson, S.A. 1960. Immunoassay of endogenous plasma insulin in man. *J. Clin. Invest.* 39:1157-1175.

In Press

2. Gardner, W., and Schultz, H.D. 1990. Prostaglandins regulate the synthesis and secretion of the atrial natriuretic peptide. *J. Clin. Invest.* In press.

Complete books

3. Myant, N.B. 1981. *The Biology of Cholesterol and Related Steroids*. London: Heinemann Medical Books. 882 pp.

Articles in books

4. Innerarity, T.L., Hui, D.Y., and Mahley, R.W. 1982. Hepatic apoprotein E (remnant) receptor. In *Lipoproteins and Coronary Atherosclerosis*. G. Nosedá, S. Fragiaco, R. Fumagalli, and R. Paoletti, editors. Amsterdam: Elsevier/North Holland. 173-181.

Abstracts

5. Packman, C.H., Rosenfeld, S.I., and Leddy, J.P. 1981. Inhibition of the C8/C9 steps of complement lysis by a high density lipoprotein (HDL) of human serum. *Fed. Proc.* 40:967a. (Abstr.)

11. **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) and explanation in sufficient detail to make the figure intelligible without reference to the text (unless a similar explanation has been given in another figure). Provide a key to any symbols used.
12. **Tables.** All tables should be double-spaced on manuscript pages. Tables should be self-contained and self-explanatory. Provide brief titles and use superscript capital letters starting from A and continuing in alphabetical order for footnotes.

NOTE: **For Bound Copy:** The full thesis title, the student's full name, "Yale University", and the year of degree should be imprinted on the cover. An abbreviated title, student's name and year should be imprinted on the spine.

Thesis Typing and Assembly Instructions

The final submission of the M.D. thesis should meet the following requirements:

Paper: 20 lb. weight paper of good quality; corrugated bond is not acceptable. All pages must be a high-contrast, dark image on white paper.

Print Size: Use a 10-12 point font.

Typing: Double spaced on one side of the page. Single spacing may be used within block quotations, footnotes, and bibliography, but double spacing must be used between successive entries.

Margins: 1-1/2 inch left hand margin (normally, the binding edge), 1 inch on the three other edges. These margins apply to full-page photographs and pages containing tables and illustrations, as well as to pages of text.

Page Numbers: Each page in the thesis should be numbered except the title page, table of contents, abstract, and acknowledgements. The number should be placed either at the top center or at the top right hand corner at least 1/2 inches from any edge.

Number of Copies: The Office of Student Research requires one letter-quality printed original hard bound cover, any color one copy for the department chair's office and one copy for your advisor is optional (contact your Departmental Thesis Committee). The copies should be reproduced on a good copying machine. These copies may be bound with soft covers. **Allow at least one week for copying and binding of your thesis.**

Yale Medicine Thesis Digital Library. The Office of Student Research also requires a copy of your thesis on a CD to be submitted to the Yale Medicine Thesis Digital Library. A completed agreement form (to be sent to all graduating medical students and available in the Office of Student Research) must accompany the CD. Both the CD and the agreement form must be delivered to the Office of Student Research, 310 ESH.

Bound Copy: The full thesis title, the student's full name, "Yale University", and the year of degree imprinted on the cover. An abbreviated title, students name and year imprinted on the spine.

Ordinarily, photographs should be scanned and entered electronically into the text. To mount photographs, use Duco or equivalent cement, rubber cement or "permanent" glue. Regular glue, picture corners, and adhesive cellophane are not acceptable. If charts, graphs, maps, tables, or computer printouts that are larger than the standard size are to be used, they should be folded carefully into the manuscript, with the fold at least 1/2 inch from the right hand edge of the page.

Legends are placed below the illustrative material. A legend may appear, however, on a facing legend page when both illustration and the legend cannot be accommodated on one page.

The Office of Student Research has a list of typists, copying and binding services. A thesis which contains strikeovers, messy erasures, and careless spacing and centering, or in which the fundamentals of punctuation and spelling are not observed, may not be accepted. **Allow at least one week for copying and binding of your thesis.**

Typing and Binding Costs:

The cost of typing and binding the dissertation is the responsibility of the student. Departmental or research funds should not be used for this purpose.

Abstracts:

The abstract should be placed immediately after the title page. A copy of the abstract is also be submitted to *The Yale Journal of Biology and Medicine*. See section on "Abstracts of M.D. Thesis" for more detailed information.

Title Page Format:

(Full Title of Dissertation)

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)

Abstracts of M.D. Theses

All abstracts of Yale medical student theses are published in *The Yale Journal of Biology and Medicine*. A standardized format for the abstract of each M.D. thesis is required (see the following instructions on page 21). **This format must be followed for all abstracts published both in the bound thesis and in the abstract submitted for publication.** When theses and abstracts are in final form and have been approved by faculty sponsors, students are required to submit a copy of their abstract on a CD to *The Yale Journal* for publication. The editors of *The Yale Journal* will not review abstracts for content, although abstracts of poor quality may be rejected. It will be the responsibility of the student investigator and the faculty advisor to prepare the abstract. Faculty sponsors must give written approval of the abstract as published in the bound thesis and as submitted for publication in *The Yale Journal*.

A portion of the high quality original research done by Yale Medical students was at one time unavailable to interested investigators outside or even within the Yale community. Publication of theses' abstracts now insures access for all scientists to a summary of such work, will provide students with a formal citation for their thesis, and will demonstrate the exceptional quality of student research and student-faculty cooperation at Yale. Publication of this abstract will not jeopardize in any way the publication of a full length scientific paper.

Your thesis abstract must be submitted to *The Yale Journal*, even if you are publishing your results in an original paper. Remember that positive results are not a prerequisite; well-designed and rationally executed investigations are of interest to other researchers in that field. We look forward to 100% participation by your class in this effort to disseminate the excellent research done by Yale medical students.

Instructions for Yale Medical Student Thesis Abstracts:

**** These instructions for preparing abstracts are to be used for both the bound thesis and publication of abstracts in *The Yale Journal of Biology and Medicine*.**

1. Abstracts may be typed or printed by word processor on standard 8 1/2" x 11" white paper with 1-1/2 inch left hand margin (normally, the binding edge), 1 inch on the three other edges. Abstracts may be no more than 500 words in length, not including title and author information. Entire abstract including title page must be double-spaced and should be no more than one page at length.
2. Titles should be brief, clear and carefully chosen. The title should not exceed 100 characters including spaces between words. Capitalize entire title, using no abbreviations.
3. 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, his or her 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).
4. For thesis work done at another institution, designate senior author's departmental and institutional affiliation. In parenthesis, indicate Yale faculty sponsor and institutional affiliation with the phrase: "Sponsored by..." (see examples).
5. Organize the body of abstract as follows:
 - A statement of the purpose of the study (preferably one sentence).
 - A statement of the methods used.
 - A summary of the results presented in sufficient detail to support the conclusions. Include actual values with statistics, if appropriate.
 - A statement of the conclusions reached.
 - Do not use subtitles; e.g., methods, results.
6. 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.
7. Abbreviations may be used in text only if defined initially by placing them in parenthesis after the full work first appears in the text. Abbreviations may not be introduced in the title.
8. 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).
9. Completed abstracts must be approved by faculty advisor. You must submit a signed permission form and a CD containing your thesis abstracts to the *Office of Student Research, 310 ESH*.

Examples of Titles and Authors of Abstracts:

1) Thesis done at Yale:

INCIDENCE OF SUPRAVENTRICULAR ARRHYTHMIAS IN AN AGING POPULATION.
John M. Smith, Walter T. Donigan, and Marion L. Green. Section of Cardiology, Department of Internal Medicine, Yale University, School of Medicine, New Haven, CT.

2) Thesis done at Yale, where faculty advisor is not a co-author:

INCIDENCE OF SUPRAVENTRICULAR ARRHYTHMIAS IN AN AGING POPULATION.
John M. Smith and Walter T. Donigan (Sponsored by Marion L. Green). Section of Cardiology, Department of Internal Medicine, Yale University, School of Medicine, New Haven, CT.

3) Thesis done elsewhere:

INCIDENCE OF SUPRAVENTRICULAR ARRHYTHMIAS IN AN AGING POPULATION.
John M. Smith and Walter T. Donigan. Section of Cardiology, Department of Internal Medicine, St. Elsewhere Hospital, Boston University, Boston, MA. (Sponsored by Marion L. Green, Department of Medicine, Yale University School of Medicine).

Thesis Approval Process

There are three levels of review of M.D. theses as follows:

- First Level** - Student/Thesis Advisor
- Second Level** - Departmental Review
(Departmental Thesis Committee)
- Third Level** - Thesis Awards Committee
(Thesis Subcommittee)

1. All students expecting to graduate in May of a given year, complete in the fall of the preceding year, a Thesis Information Form indicating:

- the title of his/her thesis;
- his/her advisor and department

This Thesis Information Form must be signed by the student and forwarded to the Director, Office of Student Research.

2. Students must include in the methods portion of their thesis, specific details of exactly which procedures, methods and experiments were conducted by the student and which procedures, methods and experiments, generation of data, or production of reagents, were performed by others. 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 and is necessary for academic honesty.

3. Following writing, reviewing and editing of drafts of the thesis by the student and approval by his/her thesis advisor, a formal letter from the faculty advisor must be sent to the Department Thesis Committee Chairperson indicating faculty approval of the thesis. The advisor must be a member of the full time faculty at the School of Medicine. This letter should accompany the submission of the thesis by the student for departmental review. This letter should state that the work is original and has been done by the student.

4. All student theses should be reviewed by at least one external reviewer at the Departmental Thesis Chair level of review. An external reviewer is defined as external to the specific project and may be a member of the department or the section where the work is performed or may be a member of another department. This reviewer is strongly urged to meet in person with the student to describe her/his comments and suggestions. A written summary of the reviewers critique (which may be brief) should be sent to the student and to the Department Thesis Chairperson.

5. Changes recommended by the reviewer(s) are then incorporated into the final bound thesis copy. Upon completing the recommended changes the student will be notified by the Departmental Thesis Chair of his/her approval and the student can proceed on binding the thesis and final submission to the Office of Student Research.

6. Recommendations for Honors - Elements of the third review (Awards Committee). The basis for honors should be an excellent to outstanding thesis with original observations judged worthy of publication in a peer-reviewed journal. One thesis per department, or 20% of the total theses done in a department may be submitted for honors only if each meets this criterion for honors.

7. Theses submitted by the Departmental Thesis Committee to the Thesis Awards Committee for honors consideration must be accompanied by the following:

a) a letter from the faculty advisor recommending the thesis for honors, indicating why it is recommended and stating specifically all methods and data generated by the student and all methods and data generated by others. The letter should indicate any publications resulting from the work or in preparation. To be considered for honors, the faculty advisor must indicate that in his or her opinion, the work of the student is definitely considered to be worthy of publication in a peer-reviewed journal.

b) a letter from the Department Thesis Committee Chairperson indicating the reasons for recommending for honors. Comments or a letter from the external reviewer may also be included.

Note: If more than one thesis is submitted by a Department, the Departmental Thesis Committee should list in rank order the department's nomination for honors.

Thesis Committees

Departmental Thesis Committee:

Each Department Chairperson will appoint a Departmental Thesis Committee of three senior faculty members who will be responsible for approving completed dissertations done within that department. 2007-2008 Departmental Thesis Committee Members are:

Anesthesiology	Dr. David Silverman	Neurobiology	Dr. Michael Schwartz
Cell Biology	Dr. Peter Takizawa	Neurology	Dr. Hal Blumenfeld
Child Study Center	Dr. James Leckman	Neurosurgery	Dr. Anne Williamson
Dermatology	Dr. Robert Tigelaar	Obstetrics & Gynecology	Dr. Errol Norwitz
Diagnostic Radiology	Dr. Kevin Johnson	Ophthalmology	Dr. Miguel Coca-Prados
Epidemiology & Public Health	Dr. Elizabeth Claus	Orthopaedics	Dr. Jonathan Grauer
Genetics	Dr. Margretta Seashore	Pathology	Dr. Jeffrey Sklar
History of Medicine	Dr. Naomi Rogers	Pediatrics	Dr. Howard Pearson
Immunobiology	Dr. Peter Cresswell	Pharmacology	Dr. Anton Bennett
Internal Medicine	Dr. Larry Young	Physiology	Dr. Bliss Forbush
Laboratory Medicine	Dr. Peter Tattersall	Psychiatry	Dr. Bruce Rounsaville
Molecular Biophysics & Biochemistry	Dr. William Koningsberg	Surgery	Dr. John Geibel
		Therapeutic Radiology	Dr. Lynn Wilson

The Thesis Subcommittee of the Curriculum Committee:

A Thesis Subcommittee of the Curriculum Committee has been formed and meets regularly to recommend policy to the Curriculum Committee for all aspects of the Thesis requirement. Specifically, rules and regulations will be set and deadlines established. The Committee will serve as a reviewing body to determine prizes and guidelines for the awarding of prizes. 2007-2008 Thesis Subcommittee Members are:

Dr. Nancy R. Angoff	Dr. James D. Jamieson
Dr. Richard Belitsky	Dr. Nancy Kim
Dr. Emile Boulpaep	Dr. Forrester A. Lee
Dr. Dennis Cooper	Dr. Richard Lifton
Dr. Jose Costa	Dr. I. George Miller
Dr. Anne Curtis	Dr. Naomi Rogers
Dr. Thomas Duffy	Dr. Peter Takizawa
Dr. John N. Forrest, Jr.	Dr. Bruce Wexler

Office of Student Research:

The Chairperson of the Thesis Subcommittee has established an office dedicated to student research where lists of faculty research interests are kept up to date; deadlines and applications for stipends are available; where advice can be given to students searching for research projects; where information about past student projects is kept; and where sources of funds can be reviewed. The Office of Student Research is under the direction of Dr. John N. Forrest, Jr. Specific questions about the thesis requirement should be directed to Donna Carranzo, Mae Geter or Dr. Forrest at the Office of Student Research, 3rd Floor Harkness Dorm, 310 ESH, 785-6633.

