The ABI Major

Student Survival Manual
# The Animal Biology Major Program

The Animal Biology (ABI) major specifically caters to those students ultimately seeking a professional career in research focused on the biology of animals. ABI

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intensively educates students in the natural sciences, with heavy emphasis on methods for deriving new information about animals. Thus, the process and principles of science, and concepts in research methodology receive the highest priority. ABI encourages students look beyond particular groups of animals in which they are interested and to apply the process of science as a way of establishing new and reliable information about them. The major places priority on seeking solutions to conflicts between the needs of animals, and evermore pervasive human enterprise, such as agriculture or advancing urban areas. However, animal behavior, animal nutrition/diet, conservation, ecology/ecosystem function, genetics, immunology, parasite-host interactions, reproduction, wild animals in captive settings and wildlife management exemplify the diversity of research areas encouraged in ABI. Animal care and husbandry remain the prevue of other programs.

**Student Learning Outcomes for the Animal Biology Major**

1. Ask and answer novel questions in biology, and derive new information and ideas using the process and principles of science.

2. Simply and effectively communicate complex ideas in biology in writing and speech to groups of people.

3. Mediate conflicts between the biosphere and human enterprise incorporating the most reliable biological fact and thought.

4. Distinguish between real scientific fact and progress in biology from bias-driven public-relations pseudoscience.

5. Using a team approach and the most contemporary thinking in biology, solve problems of a biological nature.

**The Curriculum**

The curriculum consists of core biological sciences courses that build on animal biology from molecular foundations to the ecological and evolutionary levels of organization. After completing the core courses, usually at the beginning of the junior year, ABI students design their own academic program. The program includes a
research project of the student’s choice called the Senior Practicum, (essentially an undergraduate thesis project), completed under the guidance of a faculty mentor. The student and mentor select twenty five units of supportive coursework or Restricted Electives; these provide the foundation for the Practicum. Essential corollary skills of science, including scientific writing, critical thinking; public speaking and research teamwork naturally develop from this process. The ABI research experience thus remains almost unique among undergraduate science majors at UC Davis. By graduation, in addition to completing coursework on the principles of biology, every ABI student engages in one complete cycle of the scientific process by conceiving an idea, formulating a question, deriving hypotheses, making predictions, testing those predictions with observations and completing a manuscript (frequently publishable) detailing their efforts and results. The student directs this entire effort in a manor to catalyze their post graduate aspirations.

**Appropriate Practicum Projects**

Identifying post-graduate professional aspirations constitutes the key to selecting a Practicum Project, a Mentor, and the Restricted Electives. That ultimate professional interest obviously identifies the kinds of scientific inquires, list of potential mentors and the coursework from which the student selects. Many have a well established longstanding interest in some profession, and for this group the selection process becomes comparatively easy. But for those that remain unsure, the process remains rather more difficult. Universities certainly top the list of great places to make that decision; in no other venue are nearly all the choices so well advertized as in a Course Catalogue, and available direct assess to any potential choice via coursework! However it comes about, it behooves the student to give this decision top priority.

The practicum may be experimental biological research, or a problem-solving issues paper. These take on the same basic scientific inquiry and report structure. Practicum projects may be off campus, and the primary mentor need not be a UCD faculty member, however, in this case students must additionally have an on-campus faculty member as a co-mentor. Students may collaborate on a project, provided that
the project requires effort commensurate to the number of students. An “Internship” does not constitute a practicum in and of itself, but may be an entrée to a laboratory, a practicum project or to a relationship with a prospective mentor.

**Experimental biological research**

Essentially this constitutes a standard scientific inquiry with hypotheses that make predictions about future observations derived from experiment, using the process and principles of science. In general, a student or team of students conducts such an inquiry in the laboratory or field. The research project may be independent of, or be within the mentor’s program of research, most often the later. Collaborating in a research team on an ongoing project with other researchers in the laboratory constitutes a highly desirable option. The student receives mandatory safety and other training to complete the work. With mentor guidance and administrative oversight, the student may collaborate with a graduate student or post doc. In general, students develop a protocol, set up the experiment, collect, analyze and interpret the data, and write a research paper in the format of a publishable scientific manuscript. This becomes the Practicum Report. The discussion section of the paper should argue the significance of the research in the greater context of science and societal interests.

**Animal “Issues” Research**

A student or team of students selects some animal-related issue and conducts a standard scientific inquiry in the standard way with hypotheses and predictions, but where the observations derive from library, interview based survey and similar sources. Thus, the “Issues paper” differs from an experimental biological research project only in that observations come from the literature, interview, opinion surveys and the like. The manuscript exhibits the same logical construction, format and structure as for experimental biological research. The discussion of this paper evaluates the findings in relation to economics, society, stakeholder interests, animal welfare or environment, and makes relevant conclusions. The mentor again guides all aspects of the work.

**Ongoing research**
Alternatively, having identified a potential mentor in a field of study commensurate with your personal interests and goals, and possessing a few general project ideas in mind, ask him or her if there is an ongoing research effort in their lab with which they could use assistance. In this case the student becomes part of the lab team, a far better experience as virtually all modern science is done by teams of collaborators. Importantly, in the eyes of the mentor the student becomes a valuable asset rather than an additional responsibility. The student can easily organize their portion of the ongoing project into a practicum proposal and report as described in the sections of this document devoted to those requirements.

Launching the Practicum effort: ABI187 Seminar

The ABI 187 Seminar course offered every Fall and Winter quarter leads students through the process of deciding on a practicum project, writing the practicum proposal, finding a mentor, and together with the mentor, selecting the classes to fulfill the restricted electives requirement. ABI Seminar should be taken as soon as possible after ABI50A, (Animal Biology Laboratory, but delaying the decision process until the ABI Seminar risks unduly complicating the already difficult Junior and Senior years most students experience. Transfer students should take ABI 187 during the first fall or winter quarter at UCD. ABI almost uniquely offers a great deal of freedom in choice of academic pathways and the anxiety of freedom troubles many students. Delay frequently occurs; no one wants to make a decision that prevents or delays graduation or proves misguided following graduation! Preparing early and prior to ABI187 remains the best way to avoid such problems.

Thus, with defined interests, start thinking about projects and look for faculty with related research programs. Politely make an appointment and ask about working on one of their projects as an assistant. When you interview faculty, take copies of the ABI Practicum Mentor handout and explain your interests to that person. If the situation seems auspicious, politely ask if he or she would be willing to be your mentor. Internships are a great way to gain experience and learn if you really like a particular
field of animal biology, and also to meet and develop relationships with potential mentors. Begin this process now.

**ABI Mentor Instructions and Responsibilities (What a Mentor Does)**

Prospective mentors interview ABI187 students when they make appointments and potentially choose one or more to work in their labs. They are strongly encouraged to contact the ABI Master Advisor with any questions about the student(s), the nature and intent of the practicum, or the ABI major.

The mentor helps students select research questions, hypotheses and research objectives that provoke thought and provide a capstone undergraduate research experience. The ABI Practicum section of this handbook details the three categories of acceptable practicum projects. Ideally, the project should be in an area of research directly relevant to the student’s ultimate professional goals. Students establish a tentative, two-quarter timetable for completion of the practicum including writing for the mentor to approve.

Students may work with anyone in a lab under the supervision of the mentor, and may work in groups. Thus, with mentor oversight, a graduate student or post doc may day-to-day guide students on the project. Mentors meet regularly with students to help keep them on track.

Mentors assist students in selecting the restricted electives and for their academic plan. These provide the concepts, background ideas or skills that amplify the practicum project. They must total 25 units. This document lists the selection criteria for restricted electives that may be used by the student in his or her practicum proposal, together with the restricted electives form for the student to fill out and the mentor to sign. Mentors see that students have necessary technical and safety training, together with the environment, resources, and guidance for the work to be completed.

We recommend students log their activities and thoughts during the project in notebooks in the standard way, whether the project is experimental research, or an animal issues project or ongoing research. Notebook entries should be made in a
timely manner. You should read and comment on the notebooks periodically.

The Mentor encourage high quality work, analysis, writing, and timely completion. Enforce the universal processes and principles of science. Interact with students in the standard way a principal investigator guides anyone working in their lab. Make corrections on drafts of the report and the final report prior to submission.

Although the practicum report should be written with the standard sections, logic and format of any common scientific report prepared for publication, the mentor may suggest other manuscript writing methods. Otherwise sections in this document detail preferable criteria for the process or writing a generic scientific publication. “Issue” based projects follow the same basic structure as outlined in this handout. In this case data used to test predictions from the student’s hypotheses derive from the literature or other sources. The guide to authors of a good journal in the mentor’s field would provide appropriate details of format. Where the nature of a practicum deviates from normal scientific reporting, students should be guided by an agreement between the master advisor and mentor.

The mentor determines that the final project paper meets his or her critical standards and signs the signature page.

The first meeting with a potential mentor: The Approach

Realize that meeting with a prospective mentor for the first time is just like having a job interview. For all practical purposes you will be interviewing that person to determine if he or she constitutes a good fit for you and your research aspirations. . Interestingly, this interview will be reciprocal, each of you will be “interviewing” the other! You will interview a potential mentor, and be interviewed as a potential researcher. Conduct yourself as you would in a professional setting. Dress appropriately, prepare by reading the mentors publications, understand the mentor's work, and have whatever questions you may have ready. The key words are Preparation and Questions, it is vital that you are fully prepared for your mentor meeting.

Always be professional when working with a mentor; it is of the utmost
importance to be so during the first contact with him or her. The goal is to convince your prospective mentor that you would make a valuable team player to his/her lab. Do not pursue mentors, labs or projects in which you are not truly interested, nor settle for a research effort simply because the lab is willing to accept you as labor or to merely satisfies your ABI requirements. Focus on people and situations that match your career goals.

If a potential mentor does not respond to an initial email, contact them again after about a week or so. Researchers at universities are exceedingly busy, obtaining a response often requires several attempts; most delightedly talk to students about their research and professional development, particularly during office hours. Once you establish contact, restate your real interest in the kind of work they do and your fascination with becoming involved in a research project in that area. Ask if they need help on a research project in which they are currently engaged. Even if they seem to respond ambivalently, meet with that person anyway. Their personal impression of you may change their attitude. At the least they will likely know of other persons involved in the same area of research you can contact.

Be certain to study the faculty member’s research interests, areas of specialization and publications before you go to office hours.. Be able to state why you are seeking out this particular person’s advice. Take along a list in your mind of specific questions or requests for guidance. Do not walk in and say "So, I want to do research in your lab and you to be my mentor so I can graduate," with no clue what the researcher is doing or what part of his or her work you could be involved in; you need to prepared!

Bring background information about yourself, including your name, address, phone number, email address, your area of research interest, your educational background, any previous research experience. Include a paragraph or two summarizing your research interests. In effect, go prepared with the Curriculum Vita (CV) (aka Resumé) that you develop in ABI187. Many mentors also like to see a copy of your academic transcripts. Take along all these items so that if asked for they can be immediately provided.
Bring along some potential senior practicum project ideas you have thought through. This will demonstrate to the mentor that you have critically thought about key questions, and developed corresponding hypotheses to test your ideas. Realize that your mentor will likely find flaws in your potential research effort and suggest modifications or alternatives. Be open to these approaches; this is what a mentor is for—putting you on a viable track. Under no circumstances give the impression that you will be just another drain on your potential mentor’s time. Rather, make it clear that you will be exactly the opposite, a contributing facilitator in the mentors research team.

**Some tips for interviewing:**

- Always bring a notebook and a pen
- Bring a copy of background research
- Maintain good posture
- Dress appropriately
- Be polite and respectful
- Knock on the door (even if it is open). Do not just barge in because it's 4 p.m. and that's when you were supposed to meet.
- Write down the office number and time you are supposed to meet. Laboratories can be confusing.
- Arrive at the building early. You may want to do a quick walk-by to make sure you know where the office is.

Before leaving, think about the follow-up you should have with the potential mentor. If you have established a good rapport and can develop an ongoing relationship, make arrangements for the next meeting to continue the process. Ask what you can accomplish in the interim period.

If there isn’t a good match between your interests and those of the potential
mentor, remember to ask that person to suggest other colleagues you might approach. Even if this particular individual has been very helpful, it will likely be useful to speak with those people as well, the more input you get in finding a mentor, the better.

**Questions a Student might ask a Mentor**

Try to begin the conversation by talking about the potential mentor’s current research. Communicate your fascination with it.

- What are the various projects in the mentor’s research program?
- What journals are important to read?
- How did you get into this particular area of research?
- What has been your career path and former positions? (Actually you should have a general idea about these from the background research you have done on your potential mentor)
- Who helped you in that process and how did you progress in this field?
- Looking back, is there anything you would change or do differently based on what you have learned over the course of your career?
- What is the best piece of professional advice you’ve ever received and used or implemented?
- What are the things you find personally rewarding in your career?
- What characteristics do you look for in a student?

**Questions a Mentor might ask a Student**

- What do you want to be when you grow up (What profession do you want to be in when you’re older?) and why?
- Why did you choose to attend UC Davis?
- Why did you choose Animal Biology as a Major?
- What classes have you taken? Which one did you enjoy and why?
- What is your motivation for pursuing this (the mentor’s) area of interest?
- What have you learned in your course work that fascinates and interests you enough to engage in a more in depth investigation?
Tell me the 5 best things about you?
What skills do you have?
What skills would you like to develop here at UC Davis?
What have you done, in school or sports or anywhere that you are most proud of?

The Practicum Proposal: What it looks like, how to format it, etc

The practicum proposal usually constitutes a description of standard scientific inquiry with hypotheses that make predictions about future observations derived from experiment. The “Issues paper” option differs from an experimental biological research project only in that the observations come from the literature, interview, opinion surveys and the like. Both kinds of practicum use the process and principles of science in the same way. Thus, experimental biological research and issues paper proposals take the same form described herein. A brief outline of the Practicum Proposal follows here. Explanations of each section follow in subsequent sections.

Outline of the proposal
A. Title/Signature page: (See Appendix 1 for this signature page)
B. Cover page
C. Project Description
   1. Abstract
   2. Introduction
   3. Hypotheses
   4. Research objectives
   5. Methods
   6. Predicted outcomes
   7. Timetable
D. Importance to self and society
E. Academic Plan
1. Academic Interest

2. Restricted electives (See appendix 2 for Restricted Electives page)

3. Academic Schedule

F. Curriculum Vitae (Résumé)

G. Opportunities Related to the Practicum (If any)

**Explanation of Sections**

A. Title/Signature Page (See Appendix 1 for the title/signature page)

Print out The Title Signature Page (Appendix 1) and obtain the required signatures after the mentor approves the proposal. Include this on top of the proposal packet as the first page. Student and mentor signatures on the proposal indicate that both accept responsibility for the project. The specifics of the proposal, however, are tentative, and aspects may change as the project develops. This proposal becomes part of the student’s academic file. If major changes occur to the proposal, a mentor-signed revised proposal must be submitted. Seek guidance from the Master Advisor to determine if this is necessary; most often, it is not.

B. Cover page (Format in some attractive way)

1. Practicum Title (Descriptive title of proposed Practicum)

2. Name (Your name as on your UC documents)

3. Projected graduation date

4. Coursework Specialization Title (Descriptive title of proposed coursework specialization)

5. Academic Advisor (Name and departmental affiliation)

6. Mentor (Name, affiliation, and addresses of mentor for the Practicum)

7. Date
C. Project Description

The project description should approximately be four single spaced pages of text, but may be longer if necessary. Follow the section format below. Much of the structure and logic of a good proposal parallels the scientific report one would write detailing the results of the work, but written in the future tense (we shall do, rather than we did).

1. Abstract. Write the abstract last. The first sentence is essentially your hypothesis rewritten as a statement of what will be done, followed in sequence by the each of your research objectives, and your anticipated results. Copy and paste each of these sentences to the abstract and then edit them as necessary so they form a short cohesive paragraph.

2. Introduction. This section should only consist of two paragraphs. The first defines the broad context of the problem to be studied and begins with a very broad statement like: “Fishes are known to swim sometimes but drown occasionally”. Subsequent sentences set the stage and inform the reader about where, when and why, and what form of science this problem effects. It ends with a statement of the general problem as you understand it and intend to study.

   In the second paragraph the writer takes the general problem stated above and through logical arguments focuses on the question that seems most central to its solution. The usual method develops the question either as a paradox or lacuna: Problems stated as a paradox (two mutually exclusive truths) have very much greater power than those stated as a lacuna (region where knowledge is lacking). Bring in any citations that are germane to your arguments here, but do not attempt to provide a “literature review”. Subsequent sentences narrow down, define and rule out the possible solutions to this problem until you have only one or as few as possible. Develop an argument that ultimately specifies a particular question central to the solution of your problem and which can be answered by scientific research. This paragraph ends with a concise statement of this question you have developed from the research problem.
3. Hypotheses. This section organizes the research based on the question. The first sentence is a concise statement of the hypothesis(ies) to be tested, which derives from the last sentence of the second paragraph of the introduction. In fact, it can be that sentence but inverted and stated as a hypothesis: “It may be that………..” is one way of beginning a hypothesis. This would be followed by a statement of the alternate hypotheses.

4. Research objectives. Here, write a series of sentences or numbered clauses that state in sequence exactly what you must do to test your hypothesis: “Accordingly we will (1)…..,(2)…….., and etc”. These objectives or experiments must be logically arrayed so that the first provides a foundation for the second which then builds on the first and so on. The final sentence defines the one piece of critical information that would falsify your hypothesis: “In particular, we seek to determine if……. (Whatever it is) ”.

5. Methods. Write the “M&Ms” by copying and pasting each of the research objectives to that section. These are the “Accordingly we shall” sentences or clauses. Each becomes a topic sentence for a short paragraph about the techniques you anticipate using. They begin something like: “In order to determine such and such, we shall do such and such”. Be certain you include how you collect your data and how they shall be analyzed. Thus, the objectives and M&Ms are written in parallel.

6. Predicted outcomes. Copy and paste each of the research objectives to this section as you did for the M&Ms. Each of these now becomes a topic sentence for a short paragraph detailing what you reason the results will most likely be. They begin something like: “We first shall first determine if”. Then go on to write what you think the most likely result will be. Where alternate results seem not unlikely, include those as well. Again these are arrayed in parallel with the objectives.

7. Timetable. Here, with the guidance of your mentor provide a schedule of work with estimates of how long each objective will take to complete and a calendar of
approximate completion dates. Consider doing this graphically. The actual work on a project should last about 2 quarters or completed over a summer.

D. Importance to self, society, and biology

This section constitutes a more personal exposé on the importance of the work you intend to do, not only to yourself and your career development but to societal interests. State what the project means to you as a student or as a person. Talk about why do you want to do this project and what will you learn.

E. Academic Plan

1. Academic Interests. This constitutes a statement of the student’s broad areas of academic interest and particular area of specialization.

2. Restricted Electives. Selected with and approved by the mentor, the academic plan includes a list of courses that the student takes to fulfill the Restricted Electives requirement for graduation in the ABI major (See Appendix 2). This consists of 25 quarter hours of upper division courses; lower division courses generally do not qualify. Independent Research (limited to two 199 units) must be approved by the mentor together with a brief written explanation about how they fit into the academic plan. The courses should fulfill one of the following criteria:

   a. Teach skills needed to complete the practicum. For example, if collecting numerical data needing analysis, take an advanced course in statistics.

   b. Teach procedures required in the laboratory. For example, take one or two 199 research units with the mentor before the practicum begins to learn highly technical processes in cases where training is unlikely to be available elsewhere.

   c. Provide background adding depth and breadth to knowledge about the practicum project.
3. Academic Schedule. Organized with academic advisor guidance, this constitutes a schedule of classes the student will take during each remaining quarter.

F. Curriculum Vitae (CV, Résumé) Limit this to two pages. Format it in an attractive way. Go to one of the meetings at the Resume Clinic at the UCD Internship and Career Center, for guidance on how to write an effective Résumé). Include the following:

1. Personal information
   a. Name and citizenship; birth date is optional and by law cannot be required, but not a bad idea to include in this context
   b. Contact information (Address and phone number, either home, work, e-mail, or webpage address, whichever reliably reaches the student)

2. Statement of Interests (One objective paragraph statement of interests and most likely career goal and alternates, i.e., an expanded statement of purpose)

3. Education (Junior colleges attended; current university, college, major, minor, expected graduation date; list of “important” classes; current GPA)

4. Work and Volunteer Experience (Demonstrate good work ethic and technical and other skills. Include dates, position titles, employing organizations, supervisors, duties and skills demonstrated, reason for leaving if not obvious)

5. Special skills (Relevant skills, be explicit)

6. Awards and Accomplishments (Relevant special awards and accomplishments)

7. References (Names and addresses of 3 people who can write substantive letters of recommendation. Annotate the list to explain what each writer can contribute (e.g., how you demonstrate your intellect, communications skills, creativity, work ethic, humanity. Before listing a referee ask their permission.)

Opportunities Related to the ABI Practicum
UCD has a number of opportunities for undergraduate student to present and fund their work. While no requirement for ABI students to participate in any of these opportunities exists, they can be rewarding in a number of ways. Not exhaustive, this list should make you think about how to make the most of your research experience.

1. Internships

   Under the guidance of a faculty or staff member, a campus department or off-campus organization, students may frequently undertake specific tasks in order to learn a technical skill or a particular set of procedures relevant to animal biology. There are numerous state, federal and industry organizations that have such internships, and these can have the added advantage of positioning a student for employment upon graduation. In some fields internships are essential for later employment- forensics for example.

2. President’s Undergraduate Fellowship.

   http://trc.ucdavis.edu/trc/grants/undergrad/

   The President's Undergraduate Fellowship Program (PUF) supports undergraduate students doing research or creative projects under the guidance of UC Davis faculty members. Students from all discipline areas are eligible to apply. Past projects have involved laboratory research, field studies, survey research, film production, design and creation of art elements, music composition, fine arts performances, travel to library or research collections, and many other endeavors. Group projects are not appropriate; separate, but linked, projects may be. The maximum award is $2000.

3. Annual Undergraduate Research, Scholarship and Creative Activities Conference at UC Davis.

   The conference is described below. This conference along with many other types of opportunities for undergraduate research funding and organizations is
listed at the following website:

http://www.urc.ucdavis.edu/

UC Davis undergraduates in all academic fields are invited to submit an abstract and registration information to participate in the annual Undergraduate Research, Scholarship and Creative Activities Conference. Research projects must have been conducted under the supervision of a faculty member or professional in the field. The conference is designed to acquaint undergraduates with the process and academic rigors of presenting research in a scholarly manner.

Additionally, the conference will stimulate interaction between students and faculty, while encouraging undergraduates to pursue advanced degrees toward the goal of research and college teaching.

Students will present their research projects to faculty, staff and other conference participants in either an oral or poster format. The oral presentation will allow students to give a 15-minute presentation of their topic and includes time for questions. Each oral session will be moderated by a faculty member. In the poster session, students will have designed a visual poster representing their research and will be presenting their work to individual conference participants.

Look for the annual announcement in January of each year.

**General expectations of the Practicum**

1. It should be consistent with the above format.

2. It should take approximately two academic quarters to complete, from the start of the work to the submission of the project report. It is not an open-ended mini-master’s thesis.

3. It must provide the student opportunities to demonstrate critical thinking, develop practical skills, communicate, and be creative in an animal biology and scientific
4. Practicum quality must reflect the expected development of general admissions undergraduates. We expect students to do their very best and extend themselves. Mentors assure quality of work.

**ABI 189 and 189d: Measures of research and writing progress**

ABI 189 units measure your practicum work. Students sign up for units over two quarters while actively engaged in completing the practicum project. Arrange a CRN with your mentor and the staff advisor at the beginning of the first of the two quarters work. Credit hours vary, but plan on three hours of practicum work for each credit hour.

ABI 189d gives each student working on their practicum an opportunity to discuss progress and problems with an advisor and other ABI students once a week during the first quarter of practicum work. This fosters discussion of your research topics and efficient problem solving. During Fall, Winter and Spring quarters every year, an advisor will be available for set office hours.

A student cannot register for these courses until a completed and Mentor signed Practicum Proposal is turned in to the Academic Advisor and approved.

**Potential Exceptions to the Rules Governing Restricted Electives**

Including “lower division” courses in the 25 units of Restricted Electives requires special approval. ABI students and mentors must provide evidence justifying a major requirement exception, and we review such evidence during the process of “Degree Certification”, for graduation of each student. Within the ABI Major all special exceptions to the major requirements are considered on a case by case basis. But the rules are as follows:

1. Use no more than one pre-approved lower division course for RE 25 unit requirement.

2. All requests for exception must be in writing signed by the mentor with an
explanation why it should be considered. A copy of this document must be provided to us for the student’s file.

3. If a comparable upper division course does not exist to meet a heuristic need, we will consider approving the lower division course for RE unit credit only if becomes crucial to your practicum project and your mentor approves.

4. If the lower division course is a “required” prerequisite to more than one of your upper division RE courses, we will consider including this course for your RE units. However, many upper division courses require prerequisite lower division courses, just because a prerequisite course is required for some RE does not mean it also qualifies as an RE.

Students should additionally select alternate courses that quality for RE status and can be substituted into their RE list should one or more of their “first choice” courses become unavailable. Check with the offering department about the scheduling of their RE courses to be certain that they actually still exist and will be offered when the UCD course catalogue indicates.

Structure of the Practicum Report

What follows here is a brief description of how to write a scientific report. Realize that there are many different kinds of scientific articles with different objectives and audiences. The one we provide you here is very good for the general case. You should use this structure and logic for your final individual report whether it is bench, field or literature based.

Abstract:

Write the abstract last. The first sentence is essentially your hypothesis rewritten as a statement of what was done, followed in sequence by the final sentences of each paragraph of the results section, and the final sentence of the paper. Copy and paste each of these sentences to the abstract and then edit them as necessary so they form a cohesive paragraph.
Introduction

The introduction to your report should only consist of three paragraphs. The first paragraph defines the broad context of the problem to be studied and begins with a very broad statement like: “Birds are known to fly upside down sometimes but tend to crash and burn when they do so”. Effectively the subsequent writing narrows the topic sentence down to a specific problem. It also sets the stage and informs the reader about where, when and why of the problem, and what form of science this problem effects. It ends with a statement of the specific problem as you understand it and intend to study.

In the second paragraph the writer takes the problem stated above and through logical arguments focuses on the likely solutions that seem most central to its resolution. Bring in any citations that are germane to your arguments here, but do not attempt to provide a “literature review”. Subsequent sentences narrow down, define and rule out the possible solutions to this problem until you have as few as possible, generally two. Develop an argument that ultimately specifies a particular question central to the resolution of your problem and which can be answered by scientific research. The usual method develops possible solutions either as a paradox or lacuna: Probable solutions stated as a paradox (two mutually exclusive truths) have very much greater power than those stated as a lacuna (region where knowledge is lacking). This paragraph ends with a concise statement of this question you have developed from the research problem.

The third paragraph organizes the research based on the question. The first sentence is a concise statement of the hypotheses to be tested, which derives from the last sentence of the second paragraph. In fact, it can be that sentence but inverted and stated as a hypothesis: “It may be that…………” is one way of beginning a hypothesis. The second sentence begins a series of sentences or numbered clauses that state in sequence exactly what you must do to test your hypothesis: “Accordingly we did (1)……,(2)……, and etc”. These objectives or experiments must be logically arrayed so that the first provides a foundation for the second which builds on the first and so on.
The final sentence of the third paragraph defines the one piece of critical information that would falsify your hypothesis: “In particular, we sought to determine if…….. (whatever it is) ”.

**Materials and Methods**

The “M&Ms” may be written anytime, potentially during the conduct of the research when applying them. Copy and paste all but the first and final sentences of the third paragraph of the introduction to an empty page. Rewrite each sentence to become the “Accordingly we did” sentences or clauses. Each becomes a topic sentence for a short telegraphically written paragraph about the techniques you used. They can begin something like: “In order to determine such and such, we did such and such”. Be certain you include how you collected your data and how they were analyzed. Particularly short or related paragraphs can be combined as is expedient. Thus, the third paragraph of the introduction and the M&Ms are written in parallel.

**Results**

This is the first section to write, in part because once you have written it, you know exactly what you have (or do not have)! Focus particularly on generating the graphs, charts and tables you must show your readers. This section and the introduction could be written as the work progresses, in part to keep the research on track.

Simply copy and paste all but the first and final sentences of the third paragraph of the introduction to an empty page as you did for the M&Ms. Rewrite each of these to become a topic sentence for a paragraph about the results you achieved for that objective. They begin something like: “We first determined……..”, or “We compared such and such and discovered……….”. Again these are arrayed in parallel with the sequence in the third paragraph of the introduction. As with the Materials and Methods, particularly short or related paragraphs can be combined as is expedient. Each ends with an explicit statement of the particular result obtained. The final sentence of the results section states whether you falsified your hypothesis- the final result of your
research effort.

There is no discussion in this section, factual results only.

**Discussion**

The first sentence of the discussion states the most important fact you have discovered with your research, preferably the one which determined whether your original hypothesis was correct. The rest of the paragraph discusses its impact on our understanding of the research problem as a whole.

Subsequent discussion paragraphs may address a variety of lateral issues impacted by your results, or provide you the opportunity to further discuss why you did things the way you did, or to make further predictions along this line of research, or improve your arguments, and the like. Describe briefly where you think the research should go from here. Be sure to discuss and hopefully dismiss with evidence from the results section or argument any alternate explanations that compete with your findings. Include where necessary, what might be wrong and how could future workers deal with the problem. You might speculate what the next experiment should be and why. End the paper with an explicit statement of final result of your hypothesis test.

There are no new results written into this section not previously set out in the results section.

**Format of the Practicum Report**

The format of your report can follow the guidelines preferred by your mentor, or the Guide to author of the best scientific journal you could publish your study in or the very generic and standard criteria set out by the ICMJE that follows.

Whatever format you chose, the top page must be a signature page set out in the same way as for the practicum proposal (see appendix 1), with signatures of the Faculty Advisor, the Academic Advisor, your Mentor and you.

Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for
IV. MANUSCRIPT PREPARATION AND SUBMISSION

IV. A. Preparing a Manuscript for Submission to a Biomedical Journal

Editors and reviewers spend many hours reading manuscripts, and therefore appreciate receiving manuscripts that are easy to read and edit. Much of the information in a journal’s Instructions to Authors is designed to accomplish that goal in ways that meet each journal’s particular editorial needs. The following information provides guidance in preparing manuscripts for any journal.

IV. A. 1. a. General Principles

The text of observational and experimental articles is usually (but not necessarily) divided into the following sections: Introduction, Methods, Results, and Discussion. This so-called “IMRAD” structure is not an arbitrary publication format but rather a direct reflection of the process of scientific discovery. Long articles may need subheadings within some sections (especially Results and Discussion) to clarify their content. Other types of articles, such as case reports, reviews, and editorials, probably need to be formatted differently. Electronic formats have created opportunities for adding details or whole sections, layering information, crosslinking or extracting portions of articles, and the like only in the electronic version. Authors need to work closely with editors in developing or using such new publication formats and should submit supplementary electronic material for peer review.

Double-spacing all portions of the manuscript—including the title page, abstract, text, acknowledgments, references, individual tables, and legends—and generous margins make it possible for editors and reviewers to edit the text line by line and add comments and queries directly on the paper copy. If manuscripts are submitted electronically, the files should be double-spaced to facilitate printing for reviewing and editing. Authors should number all of the pages of the manuscript consecutively, beginning with the title page, to facilitate the editorial process.

IV. A. 1. b. Reporting Guidelines for Specific Study Designs

Research reports frequently omit important information. Reporting guidelines have been developed for a number of study designs that some journals may ask authors to follow. Authors should consult the Information for Authors of the journal they have chosen. The general requirements listed in the next section relate to reporting essential elements for all study designs. Authors are encouraged also to consult reporting guidelines relevant to their specific research design. A good source of reporting guidelines is the EQUATOR Network (http://www.equator-network.org/home/).

IV. A. 2. Title Page

The title page should have the following information:

1. Article title. Concise titles are easier to read than long, convoluted ones. Titles that are too short may, however, lack important information, such as study design (which is particularly important in identifying randomized, controlled trials). Authors should include all information in the title that will make electronic retrieval of the article both sensitive and specific.

1 This document is extracted from and derives almost entirely from: http://www.icmje.org/urm_full.pdf  Publication Ethics: Sponsorship, Authorship, and Accountability, International Committee of Medical Journal Editors Updated April 2010:
2. Authors’ names and institutional affiliations. Some journals publish each author’s highest academic
degree(s), while others do not.

3. The name of the department(s) and institution(s) to which the work should be attributed.

4. Disclaimers, if any.

5. Contact information for corresponding authors.

   The name, mailing address, telephone and fax numbers, and e-mail address of the author responsible
   for correspondence about the manuscript (the “corresponding author;” this author may or may not be
   the “guarantor” for the integrity of the study). The corresponding author should indicate clearly whether
   his or her e-mail address can be published.

6. The name and address of the author to whom requests for reprints should be addressed or a
   statement that reprints are not available from the authors.

7. Source(s) of support in the form of grants, equipment, drugs, or all of these.

8. A running head. Some journals request a short running head or footline, usually no more than 40
   characters (including letters and spaces) at the foot of the title page. Running heads are published in
   most journals, but are also sometimes used within the editorial office for filing and locating manuscripts.

9. Word counts. A word count for the text only (excluding abstract, acknowledgments, figure legends,
   and references) allows editors and reviewers to assess whether the information contained in the paper
   warrants the amount of space devoted to it, and whether the submitted manuscript fits within the
   journal’s word limits. A separate word count for the Abstract is useful for the same reason.

10. The number of figures and tables. It is difficult for editorial staff and reviewers to determine whether
   the figures and tables that should have accompanied a manuscript were actually included unless the
   numbers of figures and tables are noted on the title page.

IV. A. 3. Conflict-of-Interest Notification Page

To prevent potential conflicts of interest from being overlooked or misplaced, this information needs to
be part of the manuscript. The ICMJE has developed a uniform disclosure form for use by ICMJE
member journals (http://www.icmje.org/coi_disclosure.pdf). Other journals are welcome to adopt this
form. Individual journals may differ in where they include this information, and some journals do not
send information on conflicts of interest to reviewers. (See Section II. D. Conflicts of Interest.

IV. A. 4. Abstract

Structured abstracts are preferred for original research and systematic reviews. The abstract should
provide the context or background for the study and should state the study’s purpose, basic procedures
(selection of study subjects or laboratory animals, observational and analytical methods), main findings
(giving specific effect sizes and their statistical significance, if possible), principal conclusions, and
funding sources. It should emphasize new and important aspects of the study or observations. Articles
on clinical trials should contain abstracts that include the items that the CONSORT group has identified
as essential (http://www.consort-statement.org/?_1190).

Because abstracts are the only substantive portion of the article indexed in many electronic databases,
and the only portion many readers read, authors need to be careful that they accurately reflect the
content of the article. Unfortunately, the information contained in many abstracts differs from that in the
text (7). The format required for structured abstracts differs from journal to journal, and some journals
use more than one format; authors need to prepare their abstracts in the format specified by the journal
they have chosen.

The ICMJE recommends that journals publish the trial registration number at the end of the abstract.
The ICMJE also recommends that, whenever a registration number is available, authors list that number
the first time they use a trial acronym to refer to either the trial they are reporting or to other trials that
they mention in the manuscript.

IV. A. 5. Introduction
Provide a context or background for the study (that is, the nature of the problem and its significance). State the specific purpose or research objective of, or hypothesis tested by, the study or observation; the research objective is often more sharply focused when stated as a question. Both the main and secondary objectives should be clear, and any prespecified subgroup analyses should be described. Provide only directly pertinent references, and do not include data or conclusions from the work being reported.

IV. A. 6. Methods

The Methods section should include only information that was available at the time the plan or protocol for the study was being written; all information obtained during the study belongs in the Results section.

IV. A. 6. a. Selection and Description of Participants

Describe your selection of the observational or experimental participants (patients or laboratory animals, including controls) clearly, including eligibility and exclusion criteria and a description of the source population. Because the relevance of such variables as age and sex to the object of research is not always clear, authors should explain their use when they are included in a study report—for example, authors should explain why only participants of certain ages were included or why women were excluded. The guiding principle should be clarity about how and why a study was done in a particular way. When authors use such variables as race or ethnicity, they should define how they measured these variables and justify their relevance.

IV. A. 6. b. Technical Information

Identify the methods, apparatus (give the manufacturer’s name and address in parentheses), and procedures in sufficient detail to allow others to reproduce the results. Give references to established methods, including statistical methods (see below); provide references and brief descriptions for methods that have been published but are not well-known; describe new or substantially modified methods, give the reasons for using them, and evaluate their limitations. Identify precisely all drugs and chemicals used, including generic name(s), dose(s), and route(s) of administration.

Authors submitting review manuscripts should include a section describing the methods used for locating, selecting, extracting, and synthesizing data. These methods should also be summarized in the abstract.

IV. A. 6. c. Statistics

Describe statistical methods with enough detail to enable a knowledgeable reader with access to the original data to verify the reported results. When possible, quantify findings and present them with appropriate indicators of measurement error or uncertainty (such as confidence intervals). Avoid relying solely on statistical hypothesis testing, such as \( P \) values, which fail to convey important information about effect size. References for the design of the study and statistical methods should be to standard works when possible (with pages stated). Define statistical terms, abbreviations, and most symbols. Specify the computer software used.

IV. A. 7. Results

Present your results in logical sequence in the text, tables, and illustrations, giving the main or most important findings first. Do not repeat all the data in the tables or illustrations in the text; emphasize or summarize only the most important observations. Extra or supplementary materials and technical detail can be placed in an appendix where they will be accessible but will not interrupt the flow of the text, or they can be published solely in the electronic version of the journal.

When data are summarized in the Results section, give numeric results not only as derivatives (for example, percentages) but also as the absolute numbers from which the derivatives were calculated, and specify the statistical methods used to analyze them. Restrict tables and figures to those needed to explain the argument of the paper and to assess supporting data. Use graphs as an alternative to tables with many entries; do not duplicate data in graphs and tables. Avoid nontechnical uses of technical terms in statistics, such as “random” (which implies a randomizing device), “normal,” “significant,” “correlations,” and “sample.” Where scientifically appropriate, analyses of the data by such variables as age and sex should be included.
IV. A. 8. Discussion

Emphasize the new and important aspects of the study and the conclusions that follow from them in the context of the totality of the best available evidence. Do not repeat in detail data or other information given in the Introduction or the Results section. For experimental studies, it is useful to begin the discussion by briefly summarizing the main findings, then explore possible mechanisms or explanations for these findings, compare and contrast the results with other relevant studies, state the limitations of the study, and explore the implications of the findings for future research and for clinical practice. Link the conclusions with the goals of the study but avoid unqualified statements and conclusions not adequately supported by the data. In particular, avoid making statements on economic benefits and costs unless the manuscript includes the appropriate economic data and analyses. Avoid claiming priority or alluding to work that has not been completed. State new hypotheses when warranted, but label them clearly as such.

IV. A. 9. References

IV. A. 9. a. General Considerations Related to References

Although references to review articles can be an efficient way to guide readers to a body of literature, review articles do not always reflect original work accurately. Readers should therefore be provided with direct references to original research sources whenever possible. On the other hand, extensive lists of references to original work on a topic can use excessive space on the printed page. Small numbers of references to key original papers often serve as well as more exhaustive lists, particularly since references can now be added to the electronic version of published papers, and since electronic literature searching allows readers to retrieve published literature efficiently.

Avoid using abstracts as references. References to papers accepted but not yet published should be designated as “in press” or “forthcoming”; authors should obtain written permission to cite such papers as well as verification that they have been accepted for publication. Information from manuscripts submitted but not accepted should be cited in the text as “unpublished observations” with written permission from the source. Avoid citing a “personal communication” unless it provides essential information not available from a public source, in which case the name of the person and date of communication should be cited in parentheses in the text.

For scientific articles, obtain written permission and confirmation of accuracy from the source of a personal communication. Some but not all journals check the accuracy of all reference citations; thus, citation errors sometimes appear in the published version of articles. To minimize such errors, references should be verified using either an electronic bibliographic source, such as PubMed or print copies from original sources. Authors are responsible for checking that none of the references cite retracted articles except in the context of referring to the retraction. For articles published in journals indexed in MEDLINE, the ICMJE considers PubMed the authoritative source for information about retractions. Authors can identify retracted articles in MEDLINE by using the following search term, where pt in square brackets stands for publication type: Retracted publication [pt] in PubMed.

IV. A. 9. b. Reference Style and Format

The Uniform Requirements style for references is based largely on an American National Standards Institute style adapted by the NLM for its databases. Authors should consult NLM’s Citing Medicine for information on its recommended formats for a variety of reference types. Authors may also consult sample references, a list of examples extracted from or based on Citing Medicine for easy use by the ICMJE audience; these sample references are maintained by NLM.

References should be numbered consecutively in the order in which they are first mentioned in the text. Identify references in text, tables, and legends by Arabic numerals in parentheses. References cited only in tables or figure legends should be numbered in accordance with the sequence established by the first identification in the text of the particular table or figure. The titles of journals should be abbreviated according to the style used in the list of Journals Indexed for MEDLINE, posted by the NLM on the Library’s Web site. Journals vary on whether they ask authors to cite electronic references within parentheses in the text or in numbered references following the text. Authors should consult with the
journal to which they plan to submit their work.

IV. A. 10. Tables

Tables capture information concisely and display it efficiently; they also provide information at any desired level of detail and precision. Including data in tables rather than text frequently makes it possible to reduce the length of the text.

Type or print each table with double-spacing on a separate sheet of paper. Number tables consecutively in the order of their first citation in the text and supply a brief title for each. Do not use internal horizontal or vertical lines. Give each column a short or an abbreviated heading.

Authors should place explanatory matter in footnotes, not in the heading. Explain all nonstandard abbreviations in footnotes, and use the following symbols, in sequence: *, †, ‡, §, _, ¶, **, ††, ‡‡, §§, _, __, ¶¶, etc.

Identify statistical measures of variations, such as standard deviation and standard error of the mean. Be sure that each table is cited in the text. If you use data from another published or unpublished source, obtain permission and acknowledge that source fully.

Additional tables containing backup data too extensive to publish in print may be appropriate for publication in the electronic version of the journal, deposited with an archival service, or made available to readers directly by the authors. An appropriate statement should be added to the text to inform readers that this additional information is available and where it is located. Submit such tables for consideration with the paper so that they will be available to the peer reviewers.

IV. A. 11. Illustrations (Figures)

Figures should be either professionally drawn and photographed, or submitted as photographic-quality digital prints. In addition to requiring a version of the figures suitable for printing, some journals now ask authors for electronic files of figures in a format (for example, JPEG or GIF) that will produce high-quality images in the Web version of the journal; authors should review the images of such files on a computer screen before submitting them to be sure they meet their own quality standards.

For x-ray films, scans, and other diagnostic images, as well as pictures of pathology specimens or photomicrographs, send sharp, glossy, black-and-white or color photographic prints, usually 127 _ 173 mm (5 _ 7 inches).

Although some journals redraw figures, many do not. Letters, numbers, and symbols on figures should therefore be clear and consistent throughout, and large enough to remain legible when the figure is reduced for publication. Figures should be made as self-explanatory as possible, since many will be used directly in slide presentations. Titles and detailed explanations belong in the legends—not on the illustrations themselves. Photomicrographs should have internal scale markers.

Symbols, arrows, or letters used in photomicrographs should contrast with the background. Photographs of potentially identifiable people must be accompanied by written permission to use the photograph. Figures should be numbered consecutively according to the order in which they have been cited in the text. If a figure has been published previously, acknowledge the original source and submit written permission from the copyright holder to reproduce the figure. Permission is required irrespective of authorship or publisher except for documents in the public domain.

For illustrations in color, ascertain whether the journal requires color negatives, positive transparencies, or color prints. Accompanying drawings marked to indicate the region to be reproduced might be useful to the editor. Some journals publish illustrations in color only if the author pays the additional cost. Authors should consult the journal about requirements for figures submitted in electronic formats.

IV. A. 12. Legends for Illustrations (Figures)

Type or print out legends for illustrations using double spacing, starting on a separate page, with Arabic numerals corresponding to the illustrations. When symbols, arrows, numbers, or letters are used to identify parts of the illustrations, identify and explain each one clearly in the legend. Explain the internal scale and identify the method of staining in photomicrographs.
IV. A. 13. Units of Measurement

Measurements of length, height, weight, and volume should be reported in metric units (meter, kilogram, or liter) or their decimal multiples. Temperatures should be in degrees Celsius. Blood pressures should be in millimeters of mercury, unless other units are specifically required by the journal. Journals vary in the units they use for reporting hematologic, clinical chemistry, and other measurements. Authors must consult the Information for Authors of the particular journal and should report laboratory information in both local and International System of Units (SI). Editors may request that authors add alternative or non-SI units, since SI units are not universally used. Drug concentrations may be reported in either SI or mass units, but the alternative should be provided in parentheses where appropriate.

IV. A. 14. Abbreviations and Symbols

Use only standard abbreviations; use of nonstandard abbreviations can be confusing to readers. Avoid abbreviations in the title of the manuscript. The spelled-out abbreviation followed by the abbreviation in parenthesis should be used on first mention unless the abbreviation is a standard unit of measurement.

IV. B. Sending the Manuscript to the Journal

An increasing number of journals now accept electronic submission of manuscripts, whether on disk, as an e-mail attachment, or by downloading directly onto the journal’s Web site. Electronic submission saves time and money and allows the manuscript to be handled in electronic form throughout the editorial process (for example, when it is sent out for review). For specific instructions on electronic submission, authors should consult the journal’s Instructions for Authors.

If a paper version of the manuscript is submitted, send the required number of copies of the manuscript and figures; they are all needed for peer review and editing, and the editorial office staff cannot be expected to make the required copies.

Manuscripts must be accompanied by a cover letter, which should include the following information.

● A full statement to the editor about all submissions and previous reports that might be regarded as redundant publication of the same or very similar work. Any such work should be referred to specifically and referenced in the new paper. Copies of such material should be included with the submitted paper to help the editor address the situation.

● A statement of financial or other relationships that might lead to a conflict of interest, if that information is not included in the manuscript itself or in an authors’ form.

● A statement that the manuscript has been read and approved by all the authors, that the requirements for authorship as stated earlier in this document have been met, and that each author believes that the manuscript represents honest work if that information is not provided in another form (see below).

● The name, address, and telephone number of the corresponding author, who is responsible for communicating with the other authors about revisions and final approval of the proofs, if that information is not included in the manuscript itself.

The letter should give any additional information that may be helpful to the editor, such as the type or format of article in the particular journal that the manuscript represents. If the manuscript has been submitted previously to another journal, it is helpful to include the previous editor’s and reviewers’ comments with the submitted manuscript, along with the authors’ responses to those comments. Editors encourage authors to submit these previous communications. Doing so may expedite the review process.

Many journals now provide a presubmission checklist to help the author ensure that all the components of the submission have been included. Some journals now also require that authors complete checklists for reports of certain study types (for example, the CONSORT checklist for reports of randomized, controlled trials). Authors should look to see if the journal uses such checklists, and send them with the manuscript if they are requested.

Letters of permission to reproduce previously published material, use previously published illustrations, report information about identifiable persons, or to acknowledge people for their contributions must accompany the manuscript.
V. REFERENCES

A. References Cited in This Document


B. Other Sources of Information Related to Biomedical Journals

World Association of Medical Editors (WAME)
Council of Science Editors (CSE)
European Association of Science Editors (EASE)
Cochrane Collaboration
Committee on Publication Ethics (COPE)
EQUATOR NETWORK http://www.equator-network.org
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Signature: ___________________________  Printed name: ___________________________  Date: ________________

Academic Advisor:

Signature: ___________________________  Printed name: ___________________________  Date: ________________

Master Advisor:

Signature: ___________________________  Printed name: ___________________________  Date: ________________

Practicum Mentor:

Signature: ___________________________  Printed name: ___________________________  Date: ________________
**ABI Restricted Electives**

The student’s academic plan includes a list of courses that he or she will take to fulfill the restricted electives requirement for graduation in the ABI major. This consists of 25 quarter hours of upper division courses; lower division courses generally do not qualify. Independent Research (199 units) must be approved by the mentor together with a brief written explanation about how they fit into the academic plan. The courses should fulfill one of the following criteria:

1. Teach skills needed to complete the practicum. For example, if collecting numerical data needing analysis, consider an advanced course in statistics.

2. Teach procedures required in the laboratory. For example, consider 199 research units with the mentor before the practicum begins to learn highly technical processes where training opportunities are unavailable elsewhere.

3. Provide background adding depth and breadth to the student’s knowledge about the subject area of the practicum project.

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Mentor Signature
Printed name
Date