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ABSTRACT

This manual was written as an aid to teaching assistants (TAs) who conduct the laboratory portions of life science courses at the University of Washington. In general, this manual does not present specific factual material. Rather, it offers suggestions on how to handle various teaching situations and provides a framework to use in many different life science lab applications. Included in the contents are: "What Is a Laboratory TA?"; "What Can You Teach in the Lab?"; "Interacting with Your Students"; "Interacting with Your Colleagues"; "Integrating the Laboratory with the Lectures"; "Preparing for a Lab"; "Running a Lab"; "Evaluating Student Performance in the Lab"; "Evaluating Your Effectiveness as a T.A."; "Safety"; "Working with Biological Material"; "Care of Equipment"; "Designing Your Own Laboratory Exercise"; and "Teaching Resources." The "Ten Essentials of Being a Successful T.A." are listed in the concluding section. (CW)

The materials in the Special Collection on the Training of Teaching Assistants were developed through the active efforts of numerous educators who first met at the 1986 National Conference on the Institutional Responsibilities and Responses in the Employment and Education of Teaching Assistants held at the Ohio State University. Assisted by more than 80 individuals, the committee chairs listed below were able to establish the collection which will be developed and maintained by the ERIC Clearinghouse for Higher Education. This arrangement will enable faculty members, faculty developers, administrators, TA supervisors, and graduate teaching assistants to have access to TA training materials produced by institutions across the nation.

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REFERENCE MANUAL FOR TEACHING ASSISTANTS IN LIFE SCIENCE LABORATORIES

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1985

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I. INTRODUCTION

This manual was written as an aid to Teaching Assistants who conduct the laboratory portions of life science courses at the University of Washington. Life science laboratories present T.A.'s with a variety of unique teaching situations that are not discussed in detail in other more general manuals. As a T.A., you will be faced with the challenge of teaching students whose science backgrounds and interests range from practically nothing to quite a bit. You will be asked to introduce them to both the hands-on aspects of doing science and to the facts and unifying principles of your discipline. In addition, your laboratory section will probably be only a part of a larger course involving lecture presentations, and you may be only one of several people on its teaching staff. You may have little control over what subjects you are to teach in the lab and you most likely will need to work closely with your colleagues to make the entire course a success. Therefore, a variety of topics unique to your teaching needs are addressed here to help you do the best job possible of teaching in the lab and in the course with which your lab is associated.

In general, this manual does not present specific factual material. Rather it offers suggestions on how to handle various teaching situations and provides a framework to use in many different life science lab applications. Do not read it only at the start of your T.A. career and then set it aside. You should refer to it whenever you have a need for specific information or advice as you teach your labs.

No attempt has been made here to address all of the topics of concern for T. A.'s at the University of Washington but only those that are specific to laboratory T.A.'s in the life sciences. If you have other questions about your Teaching Assistantship you should consult Mentor, the University Handbook for New Teaching Assistants. Copies are available from the Graduate Program Assistant in your department and from the Center for Instructional Development and Research (3-6588). In addition, you should be sure to find out about and follow any specific guidelines for teaching established by your department. Many departments have written guides to being a T.A. which should be available from your Graduate Program Assistant.

The Value of Being a Teaching Assistant

This manual presupposes that you want to be a good laboratory Teaching Assistant. However, many graduate students feel that being a good T.A. requires time that can be better spent doing research, writing grant proposals and papers, and applying for faculty positions. Unfortunately, this perception causes many graduates to miss a valuable opportunity for career development. Apart from allowing you to earn a salary, being a laboratory T.A. offers many opportunities for improving the quality of your research and increasing your enjoyment of science.

1) Most importantly, being a laboratory T.A. is an invaluable apprenticeship for a faculty career. Having had experience as a teacher can be important in getting a faculty position. Many institutions are now looking to hire graduate students with teaching experience as well as with publications and the ability to acquire outside funding. Having experience as a T.A. also makes it easier for you to begin your new job with little waste of time and effort. Many institutions will want you to begin teaching your own course during your first quarter on their faculty, as well as to apply for grants, write papers, and work with graduate

students. If you already have the experience of organizing material for a course and feel comfortable talking with a group of undergraduates, then the amount of time you have to spend on your teaching responsibilities will be greatly reduced.

2) You can try out new ideas in your own area of research. If, for example, your research is on the effect of temperature on locomotion in frogs, you may find it too time consuming to extend your work to include other species of amphibians. However, in the laboratory section of a course, you may have the opportunity to have your students run experiments on locomotion with several different species of general interest to you.

3) Your students often have fresh ideas on a subject. They have generally not thought about a particular question for as long as you have and therefore they have not yet developed the tunnel vision that we sometimes have concerning our own work. They are likely to be less inhibited about asking questions and making comments than would be students who have their perceptions already developed. Occasionally, a student may provide you with a useful insight. Special advantage of this opportunity can be taken in the laboratory because you will be interacting directly with the students and not lecturing to them from beyond a podium.

4) Learning to explain scientific concepts to students will give you invaluable experience in communicating with your peers about your own research. If you cannot explain mitosis and meiosis to students who are making an effort to understand these concepts, then you will be much less able to explain the intricacies of your research to a room full of colleagues that have heard 30 other presentations that day. Most of the people that you talk to about your research during your professional career will not be versed in the latest theories and terminology for your discipline; therefore, your ability to explain clearly what you are talking about will determine whether the importance of your work is recognized.

5) Teaching undergraduates helps you to understand a subject. We all have had the experience of feeling like we "understand" a topic but then discover that we cannot explain it to anyone else. In reality, we do not really understand it; we just remember having seen or studied it before. However, when you are responsible for explaining material to students you make the effort to organize the material in your own mind so that you truly understand it.

6) Teaching labs often allows you to work with equipment and do experiments in areas of research that are not your own. This can often give you a fresh perspective on your own work by allowing you to step back and look at a subject in a different way. For example, if your research is on the nutritional value of fruit and the evolution of fruit dispersal mechanisms, you may not have much opportunity to explore the biochemistry of sugar metabolism and transport. However, a lab exercise on this subject may allow you to think about the role molecular processes in ecology and evolution. Besides, we are all in the life sciences because we enjoy it, and working in new areas can be a great deal of fun.

7) Being a T.A. in a lab gives you the opportunity to work closely with people. In general, your students will be extremely friendly and will appreciate the effort you make on their behalf. These interactions can make your time here at the University of Washington far more enjoyable than if you isolated yourself in a research lab. In addition, many of your students, especially those in upper division courses, are prospective scientists. Some of them will continue their education in graduate school and become your colleagues and peers. By working with them

now you have the opportunity to establish contact early in their careers and to help prepare them for making contributions in your field.

II. WHAT IS A LABORATORY T.A.?

A laboratory instructor is many different things to different people and your ability to do your job effectively depends on understanding early on what is expected of you.

Student Expectations

Most importantly, you are the guide for the students. Your job is to help them understand a large body of new and usually difficult material. You also need to provide them with supplementary information and alternative explanations for the material. Because the instructor of the course is often inaccessible, you will usually be the students' only personal contact with the subject and the department. They will look to you as a role model to show them how the subject can be approached and understood.

On occasion, students will have expectations of you that are not appropriate and that should be avoided. Often a student will want you to be a source of easy answers. If they get in the habit of depending on you for the answers, however, then they never develop the skills necessary to solve questions for themselves. You will have to develop a sense for when a student has made an honest effort to find a solution and when he or she is simply using you as a crutch. Also, some students feel that you are supposed to know all the answers. Let them know early on that your role is to help them learn how to solve problems and that you may not know everything about the subject.

Faculty Expectations

The faculty will look to you to help teach not only the laboratory but other aspects of the course as well. Expectations will vary among instructors and departments but you can anticipate being asked to:

1) Work up to 20 hours per week.

2) Teach one or more labs per week. This may involve set up, clean up, and other manual chores as well as actual teaching.

3) Attend lectures. Your students are going to ask you for help in understanding the lecture material and if you have not attended the lectures to hear what the instructor is talking about you will be of little use to the students. Also, part of the purpose of a lab is to provide amplification on the lecture material. Only by attending the lectures can you decide what material in the lab should be emphasized and how it should be presented.

4) Hold office hours and attend a weekly T.A. meeting.

5) Arrive on time to all lectures, labs, and meetings. It is disruptive when you arrive late and wastes the time of many other people.

6) Proctor and grade exams.

7) Grade papers and assignments. These may include papers and assignments that you have assigned as part of the lab as well as those that the instructor assigned in the lecture.

8) Evaluate student performance in the lab. The laboratory portion of a class often presents to the students a different set of information than does the lecture. Many instructors want the T.A.'s to evaluate the students' understanding of this information in the lab.

9) Provide the instructor with first-hand knowledge of the students. Most instructors want to know about the students as individuals but find that the job of getting to know 250 or more students is too difficult of a task. Usually the instructor will not attend each lab every week and therefore will not have complete knowledge of your students' abilities, accomplishments, and improvements. Your knowledge of the students as people is the only way that many instructors have of treating the students as individuals.

10) Provide to the students an enthusiastic and knowledgable role model for how the subject can be approached. If the students only had the instructor to learn from, then many would come away from the course with the impression that doing science means standing in front of a room and drawing pictures on an overhead projector.

11) Provide the instructor with informal evaluations of aspects of the course, including lectures, lab exercises, and exams.

12) Stay on campus at the end of the quarter until final grades are assigned. Your help in grading the final exam and in providing information on each student's performance in the lab is usually essential to completing the assignment of final grades.

Each instructor will have his or her own set of expectations that include some not mentioned here. Don't assume that they are going to tell you everything that they will want from you during the quarter. Be sure to ask at the beginning of the quarter what will be required of you so that you are not unpleasantly surprised later on.

Your Own Expectations

Being a graduate student in the life sciences requires a lot of work. In order to satisfy your responsiblities as a T.A. at the University, finsh your degree, and find a permanent position, you will have to juggle many responsibilities and obligations. You are going to have to learn through your own experience how to strike this balance. The only advice that can be given is that the answer lies somewhere between meeting all your obligations as a teacher and scholar and trying to be all things to all people. Do your best but don't burden yourself with guilt if you aren't perfect.

Over time you will develop your own strategies to do your best job with the least amount of wasted time and effort. Here are some general recommendations which past T.A.'s have found to make the job easier:

1) Expect to put in a lot of time and work at being a T.A. and then be pleasantly surprised if your teaching commitments ultimately require less time than you expect. Many T.A.'s create frustration for themselves by assuming incorrectly that they will be able to get out of a lot of work and then discover that they have overextented themselves.

2) Make every effort you can to help improve the course. Not only will this make your commitment to the course greater but it will give you experience in developing teaching strategies that you can use in the future.

3) Be supportive of your colleagues. The course will run more smoothly and you will have fewer negative personal interactions if everyone associated with the course works together.

4) Be supportive of the goals and approaches of the course. As a T.A. you have only limited control over how the course will be run. Although the course may not be structured exactly as you would like, remember that everything will run much more smoothly if you try to emphasize the good parts of the course and to be patient with the parts with which you disagree. You'll have a chance to run your own course some day.

5) Be supportive of your students. If you develop a positive relationship with them then they will work with you on making the quarter a productive one.

6) Get to know your students. This means not only learning their names but their special instructional needs. Their majors will range from that of your own department to that of a department completely unrelated to yours. For some students your class may be required and for others it may simply provide distribution credits needed for graduation. You will be able to do the best job with the least amount of misdirected time and effort if you learn what each of your students needs. Do not treat them as second class citizens. Remember that yours may be the only science course that they ever attended and their impression of the entire field of science may depend on how you interacted with them.

7) Know what kind of class you are teaching and adjust your expectations of your students accordingly. If you are teaching a lab that is for upper-division majors only, then you can expect your students to be more knowledgeable of the material than if it is an introductory course with no prerequisites. You'll have fewer instructional problems if you neither aim too far over the heads of your students nor present material that is not challenging enough.

8) When organizing information for presentation to your students. think about the subject from their perspective. Think about whether your discussion will make sense to them given their current level of understanding. Use examples to illustrate points that may not be clear to them but make sure that the examples themselves are understandable.

9) Read and understand the lab assignment before you have to teach the lab. This is best accomplished by coming to the T.A. meeting and going through the lab at that time or by scheduling time to go through the lab on your own before teaching it. Preparing for lab will allow you to meet your responsibilities as a teacher and will go far towards helping you develop a positive working relationship with your students. Going through the lab in advance will also allow you to determine what equipment and supplies you must have available so your students will be able to complete the assignment.

10) Be sure to let someone that is associated with the course know if you are sick so that arrangements can be made to have your labs taught.

Resources for Developing Teaching Skills

Although you will develop many of your teaching skills directly in the lab as a result of practice and experience, you can speed up the process by getting advice from other sources. There are many resources available on campus to help you develop the skills you will need to teach in the laboratory. A few of them are briefly outlined here and are more fully described in Mentor.

1) The Center for Instructional Development and Research (3-6588) is a University organization that provides on request individual assistance in communication techniques, test construction, problem solving, and evaluation of teaching. It is also available to present departmental workshops on these topics.

2) The Educational Assessment Center (3-1170) Provides assistance in constructing test, instructional evaluation, and use of student rating forms.

3) Working in the laboratory also involves responsibility for the health and safety of the students. The Department of Health and Safety (3-7262) presents regular workshops and seminars on first aid, laborarory safety, fire, and radiation.

4) Your department may offer its own workshops on how to be a laboratory Teaching Assistant. Check with your Graduate Program Advisor to find out if workshops are offered. If your department does not offer a workshop, you may want to suggest to your department chair that one be organized.

5) One of the best sources of advice on teaching is your own colleagues. The course instructor will usually be happy to help you develop your teaching skills. Your fellow T.A.'s and graduate students may also have advice and can help you learn from their mistakes. You can benefit from their experience by observing how they present material and interact with their students or by having them attend your lab and then talking with them about what they observed.

III. WHAT CAN YOU TEACH IN THE LAB?

Too often we feel that the only things we should or are allowed to teach in a science lab are the specific sets of facts or techniques that are outlined in the lab manual. However, if this gives the students an impression of science as a restricted and procedure-bound set of steps, then they would never develop any of the higher-order skills that are required to be a professional in any field. There are a number of additional concepts that a T.A. should keep in mind as being of importance to expose students to and take every opportunity to introduce them in discussions and presentations in and out of the laboratory.

The Unifying Themes of the Life Sciences

Obviously, the body of knowledge encompassed by the life sciences is not simply a collection of facts and hypotheses. There are a few basic themes that unify all of the life sciences, from the study of molecules to entire ecosystems. We all have our own ideas about what these are but most of us would include the following points outlined by the Biological Sciences Curriculum Study Group (Biology Teachers' Handbook, 1970, John Wiley and Sons):

1) Evolution. The presence of change in living things through time is one of the most basic principles we hold to be true about life, but it is also one of the most controversial. It is important to respect the religious beliefs of students. You can clarify many misconceptions that students have concerning the theory of evolution, however, if in your regular discussions you point out the evidence for evolution (e.g., fossil record, patterns of species distributions, unity of organic design) and distinguish this from the processes of evolution (e.g., natural selection, sexual selection, artificial selection, cultural selection, genetic drift).

2) Diversity of life. There is never time in a lab to demonstrate everything of interest about all of the species on Earth. Unfortunately, too many students come away from a lab thinking that they have learned about the operon, the bacteria, the fish, the primate, or the flowering plant. In your regular interactions with them, remind them that they are looking at only one or a few representatives of a fantastically diverse group of living things, each with its own special adaptations for existance.

3) Unity of pattern in living things. Despite the diversity of life, however, there are many basic patterns that serve to remind us of the fundamental unity of life. Excellent examples of this include the homology of the genetic code, the similarity among organisms of major biochemical pathways, and the cellular basis of biological structure. Pointing out to students that certain patterns and processes unify living organisms serves to remind them that studying life sciences is not simply collecting facts and figures but involves the search for basic principles as well.

4) Relationship between organisms and the environment. Students often forget that the laboratory is not the natural habitat for organisms and that their form and function have evolved over time in response to environmental condtions. Organisms are affected by the environment over short periods of time as well. Changes in habitat structure and the quality of air and water will influence the well-being of all levels of biological organization.

In addition, the life processes of organisms affect their environment. For example, the evolution of Earth's atmosphere was influenced by photosynthesis and the formation of soil from bedrock is brought about in part by the physical and chemical actions of terrestrial plants and animals.

5) Complementary relationship between structure and function. This applies to all levels of biological organization. The functional design of organisms and their parts is described both by the structures that allow organisms to exist and by the function of these structures. Emphasizing this helps students to develop a holistic as well as a reductionist approach to the life sciences.

6) Regulation of biological processes. Homeostasis, the ability to maintain a stable internal environment, is one of the most important characteristic of living systems. Providing students with a relatively simple distinction between living and non-living matter will help them discover for themselves other unifying principles.

Critical Thinking

As mentioned above, the ultimate of training students in the life sciences is not merely to fill them with facts but to teach them how to approach and analyze a problem. How do we formulate questions and establish facts? How do we determine the meanings of observations? How do we reason? Teaching students to think critically can be approached by helping them develop an awareness of the steps one goes through in a scientific investigation.

1) How to ask questions. Scientists spend their time trying to answer questions for which there are no known answers. But the quality of the research and importance of the answer often depends on how good the question is. Asking insightful and meaningful questions is a skill that must be learned and part of the students' training in the laboratory should include practice in asking questions. Encourage the students to ask questions for the sake of forming the question and analyzing how it is done.

One exercise that you can use in lab or as an outside exercise to encourage students to develop their skills at inquiry is the 20 Question Game. Have the students sit quietly in the lab or elsewhere and think about the coursework or their surroundings. This exercise works very well if they go to a park or beach. Each student should write down 20 questions that come to his or her mina about the life sciences. It is not important whether the question has a known answer. The goal is to g:ve the students practice in using their imaginations.

After that, discuss their questions with them individually or in groups. What types of questions did they ask? Usually their questions will fall into a few categories: why is it so, how does it work, structure and function, what if ..., and taxonomic. What are the advantages and difficulties of each kind? How would one go about answering them? Would the answer to the question say anything significant about the nature of biological patterns? Can the question be feasibly answered given available time resources? Are the questions generalizable? With practice, the students will go from asking questions like, "Why is this tree taller than that one?" and "How many molecules are in the human body? to "What are the factors that control plant growth?" and "How do cells select which molecules cross membrane boundaries?". In a short while, the students will find that questions come more freely to mind and that many of them could 'ead to productive research programs.

2) How to answer questions. Finding the answers to questions represents the physical labor of doing science. As you talk to students and answer their questions, tell them about the process whereby the answers were found.

The basis of most scientific investigation is an observation about a pattern in nature. A tentative explanation for the pattern can be given and is called a hypothesis. Before the explanation can be accepted, however, it must be tested. A prediction is made about what should be seen under other circumstances or at a different time if the explanation is correct. The results of the experiment may be as predicted, and therefore support the explanation and add to our confidence in it, or may not be as predicted and indicate that the explanation needs to be revised. Ideally, this process is repeated until the results from all the experimental tests can be explained by only one hypothesis. Point out to the students that by this process you can never prove a hypothesis; you can only fail to disprove it. Science advances because as techniques are improved additional predictions can be tested to further refine the hypothesis.

This process of investigation serves as a heuristic model to describe the thought processes that go on when a person tries to answer a question. Another set of skills necessary to answer questions are those involved in running a valid experiment. The details will vary from discipline to discipline, but virtually every experiment involves first defining the terms with which you are describing the system, identifying the variables and assumptions, identifying the possible sources of error, and determining what is already known about the system. The next step involves comparing an experimental group to a control group, which should differ from the experimental group in only one variable. Experiments can be either manipulative, in which the scientist causes the difference between the two groups, or natural, in which advantage is taken of natural differences between groups. The strength of the experiment is influenced by both sample size and replication of experimental and control groups.

3) How to deal with numerical data. Students often want to record their results on paper towels or scrap paper. These are easily lost and are hard to keep organized. The data should be recorded in a lab notebook or on data paper that can be easily stored safely in a binder and with column headings and descriptions that will allow the data to be interpreted at a later time. Encourage the students to treat all their data as important, even if they think they already know what the answer will be, and to make their measurements with all the accuracy allowed by their equipment. They should also think in advance about how they will analyze their data. This will help them to avoid collecting data that cannot be analyzed or that do not answer their question.

When the students analyze their data, have them keep in mind the question that they are trying to answer. Students often analyze their data in a particular way only because they saw that the data could be put together in that fashion and not because it addressed their question.

Many students will not yet have studied statistics and therefore you can only expect a minimal amount of sophistication in how they analyze their data. The best that many students will be able to do to simplify their data is to calculate mean values. However, take the opportunity to tell them about the need for statistics to test for chance. Even though a hypothesis can never be proved, a statistical test can tell you how likely it is that your results could have occurred by chance.

The hardest thing for many students to learn is how to interpret their data. Introduce them to the ideas of causation and correlation. In the life sciences, we are usually interested in discovering what the cause of a pattern is but can often only determine if two variables are correlated with one another. Also, remind them of the complexity of living systems. Not only is any pattern likely to be influenced by more than one variable but each variable is likely to have multiple effects.

Encourage them to display their data in ways that are easily interpreted by other people, such as in graphs or tables. This will help them learn to communicate their results and will often give them new ideas about what their data might mean.

How to Communicate

Both written and oral communication are important in every profession, not just in the life sciences. However, many students feel that because they are not in an English class that the quality of their writing is not important. Strongly discourage this view. Clear and effective communication skills are vital no matter what profession the students plan to enter. Make every effort you can to comment constructively on both their basic writing skills and their ability to effectively communicate their scientific ideas on paper.

Also encourage them to practice their oral communication. Students often have difficulty expressing themselves verbally in science classes because of the large number of new terms. At first, get them to think about what they are trying to say in non-technical language. Then provide for them the scientific terminology for their ideas. In this way they will improve their ability to interact verbally with someone and to use scientific terminology to increase the precision of their communication.

Scientific communication also involves the use of visual aids. Get the students to draw diagrams of concepts and specimens that they observe in the lab. If they are required to give formal oral presentations in the laboratory, help them to organize and use illustrative slides and overhead projections.

Implications of the Laboratory Exercise

As we have discussed before, the life sciences are more than collections of facts and observations. They have a historical and philosophical component as well. Talk to the students about the history of the current understanding of a field. Encourage them to think about the social and ethical implications of scientific knowledge. The world today is rapidly changing because of many advances in the life sciences and the impact of this change on our society is something about which everyone should be aware. Research in genetic engineering, agriculture and fisheries practices, and medical technology all have emotional as well as technical content. Encourage your students to think and talk about the implications for society of the subject they are studying. This will often stimulate them to learn more about the subject because it allows them to generate their own reasons for why the material is relevant.

In addition to the historical and ethical importance of a new fact or observation, encourage the students to think about how scientific information might influence future research. Remember that one of our goals in the laboratory is to teach the students how to ask questions.

Everyone is Capable of Doing Science

A difficult thing to convey to students whose major is not in the Life Sciences is that everyone is capable of doing science. Their lack of confidence in their scientific abilities often results from high school science courses in which they were taught only to memorize facts and formulae. As a result, they never learned that science is as much a way of thinking as it is a body of knowledge. These students can often be helped by using examples of hypothesis formulation and testing that relate to non-laboratory situations. For example, people often go through the process of formulating, testing, and revising a hypothesis whenever they burn a cake in the oven or their car refuses to start. Get them to recognize that they already know how to do science and that by taking a life science course they are simply broadening their awareness of the world around them.

Science as Discovery

Another attitude that students occasionally have is that science is an impersonal and unemotional subject. Especially in introductory courses, laboratories are often prearranged exercises in which the T.A. already knows the expected results. Therefore, the whole process appears cut-and-dried. In your discussions with them, let them know that science is a way of exploring the unknown and that all of our explanations for patterns in nature are tentative. The force that drives most scientists is the excitement of exploration and the chance that something completely unexpected may be discovered. Many of the most significant biological discoveries, such as the discovery of penicillin, have come about by accident; observations were made in areas and under conditions that were not planned. Science offers everyone the opportunity to let their mind go where no one else's has gone before.

The Difference Between Memorization and Understanding

Your students will inevitably ask how to study for a test or complain that science is nothing but the memorization of facts. Tell them that they should try not to memorize but to understand the material; in other words, they should be able to explain in some depth the reason why a pattern is the way it is. If in the face of their logical analysis the pattern still doesn't make sense, then perhaps they have identified a new direction for research. Simple memorization of facts, however, has never resulted in any lasting contribution to our scientific knowledge.

Integration of Information

Remind the students as they work in the lab of the need to remember and use information that they have acquired from other sources. This includes material as basic as simple arithmetic. In lower division courses students will occasionally say that they cannot multiply because they have not had math in awhile. Do not let them believe that this is a valid excuse. Encourage them to review these skills immediately and require that they use them.

In upper division courses, encourage students to use information acquired in other courses. For example, if you are teaching a physiology laboratory, you may not have time to teach the students about biochemistry. However, many physiological processes are determined by rates of chemical reactions. If some of your students have had biochemistry, get them to share their knowledge with the others in the class. This kind of interaction impresses upon them the value of taking a diversity of life-science courses, of the importance of remembering the material in a course even after it is over, and of the interrelated patterns of living systems.

Ability to Think and Work Independently

Often students work in groups in the interest of time and equipment. Ultimately, however, every student is responsible for his or her own performance. Encourage them to be sure that they can solve the questions and can perform the techniques for themselves.

By teaching your students the skills and perspectives described above, your students will have gained knowledge and abilities that will stay with them long after the particular facts of your discipline have become outdated.

IV. INTERACTING WITH YOUR STUDENTS

Successful teaching involves more than simply introducing the students to the correct facts and skills. It also involves techniques for interacting with individuals. You will develop many of your own techniques over time as you learn what works for you and what does not. You are your own best guide to how to behave. Ask yourself how you would like to be treated by a T. A. or an instructor. If you follow the examples of the best T.A.'s you ever had and avoid the errors of those that were not as good, then you will rarely be at a loss to know how to handle a situation. However, there are some basic principles that will make your personal interactions with students constructive and enjoyable.

Engage Your Students During Lab

Don't hold back from your students as a solitary figure at the front of the lab waiting for people to approach with questions. Walk around and talk with them. Act as their guide to the information rather than as their answer person. If you give them the answer to every question rather than help them solve the question themselves, they will never learn the process whereby answers are derived. When they ask you a question, talk about how you would solve the problem before giving them the answer. Tell your students something about your own research interests and professional aspirations. This will help them to realize that Teaching Assistants are regular people and that they also have responsibilities and interests outside of the class laboratory.

On occasion you may decide to hold an informal discussion of some material, either with a small group of students or with the entire class. Try to get the students to think out loud. What is the question? What information do you need to know in order to achieve an answer? What facts do they already know from the lab, lecture, or other sources?

It is also important to provide the students with the time to talk with you outside your lab. You should hold regular office hours in which you are available to students for questions and review. In your interactions with students during office hours, emphasize the importance of critical thinking and effective communication just as you do in the lab.

While working with your students, avoid letting them think that your role as a T.A. is to be their personal tutor. Urge them to develop the ability to think and work on their own. However, let them know that you are willing to be their ally in their efforts to learn the material. Steer them in the right direction and offer advice on how the subject can be found. Judge for yourself when you should simply give the student the answer to a conceptually difficult question; however, you will usually want them to first make an effort to solve it for themselves.

Teach Your Students

You can use several techniques to help your students learn the material. The first is to let them know what the important points are. Although we would like to feel that everything about our subject is important and deserving of study, it usually is not practical to require that they know everything. Letting them know what you will hold them responsible for gives them a way to organize the information. Also, when explaining things to students, either formally or informally, do not make too many assumptions about what they already know. Go back to the basics in your explanation and then make it more sophisticated if everyone understands the basic concepts. You will usually encounter a diversity of backgrounds among your students. Their knowledge and experience will range from next to nothing to a large amount. Adjust the level of your presentation accordingly. Don't talk over the heads of anyone on points that are of importance for the basic understanding and completion of the lab exercise but try to include material that will challenge the more advanced students.

Indentify early in the quarter who needs extra help. Walking around the class and informally quizzing students about the material can help you achieve this. Make an effort to direct to them special attention that is geared towards their level of understanding.

A guaranteed way to confuse and discourage everyone in your class is to overload them with vocabulary. Think of scientific vocabulary as being foreign language to your students. If you immediately establish that you are going to talk in a language that they cannot understand and have little hope of mastering in a short period of time, then you have given them little reason to try and learn the material. Emphasize the concepts and gradually introduce them to the terminology that scientists use to discuss those concepts. If you encourage your students to use the terms that you introduce, then over time they will develop a large and useful vocabulary.

When You Don't Know the Answer

You will regularly be asked questions to which you do not know the answer. This is a normal part of teaching in the lab. The best way to deal with this is to admit that you don't know the answer. Then follow this up by talking with them about their question. This can be done several ways and you will have to adapt your approach to the question itself.

1) Tell the student what you <u>think</u> the answer is.

2) Talk with them about how you would go about solving the problem. Describe the data you would need and an experimental protocol for acquiring those data.

3) Give them suggestions on where they can find the answer. This may include the text, instructor, or library.

4) Offer to find the answer for them and give it to them at a later time.

Treat Your Students with Respect

If you treat the concerns and feelings of your students with respect and let them know that you are working with them, then you will be able to develop a comfortable and successful relationship. Think carefully about what you say to them of a personal nature. Never say anything to them, either verbally or in writing, or behave in any way that could be interpreted as insulting or demeaning. Comments about their level of knowledge or skills must always be phrased so that they know that you are trying to be constructive and to help them improve. Personal comments about their race, sex, nationality, political or religious beliefs, age, or any other characteristic that is not directly relevant to the subject matter of the lab are never appropriate. Also avoid making negative comments to a student about other people, including the instructor, T.A.'s, and other students. These kinds of remarks make the smooth running of the course very difficult and reflect poorly on you as a professional scientist.

Be friendly and enthusiastic rather than authoritarian with your students. Support them expressively when they do something right, especially students who may be unsure of their ability to perform well in a science class. When someone makes an incorrect statement or performs a technique incorrectly, do not say anything to make them feel inadequate. Discourage the idea or action and not the person who made it.

Remember that your students are undergraduates and not graduate students. They may not be up on all the latest theories and experiments in your field. Also, they may not be able to devote all their time to your class. Don't expect them to already be at your level of understanding. Try instead to help them come up to your level.

An important subject to consider is that of personal involvements with your students. It is generally not a good idea to become personally involved with someone who is currently a student in your lab section. It puts you, your friend, and all the other students in an awkward position regarding unbiased grading and interactions in the lab. If you cannot wait until the following quarter to develop the relationship, then encourage your friend to transfer to a lab section that is taught by a different T.A.

When Problems Occur

Many problems can be avoided by developing in the students respect for your position as a Teaching Assistant. Avoid expressing the attitude that you are "only a T.A.." Let them know through your actions that you are a professional scientist and a representative of the University of Washington.

Occasionally, however, despite all of your best efforts, you will have a bad interaction with a student. These can be several types but they should all be handled quickly and with care. First, if you are wrong about something and you know you are wrong, then admit it. Maintaining an error because of pride never gained anybody anything. If a student complains to you about the instructor or the other T.A.s, listen politely and offer any insights you have on the positive aspects of the situation, but do not take sides for or against them. Encourage the student to speak directly with the instructor about the situation.

Sometimes you will have a student that is abusive to you or other students. They may argue with you on every point, criticize you when you don't know the answer, ridicule the other students, complain about every assignment, or even, in rare instances, demand that you change their grade. In all such cases, try to calmly let them know that their attitude is not appropriate and that nothing will be gained by an aggressive attitude. Sometimes a student does not mean to be abusive. Give them the benefit of the doubt, remind them that you are willing to talk to them in a rational way, and let them know that other people would like to be treated politely. Never threaten or argue with them; that will usually only make things worse.

If the problem persists, do not keep it to yourself. The ultimate responsiblity for dealing with such situations rests with the course instructor and you should keep them abreast of all such situations. Virtually every instructor at the University of Washington will support your position 100%, especially if you let them know about the situation before it has escalated out of control.

You must be alert also for students that cheat, plagiarize, or vandalize the experiments of others. These are serious violations of academic standards and must not be ignored. Do not initiate disciplinary action yourself but report such cases to the instructor of the course. Encourage the instructor to speak with the student and report the violation to the University Disciplinary Committee. Do not let the student dissuade you from reporting the violation. Habitual offenders will almost always claim that it was their first offense and that it will never happen again. If they always get away with it, however, then they never learn how truly serious their actions are.

V. INTERACTING WITH YOUR COLLEAGUES

It is important for both personal and professional reasons to learn how to work with other people. You can perfect some of these skills while being a Teaching Assistant. As a laboratory T.A. you will almost always be working with at least one course instructor and other T.A.'s. Learning to work well with them to make the course run smoothly will help you work well with your colleagues in the future no matter what setting you are in.

In order to work well with your colleagues you must remember that your common goal is to offer the best course possible and that this will require a team effort. Everyone you work with is a professional and you should treat them with the same respect that you would like to receive. Everyone recognizes that you have many responsiblilities other than the course. Let them know that you are taking your responsibilities for the course seriously, and they will help you balance the course with your other responsiblities.

Working with the Instructor

It is important to develop a constructive and realistic attitude about working with the course instructor. Feel free to offer suggestions about how aspects of the course might be better organized. You must be careful, however, in how you present your suggestions. If they sound like demands you are going to receive less cooperation. Don't be offended if they don't follow your advice. They usually have a good reason for doing what they are doing. Perhaps they have already tried what you have suggested and know that it is impractical due to time or facilities. Perhaps they may simply prefer a different approach to the subject. You can always save your ideas and use them yourself when you get the opportunity to teach your own course.

Make sure that the instructor gives you guidance about your responsibilities and what he or she wants taught in the labs. You have a right to be informed well in advance of a lab session what material you have to present. Explain to your instructor that one of your responsiblities as a T.A. is to communicate clearly with the students; therefore, the instructor needs to communicate clearly with you about his or her expectations. On rare occasions, however, you may work with an instructor that is either disorganized or disinterested and does not give you the guidance you need. If this happens, talk to your colleagues to find out what the accepted practices are in your department for grading, interacting with your students, and developing lab exercises. Follow their advice and simply try to do your best.

Working with Other Teaching Assistants

In addition to working with an instructor, you will often work with other T.A.'s who are also responsible for laboratory sections. The other graduate students that you work with as T.A.'s will provide some of the closest personal and professional contacts that you develop in graduate school. Courses that have more than one T.A. run most smoothly when the T.A.'s work well together. Remember that the other T.A.'s are usually also graduate students and have similar professional responsiblities outside of the class laboratory. Respect their needs and meet your own responsiblities so your colleagues do not have to take time to cover for you. Don't leave a mess in your lab for them to have to clean up the next day before they can teach. Don't be afraid to ask for help when you need it or to offer help when you can be of assistance. Above all, keep an enthusiastic attitude about the course and your role as a T.A. No one likes to work with people who constantly complain about their jobs.

VI. INTEGRATING THE LABORATORY WITH THE LECTURES

The laboratory can offer students an additional benefit in learning a subject if an effort is made to integrate the lab with the lecture part of the course. As a T.A. you can play a major role in providing this integration.

First, as the laboratory T.A. you can use your presentations in lab to amplify or clarify points that are made in lecture. This can be done easily by regularly attending lectures and thinking about how you might emphasize or review in lab the material being presented in lecture by the instructor. For example, if the instructor lectures on the seasonal cycle of lakes and your upcoming lab is on the history of pollution and recovery in Lake Washington, you can introduce the lab exercise by reviewing the seasonal cycle using Lake Washington as your example. This brings together both the general patterns of lake ecosystems and the specific example upon which the students will focus in lab.

You also can use the time in the lab to help prepare the students for the lecture exams. Quiz the students about the material as you walk around and talk with them. Ask them if they understood obscure points from the lecture. This lets both you and students know whether or not they understand the material. You can also give your students suggestions on how to organize the subject material so that it makes the most sense and on how to study for maximum comprehension.

It is important, however, not to take up all their time in lab with review and discussion. The primary purpose of the lab session is for the students to get hands-on experience with the subject. Usually the laboratory assignments require the full lab period and priority should be given to the students completing the assignment.

VII. PREPARING FOR A LAB

Before you can enter a lab and guide your students through an exercise, you will have to prepare yourself to teach the material. It is important to go through the laboratory exercise yourself. It is the only way you will discover what information you must teach to the students, what equipment you will need, how to describe important procedures, what parts of the exercise the students will have trouble with, and what mistakes they are likely to make. You should go through the exercise either at the weekly T.A. meeting or, if the instructor does not schedule such a meeting, some time on your own before your lab session meets.

If your course has a weekly meeting of the T.A.'s, it is important that you attend. Often other issues related to the labs are discussed at this time, including grading procedures, changes in the lab excercise, supplementary material on the subject of the lab, and suggestions to help the students complete the assignment.

Read the laboratory assignment carefully before your lab session meets and think about the assignment from two different perspectives. First, look at the assignment from the students' point of view. Think about whether they will understand the terminology and the purpose of the exercise. Look for ambiguities and poorly described procedures that are likely to give students trouble. Then look at it from an instructor's point of view to see how the material should be organized and what verbal information must be given to introduce and clarify the assignment.

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Make sure you understand what you are to teach. This is the most fundamental aspect of a T.A.'s responsibility. Ask the instructor to explain to you anything about the assignment or the subject matter that you do not understand. Read the text or supplemental material if you need additional information on the subject. Looking at the textbook to see what it says about the subject of the lab also prepares you for questions on the reading and allows you to point out to the students how the text can supplement the lab assignment. The laboratory session will be more productive and enjoyable for both you and the students if you have a clear understanding of the material you are to teach.

You will usually need to prepare an oral presentation to introduce the lab assignment to your students. This is primarily a summary of the written description of the lab assignment but should include all the information that they need to understand and complete the lab assignment: the purpose of the assignment, background information to illustrate major points, location of lab materials, procedures for the operation of the equipment, guidelines for safety and clean up, and description of the written material that they must turn in. Keep your presentation short so the students will have enough time to complete the assignment. As you prepare your presentation, stop and ask yourself whether you would understand it if you were one of the students. Are the terms all clarified and the examples clear? Are the organization and purpose of the presentation obvious?

Are the take-home messages of the assignment given? Is it clear what you will hold the students responsible for and what you expect them to turn in?

Make sure that you bring to lab any equipment or supplemental material that your students will need to understand and complete the assignment, including a copy of the textbook, other texts, or diagrams to help the students visualize what they will see in lab.

Finally, before teaching in any laboratory you should know the location of the safety and first-aid equipment, fire alarm, telephone, and nearest exit from the building.

VIII. RUNNING A LAB

When you actually work with your students in the laboratory you need to think about several different things.

1) The instruction that you provide to the students during the lab session should be a blend of substantive presentation (the facts and techniques), hands-on experience with the material, opportunities for the students to extrapolate from their acquired knowledge to new ideas, discussion of examples and applications of the information, and exposure to the higher-order skills, such as techniques for critical thinking, discussed in Part III. These aspects should be developed both in your oral presentation at the start of the lab session and in your informal discussions with students.

2) You can help your students complete the lab successfully by demonstrating enthusiasm and interest in the subject matter. If, for example, the students perceive that you think the anatomy of the primate shoulder girdle is uninteresting, then they will not work very hard to learn the material.

3) Try to interact with everyone in the room during the lab period. This will make it necessary for you to change gears quite often because you will want to interact differently with each student. For those that are mastering the subject quickly, you will want to provide more challenging discussion. Those students that are having a harder time will need more remedial help. It will be much harder for you to determine who needs help and who is ready to move on to more challenging material if you don't work with them individually as much as possible.

4) Have the students work together, either formally or informally. In this way they can help each other learn the material, answer each others' questions, and share equipment and good preparations. When they work in groups, check on the progress of the individuals in each group. It is easy for a student who is having difficulty with the subject to hide this fact if they are in a group with other students that are quickly mastering the material. If you only ask the group about its progress, then you will not notice whether a particular individual is having trouble. Encourage everyone in the group to participate and make it everyone's responsibility to help their group members understand the material. Have them quiz each other about the assignment and related information.

5) As you interact with your students in the lab, check on the quality of their written work, drawings, and techniques of data collection. Ask to see their notebooks and make suggestions at that time on how they could improve the quality of their work.

6) Stay organized. Know where your equipment and reference material is and make note of any equipment or supplies that are in need of repair or replacement. This way you are less likely to forget to take care of it before the next lab.

7) Help the students to stay organized. Remind them on occasion how much time they have left in the lab session and what aspects of the assignment they should be absolutely sure to complete. Make sure that they follow all of the safety rules and guidelines for cleaning up that you have established.

8) Try to get the course instructor to visit the lab on occasion. The students benefit by his or her presence in the lab because it gives them the opportunity to interact with the instructor and because it reminds them that the information in the lab should be integrated with the rest of the course. Most instructors will make an effort to attend at least part of each lab, especially if you invite them to come to the lab once in a while to talk with the students.

IX. EVALUATING STUDENT PERFORMANCE IN THE LAB

In addition to presenting the students with information in the lab, you will usually be responsible for evaluating how well they learned the material or carried out their assignments. This responsiblity may include choosing a grading scheme and developing the evaluation materials. Before you establish a grading policy for your lab, however, you should first talk with the course instructor about what information he or she will want from you at the end of the quarter. The instructor may ask for a record of student attendance in lab, a quantitative assessment of their performance, or a subjective evaluation of student competencies and attitudes. Also find out what evaluation techniques the instructor does not want you to use. The instructor may ask that you do not give or assign such things as pop quizzes, multiple choice tests, or term papers.

Determine at the start of the quarter what evaluation techniques you are going to use. If you work with other T.A.'s in the course, standardize your procedures so that all the students in the class are being evaluated in the same way. The particular techniques that you use will depend on what skills or ideas in the course you consider to be important; however, remember that most of your students are undergraduates and not graduate students. Do not have unrealistic expectations of what they can do and how much time they can put into your class. Some T.A.'s incorrectly believe that the excellent students can be separated from everyone else by asking impossibly difficult questions or by requiring the students to perform at a level expected of advanced graduate students. This approach will usually only result in discouraging the students and developing an antagonistic relationship between you and your class. Create an evaluation system that encourages everyone to learn, conveys information as it tests, and allows you to realistically assess how much information each student has acquired.

Written and Practical Exams

Written and practical exams can be useful ways to determine if the students understand a body of information or can use it to solve other problems. A poorly written and organized exam, however, will probably not tell you what you want to know about the achievements of your students. When you develop test questions, first decide what is important for the students to know. This can be factual information, techniques, problem-solving skills, or the ability to recognize relationships. Don't write questions that test the students on material that is not important. State the questions clearly so the students will know exactly what kind of answer you are looking for. For example, don't ask "Is the egg produced by the male or the female?" if you want them to describe the female oviduct. They can only be expected to respond to what you actually asked. Don't make the test ridiculously difficult. If you ask trick or unsolvable questions, then you will only discourage your students from learning anything at all about the subject. Avoid asking questions that have a high probability of being answered correctly by chance. What you are trying to determine is who understands the material and who does not. Also, decide how much time you have for the exam and ask the students only as many questions as can be answered in that time.

Write out the answer key before you give the exam so you are forced to determine if the questions are answerable. It is also a good idea to have a colleague look at your test before you give it to the students. He or she can often tell you whether the questions are ambiguous or overly difficult, and if the test is too long.

Compare your answers to the questions to see whether you both agree on what the questions are asking.

If the instructor gives you an exam to administer in lab, look at it carefully before you give it to your students. Make sure that you understand both the questions and the answers. If not, don't be embarrassed to ask the instructor to go through the exam with you. The problem may well be that the questions are ambiguous or that the instructor does not recall correctly what information has been given to the students.

When you grade an exam, try to be as fair and consistent as possible. After grading a large number of exams, you may have to go back and change the grades on the earlier ones because your perception of what an acceptable answer is has changed. You should also provide as much feedback on the exam as possible to help the students learn what it is they did not understand. However, never write anything on an exam that could be interpreted as demeaning or insulting.

Laboratory Notebooks and Reports

Another evaluation technique is to require that the students keep and turn in a laboratory notebook or a laboratory report. Notebooks are an effective way to teach your students how to record their observations and thoughts while performing a lab exercise. Tell your students in advance how they should keep their notebooks and what the criteria for evaluation will be. Drawings should be large, clean and completely labeled. Each drawing should include a scale and written information to describe how the specimen was prepared for observation. Notebooks should also include information on the techniques and procedures followed in the lab exercise. Evaluate the notebooks for completeness and clarity, and provide written feedback so the students can improve their skills of keeping written records of their work.

Laboratory reports are usually based on experiments performed in the lab or are follow-ups to a lab exercise. Be sure to tell your students in advance what your criteria for evaluation will be. If the report is based on an experiment done in class, you should evaluate it as if it were a contribution to the scientific literature: proper format for your discipline, complete description of procedures and techniques, clear presentation and interpretation of observations and results, informative literature search and discussion, and proper use of the English language.

Reports that follow up on a lab exercise may involve a literature search to learn what additional information is known about a subject or the design of an experiment to answer other related questions. Evaluate these reports in the same manner as describe above.

The comments that you give to students on their lab reports can be the most important feedback they receive in a lab because their written work is of the style that they will use as professional scientists. Any advice that you can give them as undergraduates on how to better communicate in writing their hypotheses and results will greatly help them in the future.

Subjective Evaluations

You may wish to evaluate your students on such things as their enthusiasm, patience, effort, attention to detail, willingness to help others, ability to follow instructions, and professional attitude. These are all important traits for the students to develop but they are often difficult to compare fairly among individuals. If you use a subjective assessment of your students performance, be careful not to discriminate against anyone unfairly because they were quiet and undemanding, or because for some reason you did not like them. Anytime you assign a subjective grade, be sure that you can justify the grade on legitimate grounds.

Letters of Recommendation

As a T.A., students will occasionally ask you to write letters of recommendation for them. It is better to advise the student to ask the course instructor to write the letter. Graduate and professional schools do not take very seriously letters written by graduate students. The instructor of the course may subsequently ask for your assessment of the student's performance in lab. Ask the instructor for the specific characteristics of the student's work they would like you to evaluate. Most letter of recommendation forms specify the points on which they would like comments. Write out your comments following the same guidelines as for other subjective evaluations; try to be fair, impartial, and complete.

Keep your grade records for at least a year after the class is over and longer if you can. Students may come back to you after several quarters to ask for a letter of recommendation and you will need these records to assess accurately their performance.

Explaining Your Evaluation Policy

Make sure that you tell your students at the start of the quarter what your grading policy will be and how the evaluations will be used to determine their final grade. Try to emphasize the positive aspects of your evaluation system when you explain it to your students. We all recognize that it is virtually impossible to avoid giving tests and assigning grades; however, the pressure of being evaluated can be eased for the students if you tell them how your evaluation techniques emphasize basic educational goals. Tell them that you are taking attendance in order to learn their names and to make the class more personal, and that attendance in the lab is required because the information in each lab is used to build a general understanding of the subject. Explain to them that notebooks allow them to systematically record their observations and ideas, and that reports give them experience in written communication. In this way your students will see the benefits of having standards of performance and of requiring particular kinds of assignments.

X. EVALUATING YOUR EFFECTIVENESS AS A T.A.

No matter how much experience you have had as a laboratory T.A., you will be interested to learn how effective you are as a teacher. You may want to use this information to modify unproductive teaching practices, to determine why you cannot develop a positive working relationship with your students, to get feedback on new laboratory exercises that you have developed, or simply to acquire documentation of your teaching ability for inclusion with your job applications.

Informal Evaluations

You can get informal feedback on your work at any time during the quarter. This feedback can come from both your students and your colleagues. At the start of the quarter, ask them to bring to your attention anything they see that needs improvement or that works especially well. Remember that people will be more likely to give you casual advice if they sense that you will not resent constructive criticism but will take it in the sprit with which it is given. You will probably get more feedback from your students than from your colleagues simply because your students work with you in the classroom more often. Invite the course instructor or a fellow T.A. to sit in on one of your classes so they can observe and comment on what you are doing.

Do not feel obliged to take all of the suggestions that are given to you. If you encourage people to give you advice, however, you should be prepared to explain to them in a friendly manner why you may not have followed a particular suggestion.

University Evaluations

The Educational Assessment Center (3-1170) makes available to all departments on campus a variety of mark-sense evaluation forms for different teaching formats as well as a general form for written answers to the questions "What did you like about the course?" and " How could the course improve?". Unfortunately, the EAC does not have a form that is specific for the laboratory setting. Those closest to it are those for Problem Solving (Form D) and Quiz Sections (Form F). The EAC will tabulate the students' responses to the questions on the mark-sense forms and will provide you with a summary of the results and information on how to interpret them.

The Center for Instructional Development and Research (3-6588) will help you interpret the results of student rating forms. It is also possible to have a staff member from the Center view you as you teach in your laboratory and suggest ways for you to improve your teaching skills. All interactions with the Center are for purposes of improvement of teaching and cannot be used for personnel decisions.

Department Evaluations

Some departments have their own forms for the evaluation of T.A. performance in the lab. Ask your instructor or the person in charge of T.A. assignments for a supply.

Individual Evaluations

You may want to write your own evaluation form. This will allow you to get feedback on specific points of interest to you. Here are a few suggestions for developing your own form. Keep the questionaire short and the questions unambiguous. Don't make the questions too complicated or difficult to answer. For example, ask your students to comment in general on your preliminary presentations rather than separately on each lab presentation. The following questions can be used to provide useful feedback on your effectiveness as a T.A.: Was the T.A. knowledgeable in the subject matter? Was the T.A. able to explain the subject matter clearly? Was the T.A. able to help you with difficult techniques? Was the T.A. able to demonstrate the significance of the material? How would you rate the T.A.'s willingness to help students? Was the T.A. available to help you outside laboratory hours? How would you rate the usefulness of the explanations at the beginning of the lab?

It is important to assure students that their evaluations will be anonymous and that their comments cannot affect their grades. This can be accomplished by either having the evaluations collected by one of the students and delivered to your department office to be kept until final grades have been assigned or by allowing the students to type their comments and turn them in at a later time to a third party.

When to Ask for Evaluations

Most people prefer to have evaluations done near the end of the quarter. However, much can be gained by also having evaluations done part way through the course. It gives the students an incentive to be complete and constructive in their comments because they may have the opportunity to benefit from any improvements in the course. It also gives you a chance to talk with the students as a group about your teaching strategy if you discover that they do not understand your approach. By explaining the reasons for your approach, you can encourage their acceptance of the goals and design of the lab. For the most complete comments on your effectiveness as a T.A., consider having both mid-quarter and final evaluations.

XI. SAFETY

The laboratory environment presents many opportunities for accident or injury. These risks, however, can be greatly reduced if you are alert for situations that are likely to cause trouble, if you teach your students how to work safely in the laboratory, and if you prepare yourself to respond to an emergency.

Avoiding Problems

Keep the laboratory clean and organized. This will minimize the chance of anyone tripping or knocking something over. It also allows you to be aware of what equipment and supplies are out in the lab so you can be alert for any potential problems.

Teach your students about the proper safety procedures in the laboratory. Laboratories in each discipline of the life sciences will have their own special points of concern but most will need to observe the following procedures:

1) Put all broken glass and sharp objects in a box specifically designated for that purpose. These objects should never be left lying around, placed in the regular trash, or put down a sink.

2) Use extreme caution whenever you use chemicals. Never mouth pipette chemicals or any solution that contains biological material. Do not inhale chemical fumes, stopper glassware in which exothermic reactions are occurring, or work with volatile or radioactive chemicals away from a ventilation hood. Immediately clean up any spills so that no one can slip or spread the material around.

3) Guard your eyes. Always use safety glasses when you work with chemicals or anything that is likely to break or shatter, and immediately use the eyewash if you get anything into your eyes.

4) Be careful not to place heavy objects or glassware near the edge of a bench or table. Have all equipment repaired that does not rest in a stable position. Do not place books or backpacks on lab benches where they can accidentally knock over other items. Do not allow electrical cords to hang over the edge of a lab bench or table where they could accidentally be caught by something. All cords should be plugged in on the opposite side so that the cord cannot accidentally be pulled.

5) Don't drink the water in the lab rooms. Many buildings on campus have plumbing systems for water that is drinkable and water that may be contaminated by material that has been pored down a sink elsewhere. Drink only from a water fountain.

6) Avoid electrical shocks by drying your hands before unplugging electrical cords. Watch for any equipment that has a broken or frayed cord; have these items repaired before allowing them to be used in the lab.

7) Use caution whenever there is an open flame in the lab. Do not put anything flammable, such as books, backpacks, and data paper, near the fire and be careful not to get your hair or clothes near the fire as you work around the flame.

You can help your students to learn these safety rules if you always set a good example in your work in the lab and if you constantly remind them of the need for caution. Before each lab exercise, tell the students about the safety considerations for the current lab and what parts of the exercise require special caution. Watch the performance of the students and enforce your safety rules. If a students is doing something that is dangerous, stop what they are doing, tell them what the consequences could have been, and tell them how to carry out the procedure correctly.

It is also a good idea to ask the students at the start of the quarter to tell you privately if they have any health problems, such as allergies, diabetes, or epilepsy, of which you should be aware. Knowing about these situations ahead of time will help you better diagnose and assist anyone that has an allergic reaction or seizure during the lab session.

Preparing for Problems

The best way to prepare for problems in the lab is to acquire the information you need to know in case of emergency. Learn where the nearest phone is and how to use it to call the campus emergency number (222). All emergencies should be reported by calling this number. Know the location of the nearest fire alarm and building exit. Keep a first-aid kit available and learn how to perform simple procedures such as cleaning and bandaging cuts. Learn the location and instructions for use of all safety equipment, such as the fire extinguisher and eyewash.

You can better prepare yourself to handle emergencies in the laboratory by attending safety seminars offered at the start of every fall quarter by the Department of Health and Safety (3-7262). These seminars provide information on first-aid, fire, laboratory safety, and radiation. You should also talk to the administrator of the building in which you are teaching to find out about specific safety concerns for your classroom.

When a Problem Occurs

Most T.A.'s go through their entire career without ever having a health or safety problem in the laboratory. However, if a problem occurs, act quickly and keep the safety of you and your students as your first priority. Even though you are not likely to ever have a problem, if you do it will probably be among the following:

1) Fire. If it is small, use the fire extinguisher to contain it. Immediately have a student set off the fire alarm and call the emergency number (222). Have your students immediately evacuate the building. If a fire alarm sounds in the building while you are teaching a lab, immediately vacate the building unless you have previously received notice in writing from the building administrator that a fire alarm will sound at the time to test the alarm system. You do not have the prerogative to decide for yourself whether or not to respond to the alarm.

2) Fainting. On occasion a student will faint from the sight of blood, heat, or exhaustion. Lay them comfortably on the floor and prop their feet up to help blood return to their head. Call 222 for assistance if they do not regain consciousness within a short period of time. Afer the student has regained consciousness, their immediate reactions will be embarrassment and the desire to get back up on their feet right away. Assure them that everything is all right and

keep them from getting up, even if you have to gently restrain them After five minutes or so, let them slowly get up to a sitting and then a standing position.

3) Sickness. Students will occasionally complain during lab of not feeling well. Encourage them to take care of themselves and not worry about the completion of the assignment. Based on their degree of discomfort, they should either sit or lie down for a rest, go outside to get some air, or have another student accompany them to Hall Health for treatment.

XII. WORKING WITH BIOLOGICAL MATERIAL

In many laboratory exercises you will be working with living organisms. It is important that you follow proper procedures for the maintenance of the organisms, for the use of living organisms in experiments, and for the disposal of dead tissue. It is also important to teach your students respect for their work with living organisms.

Care of Living Organisms

If you are using live animals in the lab, find out what the proper conditions are for their maintenance. Consider their requirements for food, water, air, salt balance, light, temperature, clean bedding, space, and shelter, exercise, and freedom from stress. Many departments have animal technicians who are trained in procedures for animal care. Ask for their advice on the proper care and handling of your animals. Biological supply houses will often give you instructions for the proper care of animals that you order from them. You can often borrow live animals for demonstrations from research labs. Be sure to ask about the care of the animals when you pick them up. Check on the condition of the animals at least once a day and immediately take care of their needs. Remove the animals from the lab room as soon as you are through with them. Return animals that were collected locally to the location of capture or find them homes where they will be cared for.

Plants are easier than animals to maintain in the lab but they still require some attention. Satisfy their requirements for light, soil, water, temperature, humidity, and air. Plants can often be borrowed for teaching purposes from the University greenhouses or research labs. Follow the advice of the technicians as to the maintenance of these specimens. Plants can also be grown or collected locally for use in lab.

Experimentation

You will teach your students the proper respect for living organisms as well as the guidelines for experimentation with living material if you yourself work carefully and with respect for the organisms in the lab. As scientists and teachers we have a responsibility to treat all living things with respect and to teach our students to do the same. On the other hand, many research programs absolutely require that living organisms be used for experimentation. If we are to maintain our right to use living organisms in the lab then we must be sure to follow the proper procedures.

The use of living organisms, especially animals, as experimental subjects requires that you pay a great deal of attention to their treatment. Never subject an animal unnecessarily to disruptive or uncomfortable conditions or to pain unless you are properly using anesthesia. If you are unsure about how to anesthetize an organism, follow the advise of someone that has experience with that species.

When animals must be sacrificed, do it quickly and with as little pain to the animal as possible. There are recommended procedures for different species (McDonald et al., 1978, J. Amer. Vet. Med. Assoc. 173: 59-72). Consult an animal technician or an experienced researcher in your department for advice.

Common techniques for euthanasia include suffocation, lethal injection, quick freezing in liquid nitrogen, a sharp blow to the back of the head, and pithing.

Place the dead animals or their parts in a sealed plastic bag and store it in the freezer in your building that is designated for animal disposal. An animal technician or anyone who conducts research on animals should be able to tell you where this is. Be sure that any animal you dispose of is dead.

All bacteria, algae, fungi, and small animals such as fruit flies should be autoclaved to prevent them from contaminating other cultures or colonies. Anyone who conducts research with these materials can tell you the location of the autocolaving facilities for your department.

Teaching Students to Work With Biological Material

Teach them proper techniques for observing, handling, and maintaining the organisms you work with in the lab. Let them know that they should work to get the most out of the lab exercise and not cause an organism to be disrupted or killed for no reason. You can minimize the number of animals sacrificed by having the students work together or use preserved specimens when possible.

Often, you will find many who are uncomfortable working with animals. Don't ridicule them. Always respect their feelings and be sure you make clear the necessity of sacrificing or experimenting with animals. Allow some time for students to familiarize themselves with methods of anesthesia or euthanasia. Students who are emotionally upset by dissections should instead observe the work of others as to become familiar with the information presented in the lab exercise. Students that object altogether to the use of animals in laboratories should be referred to the course instructor so that an alternative strategy for their full participation in class can be found.

XIII. CARE OF EQUIPMENT

You are responsible for all of the equipment that you may use in the laboratory. Before using any item, learn from the equipment manual or from someone who is experienced in its use what the proper procedures for use are. Ask someone for help if you do not understand how a piece of equipment works. Do not force any moving part even if you are absolutely sure that you know which way it should move. A simple maintenance procedure of lubrication can turn into an expensive repair requirement if you are not gentle with a machine.

Instruct your students in how to use and care for all the equipment in the lab. Also place written instructions on how to operatate a piece of equipment next to it so the students can refer to the instructions before use. The normal wear-and tear on equipment can be greatly reduced if it is used correctly. Students are also less likely to injure themselves if they use the equipment properly. Be alert for students that do not follow your directions. They are often in a hurry to leave the laboratory and may not turn off a piece of equipment or return it to its storage compartment unless you remind them. The students will become more conscientious in their treatment of equipment if you make an effort at the beginning of the quarter to emphasize and enforce the guidelines for equipment use.

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Regularly inspect the equipment in your care. If an item needs maintenance or repair, immediately bring it to the attention of the person in your department whose responsibility this is. If you deal with minor problems quickly, then they won't turn into major ones and cause injury or delay in a lab.

Make sure that you follow all security procedures for your building. Lock all windows and doors when students are not in the lab. Lock all equipment in storage compartments when not in use. Provide locks for large pieces of equipment, such as computers, that cannot be stored in compartments. Close the curtains whenever expensive equipment must be left out for displays.

Finally, it is a good idea to inventory your equipment after each lab session. If, for example, you used compound microscopes during the lab exercise, then count and inspect the microscopes as you lock them in their cabinets. This kind of inventory information will allow you to more quickly identify and describe problems of theft or vandalism. Immediately report any occurrence of theft or vandalism to the chairman or administrator of your department. Additional information on methods of building and equipment security is available from the University Police Department (3-9331).

XIV. DESIGNING YOUR OWN LABORATORY EXERCISE

At some point you may be asked by the course instructor to design and organize a laboratory exercise. The specific details of the exercise will depend on the subject of the course, but a few general principles can help you put together a well-organized assignment no matter what topic you present.

Determine Who Your Students Are

Decide what level of knowledge you can expect your students to have and what they need to learn in your course. If they are non-science majors who are looking for an introduction to your field, then they may benefit from a simple demonstration of one or two basic concepts. If they are advanced students that may go on to graduate school in your field, then they should be exposed to state-of-the-art techniques and procedures used in experimentation. For example, students in an introductory fisheries laboratory may learn a great deal from a lab that has on display examples of all the major families of fishes, whereas students in an upper-division course may profit more from studying feeding behavior of fish by using such advanced techniques as x-ray cinematography. A laboratory exercise will usually be best received by the students if its approaches and goals are aimed at the appropriate level.

Choose a Topic

You will want to develop an exercise that has clearly defined goals and that fits in with the lectures and the other labs in the course. If a topic does not come readily to mind, you have several resources that can help. The first is your colleagues. They can give you suggestions for laboratory exercises that they have tried in the past or have wanted to try but have not had the opportunity. The course lectures themselves will often suggest laboratory exercises. Historical or illustrative experiments that are described in lecture can be set up for the students to do in the laboratory. The study of biological structures that are difficult to visualize in lecture are also good foundations for lab exercises.

Journal articles in your field are a good source of ideas. Replication or modification of experiments reported in the literature will allow the students to think about and discuss current research as well as the chance to make an original contribution to the field. Another source of ideas are books that describe laboratory exercises, such as Tested Studies for Laboratory Teaching (Proceedings of Workshop/Conferences of the Association for Biology Laboratory Education, Kendall/Hunt Publ. Co.) and Research Problems in Biology: Investigations for Students (Biological Sciences Curriculum Study, Oxford Univ. Press). Both series describe lab exercises in a wide range of life science disciplines and are available in Suzzallo Library. The task of choosing a topic for a lab can be simplified if you keep your eyes open for potential lab exercises even when you are not teaching. Many laboratory instructors maintain a file of potential laboratory exercises that they may be interested in using in the future.

Choose a Format

When designing a format with which to teach a concept in the laboratory, many people decide to use a standard lab format in which the students come to lab at a prearranged time and work two or three hours. Although this approach has its advantages, you should give some thought to alternative designs.

1) Student-designed experiments. Do not underestimate the ingenuity of students to design interesting and exciting projects. Labs in which students perform their own experiments have great potential for stimulating the students because they get to carry out investigations on things of particular interest to them and they get to experience how science is really done. You can organize these projects in a number of ways. For example, one lab can involve everyone in the class conducting the same experiment on the same basic question in order to learn basic principles or how to use the equipment. This lab can then be followed up by having the students work in groups of two or three to design an experiment that extends the investigation that they just completed. As their T.A. you should help them to ask meaningful questions and to design an experiment that will answer those questions. Be alert for experiments that may put human subjects in danger or that do not follow the proper guidelines for the use of animals. No experiment should be allowed that uses alcohol, drugs, or conditions in which someone could be injured. Encourage your students to consider their ethical responsibilities for the wise use of experimental subjects.

After discussing with them their experimental question, have them determine what equipment and supplies they will need. Offer to get for them anything that you have available and suggest to them where they may be able to find the remaining items. Research faculty are often willing to lend equipment for student projects.

2) Computer-aided instruction. Some biological principles can be conveniently explored using computer simulations and graphics. Several computer programs and some microcomputers are available for instructional use on campus. Ask your colleagues who are familiar with computers if any instructional computer facilities are available in your department. If you have skills in computer programming and have access to a microcomputer, then you may enjoy developing your own course software.

There are two other resources that offer computer facilities for instructional use. First, the Biology Science Area (3-8038) has computer software on a variety of biological topics. Arrangements can be made with the proctor of the BSA to have your students go there in small groups. Also, the Olympus Project, an IBM equipment grant to improve instruction at the University, has made available a large number of microcomputer work stations, diverse course software, and a staff that can advise you as you develop your own course software. Departments in the life sciences should contact either the Arts and Sciences Undergraduate Olympus Cluster (3-0490) or the Center for Instructional Development and Research Olympus Cluster (3-0751) to talk with a staff member about arrangements to use the facilities or advice on software design.

Unfortunately, microcomputers for instructional use are not yet so common on campus that the available facilities can easily handle large classes. Try to avoid having more than three or four students working on a machine at one time and be sure to schedule enough time for everyone to complete the lab assignment. Also, educational software and the procedures for using computers are often so complicated that the students lose sight of the object of their assignment. Make sure that the directions for the use of the computer and the software are clear and accurate and be certain to explain to the students what the purpose of the assignment is.

3) Audiovisual materials. Students may also benefit from watching a film or videotape on a topic of biological interest. This gives them the opportunity to see examples and explanations of things that may be difficult or impractical to have in the lab. You can reserve films or videotapes for presentation during the lab session from the Instructional Media Service (3-9909; see Part XV on Teaching Resources).

The Biology Science Area (3-8038) also has instructional material that can be viewed in the Center. These materials include videotapes, filmloops, slide-tape programs, overhead transparencies, and filmstrips.

4) Field trips. Many things of interest in the biological world can be better observed or studied somewhere other than in the laboratory. At the University of Washington you can easily take students to a number of interesting locations on or near campus. These include Lake Washington, Foster Island, the Arboretum, the Burke Memorial Museum, the Botany Herb Garden, Ravenna Park, and Montlake Fill. The entire campus itself can be used as a place to observe and study a variety of organisms and their interactions, including trees, birds and insects. You can also arrange to visit research laboratories that are conducting experiments or are working with equipment that would be of interest to your students.

Other locations off-campus that are easily accessible for short field trips are the Woodland Park Zoo, the Aquarium, the Pacific Science Center, the Ballard Locks, Discovery Park, Lake Sammamish, and many locations along the shore of Puget Sound. The number of potential locations increases exponentially the further you are willing to travel from the campus and if you are willing to camp out overnight. You can acquire a long list of field trip sites by talking to others in your department that have led field trips. Make sure that you have the necessary permission for the project that you have planned for your class. Manipulations and collections of plants and animals often require special permits from the State.

If you plan to take your students on a field trip you should make sure to discuss with them in advance the time and location of departure and return and any special clothing or equipment they should bring. Think ahead about whether they will need rain gear, hiking boots, warm clothes, binoculars, a clipboard and data paper, lunch, or any other items. You should also arrange to have a first-aid kit with you in case of an accident. If the course budget can pay for transportation, access to vehicles can be arranged with the University Motor Pool through your department office.

Organize the Lab

After you have decided on the topic and the approach of the lab, you need to organize it so the students will be able to carry out the assignment. Keep the lab simple. People often put too much material in to the lab assignment in order to keep the students from getting bored. If you make the assignment too long then they will either not finish or they will rush through the entire assignment and retain very little information. Any extra ideas for laboratory work can always be saved and incorporated into other labs that you may need to develop.

Write a handout for the students that describes the background, purpose, procedures, and requirements of the exercise. Make the handout as complete as possible and arrange to give it to the students in advance so they can read it before coming to lab.

Be sure that all of the equipment that the students will need for the assignment is available. It is a good idea to think about your needs for material and equipment several weeks in advance of the lab session to allow for material to be ordered, cultered, or collected. If they will require equipment that is not already available in the lab you can often borrow material from other teaching labs, research labs, or the stockroom of your department. There are sources on campus from which you can borrow biological material for classes on a limited bases. These include the Burke Memorial Museum, the Botany Herbarium, and the Botany Greenhouses. Check in advance with the supervisors of these facilities for the availability of material for loan. They can also suggest other materials that they have available that can be used for your lab. Keep a list of the equipment and material that you borrow from other people and be sure to return them in good order as soon as you are finished with the lab. You can also order supplies for a class through the purchasing secretary or stockroom supervisor in your department.

After designing the lab exercise and arranging for all of the necessary equipment, be sure to go through the lab exercise yourself. This will allow you to identify and change any parts that seemed like a good idea when you wrote the assignment but do not work in practice. If you can, have a colleague go through the lab exercise for you. They can tell you if there is enough time to complete the assignment, if the instructions and goals are clear, and if all the equipment works as it should.

XV. TEACHING RESOURCES

You have access to many resources at the University to help you develop your skills as a laboratory instructor in the life sciences. The best resource you have is always your colleagues. They have had many of the same experiences that you have had and are aware of the particular needs and challenges of teaching the material in your field. Most faculty and graduate students are happy to share advice and to suggest solutions for any situation you may face, from the need for more exact information on a topic to personality problems in the laboratory. Other resources are outlined below and are also described in Mentor.

Biology Science Area

The Biology Science Area (3-8038) has available a large amout of biological material in several different media, including videotapes, film strips, film loops, slide-tape programs, overhead transparencies, computer software, and various information files. The subjects available range from genetics and cell biology to ecology and evolution. Arrangements can be made with the proctor of the BSA to have your students go to the Center individually or in small goups to use the facilities. The BSA also has an extensive slide library that you can borrow from for class presentations as well as a copy stand that you can use to shoot your own slides.

Center for Instructional Development and Research

The Center for Instructional Development and Research (3-6588) is a central facility that assist instructors in the improvement of teaching and learning. It provides opportunities for confidential instructional consultation and access to educational materials, equipment, and services. Staff members are available to provide resources or talk with you about teaching techniques, methods for interacting with students, test construction and evaluation, problem solving, and course evaluation. All of the Center's resources are the purpose of improvement of teaching and are not for use in personnel decisions.

Of particular interest to laboratory T.A.'s are the Center's videotapes on teaching, information on teaching and learning styles in the laboratory, and resources on computer assisted instruction. Also of interest are the services for course evaluation. A staff member can observe and comment on your teaching techniques in the lab, offer ways to use videotape for evaluation, provide assistance in interpreting student ratings, and help in the development of methods for evaluating student performance.

Instructional Media Services

The Instructional Media Service (3-9909) has available a large collection of films and videotapes for instructional use, as well as film, slide, and overhead projectors, video cameras, audio cassette recorders, and screens. IMS can also in many cases provide an operator for a film. Their main catalog and catalog supplement lists their films by academic subject, which makes it easy to locate the available titles that relate to the subject of your class. Catalogs are available from IMS and your department office. You can also arrange to preview films at IMS (3-9906) to determine whether you want to show the film to your class. Rental is free for University classes: however, you should call as early as possible to reserve the materials you are interested in to be sure that they are available.

Requests for audiovisual equipment in the Health Science complex should be directed to the Academic Services branch of Instructional Media Services (3-6729). Any requests that you have should be placed through your department secretary.

Educational Assessment Center

The Educational Assessment Center (3-1170) provides instructional evaluation forms for use in a variety of teaching situations other that the laboratory setting. Their mark-sense forms for Problem Solving (Form D) and Quiz Sections (Form F) can perhaps be modified to suit your needs. The EAC will also summarize and provide you with information on interpreting the results of the evaluations. Staff members are also available to help you design your own evalution forms or test questions.

University Library System

The library system at the University of Washington is one of the best in the country. In it you can find detailed information on any subject on which you are teaching as well as information on the craft of teaching itself. Details on the hours and facilities of the several branches of the library system can be obtained by calling Library Information (3-0140) or by refering to Mentor.

XVI. CONCLUSIONS

The concepts discussed at length in this manual can be summarized into The Ten Essentials of Being a Successful T.A.

1) Act as a guide and a role model for your students and not as an answer person.

2) Treat your students and colleagues with the same respect with which your would like to treated.

3) Be supportive of your students, your colleagues, and the goals of the course.

4) Find out from the course instructor what your responsibilities will be during the quarter and meet those responsibilities.

5) Understand what you are to teach before you walk into a laboratory session.

6) Think about the material you are to teach from the students' perspective. Use vocabulary, examples, and a format for presentation that they will understand.

7) Keep the safety of you and your students as your first priority.

8) Admit it when you do not know the answer to a question.

9) Remember that you are a professional scientist and a representative of the University of Washington. Do not express the attitude that you are "only a T.A."

10) Follow the examples of the best T.A.'s and instructors that you had when you were an undergraduate and avoid the mistakes of those that were not so good.

EVALUATION OF THE LABORATORY TEACHING ASSISTANT MANUAL

The Center for Instructional Development and Research would like to know how useful you found this manual to be. Your comments will be used to revise the manual to make it a better tool for T.A.'s in the life science laboratories. Please return this form to: CIDR, DC-07.

Department ____

How many quarters had you been a T. A. before you read this manual? ______________

Besides this manual, what additional training did you receive to help you develop your teaching skills (e. g., seminar, workshop)?

What does this manual not include that you would like to have discussed?

What does this manual not discuss in enough detail?

How could this manual be made more useful?

How could the format, organization, or writing be improved?

Other comments?