# INTRODUCTION TO THE NEUROSCIENCE LABORATORIES AND CLASSROOM ACTIVITIES

## *Some General Notes From the Primary Editors*

### Notes About Terminology

Most of the neuroscience laboratories and classroom activities in this publication provide opportunities for students to design and conduct their own experiments. Because of editing considerations, different terms are used to describe these activities. For example, the words "lab," "laboratory," "activity," "experiment," or "investigation" may be used interchangeably. All of these terms, however, are referring to experiences in which students are involved actively in their own learning.

### How To Use This Lab Manual

In order to save time and avoid confusion, the Primary Editors strongly suggest that you do the following before conducting any of these labs or activities with your students:

- Read ”How To Use This Lab Manual,“ ”How Are These Labs Set Up?,“ and Appendix A. They clarify important information about individual sections of each lab.
- Read the section on ”The Learning Cycle“ (see page 17) if you are not already familiar with it.
- Read other sections in this introduction, ”Notes About Metric Units,“ and ”Modifying These Labs for Students Who Are Exceptional“ for important information on these topics.
- Read each lab activity all the way through before conducting it with your students.
- These labs are meant to be conducted with teachers and neuroscientists working in partnership. You will receive notification of the name of your teacher or neuroscientist partner, and how to contact that person, in a separate mailing, if you have not received this information already.

This publication is part of a larger project that has been a true partnership between high school biology teachers and neuroscientists from the beginning. The labs were written by teachers who learned about "cutting edge" research from neuroscientists in a 1992 workshop at Wake Forest University. The labs were then field tested by teachers nationwide. Each of these teachers — workshop participants and field testers — had a neuroscientist partner with whom to work. Since many of these labs are based on "cutting edge" research, the neuroscientists have been very helpful in answering teacher and student questions as they arise. In many cases, neuroscientists have visited the high schools of their teacher partners to help them teach these labs. Neuroscientists have also hosted visits to their laboratories for the teachers and students. The teachers and neuroscientists have learned a great deal from each other.

It is our goal to continue this very successful partnership as the labs are distributed and implemented. We want to try to match each teacher who receives a copy of the lab manual with a neuroscientist partner, and vice versa. As you work together with your partner to plan how to implement these labs, we hope you will find the suggestions in Appendix B, "Scientists' Guidelines for Preparing Activities for High School Students," helpful. These suggestions were written by the teachers who participated in the 1992 summer workshop.

## How Are These Labs Set Up?

So that you will have a better understanding of how these labs were developed, the format used to write them is summarized in Appendix A. Where appropriate, brief information about each section of the format is given. In some labs, full-page charts, data tables, graphs and/or diagrams are provided for your convenience. These pages can be reproduced as overhead projector transparencies or student handouts.

A "skeleton" of the format is reproduced here for your convenience:

### Directions for Teachers

Synopsis

Level

Student Prior Knowledge

Integration

- *Into the Biology Curriculum*
- *Across the Curriculum*

Objectives

Getting Ready

- *Length of Lab*
- *Materials Needed*
- *Preparation Time Required*
- *Directions for Setting Up the Lab*

Teacher Background

Safety Notes

Procedure

- *Exploration*
- *Concept/Term Introduction*
- *Application*

Teaching Tips

Suggested Modifications for Students Who Are Exceptional

Answers to Questions in "Directions for Students"

References

Suggested Reading

**Directions for Students**

Introduction

Materials

Safety Notes

Procedure

- *Exploration*
- *Concept/Term Introduction*
- *Application*

Analysis

### Notes About Metric Units

Wherever possible, we have used metric units throughout this publication. In some cases, however, a piece of equipment may be listed in English units because these are used commonly in catalogs and stores that sell the items. Even in most of these cases, however, we give the metric equivalent in addition to the English unit to reinforce the metric units for students.

## *The Learning Cycle*

All of the labs in this publication are developed around the Learning Cycle. The paragraphs that follow will give you an idea of what the Learning Cycle is and how it can be used.

(The following Learning Cycle summary was written by Robert H. Evans, Associate Professor of Education, Wake Forest University, Winston-Salem, North Carolina, and reprinted with permission. Portions of this section were adapted from the following source and used with permission: Lawson, A.E., Abraham, M.R. & Renner, J.W. [1989]. *A theory of instruction: Using the learning cycle to teach science concepts and thinking skills.* Manhattan, KS, NARST Monograph, Number One.)

### Part I

Read over the following descriptions of two biology classes. Look for differences in these two approaches to teaching the same material. Write down a word or two in the margins of this sheet to characterize these differences.

#### *Lesson I*

Explain to the students that temperature has a general effect on the metabolism of invertebrates. Higher temperature means a higher rate and low temperature slows down metabolic activity. One such example is a cold-blooded animal like the *Daphnia* that is directly influenced by the environmental temperature. Now have your students go to the laboratory and use live *Daphnia* to verify that what you have explained is correct.

### *Lesson II*

Provide the students with live *Daphnia,* a hot plate, dextrose solution, 5% solution of alcohol, a light source, rulers, thermometers, slides, pH paper, balances, graph paper, microscopes, a stirring device, and ice cubes. Ask them to investigate the influence of environmental changes on the heartbeat of *Daphnia* and to search for quantitative relationships among the variables.

Pool the student results and help the group use these results to discover a relationship between metabolic rate and temperature. Lead them to the conclusion that a cold-blooded invertebrate like the *Daphnia* is influenced directly by environmental temperature and that higher temperature means a higher metabolic rate and low temperature slows down metabolic activity.

Have the students think of other invertebrates whose metabolic rates might also be influenced by temperature. Discuss with the students how some of these influences might be of importance to humans.

## Part II

You may want to reread the two lessons above to see all the differences.

In examining these lessons, you probably noticed that Lesson I begins with a generalization followed by the specific concepts. The teacher has the students confirm this information.

Lesson II differs in that without the orientation of the specific concepts, students do a less-focused lab to discover something about the generalization. Their results are then used by the teacher to help students construct the specific concepts and the overall generalization. Finally, the students are led to apply their new knowledge to other situations.

Lesson I is an example of traditional deductive science teaching. Lesson II illustrates teaching with the Learning Cycle. The lab phase is called the ***Exploration*** phase and it always comes first. It is here that students, with minimal guidance from the teacher, use their hands and minds to explore, investigate, and find patterns. Next is the ***Concept/Term Introduction*** phase in which the teacher helps students explain the patterns they've discovered, giving names to them. Finally, students apply what they have discovered to other situations in order to broaden the range of these new concepts. This phase is called ***Application***.

The sequence of these Learning Cycle steps is crucial for students to construct new knowledge actively. It is through this active construction that new knowledge is best learned, most useful, and ultimately most transferable. The passive exposition and secondary confirmation of Lesson I doesn't challenge old ways of thinking and provide opportunities for resolution of complexities the way the Learning Cycle of Lesson II does.

## Part III

The Learning Cycle is a natural and useful way to learn most things. It is natural because most of us, when confronted with something new to learn, choose it. Think, for example, of the last time you set up a new TV, stereo, or computer. Unless you are very disciplined, you probably followed your natural learning instincts by opening the box and attempting a setup without first reading all of the instructions from beginning to end. Only after you ran into problems or had questions, did you reluctantly refer to the information booklet. Knowing about our natural inclination, product information booklets almost always admonish us to "Read Completely Before Attempting To Operate This Equipment!" We *explore* the new object before referring to booklets for *term introduction* about how to operate it. Last of all, the final booklet pages on what to do if it doesn't work help us *apply* our new understanding of our TV in case it doesn't work.

Another example might be when given a new piece of computer software. Most of us are tempted to try it out in the computer before reading the book of instructions. Only when our *explorations* falter do we refer to the text to help us understand and give terms to what we have discovered. Then we're ready to go back and *apply* this new understanding to our software. These Learning Cycles continue for months and even years, until we're completely familiar with our new software. Compare this natural Learning Cycle approach to a deductive approach in which we had read and learned the entire manual before ever touching the computer!

### Conclusion

The Learning Cycle is probably a more natural, effective, and useful way to learn than traditional deductive methods. Parts I, II, and III of this section are meant to follow the three phases of the Learning Cycle.

### Reference

Lawson, A.E., Abraham, M.R. & Renner, J.W. (1989). *A theory of instruction: Using the learning cycle to teach science concepts and thinking skills.* Manhattan, KS, NARST Monograph, Number One.

## *Modifying These Labs for Students Who Are Exceptional*

It is important for teachers to accommodate the needs of all students in their science classrooms. NABT recommends that the AAAS *Barrier-Free in Brief* series serve as a source of information on science/mathematics learning and disability. The four-booklet series is unique, succinct, and reliable. Any or all of the booklets are **FREE** and available from AAAS; Project on Science, Technology and Disability; 1333 H Street, NW; Washington, DC 20008; (202) 326-6630 (V/TDD); (202) 371-9849 (FAX); bgoodric@aaas.org (E-mail). The titles of these four booklets with a brief description of their contents are listed below:

- *Workshops and Conferences for Scientists and Engineers* explains how to plan accessible meetings and workshops. *

- *Laboratories and Classrooms in Science and Engineering* describes ways to accommodate students with different disabilities in classroom and laboratory settings. *

- *Access in Word and Deed* suggests appropriate language for use in the disability community. It also provides a list of people who would provide advice relating to disability, technology, and access issues.
- *Access to Science Literacy* discusses informal science programs. It is written for program directors and parents of students with disabilities. *

Lab-specific suggestions for accommodating the needs of students who are exceptional are found within the neuroscience labs under the heading "Suggested Modifications for Students Who Are Exceptional." You will no doubt find your own creative ways to address the needs of students who are exceptional as they conduct their investigations. We realize that the modifications we have suggested in the labs do not begin to address all the needs students with single and multiple disabilities might have with these labs. These suggestions, however, will help accommodate some of these needs.

* These booklets have addresses of agencies that can provide information about obtaining assistive technology, such as Assistive Listening Devices (ALDs); light probes; and talking thermometers, calculators, and clocks.