

## Preface

Welcome to *Illustrated Guide to Home Biology Experiments: All Lab, No Lecture*.

We wrote this book in response to the flood of queries we've received from readers of *Illustrated Guide to Home Chemistry Experiments*. (That book was published in 2008 and has become an enduring bestseller, thanks both to homeschoolers and DIY hobbyists.) Most of the queries were on much the same theme: When are you going to do the same thing for biology?

This book is our answer to that question. It took us 18 months to write, and with so much to cover we had to do some juggling to make sure the most important stuff all made it into the book. Our goals for this book were:

- To write a biology lab manual suitable for a rigorous first-year high school biology course, or for a budding DIY bio enthusiast who wants to learn the fundamentals of biology lab work.
- To cover as broad a range of topics as possible while maintaining useful depth.
- To include only lab sessions that are practical to do at home and do not require the expensive equipment and resources of a formal school laboratory, other than a decent microscope.
- To keep lab costs as low as possible by designing an affordable companion lab kit as we wrote the book.
- To make the lab sessions easy to co-ordinate with popular homeschool biology texts, such as CK-12, Miller-Levine Biology, A Beka, Apologia, BJUP, and many others.

We think we accomplished those goals. We've never been entirely satisfied with any book we've written. Just ask our editor, who always has to drag the manuscript away from us as we kick and scream and beg for just a little more time. But in this case we think we did what we set out to do.

### Who This Book is For

This book is for anyone, from responsible teenagers to adults, who wants to learn about biology by doing real, hands-on laboratory work. DIY hobbyists can use this book to learn and master the essential practical skills and fundamental knowledge needed to pursue biology as a lifelong hobby. Home school parents and public school teachers can use this book as the basis of a first-year lab-based biology course.

### How This Book is Organized

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The first part of this book is made up of narrative chapters that cover how to use the book, how to equip your biology lab, and how to work safely. The bulk of the book is made up of more than 30 lab sessions incorporating about 80 separate procedures in the following 11 groups.

### Mastering Microscope Skills

In this group, you'll learn the essential skills of using a microscope, mounting specimens (including simple wet mounts, smear mounts, hanging-drop mounts, and sectional mounts), and using simple and Gram staining to reveal the microscopic details of life forms.

### Building and Observing Microcosms

In this group, you'll build microcosms—miniature worlds contained in soda bottles and populated with diverse microscopic life—and observe those tiny worlds over a period of weeks to months. You'll observe succession—the cycle of life as the microcosms grow and mature—and test the effect of pollution on those microcosms.

### Chemistry of Life

In this group, you'll explore the chemistry of life: acids, bases, and buffers, carbohydrates and lipids, proteins, enzymes, and vitamins. You'll also create and observe coacervates, non-living cell-like structures that may have played a role in abiogenesis—the development of living organisms from non-living precursors. Finally, you'll extract and visualize actual DNA, build a gel electrophoresis apparatus, and use that apparatus to do simulated DNA analysis. (Or real DNA analysis, if the necessary materials are within your budget.)

### Life Processes

In this group, you'll explore some fundamental life processes. You'll observe carbon dioxide uptake in plants, determine the effect of light intensity on photosynthesis rate, and use chromatography to analyze chlorophyll and other plant pigments. You will investigate osmosis, the process by which nutrients and wastes are transported across cell membranes. Finally, you'll observe mitosis, a process by which cells reproduce themselves.

### Ecology

You'll begin this group by sampling plant populations in a community, learning how ecologists track changes in the environment by observing changes in plant populations. You'll then learn how different organisms sometimes cooperate to the benefit of both by observing the effect of nitrogen-fixing bacteria on lima bean growth. Next, you'll do air pollution testing for particulates by building, exposing, and observing particle traps. Finally, you'll test soil and water specimens quantitatively for the presence of boron, a common environmental pollutant.

### Genetics and Inheritance

In this group, you'll explore Mendelian genetics by testing a sample population for the ability to taste phenylthiocarbamide (PTC). You'll then analyze your data by charting that ability against family relationships to determine whether PTC tasting ability is heritable in strict Mendelian terms.

### Cells and Unicellular Organisms

You'll begin this group by observing specialized eukaryotic cells, comparing and contrasting their features and structures. You'll then prepare culturing media, culture mixed bacteria species, and prepare pure broth cultures of each of those species. You'll then test each species for sensitivity to a range of antibiotics, culture an antibiotic-resistant strain, and retest the sensitivity of that resistant strain to the same range of antibiotics.

### Protista

In this survey group, you'll observe four members of kingdom *Protista*—*Spirogyra* (algae), *Euglena*, *Amoeba*, and *Paramecium*—which are simple organisms that have some of the characteristics of plants and fungi and some of the characteristics of animals. You'll use both live specimens—which allow you to observe the organisms going about their business and

interacting with their environments—and prepared slides, which allow you to observe more of the fine details of their structure.

### *Fungi*

In this survey group, you'll observe the structures and features of members of kingdom *Fungi* in the phyla *Zygomycota*, *Ascomycota*, and *Basidiomycota* using both live specimens and prepared slides.

### *Plantae*

In this survey group, you'll observe members of kingdom *Plantae* (plants), beginning with the structures and features of the simplest plants, mosses and ferns. You'll observe germination of an angiosperm (seed plant) and compare and contrast the similarities and differences in the root, stem, leaf, and reproductive structures of seed plants.

### *Animalia*

In this final group of survey lab sessions, you'll observe the structures of members of kingdom *Animalia* (animals), beginning with the simple invertebrates—*Porifera* (sponges) and *Cnidaria*—and then through *Platyhelminthes*, *Nematoda*, and *Annelida* (three classes of worms) to *Arthropods* (bugs and related creatures). In the final lab session, you'll investigate the four types of vertebrate tissues—epithelial, connective, muscle, and nerve—by observing vertebrate organs and structures made up of these tissue types.

## Acknowledgments

Although only our names appear on the cover, this book is very much a collaborative effort. It could not have been written without the help and advice of our editor, Brian Jepson, who contributed numerous helpful suggestions. As always, the O'Reilly design and production staff, who are listed individually in the front matter, worked miracles in converting our draft manuscript into an attractive finished book.

Finally, special thanks are due to our technical reviewers ???

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??? outdid themselves as technical reviewers, flagging our mistakes and contributing innumerable useful suggestions and comments. With their help, this is a much better book than it might otherwise have been. Thanks, guys.

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## Thank You

Thank you for buying *Illustrated Guide to Home Biology Experiments*. We hope you enjoy reading and using it as much as we enjoyed writing it.

## Author Bios

**Robert Bruce Thompson** is the author of numerous articles, training courses, and books about computers, science, and technology, including many co-authored with his wife, Barbara. He built his first home lab as a teenager, and went on to major in chemistry in college and graduate

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school. Robert maintains a home laboratory equipped for doing real chemistry, forensics, biology, earth science, and physics.

**Barbara Fritchman Thompson** is, with her husband Robert, the co-author of numerous books about computers, science, and technology. With her Masters in Library Science and twenty years' experience as a public librarian, Barbara is the research half of our writing team.

## Dedication

*To Charles Darwin (1809 – 1882), the towering genius whose theory of evolution is the foundation of modern biology.*

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