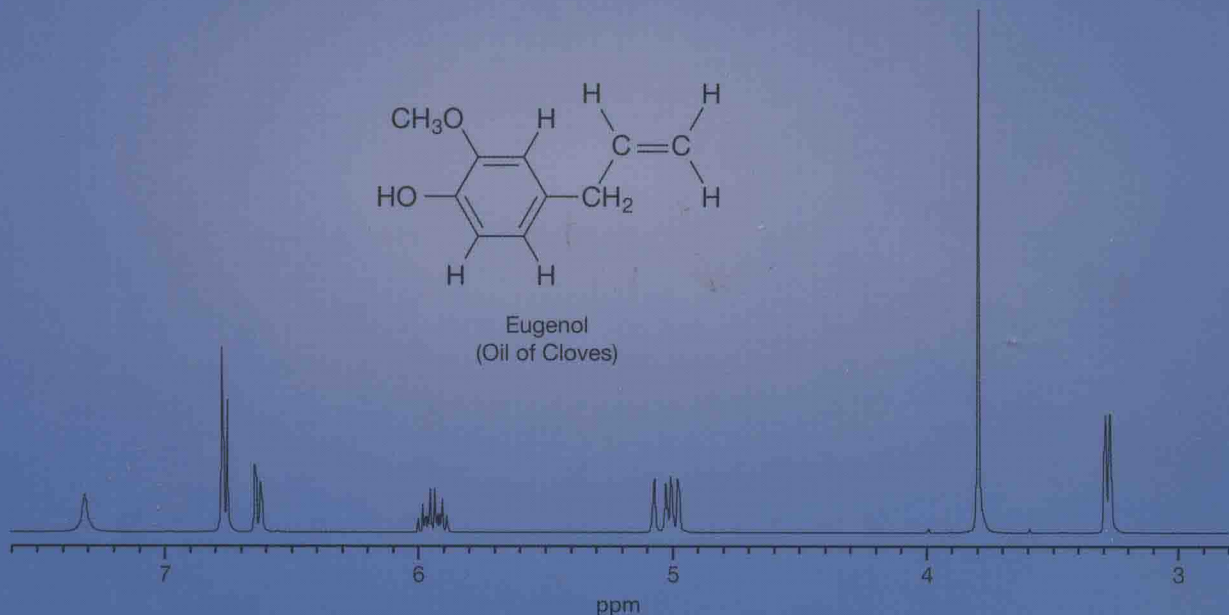


Eugenol
(Oil of Cloves)



Laboratory Techniques in Organic Chemistry

FOURTH EDITION

Supporting Inquiry-Driven Experiments

Jerry R. Mohrig
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Gretchen E. Hofmeister
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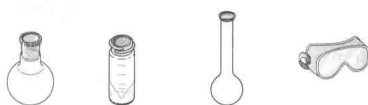
PREFACE

In preparing this Fourth Edition of *Laboratory Techniques in Organic Chemistry*, we have maintained our emphasis on the fundamental techniques that students encounter in the organic chemistry laboratory. We have also expanded our emphasis on the critical-thinking skills that students need to successfully carry out inquiry-driven experiments. The use of guided-inquiry and design-based experiments and projects is arguably the most important recent development in the teaching of the undergraduate organic chemistry lab, and it provides the most value added for our students.

Organic chemistry is an experimental science, and students learn its process in the laboratory. Our primary goal should be to teach students how to carry out well-designed experiments and draw reasonable conclusions from their results—a process at the heart of science. We should work to find opportunities that engage students in addressing questions whose answers come from their experiments, in an environment where they can succeed. These opportunities should be designed to catch students' interest, transforming them from passive spectators to active participants. A well-written and comprehensive textbook on the techniques of experimental organic chemistry is an important asset in reaching these goals.

Changes in the Fourth Edition

The Fourth Edition of *Laboratory Techniques in Organic Chemistry* builds on our strengths in basic lab techniques and spectroscopy, and includes a number of new features. To make it easier for students to locate the content relevant to their experiments, icons distinguish the techniques specific to each of the three common types of lab glassware—miniscale standard taper, microscale standard taper, and Williamson glassware—and also highlight safety concerns.



Sections on microwave reactors, flash chromatography, green chemistry, handling air-sensitive reagents, and measurement uncertainty and error analysis have been added or updated. The newly added Part 6 emphasizes the skills students need to carry out inquiry-driven experiments, especially designing and carrying out experiments based on literature sources. Many sections concerning basic techniques have been modified and reorganized to better meet the practical needs of students as they encounter laboratory work. Additional questions have also been added to a number of chapters to help solidify students' understanding of the techniques.

Short essays provide context for each of the six major parts of the Fourth Edition, on topics from the role of the laboratory to the spectrometric revolution. The essay "Intermolecular Forces in Organic Chemistry" provides the basis for subsequent discussions on organic separation and purification techniques, and the essay "Inquiry-Driven Lab Experiments" sets the stage for using guided-inquiry and design-based experiments. Rewritten sections on sources of confusion and common pitfalls help students avoid and solve technical problems that could easily discourage them if they did not have this practical support. We believe that these features provide an effective learning tool for students of organic chemistry.

Who Should Use This Book?

The book is intended to serve as a laboratory textbook of experimental techniques for all students of organic chemistry. It can be used in conjunction with any lab experiments to provide the background information necessary for developing and mastering the skills required for organic chemistry lab work. *Laboratory Techniques in Organic Chemistry* offers a great deal of flexibility. It can be used in any organic laboratory with any glassware. The basic techniques for using miniscale standard taper glassware as well as microscale 14/10 standard taper or Williamson glassware are all covered. The miniscale glassware that is described is appropriate with virtually any 14/20 or 19/22 standard taper glassware kit.

Modern Instrumentation

Instrumental methods play a crucial role in supporting modern experiments, which provide the active learning opportunities instructors seek for their students. We feature instrumental methods that offer quick, reliable, quantitative data. NMR spectroscopy and gas chromatography are particularly important. Our emphasis is on how to acquire good data and how to read spectra efficiently, with real understanding. Chapters on ^1H and ^{13}C NMR, IR, and mass spectrometry stress the practical interpretation of spectra and how they can be used to answer questions posed in an experimental context. They describe how to deal with real laboratory samples and include case studies of analyzed spectra.

Organization

The book is divided into six parts:

- Part 1 has chapters on safety, green chemistry, and the lab notebook.
- Part 2 discusses lab glassware, measurements, heating and cooling methods, setting up organic reactions, and computational chemistry.
- Part 3 introduces filtration, extraction, drying organic liquids and recovering products, distillation, refractometry, melting points, recrystallization, and the measurement of optical activity.
- Part 4 presents the three chromatographic techniques widely used in the organic laboratory—thin-layer, liquid, and gas chromatography.
- Part 5 discusses IR, ^1H and ^{13}C NMR, MS, and UV-VIS spectra in some detail.
- Part 6 introduces the design and workup of chemical reactions based on procedures in the literature of organic chemistry.

Traditional organic qualitative analysis is available on our Web site:
www.whfreeman.com/mohrig4e.

Modern Projects and Experiments in Organic Chemistry

The accompanying laboratory manual, *Modern Projects and Experiments in Organic Chemistry*, comes in two complete versions:

- *Modern Projects and Experiments in Organic Chemistry: Miniscale and Standard Taper Microscale* (ISBN 0-7167-9779-8)
- *Modern Projects and Experiments in Organic Chemistry: Miniscale and Williamson Microscale* (ISBN 0-7167-3921-6)

Modern Projects and Experiments is a combination of inquiry-based and traditional experiments, plus multiweek inquiry-based projects. It is designed to provide quality content, student accessibility, and instructor flexibility. This laboratory manual introduces students to the way the contemporary organic lab actually functions and allows them to experience the process of science. All of its experiments and projects are also available through LabPartner Chemistry.

LabPartner Chemistry

W. H. Freeman's latest offering in custom lab manuals provides instructors with a diverse and extensive database of experiments published by W. H. Freeman and Hayden-McNeil Publishing—all in an easy-to-use, searchable online system. With the click of a button, instructors can choose from a variety of traditional and inquiry-based labs, including the experiments from *Modern Projects and Experiments in Organic Chemistry*. LabPartner Chemistry sorts labs in a number of ways, from topic, title, and author, to page count, estimated completion time, and prerequisite knowledge level. Add content on lab techniques and safety, reorder the labs to fit your syllabus, and include your original experiments with ease. Wrap it all up in an array of bindings, formats, and designs. It's the next step in custom lab publishing. Visit <http://www.whfreeman.com/labpartner> to learn more.

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We hope that teachers and students of organic chemistry find our approach to laboratory techniques effective, and we would be pleased to hear from those who use our book. Please write to us in care of the Chemistry Acquisitions Editor at W. H. Freeman and Company, 41 Madison Avenue, New York, NY 10010, or e-mail us at chemistry@whfreeman.com.

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