second edition

# advanced practical organic chemistry

J. Leonard

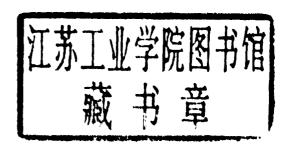
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# Advanced Practical Organic Chemistry

Second edition

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# **Advanced Practical Organic Chemistry**

# Dedicated to Professor Gilbert Stork In recognition of the skills and enthusiasm for chemistry gained in his laboratories

### Preface to Second Edition

The preparation of organic compounds is central to many areas of scientific research, from the most applied to the most academic, and is not limited to chemists. Any research which uses new organic chemicals, or those which are not available commercially, will at some time require the synthesis of such compounds.

This highly practical book continues to cover the most up-to-date techniques commonly used in organic synthesis and is based on our experience of establishing research groups in synthetic organic chemistry and our association with some of the leading laboratories in the field. It is not claimed to be a comprehensive compilation of information to meet all possible needs and circumstances; rather, the intention has been to provide sufficient guidance to allow the researchers to carry out reactions under conditions which offer the highest chance of success.

The book is written for postgraduate and advanced level undergraduate organic chemists and for chemists in industry, particularly those involved in pharmaceutical, agrochemical and other fine chemicals research. Biologists, biochemists, genetic engineers, material scientists and polymer researchers in university and industry will find the book a useful source of reference.

All the artwork for this second edition has been modernized and the chapters have been reorganized to allow for more expanded treatment of practical techniques.

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### **CHAPTER 1**

### **General Introduction**

The preparation of organic compounds is central to many areas of scientific research, from the most applied to the most "academic", and is not limited to chemists. Any research which uses new organic chemicals, or those which are not available commercially, will at some time require the synthesis of such compounds. Accordingly the biologist, biochemist, genetic engineer, materials scientist, and polymer researcher in university or industry all might find themselves faced with the task of carrying out an organic preparation, along with those involved in pharmaceutical, agrochemical, and other fine chemicals research.

These scientists share with the new organic chemistry graduate student a need to be able to carry out modern organic synthesis with confidence and in such a way as to maximize the chance of success. The techniques, methods, and reagents used in organic synthesis are numerous, and increasing every year. Many of these demand particular conditions and care at several stages of the process, and it is unrealistic to expect an undergraduate course to prepare the chemist for all the situations which might be met in the research laboratories. The non-specialist is even more likely not to be conversant with most modern techniques and reagents.

Nevertheless, it is perfectly possible for both the non-specialist and the graduate student beginning research in organic chemistry to carry out such reactions with success, provided that the appropriate precautions are taken and the proper experimental protocol is observed.

Much of this is common sense, given a knowledge of the properties of the reagents being used, as most general techniques are relatively straightforward. However, it is often very difficult for the beginner or nonspecialist to find the appropriate information. At Salford, we found ourselves handing out to students beginning research in organic chemistry a compilation of what we hoped was useful information on the practical aspects of organic synthesis, based on the authors' recent associations with some of the top synthetic organic research laboratories. We have gathered this information together in this book, and expanded it to cover some other areas, in the hope that it will be an aid to the specialist and non-specialist alike. Of course most research groups will have their own modifications and requirements, but on the whole the basic principles will remain the same.

This book is intended to be a guide to carrying out the types of reactions which are widely used in modern organic synthesis, and is concerned with basic technique. It is not intended to be a comprehensive survey of reagents and methods, but the appendix does contain some information on commonly used reagents.

If we have achieved our aims, users of this book should be able to approach their synthetic tasks with confidence. Organic synthesis is both exciting and satisfying, and provides opportunity for real creativity. If our book helps anyone along this particular path then our efforts will have been worthwhile.

### CHAPTER 2

## Safety

### 2.1 Safety is your primary responsibility

Chemical laboratories are potentially dangerous workplaces and accidents in the laboratory can have serious and tragic consequences. However, if you are aware of potential hazards, and work with due care and attention to safety, the risk of accidents is small. Some general guidelines for safety in the laboratory are presented in this section. In addition to these principles you *must* be familiar with the safety regulations in force in your area and the rules and guidelines applied by the administrators of your laboratory.

Your supervisor has a responsibility to warn you of the dangers associated with your work, and you should always consult him/her, or a safety officer, if you are unsure about potential hazards. However, your own safety, and that of your colleagues in the lab, is largely determined by *your* work practices. Always work carefully, use your common sense, and abide by the safety regulations.

Some important general principles of safe practice are summarized in the following rules

- 1. Work carefully, do not take risks.
  - This covers basic rules such as always wearing safety spectacles, never working alone, and working neatly and unhurriedly.
- 2. Assess the possible hazards before carrying out a reaction.

  Find out about the dangers of handling unfamiliar chemicals or apparatus and take note of any necessary precautions.
- 3. Know the accident and emergency procedures.

4 SAFETY

It is vital to know what to do in case of an accident. This includes being familiar with the fire fighting and first aid equipment, and knowing how to get assistance from qualified personnel.

### 2.2 Safe working practice

It has been emphasized already that you should be familiar with the regulations and codes of practice pertaining in your laboratory. We will not discuss safety legislation here but some fundamental rules should be stressed. Never work alone in a laboratory. Always wear suitable safety spectacles and a cotton lab coat, and use other protection such as gloves, face masks, or safety shields if there is a particular hazard. Never eat, drink or smoke in a laboratory. Work at a safe, steady pace, and keep your bench and your lab clean and tidy. Familiarity breeds contempt; do not allow yourself to get careless with everyday dangers such as solvent flammability. Familiarize yourself with the location and operation of the safety equipment in your laboratory.

As regards specific hazards the chief rule is to carry out an assessment of the dangers involved before using an unfamiliar chemical or piece of apparatus. Some of the commonest hazards are described in the next section. Once you are aware of the possible dangers take all the necessary precautions, and ensure that you know what to do if an accident does occur.

Store your chemicals in clearly labelled containers, and abide by the regulations concerning storage of solvents and other hazardous materials. Dispose of waste chemicals safely, according to the approved procedures for your laboratory. Never pour organic compounds down the sink.

### 2.3 Common hazards

Always assess the risks involved *before* carrying out a reaction. Extensive compilations of information about the dangers posed by a large number of compounds are available (see Bibliography). Consult these references and your supervisor before using a compound or procedure which is new to you. In some areas safety legislation makes it mandatory to conduct such a safety audit, but even if it is not legally required, it should still be regarded as an essential preliminary before doing a reaction.