



# **Compendium of Organic Synthetic Methods**

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**and**

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**WILEY - INTERSCIENCE**

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# PREFACE

*Compendium of Organic Synthetic Methods* is a systematic listing of functional group transformations designed for use by bench chemists, persons planning syntheses, students attending courses on synthetic chemistry, and teachers of these courses. The idea for this compilation came from the observation that organic chemists spend a large proportion of their time searching a formidable original literature for these hard-to-find synthetic methods.

A key feature of this book is the classification of reactions on the basis of the functional group of the starting material and of the product, without reference to the reaction mechanism. We wished to produce as comprehensive a set of reactions as possible, covering all branches of organic chemistry. Reactions giving low yields or requiring exotic reagents are not omitted. Consequently reactions included cover the full range of methods from boiling in oil to treatment with fluorine or orange-peel enzymes.

The presentation of each synthetic method in the form of representative reactions without discussion follows the plan used successfully in *Steroid Reactions* (Djerassi, Holden-Day). The limitations of such compilations containing much information but few words are obvious; there is, however, a great need for a comprehensive one-volume listing of synthetic methods as an intermediary between the chemist and the literature. The reader interested in a detailed discussion of synthetic methods should consult *Reagents for Organic Synthesis* (Fieser and Fieser, Wiley) and *Survey of Organic Syntheses* (Buehler and Pearson, Wiley).

We apologize to authors for the space-saving anonymity of references and for referring in many instances not to papers by the originators of a reaction but rather to subsequent articles by other authors. We make no apology, however, for omitting unnecessary reference punctuation, and avoiding the use of *ibid.* and other sources of confusion.

Ian T. Harrison  
Shuyen Harrison

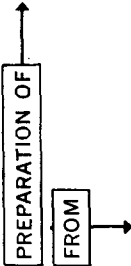
Palo Alto, California  
March 1971

# ABBREVIATIONS

Ac	acetyl
Bu	butyl
DCC	dicyclohexylcarbodiimide
DDQ	2,3-dichloro-5,6-dicyanobenzoquinone
DMA	dimethylacetamide
DMF	dimethylformamide
Et	ethyl
HMPA	hexamethylphosphoramide
Me	methyl
Ms	methanesulfonyl
NBA	<i>N</i> -bromoacetamide
NBS	<i>N</i> -bromosuccinimide
NCS	<i>N</i> -chlorosuccinimide
Ni	Raney nickel
Ph	phenyl
Pr	propyl
Pyr	pyridine
THF	tetrahydrofuran
THP	tetrahydropyranyl
Ts	<i>p</i> -toluenesulfonyl

# INDEX

Sections—heavy type  
Pages—light type



Acetylenes	Carboxylic acids, acid halides, anhydrides	Alcohols, phenols	Aldehydes	Alkyls, methylenes, aryls	Amides	Amines	Esters	Ethers, epoxides	Halides, sulfonates	Hydrides (RH)	Ketones	Nitriles	Olefins
1	16	31	46	61	76	91	106		136		166	181	196
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3	31	80	144	181	209	233	287	316	338	363	396	460	489
20	50	65	80						140	155	170	185	200
36	146	182	210						338	365	400	464	493
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13	68	122	172	202	229	266	307	328	356	377	442	476	526

PROTECTION

Sect. Pg.  
Carboxylic acids 30A 71  
Alcohols, phenols 45A 124  
Aldehydes 60A 174  
Amines 105A 266  
Ketones 180A 449

Blanks in the table  
correspond to sections  
for which no examples  
were found in the  
literature

# INTRODUCTION

**Classification and Organization.** *Compendium of Organic Synthetic Methods* contains approximately 3000 examples of published chemical transformations classified according to the reacting functional group of the starting material and the functional group formed. Those reactions that give products with the same functional group form a chapter. The reactions in each chapter are further classified into sections on the basis of the functional group of the starting material. Within each section reactions are listed in a somewhat arbitrary order although an effort has been made to put chain lengthening processes before degradations.

The classification is unaffected by allylic, vinylic, or acetylenic unsaturation, which appears in both starting material and product, or by increases or decreases in the length of carbon chains. For example, the reactions  $t\text{-BuOH} \rightarrow t\text{-BuCOOH}$ ,  $\text{PhCH}_2\text{OH} \rightarrow \text{PhCOOH}$ , and  $\text{PhCH}=\text{CHCH}_2\text{OH} \rightarrow \text{PhCH}=\text{CHCOOH}$  are all found in Section 18 on carboxylic acids from alcohols.

The terms hydrides, alkyls, and aryls classify compounds containing reacting hydrogens, alkyl groups, and aryl groups, respectively; for example,  $\text{RCH}_2\text{H} \rightarrow \text{RCH}_2\text{COOH}$  (carboxylic acids from hydrides),  $\text{RMe} \rightarrow \text{RCOOH}$  (carboxylic acids from alkyls),  $\text{RPh} \rightarrow \text{RCOOH}$  (carboxylic acids from aryls). Note the distinction between  $\text{R}_2\text{CO} \rightarrow \text{R}_2\text{CH}_2$  (methylenes from ketones) and  $\text{RCOR}' \rightarrow \text{RH}$  (hydrides from ketones).

The following examples illustrate the application of the classification scheme to some potentially confusing cases:

$\text{RCH}=\text{CHCOOH} \rightarrow \text{RCH}=\text{CH}_2$	(hydrides from carboxylic acids)
$\text{RCH}=\text{CH}_2 \rightarrow \text{RCH}=\text{CHCOOH}$	(carboxylic acids from hydrides)
$\text{ArH} \rightarrow \text{ArCOOH}$	(carboxylic acids from hydrides)
$\text{ArH} \rightarrow \text{ArOAc}$	(esters from hydrides)
$\text{RCHO} \rightarrow \text{RH}$	(hydrides from aldehydes)
$\text{RCH}=\text{CHCHO} \rightarrow \text{RCH}=\text{CH}_2$	(hydrides from aldehydes)
$\text{RCHO} \rightarrow \text{RCH}_3$	(alkyls from aldehydes)
$\text{R}_2\text{CH}_2 \rightarrow \text{R}_2\text{CO}$	(ketones from methylenes)
$\text{RCH}_2\text{COR} \rightarrow \text{R}_2\text{CHCOR}$	(ketones from ketones)
$\text{RCH}=\text{CH}_2 \rightarrow \text{RCH}_2\text{CH}_3$	(alkyls from olefins)
$\text{RBr} + \text{RC}\equiv\text{CH} \rightarrow \text{RC}\equiv\text{CR}$	(acetylenes from halides, also acetylenes from acetylenes)

## INTRODUCTION



(esters from alcohols, also esters from carboxylic acids)

Sulfonic esters are grouped with halides. Hydrazines are listed with amines and hydrazides with amides.

Yields quoted are overall with allowance for percentage of conversion, impurities, etc. and therefore often differ from the values given in the original paper.

Trivial reactions not described in the given references but required to complete a sequence are indicated by a dashed arrow.

**How to Use the Book.** Examples of the preparation of one functional group from another are located via the index on p. xi, which gives the corresponding section and page. Thus Section 1 contains examples of the preparation of acetylenes from other acetylenes; Section 2, acetylenes from carboxylic acids; Section 3, acetylenes from alcohols; etc.

Sections giving examples of the reactions of a functional group are found in horizontal rows of the index. Thus Section 1 gives examples of the reactions of acetylenes forming other acetylenes; Section 16, reactions of acetylenes forming carboxylic acids; Section 31, reactions of acetylenes forming alcohols; etc.

Examples of alkylation, dealkylation, homologation, isomerization, transposition, etc. are found in Sections 1, 17, 33, and so forth, which lie close to a diagonal of the index. These sections correspond to the preparation of acetylenes from acetylenes, carboxylic acids from carboxylic acids, alcohols and phenols from alcohols and phenols, etc.

Examples of the protection of carboxylic acids, alcohols, phenols, aldehydes, amines, and ketones are also indexed on page xi.

Examples of name reactions can be found by first considering the nature of the starting material and product. The Wittig reaction, for example, is to be found in Section 199 on olefins from aldehydes and Section 207 on olefins from ketones.

The pairs of functional groups, alcohol-ester, carboxylic acid-ester, amine-amide, carboxylic acid-amide, can be interconverted by quite trivial reactions. When a member of these groups is the desired product or starting material, the other member should of course also be consulted in the text.

The original literature must be used to determine the generality of reactions. A reaction given in this book for a primary aliphatic substrate may in fact also be applicable to tertiary or aromatic compounds.

The references given usually yield a further crop of references to previous work. Subsequent publications can be found through Science Citation Index.

**Reactions Included in the Book.** Interconversions of monofunctional compounds form the major part of this compilation. Reactions of bifunctional compounds in which the two functions are identical and which give monofunctional



## INTRODUCTION

products are also included; for example,  $R_2C(COOH)_2 \rightarrow R_2CO$  (ketones from carboxylic acids).

Examples of the removal of one functional group from bifunctional compounds and the preparation of functional groups from groups not listed on the index are included in the miscellaneous sections; for example,  $RCH(Br)COR \rightarrow RCH_2COR$ ,  $RCH(OH)COR \rightarrow RCH_2COR$  and  $RCH=CHCOR \rightarrow RCH_2CH_2COR$  (ketones from miscellaneous compounds),  $RCH_2NO_2 \rightarrow RCHO$  (aldehydes from miscellaneous compounds).

Reactions are included even when full experimental details are lacking from the given reference. In some cases the quoted reaction is a minor part of a paper or may have been investigated from a purely mechanistic aspect. When several references are given, the first refers to the reaction illustrated; others give further examples, related reactions, or reviews.

**Reactions Not Included in the Book.** Reactions forming bifunctional products are not included, for example,  $RCH=CH_2 \rightarrow RCH(OH)CH_2OH$ . Chain lengthening processes via unsaturated intermediates, for instance,  $RCHO \rightarrow [RCH=CHCOOEt] \rightarrow RCH_2CH_2COOEt$ , are only partially covered. Ring forming reactions and reactions that involve several functional centers (e.g., the Diels-Alder reaction) are represented by very few examples. These gaps will be filled by a second volume, presently under consideration, which will include reactions forming unsaturated and other bifunctional products.

Reactions published after early 1971 are not included.

# **Compendium of Organic Synthetic Methods**

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# Chapter 1 PREPARATION OF ACETYLENES

## Section 1 Acetylenes from Acetylenes

Alkylation of acetylenes . . . . .	page 1-2
Isomerization of acetylenes . . . . .	2

Review: The Synthesis of Acetylenes

Org React (1949) 5 1



Bull Soc Chim Fr (1964) 2000

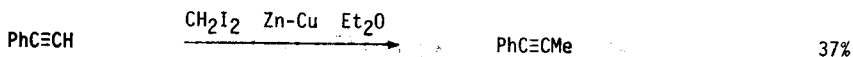


JACS (1936) 58 796  
JOC (1959) 24 840



Bull Soc Chim Fr (1965) 1525

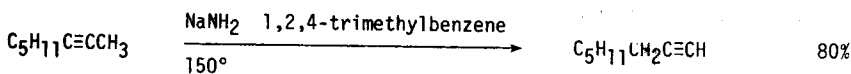
Further examples of the reaction  $RC\equiv CH + R'X \rightarrow RC\equiv CR'$  are included in section 10 (Acetylenes from Halides, Sulfonates and Sulfates)



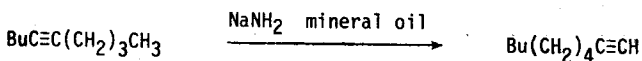
Bull Soc Chim Fr (1965) 1525  
Tetrahedron (1958) 3 197



JACS (1951) 73 1415  
Quart Rev (1970) 24 585

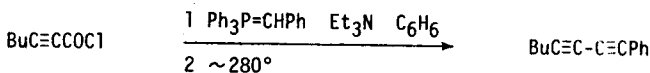


Org React (1949) 5 1

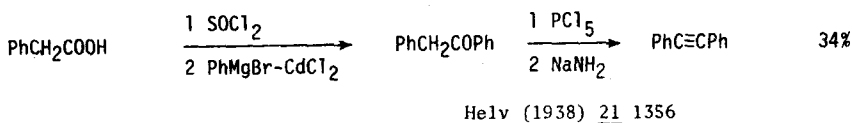
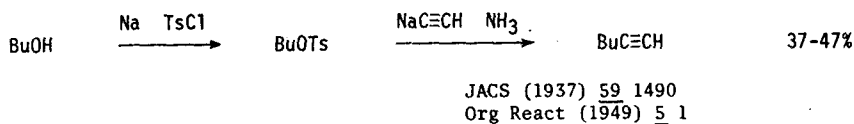
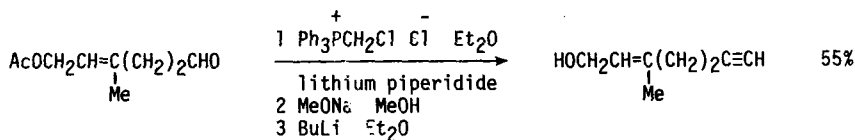
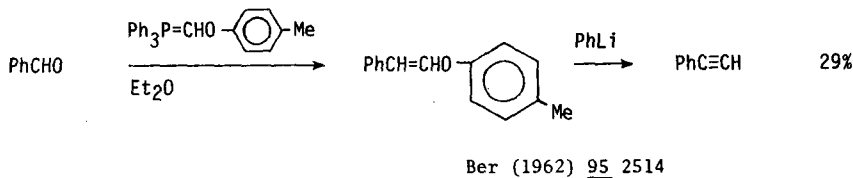


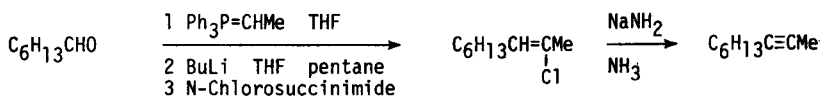
Org React (1949) 5 1

## Section 2 Acetylenes from Carboxylic Acids and Acid Halides

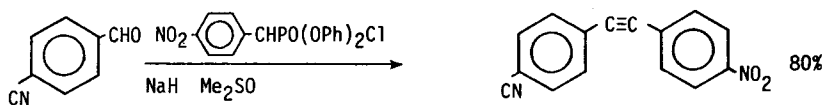
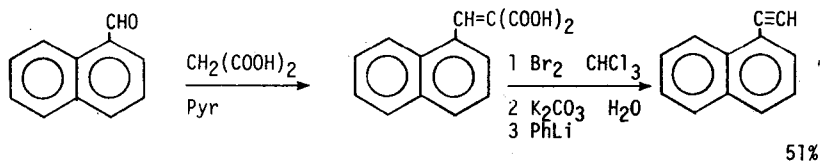
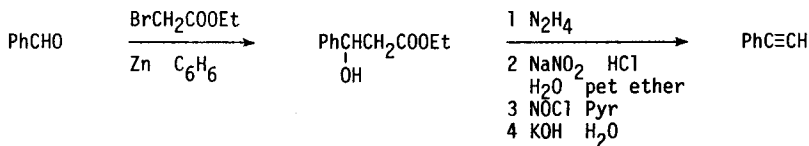


JCS (1964) 543

Section 3 Acetylenes from AlcoholsSection 4 Acetylenes from AldehydesJACS (1969) 91 4318



Tetr Lett (1970) 447

JACS (1965) 87 2777Compt Rend (1949) 229 660JACS (1951) 73 4199

## SECTION 7

## ACETYLENES FROM AMINES

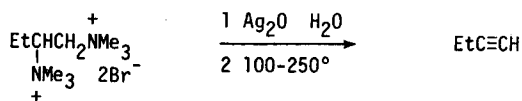
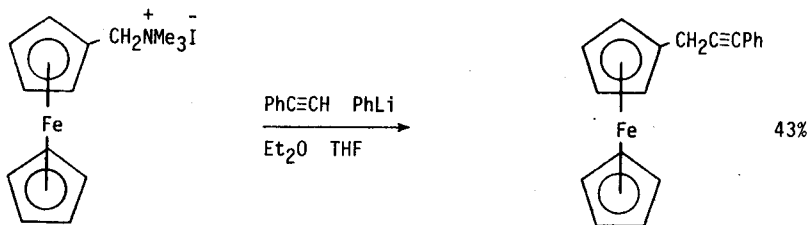
5

Section 5 Acetylenes from Alkyls, Methylenes and Aryls

No examples

Section 6 Acetylenes from Amides

No examples

Section 7 Acetylenes from AminesJACS (1939) 61 1943

JCS (1963) 2990



