



# Science of Synthesis

Knowledge Updates – Editorial Guidelines

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## Preface

### *Science of Synthesis*

*Science of Synthesis, Houben–Weyl Methods of Molecular Transformations* was launched in 2000 and was edited by D. Bellus (Basel, Switzerland), E. N. Jacobsen (Cambridge, USA), S. V. Ley (Cambridge, UK), R. Noyori (Nagoya, Japan), M. Regitz (Kaiserslautern, Germany), P. J. Reider (Princeton, USA), E. Schaumann (Clausthal-Zellerfeld, Germany), I. Shinkai (Tokyo, Japan), E. J. Thomas (Manchester, UK), and B. M. Trost (Stanford, USA). *Science of Synthesis* is a balanced and critical reference work produced by the collaborative efforts of chemists, from both industry and academia, selected by the Editorial Board. All published results from journals, books, and patent literature from the early 1800s until the year of publication are considered by the authors, who are among the leading experts in their field, to provide chemists with the most reliable methods to solve their synthesis problems.

*Science of Synthesis* is organized in a logical hierarchical system based on the target molecule to be synthesized. The critical coverage of methods is supported by information intended to help the user choose the most suitable method for their application, thus providing a strong foundation from which to develop a successful synthetic route. Within each category of product, illuminating background information such as history, nomenclature, structure, stability, reactivity, properties, safety, and environmental aspects are discussed along with a detailed selection of reliable methods. Each method and variation is accompanied by reaction schemes, tables of examples, experimental procedures, and a background discussion of mechanistic rationale, stereochemistry, scope of the reaction described and its limitations, and functional group compatibility. In a format consisting of 48 volumes, *Science of Synthesis* is a unique reference work, selecting and evaluating all synthetic methodology and thus providing more than just a compound database or an indiscriminate review of the literature.

To best meet the needs of the scientific community, *Science of Synthesis* is published as an electronic version and also in print.

### *Science of Synthesis Knowledge Updates*

From 2010 onwards, the organic chemistry reference series *Science of Synthesis* is being continuously updated with high-quality content using clearly defined criteria for method selection as well as established editorial processes. The Editorial Board, in conjunction with selected volume editors and authors, are reviewing the whole field of synthetic organic chemistry as presented in *Science of Synthesis* and are evaluating significant developments in synthetic methodology.

The series is edited by E. M. Carreira (Zurich, Switzerland), C. P. Decicco (Princeton, USA), A. Fürstner (Mülheim, Germany), G. A. Molander (Philadelphia, USA), P. J. Reider (Princeton, USA), E. Schaumann (Clausthal-Zellerfeld, Germany), M. Shibasaki (Tokyo, Japan), E. J. Thomas (Manchester, UK), and B. M. Trost (Stanford, USA).

A list of strict criteria for method selection guides the updating process in order to guarantee that only the best and most reliable synthetic methods are included in *Science of Synthesis*. Authors involved in the updating process add new methods and add new (or completely revise existing) product (sub)classes.

The updating procedure is continuous and new content will be added to the electronic version in four releases per year. *Science of Synthesis* continues to be the most up-to-date

evaluated electronic reference work available, emphasizing the most significant developments in synthetic methodology.

*Science of Synthesis* gives convenient access to a century of synthetic organic chemistry starting with the first volume of *Houben–Weyl* published in 1909 right through to groundbreaking methodology added immediately upon validation by experts. The electronic version's intuitive interface will adapt in keeping with the latest technological developments and will enable chemists worldwide in both academia and industry to solve complex synthetic problems.

### ***Science of Synthesis* Reference Library**

The organic chemistry reference series *Science of Synthesis* is complemented by a variety of organic synthesis specialist topic reference works which constitute the *Science of Synthesis* Reference Library. A modular approach is used to build the reference library using six main classifications: (1) Classical, (2) Advances, (3) Transformations, (4) Applications, (5) Structures, and (6) Techniques.

*Science of Synthesis* is organized by product topology (1D). The *Science of Synthesis* Reference Library is designed so that where possible it incorporates reaction type. This additional content is complementary to the existing scaffold of core synthetic methodology available and provides a “2D” approach in terms of product design.

The *Science of Synthesis* Reference Library is being developed in collaboration with members of the *Science of Synthesis* Editorial Board who are helping with the identification and selection of topics as well as providing guidance in relation to the scientific content and format of presentation of the product. World renowned experts are chosen to author the contributions. The high editorial quality standards associated with *Science of Synthesis* are maintained and the product is made available in both print and online formats.

The Publisher

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## 1 **Science of Synthesis: Knowledge Updates**

### 1.1 **Concept**

*Science of Synthesis* is a reference work with the largest collection of evaluated methods in organic synthesis worldwide. Its elegant, didactic presentation of synthetic methodology means it is a “must-have” treatise for organic chemistry students, lecturers, and researchers. This vast amount of useful organic synthetic information, which has been evaluated by leading world experts, is available both in print and online formats. The print volumes are of outstanding editorial quality and this has been both recognized and praised internationally by chemistry experts. The online version of *Science of Synthesis* also enables text, structure, substructure, and reaction searching via a simple interface with powerful functionality. Continual updating of the electronic version means that the content of *Science of Synthesis* remains pertinent and relevant to the synthetic organic chemist’s needs. Also, supplementing current content with special topics (e.g., catalytic stereoselective synthesis, peptides, etc.) acknowledges the broad spectrum of organic chemistry today and the need for chemists to appreciate many different peripheral scientific fields in addition to the core subject area.

- As of 2010 *Science of Synthesis: Knowledge Updates* have been published on a regular basis. Three types of update are available:
  1. revised product classes/subclasses, i.e. complete revision of entire contributions;
  2. addition of product classes/subclasses, i.e. the addition of entirely new contributions;
  3. addition of new or updated methods to product classes/subclasses, i.e. supplementary material.

The response to the publication of *Science of Synthesis* has been extremely positive and many of the most prestigious universities as well as the major chemical and pharmaceutical firms in the USA, Japan, Europe, and the rest of the world are now regularly accessing valued organic transformation data via this platform. Please see some of the comments and opinions on the project listed below:

“*Science of Synthesis* and *Houben–Weyl* are extremely important and useful review sources for synthetic chemists. Unlike most databases, they provide an overview of the synthetic literature and evaluate specific reactions and methods used for a variety of purposes. Any strong organic synthesis collection would be enhanced by this resource. [...] If funds can be spared in these times of troubled budgets, *Science of Synthesis* is an excellent investment.”

Judith N. Currano, Head of Chemistry Library,  
University of Pennsylvania, Philadelphia, Pennsylvania,  
*Issues in Science & Technology Librarianship*, No. 51, 2007.

#### **Compounds of Group 15 (As, Sb, Bi) and Silicon Compounds (Vol. 4, Ley/Fleming)**

“... a more comprehensive and thorough library reference work would be hard to find. Overall this is an admirable beginning to the editors’ aim to produce the definitive synthetic guide for practising organic chemists, and is a tribute to the remarkable breadth of knowledge and organisational skills of the volume editor, Ian Fleming.”

Susan Armstrong, University of Glasgow, UK

“At the outset, I said that it was an impressive volume that also commands an impressive list price. Let me now add, it is worth every cent of that price. To a practising synthetic silicon chemist this is a ‘must-have’ volume. It will become the definitive text against which all subsequent efforts will be judged. To the authors and editor goes a note of resounding thanks for a colossal achievement on a scale that this field has been waiting to see for some time.”

Janis G. Matisons, Flinders University, Australia

#### **Compounds of Group 14 (Ge, Sn, Pb) (Vol. 5, Thomas/Moloney)**

“The book is very well produced and its organization and clarity of presentation makes it a pleasure to use. This volume, and others in the series, would be of undoubted use in any library used by organic and organometallic chemists but research students may well favour the electronic version.”

P.D. Lickiss, Imperial College London, UK

#### **Fused Five-Membered Heteroarenes with One Heteroatom (Vol. 10, Thomas)**

“In summary, Volume 10 in the *Science of Synthesis* series provides a treasured database with a level of organization that will make a welcome addition to the field. It will be indispensable to any serious modern practitioner of chemical synthesis in industrial and academic institutions in the varied disciplines of chemical sciences. The tome should be invaluable to discovery, medicinal, and process chemists alike, providing a wealth of information and data in conveniently accessed form.”

Erick M. Carreira, Zürich, Switzerland



**Six-Membered Hetarenes with One Chalcogen (Vol. 14, Thomas)**

“While, by the Volume Editor’s own admission, *Science of Synthesis* is not intended to be comprehensive, this volume shares, with all its predecessors in this series, the broad subject coverage, high level of critical assessment, exhaustive referencing and inclusion of illustrative reaction protocols which will make the complete work (if the term ‘complete’ can ever be applied to such an immense project) a truly unique production in the area of organic chemistry. Each volume deservedly becomes an essential institutional reference work from the day that it is published.”

*Laurence Harwood, Reading University, UK*

**Six-Membered Hetarenes with One Nitrogen or Phosphorus Atom (Vol. 15, Regitz/Black)**

“Overall, this attractively produced volume provides a unique and authoritative survey of a vast amount of literature. It will be a real help to chemists requiring the synthesis of heterocycles.”

*Peter B. Wyatt, University of London, UK*

**Ketones (Vol. 26, Thomas/Cossy)**

“Volume 26 of *Science of Synthesis* offers a comprehensive, thorough, and critical treatment of the most important synthetic accesses to the ketone functionality and an up-to-date review of the synthetic literature in this field ... Together with the logical structure and the ample keyword index, all the ingredients are set for a first-line reference work which, as the other volumes of the series, should sit on the library shelves of any major research organisation. With an amazing act of balance, the authors and editors have also managed to produce a highly enjoyable didactic reading, which offers the chance to students, academics, and professionals alike to simply open at any page, sit back, and enjoy the ever-fascinating ticking of the synthesis clockwork.”

*Simona M. Ceccarelli, F. Hoffmann La Roche Ltd., Basel, Switzerland*

**Heteroatom Analogues of Aldehydes and Ketones (Vol. 27, Bellus/Padwa)**

“There is a massive amount of information in this volume, but its logical organization and thorough index make it readily accessible. The editor and contributing authors are to be congratulated for producing this valuable resource. It should be an automatic addition to the library of any institution in which synthetic organic chemistry is pursued.”

*F. G. West, University of Alberta, Canada*

## 1.2 Process

- The **title, subject, and scope** of the assigned contribution are to be clarified with the responsible volume editor.
- **Table of Contents.** In order to minimize overlap and duplication of information within the contributions please submit a table of contents to the responsible volume editor with a copy to the Editorial Office (an e-mail is sufficient: science-of-synthesis@thieme.de).
- **Coverage.** The aim of *Science of Synthesis* is to provide the readers with a critical review of the methodology chosen and to present the contribution in an informative and readable style.
  - Authors should not exceed the number of pages agreed upon in the Contributing Author's Agreement and should try to be as concise as possible in their coverage of a particular subject area. However, should an amendment to the number of pages agreed upon be unavoidable because significant new results are available then the responsible volume editor must be informed immediately. A decision can then be made between the volume editor and Publishing House about the best way to proceed.
  - Access to the electronic version of *Science of Synthesis* can also be provided during the period of writing to assist with decisions regarding content and style.
- **Language.** All parts of *Science of Synthesis* will be written in American English. All parts of the manuscript should be written in the *present* or *relevant* tense, except for the *experimental procedures*, which should be written in the *past tense*. For further details on the style of the manuscripts please see Section 3.3.2.
- **Sample Contributions.** Two sample contributions will be sent to all authors to help as a guide regarding the styles and conventions used in *Science of Synthesis*. Any queries with regard to these sample contributions should be addressed to the volume editor.

## 1.3 Selection Criteria

- *Science of Synthesis* is exclusively oriented toward synthesis and the selection of the best and most reliable synthetic procedures. All synthetic methodology reported should be checked for the synthetic importance of the synthesized compound, the ease of execution, the yield of reaction, the cost of the reaction, green issues, and also whether there are easier methods available for the synthesis of a certain compound.
- A reaction can be of high mechanistic and theoretical interest, but this is not a sufficient criterion for inclusion in *Science of Synthesis*.
- A synthetic method may be very interesting from the point of view of the mechanism, but if there is an easier and less expensive alternative then only this will be reported. The interesting alternative may or may not be mentioned.
- Authors are encouraged to report synthetic methods which would typically have been successfully applied to six different compounds with good yields. Methods that have only been reported for two or three compounds with varying yields need to be further evaluated.
- For all methods, references to the pertinent literature should be given. Important references to a particular procedure should also be given and reference to other tertiary reference works should be avoided.

## 1.4 Requirements for Final Manuscript Submission

The final manuscript as approved by the volume editor should be submitted to the Editorial Office by e-mail to: science-of-synthesis@thieme.de.

The manuscript should take the following format:

### 1.4.1 Text Folder

This folder should contain a word processor file (preferably MS Word) of the manuscript. The structure of a typical manuscript is illustrated here, however, it may be that only a subsection is required, i.e. a product subclass, for the purpose of the updates.

- Title Page
- Table of Contents
- *Product Class/es:*
  - Introductory Text
    - Background Information (e.g., history, nomenclature, applications)
    - Structure
    - Stability
    - Reactivity
    - Physical Properties
    - Spectroscopic Properties
    - Safety and Environmental Aspects
- *Product Subclass/es:*
  - Introductory Text
    - Background Information (e.g., history)
    - Comparison of Methods
    - Mechanistic Rationale
    - Stereochemistry
    - Scope
    - Limitations and Problems
    - Functional-Group Compatibility
    - Safety and Environmental Aspects
- *Method/s:*
  - Introductory Text
    - Background Information (e.g., history)
    - Mechanistic Rationale
    - Stereochemistry
    - Scope
    - Limitations and Problems
    - Functional-Group Compatibility
    - Discussion of variations on method
  - Scheme/s
  - Table of Examples
  - Experimental Procedure/s (past tense and labeled as General or Typical if necessary)
  - Safety and Environmental Aspects

Not all structures in schemes need to have a compound number. Only products of experimental procedures must have a compound number. All compound numbers should be referred to somewhere in the text. Where the full name of a compound is given, the number should appear in bold and in parentheses [e.g., (S)-butan-2-ol (**23**)]. If the full name is not given, then the number simply appears in bold with no parentheses (e.g., alcohol **23**).

Abbreviations should not be used in the running text (e.g., CO should read carbon monoxide). Abbreviations should only be used in the experimental sections (and in schemes and tables).

Schemes and figures should not be electronically embedded in the text. They should be indicated in the text using Arabic numerals as follows:

<Scheme 1> Scheme Title<sup>[ref]</sup>

<Figure 1> Figure Title<sup>[ref]</sup>

Scheme: A graphic containing chemical structures (not only chemical reactions).

Figure: A graphic containing pictorial information such as chemical apparatus or an NMR spectrum (these are found very seldom in *Science of Synthesis*).

References should be placed collectively at the end of the text and should be numbered consecutively within chapters, with no subdivisions such as <sup>[3a]</sup>, <sup>[3b]</sup>, <sup>[3c]</sup>, etc. Each reference number should contain only one citation.

For further guidelines on the presentation and format of references please see Section 3 (Manuscript Preparation).

#### 1.4.2 Graphics Folder

This folder should have multiple chemical drawing files (preferably ChemDraw) which contain figures and schemes that are to be inserted into the body of the text. For details on the appearance of figures and schemes as well as the *Science of Synthesis* ChemDraw settings please see Section 3 (Manuscript Preparation).

If necessary please contact the Editorial Office ([science-of-synthesis@thieme.de](mailto:science-of-synthesis@thieme.de)) for a copy of the *Science of Synthesis* ChemDraw template.

#### 1.5 Cross-Referencing *Science of Synthesis*

The format for citing a contribution from another volume of *Science of Synthesis* is:

*Science of Synthesis*, Vol. X [Volume Title (Section Y)]

*Example:*

For further information, see *Science of Synthesis*, Vol. 48 [Alkanes (Section 48.2.1)].

For cross-referencing sections within the same volume of *Science of Synthesis*, it is sufficient to give the section number, e.g. see Section 11.22.1.

## 2 People

### 2.1 Roles of the Participants

#### 2.1.1 The Editorial Board

The tasks of the members of the Editorial Board include:

- consulting duties and strategic planning;
- preparation of a complete concept for the update of the *Science of Synthesis* project;
- approval of the basic concept for the update of the *Science of Synthesis* project;
- participation at the Editorial Board Meetings organized by the publisher;
- monitoring the volumes for which they are responsible;
- determining which subject areas are of highest priority for updating within assigned volumes;
- the recruitment of volume editors for the individual volumes;
- participation at the review panel (as part of the Editorial Board Meeting) and determining which subject areas need to be prioritized for updating;
- assisting the publisher in marketing and promotion activities.

#### 2.1.2 The Volume Editor

The tasks of the volume editors include:

- making an annual assessment of each of the contributions in their volume and determining the type of update required according to the following criteria:
  1. identified gaps in the content
  2. paradigm change in the chemistry concerned
  3. validated requests from *Science of Synthesis* users or readers
  4. poor quality of existing contribution
  5. publication year of the original product class or subclass
- submitting the volume assessment to the responsible member of the Editorial Board;
- the recruitment of authors (contributing authors) for the individual articles;
- incorporating the individual contributions into the volume in cooperation with the Editorial Office and as described in the Editorial Guidelines;
- coordination and monitoring of the deadlines;
- the monitoring of the manuscripts, illustrations, and artwork received, in particular for their suitability, scientific content, completeness, and conformance to the publisher's guidelines and the requirements of the contract;
- indicating any necessary changes, additions, or abridgments of the manuscripts, illustrations, and artwork, if the contributing authors are not willing or able to do so;
- giving the Imprimatur for each part of the volume;
- informing the publisher regularly (at least quarterly, and also at any time at the publisher's request) comprehensively about the status of the volume/contributions.

#### 2.1.3 The Author

The tasks of the authors include:

- adhering to the specifications contained in the Editorial Guidelines. The contributing author shall furthermore take into consideration the recommendations and ideas of the volume editors and of the publisher with regard to editorial, stylistic, and professional aspects;

- writing the contribution in such a way that it corresponds to the latest state of facts or knowledge and/or state of scientific discussions of the field or subject dealt with;
- meeting all deadlines set. The deadlines set for each of the contributions will depend on the size of the manuscript and might span three to nine months;
- providing copies of texts and/or illustrations by third parties, which may be required for the completion and/or illustration of the contribution, provided that they do not have to be supplied by the editors;
- providing clear and correct representations of formulas, reaction equations, and reaction schemes in electronic form. The publisher will advise the contributing author concerning the optimal form of presentation. The publisher is authorized to rework the artwork (graphics) in order to improve the presentation or to make it consistent with the overall style of the work;
- carrying out their duties in good cooperation with potential coauthors of the contribution and additional authors of *Science of Synthesis* as well as in close contact with the volume editors and the publisher and, at request, informing the volume editors and the publisher at any time about the status of the contribution;
- giving the Imprimatur for their contribution.

#### 2.1.4 **The Editorial Office**

The tasks of the Editorial Office include:

- assisting the volume editor during the volume planning process;
- providing monthly status reports on the progress of the volume to the volume editor;
- sending an author's agreement to the author at the volume editor's request;
- setting publication dates and targets;
- coordinating and monitoring deadlines;
- copyediting the revised draft manuscript according to *Science of Synthesis* house style;
- sending copies of the page proofs to the volume editor and author;
- proofreading the page proofs and making any necessary corrections (including those indicated by the volume editor and author);
- preparing and checking the covers, title pages (indexes if necessary), and other aspects of the final published contribution and/or volume.

**2.2 The Participants****2.2.1 The Editorial Board of *Science of Synthesis*: Knowledge Updates****Prof. Erick M. Carreira**

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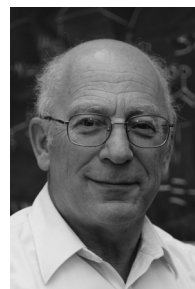
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- 2.2.2 The Original Volume Editors of *Science of Synthesis***
- Volume 1 Compounds with Transition Metal–Carbon  $\pi$ -Bonds and Compounds of Groups 10–8 (Ni, Pd, Pt, Co, Rh, Ir, Fe, Ru, Os)**  
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Authors are encouraged to write the introductory texts to the different parts of their manuscripts in the style of a review. These parts should give a general introduction which will help readers to appreciate and understand details of the later-described methods and variations. However, all other parts of the manuscript have a strictly modular organization and should include only information of interest for the given section.

### 3.3 Guidelines for Text

#### 3.3.1 Format of Text

Authors must produce their text with word processors. Authors are asked to use the document template (file: scisynth.dot) that will be provided by the Editorial Office (see Section 3.9). Updated versions of the document template can be found under [www.science-of-synthesis.com](http://www.science-of-synthesis.com). Additional macros or word processor programming must not be used. The text should be typed with 1.5 times spacing (at least 5 mm between lines) in all parts of the manuscript (including references, notes, scheme captions, and tables) and wide margins (ca. 2 cm at top, bottom, left- and right-hand side of each page). We recommend ca. 75 characters per line in a large proportional script (e.g., 12 point Times New Roman). Underlining, indentations, and block capitals should be avoided. Boldface and italic fonts should be used according to the instructions [e.g., amine 6; *J. Org. Chem.*, (1973) 38, 3438]. References, schemes, and figures (in this order) should be included at the end of the manuscript. Tables should be included in the appropriate position in the body of the text. All pages including author's address, contents, text, references, and tables must be numbered consecutively. Tables, schemes, and figures should be numbered with Arabic numbers, not Roman numerals.

#### 3.3.2 Style of the Manuscripts

- Use American spelling according to *Webster's Dictionary* [Merriam-Webster: Springfield, MA, (1990)].
- For style of the manuscripts the ACS Style Guide [*The ACS Style Guide*, 2nd ed.; Dodd, J.S., Ed.; American Chemical Society: Washington D. C., (1997)] should be consulted.
- Authors should indicate trademarks and registered trademarks by capitalization of the first letter.
- All parts of the manuscript should be written in the **present** or **relevant** tense, except for the **experimental procedures**, which should be written in the **past** tense.

#### 3.3.3 Nomenclature

In *Science of Synthesis*, systematic names will be given only to selected examples. "Correct" nomenclature should be used, **based on the rules of IUPAC** [see: *A Guide to IUPAC Nomenclature of Organic Compounds: Recommendations 1993*, Blackwell Scientific: Oxford, (1993)]. Whilst the IUPAC system is preferred whenever possible, names based on the systematic rules adopted by *Chemical Abstracts* (Appendix IV of the current *Chemical Abstracts Index Guide*) will be accepted if necessary, on the understanding that they will in most cases be converted by the editorial office into the appropriate IUPAC-approved form. **Do not use a mixture of both systems**, either within the same name or anywhere within the manuscript. An exception is the naming of ring systems, whose names and numberings should be taken or derived from the *Ring Systems Handbook* [American Chemical Society: Columbus OH, (1988) and supplements]. For biochemical nomenclature see: *Compendium of Biochemical and Related Documents*, Portland: London, (1992). Nomenclature for inorganic compounds is provided by the corresponding IUPAC rules [*Nomenclature of Inorganic Chemistry*,

1970, Butterworths: London, (1971), and *Recommendations*, 1990, Blackwell Scientific: Oxford, (1990)]. In order to facilitate the construction of IUPAC- or CAS-approved names, authors are advised to use a dedicated software program such as ACD/Name (Advanced Chemistry Development Inc., Toronto; [http://www.acdlabs.com/products/name\\_lab/name/](http://www.acdlabs.com/products/name_lab/name/)), which is utilized by our Editorial Office. Names of common reagents and solvents are to be retained, e.g. diethyl ether. Trivial names should be avoided unless they offer a distinct advantage over the corresponding systematic name or unless used by prior agreement with the volume editor and the editorial office. For classes of complex natural compounds, such as carbohydrates, peptides, or steroids, the most common name should be given. Compounds which are not named or have long names should be referred to unambiguously as “amine 2” or “thioester 14”. In matters of style, i.e. which words or prefixes are hyphenated, italicized, capitalized, etc., consult the ACS Style Guide [*The ACS Style Guide*, 2nd ed.; Dodd, J. S., Ed.; American Chemical Society: Washington D. C., (1997)].

### 3.3.4 Units

- For pressure, Torr, atm, or Pa are to be used [note: 1013.25 mbar = 760 Torr = 101 325 Pa = 14.696 psi].
- For temperature, use °C. For very low temperatures, K is also acceptable.
- Metric units (SI) should be used in all other cases, although the unit kcal will also be accepted.

### 3.3.5 Abbreviations

- Abbreviations and simple chemical formulas (e.g., CH<sub>2</sub>Cl<sub>2</sub>) should be used in tables, schemes, and experimental procedures.
- Do **not** use abbreviations in titles or the discussion text.
- Common abbreviations used in *Science of Synthesis* are given in tables to be found in the Appendix.

### 3.3.6 Experimental Procedures

- Experimental procedures should follow the style of the Thieme journal SYNTHESIS.
- The experimental procedure itself is entitled with the product, or general classification of the product name, followed by the compound number.
- All experimental procedures should be classified as one of the following:
  - (1) General Procedure: A generalized version of a widely applicable experimental procedure.
  - (2) Typical Procedure: A specific example of a widely applicable experimental procedure.
  - (3) Single Procedure: Single procedures are not to be labeled as such but are defined as follows: A specific experimental procedure for a single compound which is not applicable to similar compounds or for which the scope has not been studied.

As the criteria used to assess experimental procedures include range of applicability, the majority of procedures will be Typical or General Procedures; nontypical procedures for individual examples are restricted to unique methods that are particularly useful for the synthesis of one synthetically important compound or intermediate.

- All titles of experimental procedures should have a reference citation.
- The author should indicate aspects of the procedure which are particularly critical to success, including any new observations on or adaptations of older literature methods.



- Available details of workup should be included.
- Authors are encouraged to specifically discuss if a described method has proven to be useful for solid-phase reactions.
- Physical or spectroscopic data should be given only to a very limited extent. Authors should choose **significant** spectroscopic data (e.g., shifts of important NMR signals) of the products. These data should help chemists to repeat the procedures and identify the products.
- The solidus (forward slash) is to be used for (1) surfaces, e.g. Pd/C; (2) alloys and amalgams, e.g. 5% Na/Hg, Na/K (1:1); (3) solvent mixtures, e.g. EtOH/MeOH (95:5); (4) reagent concentrations, e.g. 2% HCl/H<sub>2</sub>O; (5) single reagents, e.g. Li/NH<sub>3</sub>.
- Write procedures in the **past tense** and include the mass, number of moles, volume, etc., in brackets **after** the name of the substances or solvents.
- Avoid starting sentences with numbers, wherever possible.

### 3.3.6.1 Example Experimental Procedure

Tributyl[(2R)-3-(methoxymethoxy)-2-methylpropyl]stannane (4); Typical Procedure:<sup>[25]</sup>

**CAUTION:** Technical grade chloromethyl methyl ether is classified as a human carcinogen, and is an eye and respiratory tract irritant.

A soln of crude 3 (7.3 g, from 15 mmol of 2) in THF (40 mL) was cooled in an ice bath and NaOH (1.5 g, 37 mmol) in H<sub>2</sub>O (8 mL) was added, followed by dropwise addition of 30% H<sub>2</sub>O<sub>2</sub> (5 mL, 50 mmol). The mixture was kept at 0 °C for 1 h, and then at 25 °C for 6 h, during which time a pasty, colorless precipitate formed. The mixture was treated with Et<sub>2</sub>O (50 mL) and filtered. The aqueous phase was separated and extracted with Et<sub>2</sub>O (3 × 30 mL) and the combined organic phase was dried (MgSO<sub>4</sub>) and concentrated. The gel-like residue was flash chromatographed [silica gel, petroleum ether (bp 30–40 °C)/Et<sub>2</sub>O 9:1] to give the labile intermediate; yield: 3.98 g (76%); this was reacted further without characterization. To a soln of the intermediate (3.6 g, 10 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (10 mL) was added iPr<sub>2</sub>NEt (1.2 g, 10 mmol), followed by MOMCl (0.89 g, 11 mmol). The mixture was stirred for 1 h at 0 °C and 15 h at 25 °C, and then concentrated. The resultant residue was treated with ice-cold 2 M HCl (10 mL) and extracted with petroleum ether (bp 30–40 °C; 2 × 20 mL). Concentration of the organic phase (10 Pa) gave the product as a colorless solid; yield: 3.7 g (92%); mp 130 °C.

### 3.3.7 Safety

Chemicals are associated with two types of hazard: hazards that are a direct result of the physical or reactive properties of a chemical; and hazards posed by the effect of a chemical on biological systems. Flammability and the stability of a chemical in air or toward water may be included in the first group, while the carcinogenic potential of a chemical or its effect on the reproductive system are health hazards due to the biological properties of a chemical. The different hazardous properties that authors should take into consideration when evaluating experimental procedures are as follows:

#### Physical and reactive chemical hazards:

- Flammability
- Explosive properties
- Stability in air or in contact with water (pyrophoric and water-reactive compounds)
- Incompatibility with commonly available chemicals and reagents
- Potential for peroxidation
- Oxidizing or reducing properties
- Storage properties

**Health effects of chemicals:**

- Known human carcinogens and probable human carcinogens according to the International Agency for Research on Cancer (IARC) classifications
- Known human teratogens
- Chemicals known to have an effect on human reproduction
- Chemicals that are irritants to the skin, eyes, and respiratory system (data from human exposure or animal tests)
- Chemicals that are corrosive to the skin, eyes, and respiratory system (data from human exposure or animal tests)
- Skin sensitizers
- Chemicals that are highly toxic as a result of some specific pharmacological mechanism (e.g., the potent neurotoxin tetrodotoxin)

**Hazard information may be found in:**

Rhodes, P. H., *The Organic Chemist's Desk Reference*, Chapman & Hall: London, (1995); pp 112–126.

*Bretherick's Handbook of Reactive Chemical Hazards*, 6th ed., Urben, P. G., Ed.; Butterworth-Heinemann: Oxford, (1999).

*Hazards in the Chemical Laboratory*, 5th ed., Luxon, S. G., Ed.; Royal Society of Chemistry: Cambridge, (1992).

It is important that authors discuss potential hazards of the described compounds. Furthermore, the methods described in *Science of Synthesis* should be discussed in terms of atom economy, as well as their possible impact on the environment. If toxic solvents (e.g., chloroform), toxic catalysts [e.g., mercury(II) chloride], toxic reagents (e.g., phosphene), or any other hazardous compounds are used or recommended in certain experimental procedures, alternatives should be discussed. Safety guidelines should be given for dangerous compounds or procedures. Warnings in experimental procedures should be given using the following format:

**CAUTION:** *Hexamethyltungsten(VI) is known to decompose explosively. Proper safety precautions should be taken during its synthesis, storage, and handling.*

**3.3.8 Copyright**

It is the responsibility of the author to obtain, where necessary, copyright permission for figures, tables, schemes, or textual information from another source that is to be reproduced in a *Science of Synthesis* contribution. The Editorial Office can always be contacted for advice on such matters, and will help authors to direct applications to the appropriate departments. In the case of reproduction of experimental procedures and schemes from journal publications, a full citation in the references section is sufficient acknowledgement of copyright ownership. Problems concerning copyright infringement usually arise when text or figures are taken from books [e.g., Brandsma, L.; Verkruijsse, H. D., *Synthesis of Allenes and Cumulenes*, Elsevier: Amsterdam, (1981)] or serial publications [e.g., *Organic Syntheses, Coll. Vol. VI*, Noland, W. E., Ed; Wiley: New York, (1988)] without significant adaptation of the original version. The copy editor assigned to each manuscript will advise the author of the need to obtain copyright permission, if they have not already done so, and will add the appropriate credit line. If there is an appropriate and adequate alternative to a reference requiring copyright then this reference should be substituted, or if a similar procedure is available then this procedure should be used instead of that under copyright. Permission request forms are in the author's information package or can be obtained from the Editorial Office.

### 3.4 Guidelines for References and Cross-References

- References should be placed collectively at the end of the text (in Part 4 of your manuscript, entitled “References”).
- References should be numbered consecutively within chapters, with no subdivisions such as <sup>[3a]</sup>, <sup>[3b]</sup>, <sup>[3c]</sup>, etc.
- Each reference number should contain only one citation.
- Use one reference number for each reference only; do not repeat a reference citation with a new number every time it appears.
- References to literature appear in the text, tables, and scheme headings as superscript 10 pt Arabic numerals in square brackets following the punctuation, e.g. This is a sample sentence.<sup>[1]</sup>
- Authors should include reference numbers for schemes and figures in the scheme/figure caption.
- Reference numbers for tables should be included in the tables as the final column, with the heading Ref.
- *Journals*: provide the names of **all** authors. Do not use “et al.”. A comma should be used to separate the name of the last author and the title of the journal.
- Use the journal abbreviation in accordance with the approved list given in Section 6.4. This is based on that of *Chemical Abstracts* [*Chemical Abstracts Service Source Index (CASSI) 1907–1994 Cumulative* and its supplements].
- *Books*: see sample references for books with and without editors.
- *Patents*: see sample reference. Important patents should be read in the original versions as *Chemical Abstracts* reports often do not contain all important details.
- *Databases*: reference can also be given to records in databases (e.g., spectra from databases such as Specinfo).
- If reference is made to a less readily available journal, the *Chemical Abstracts* reference or the English translation [e.g., *J. Gen. Chem. USSR (Engl. Transl.)*] should also be cited.
- *Science of Synthesis* will support the citation of electronic journals. As soon as general document identifiers for journal articles are available, the editorial office will include them to allow users direct access to these references.
- The use of a reference-managing program (e.g., EndNote) is strongly recommended (note, however, that use of the endnote function in MS Word is *not* recommended).
- References to *Houben–Weyl* should only be given if it is not possible to substitute these with a cross-reference in the running text. References to *Science of Synthesis* should be avoided: always give a cross-reference in these cases.
- Cross-references to *Houben–Weyl* include the volume and page number, whereas those to *Science of Synthesis* include the volume and section number, e.g. *Houben–Weyl*, Vol. 13/9b, pp 632–700 or *Science of Synthesis*, Vol. 10, [Fused Five-Membered Heteroarenes with One Heteroatom (Section 10.1.1.3.1.4)].

#### 3.4.1 Sample References

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### 3.5 Guidelines for Tables and Scheme Tables

#### Tables

Tables should be used to display examples of similar products prepared by a given method or variation in order that they may be critically discussed in the text.

**Do not list every example known; only selected examples should be given.**

Tables should contain 5 to 10 examples and should be placed in the appropriate position in the body of the text. Tables should be numbered with Arabic numerals and have captions with initial letters of major words capitalized. When referring for the first time to information given in a table, please quote the table number in brackets. The position of a table should be indicated in the text in the following way:

<Table 1> This is a Sample Caption<sup>[33]</sup>

In tables, collect comparable examples and quote, in the following order:

1. The starting material represented pictorially, e.g. either present a generalized equation above and then give only substituents R<sup>1</sup>, R<sup>2</sup>, X, etc. (see below) or, in the case of structurally diverse substrates, give the entire formula. An entry number is also acceptable for identifying the starting material. In all cases, arrange the examples in a manner which best illustrates the scope and limitations of the method (e.g., they may be listed in increasing order of substituent/reagent complexity, or in increasing order of chemical or optical yield, etc.).
2. Reagents, solvents, temperature, times, as applicable.
3. Product (formula or entry number).
4. ee, er (preferred), dr when applicable.
5. Yield data.
6. Physical data, if relevant (e.g., mp).
7. Citation of the relevant literature.

<Table 1> Caption<sup>[ref nos]</sup>

Starting Material or Entry	Reaction Conditions I	Reaction Conditions II	Product	er or dr	Yield (%)	Ref
(formula or entry number)	(reagents, catalysts, solvents)	[Temp (°C), pressure (Torr)]	(formula or R groups)			

#### Scheme Tables

Scheme tables should be employed in conjunction with schemes if the latter are likely to become overcluttered with textual notes. Scheme tables should not contain entry numbers. They should be used to illustrate methods (or variations) when (1) there are several examples for the method but they are not actively and individually discussed in the main text, and thus presented in a normal table (see above); (2) there are fewer examples but they contain several varying R substituents on the reagent(s) in the scheme; (3) there are

different conditions (e.g., solvent, temperature, ratio of reactants) employed for the same reaction which have a significant influence on the yield, purity, or optical purity, etc. of the product. All other cases should simply include the examples within the scheme itself (see below).

The content and layout of a scheme table should be similar to that employed for a table, and in all cases kept as simple as possible. An example of a scheme table is given below:

**Scheme 12** Oxidation of Aryl Sulfides with Hydrogen Peroxide in the Presence of Various Catalysts<sup>[54–58]</sup>

$$\text{Ar}^1-\text{S}-\text{R}^1 \xrightarrow{\text{H}_2\text{O}_2, \text{catalyst}} \text{Ar}^1-\overset{\text{O}}{\parallel}{\text{S}}-\text{R}^1$$

Ar <sup>1</sup>	R <sup>1</sup>	Conditions/Catalyst	Yield (%)	Ref
4-ClC <sub>6</sub> H <sub>4</sub>	Me	H <sub>2</sub> O <sub>2</sub> , VO(acac) <sub>2</sub> , EtOH, rt	90	[54,55]
Ph	Ph	UHP <sup>a</sup> , Re(PPh <sub>3</sub> ) <sub>2</sub> OCl <sub>3</sub> , MeCN	92	[56]
Ph	Ph	H <sub>2</sub> O <sub>2</sub> , TiCl <sub>3</sub> , EtOH, rt	100	[57]
Ph	Et	H <sub>2</sub> O <sub>2</sub> , TeO <sub>2</sub> , HCl, MeOH	92	[58]

<sup>a</sup> UHP = urea–hydrogen peroxide adduct.

Scheme tables should be placed below the relevant scheme heading **in the body of the text**, i.e. they should be included as part of the word processor document. Scheme tables will not have a caption but should be headed <Schemetable n> where n is the same number as the corresponding scheme.

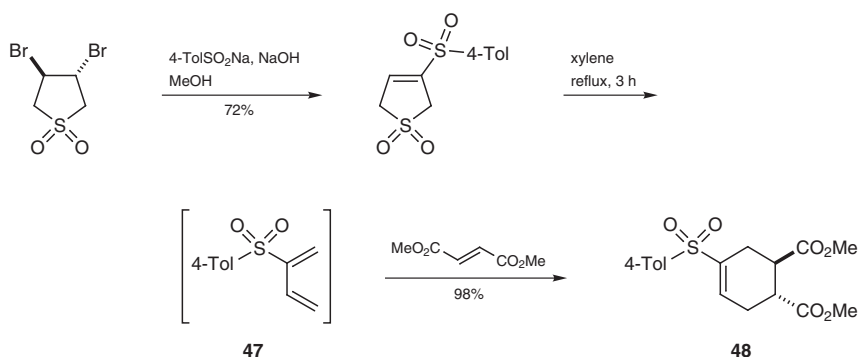
### 3.6 Guidelines for Schemes

- The schemes should be visual abstracts of the reactions performed, hence flow diagrams are preferred to individual structures.
- Schemes should be numbered with Arabic numerals and have captions with initial letters of major words capitalized.
- When referring for the first time to information given in a scheme, please quote the scheme number in brackets.
- A scheme should be indicated in the text in the following way:  
<Scheme 1> This is a Sample Scheme<sup>[10]</sup>
- Schemes should be placed separately at the end of your manuscript. Schemes and figures must be submitted on a separate sheet. They should **not** be electronically embedded in the text.
- Schemes should not exceed a width of 16 cm; schemes wider than this will not be accepted.
- Reaction arrows normally should be oriented horizontally, using more than one “line” if necessary. If there are still space constrictions, arrows oriented vertically or at 45° angles may be permitted. Authors should try to make efficient use of the space.
- Products of experimental procedures (and substrates and intermediates that are referred to in the text) should be numbered with bold Arabic numbers from left to right in sequence as they appear in the schemes. Begin from 1 at the start of each manuscript.
- Not every compound in a scheme needs to have a number. However, the title compound in an experimental procedure should have a number.
- For compounds with varying substituents, the labels R<sup>1</sup>, R<sup>2</sup>, X, etc. must be used and defined in a table or scheme table. Do not use R without a superscript.

- Use <sup>+</sup> and <sup>-</sup> (i.e., plus and minus symbols as superscripts) for electric charges (do not circle them).
- Two dots should be used to indicate a lone pair.
- Reagents, conditions, etc., should appear above the arrow, only.
- Unstable intermediates should be drawn in square brackets (see below).
- Each individual reagent, condition, etc., should be separated from the next by a comma and one character space, not a semicolon or solidus (forward slash); no comma should appear at the end of a line.
- Reagents, conditions, etc., appear in the following order:
  - (1) Reagents, including catalysts, e.g. H<sub>2</sub>(g), Pd/C, Pd(PPh<sub>3</sub>)<sub>4</sub>.
  - (2) No. of equivalents.
  - (3) Solvents.
  - (4) Special apparatus, e.g. sealed tube, autoclave.
  - (5) Temperature, e.g. rt, 50 °C, reflux.
  - (6) Pressure, e.g. 5 atm, 100 Pa.
  - (7) Time, e.g. 5 min, 6 h, 12 d.
- Eliminated products (preceded by a minus sign) and the reaction yield appear below the arrow.
- Please do not use wedged bonds (bold or hashed) to represent chiral centers; use normal bold or hashed bonds instead.
- References will not appear in schemes but in the scheme headings.
- For intermediates in schemes the following rules apply:
  1. Isolable intermediates are to be included in schemes and will get put into a separate reaction database for reaction searching.
  2. Elusive intermediates and transition states can also be put into schemes but they will not be included in the reaction database. They should be placed within square brackets.

Scheme 1 shows an illustrative example of a reaction scheme.

**Scheme 1** Synthesis and Reaction of a Dienyl Sulfone<sup>[8,9]</sup>



*Science of Synthesis* document settings can be selected automatically in recent versions of ChemDraw.

### 3.7 Guidelines for Figures

Figures should be numbered with Arabic numerals. When referring for the first time to information given in a figure, please quote the figure number in brackets. Figure captions will not be listed at the end of the manuscript and will instead stay in the manuscript. A figure should be indicated in the text in the following way:

<Figure 1> This is a Sample Figure<sup>[23]</sup>

Figures should be placed separately in Part 5 of your manuscript. They must **not** be electronically embedded in the text.

If necessary, figures will be redrawn by the publishers. For checking and correction, the redrawn figures will be sent back to the author. In the case of figures taken from existing publications, **it is the legal responsibility of the author to obtain permission for reproduction from the copyright holder**, although the Editorial Office can offer assistance with such matters; this should be done at a very early stage of the book production. For figures of apparatus, please directly contact the apparatus producer company. If figures are not produced by the author, the copyright of the figure must be included in the caption. Submit only original figures or high-quality photographic prints of originals. For the preparation of graphs, authors are requested to follow the suggestions of H. G. Hers [*Nature*, (1984) 307, 205].

### 3.8 Delivery of the Manuscripts

#### 3.8.1 Table of Contents

Authors are requested to send a copy of their table of contents to the Editorial Office and to the appropriate volume editor by e-mail ([science-of-synthesis@thieme.de](mailto:science-of-synthesis@thieme.de)). Authors will then receive a revised table of contents with comments and suggestions from the volume editor and/or the Editorial Office.

#### 3.8.2 Submission of Final Manuscript

Please send a copy of your completed manuscript to the volume editor, who will advise on revision if necessary. The **final** version of the revised manuscript has to be sent to the Editorial Office by e-mail ([science-of-synthesis@thieme.de](mailto:science-of-synthesis@thieme.de)) by the agreed deadline.

#### 3.8.3 Copyediting Process

The manuscript submitted to the Editorial Office will then be assigned to a copy editor who will copyedit the manuscript and apply the necessary styles for *Science of Synthesis*, e.g. check nomenclature, grammar, syntax, punctuation, phrasing, redundancy of text, and the like. Copy editors will correspond directly with authors regarding any queries and try to resolve them before proceeding to the page proof stage. It is inevitable that corrections will still need to be made to the page proofs, but each copy editor will aim to eliminate as many errors as possible prior to this stage by editing the manuscript thoroughly. The Editorial Office will then use the manuscripts for the production of the electronic version and prepare them for typesetting.

#### 3.8.4 Page Proofs

At this stage page proofs will be sent to the author and volume editor for correction. The correction of page proofs should be limited to the correction of printing errors or other mistakes and should not involve major changes to the text. If more extensive corrections are necessary as a result of significant new developments, the volume editor should be consulted. Please note that the symbols ■■■ indicate that something was missing or unclear in the manuscript and the pertinent information should be added during correction. The page proofs should be returned to the Editorial Office by the deadline given. The author's and volume editor's responsibilities end with the correction of the page proofs. The author and volume editor then sign the page proofs as a permission to publish the manu-

script (*Imprimatur*). By accepting a manuscript the publisher acquires all rights, in particular copyright and the right of translation. The proof sheets are not indicative of the quality of the final print.

The page layout of the contribution follows the proof correction, i.e. the text is laid out to the exact page length, the pages are numbered, and tables, schemes, and figures are placed as near as possible to the positions indicated by the author and volume editor in the page proofs.

### 3.9 Use of the Document Template

Authors will be able to download style templates for their word-processing programs from the *Science of Synthesis* Web site ([www.science-of-synthesis.com](http://www.science-of-synthesis.com)).

The *Science of Synthesis* document template contains a list of formatting styles that have to be applied to the chapter captions of your manuscript. The file is called **scisynth.dot**. However, the manuscript will not have the same print format as shown in the sample chapter. The sample chapter as it appears by using the template can also be found online: **elecsamp.doc**. This file is intended to illustrate how the template should be used. It also shows that at this stage manuscripts do **not** have the same format as in print.

### 3.10 Frequently Asked Questions

**Q: Does the document template have to be used?**

**A:** It is important for the development of the electronic version that the appropriate style name (e.g., H\_Method) is attached to the heading paragraphs for each section. It is not important that formatting properties such as font size, line spacing, or the number of lines per page match the document template. Please feel free to change these properties as long as the style naming is not reflected. Apart from style names all formatting options will be deleted by the document processing program. The document template is designed to make formatting the manuscript easier for the user in that the appropriate style can be chosen quickly from the menu.

**Q: I have never used a template before and am not sure where to start.**

**A:** There is a Readme file provided with the document template. It is advisable that you print this out and read it first.

**Q: I don't know where to save the template file (scisynth.dot).**

**A:** It is difficult to state categorically where individual users save their template files. On a PC, on which the whole Microsoft Office software package is installed, it is normally in the directory C:\MSOffice\Template. With only the Microsoft Word processor installed you will find the directory under C:\MSWord\Template. For the Macintosh it strongly depends on the version of Word used. Newer Macintosh Word versions have the same menu items as the Windows Word versions. The folder where the document templates are stored can be detected in Word in "Tools/Templates and Add-Ins". If in doubt, please refer to the in-house computer specialist for advice.

**Q: Is it acceptable to adjust the font size and spacing?**

**A:** The font type and style of the text is important for its identification. Font size and spacing is not important.

**Q: How should I handle tables?**

**A:** Tables should be composed using the table set-up tools of the word processing program. Tables should be placed in the appropriate position in the body of the text. The ta-



bles in the text should be labeled clearly with a caption, e.g. <Table 1> Table Caption (Times).

**Q: How should I handle drawings in tables?**

A: State the file name of the drawing (handwritten) in the required position in the table on the hardcopy of the manuscript. Store the drawing as a separate file using the formula name as the file name.

**Q: Is it possible to handle several schemes in one file?**

A: No. Each scheme should be saved in a separate file as should any figures using the scheme or figure number as the file name e.g. scheme1.cdx.

**Q: What word processing program should I be using?**

A: The following word processing programs are preferred:

- Microsoft Word 2000 or higher (but please save the document in .doc format)
- Microsoft Word for Macintosh 6.0 or higher

The document template is currently available for all of these packages. For other word processors please contact the Editorial Office and discuss your requirements. However the use of LATEX should be avoided.

**Q: What structure drawing program should I be using?**

A: Please generate your schemes using ChemDraw (preferably the latest version both for Microsoft Windows or for Macintosh) or using ISIS/Draw.

**Q: What are the page extent rules for manuscript submission?**

A: The volume editors and authors are requested to be aware of the contracted page extent as outlined in the Contributing Author's Agreement, and to not exceed the given number of printed pages for each volume. For estimating the final length of a contribution, the following general rules should be used:

- 1 printed page  $\approx$  3 Microsoft Word pages (**no** tables/schemes)
- $\approx$  2 Microsoft Word pages (**with** tables/schemes)

**Q: Do I need to use any particular units or abbreviations?**

A: Metric units should be used throughout the text. However, for pressure and temperature, Torr/atm/Pa and °C can be used, respectively. The unit kcal is also accepted. The use of abbreviations is recommended in schemes, tables, and experimental procedures, but not in titles or text. Please see the Appendix for a full list of abbreviations.

**Q: What do the symbols ■■■ in the page proofs mean?**

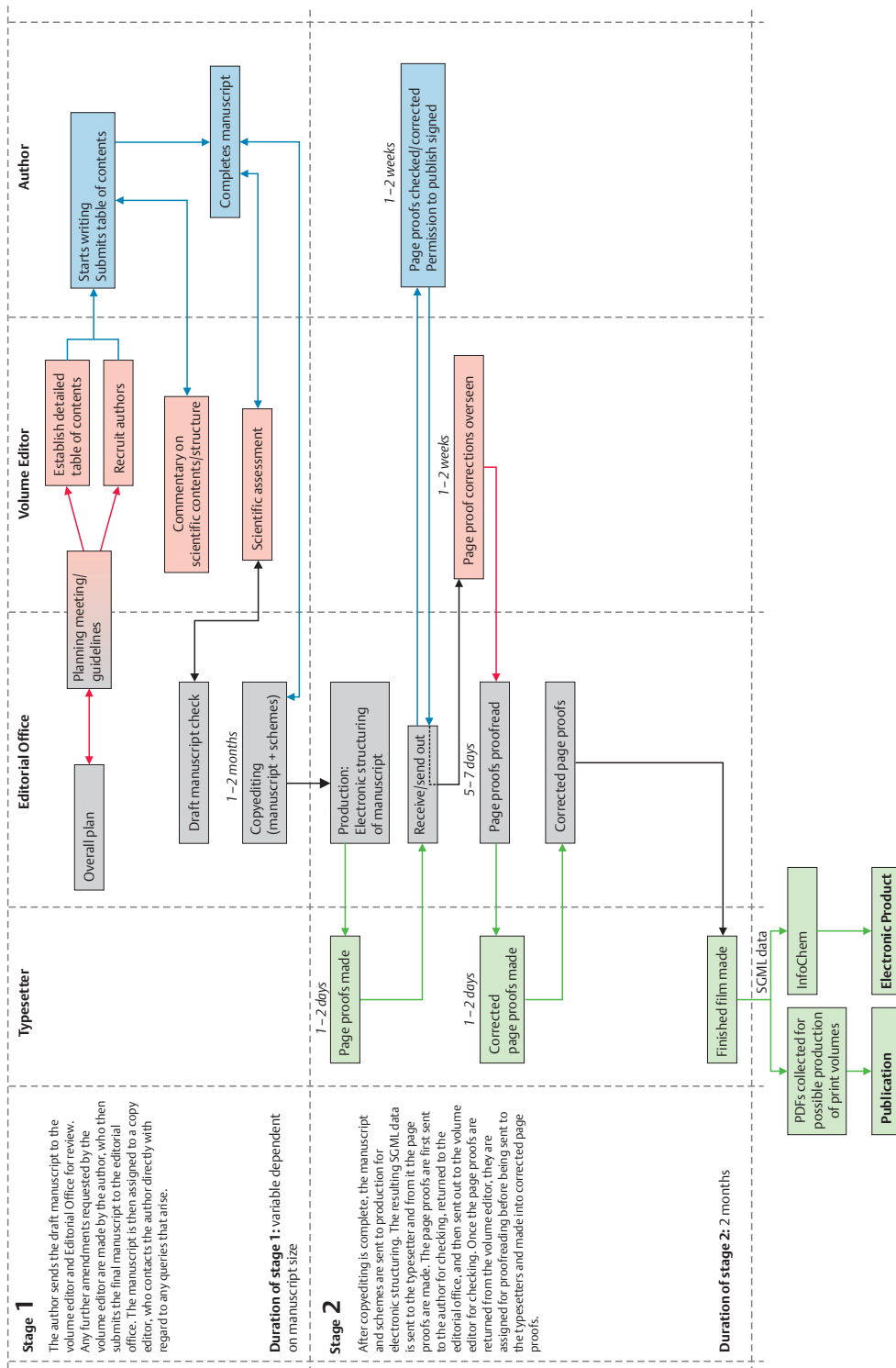
A: The symbols indicate that something is missing or unclear in the manuscript and the author should add the missing information during correction.

**Q: What is the difference between a General Procedure and a Typical Procedure?**

A: A General Procedure is a generalized version of a widely applicable experimental procedure. A Typical Procedure is a specific example of a widely applicable experimental procedure.

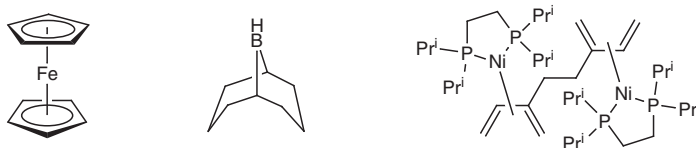
## Editorial Workflow and Processes

Workflow Chart for the Science of Synthesis Updates



5 **Appendix**5.1 **Category Information**5.1.1 **Category 1****Science of Synthesis Volumes 1–8  
Organometallics**

Examples:



Coverage:

- Compounds with Transition Metal—Carbon  $\pi$ -Bonds and Compounds of Groups 10–8 (Ni, Pd, Pt, Co, Rh, Ir, Fe, Ru, Os)
- Compounds of Groups 7–3 (Mn..., Cr..., V..., Ti..., Sc..., La..., Ac...)
- Compounds of Groups 12 and 11 (Zn, Cd, Hg, Cu, Ag, Au)
- Compounds of Group 15 (As, Sb, Bi) and Silicon Compounds
- Compounds of Group 14 (Ge, Sn, Pb)
- Boron Compounds
- Compounds of Groups 13 and 2 (Al, Ga, In, Tl, Be...Ba)
- Compounds of Group 1 (Li...Cs)

The synthesis of compounds with an M—C  $\sigma$ -bond is included; compounds are also included, if a M—X bond is present or formed at the same time.

In general, the coverage is restricted to organometallic compounds that can be isolated or at least characterized in solution. However, identifiable but non-isolable organometallic intermediates that play an important role in catalytic or stoichiometric processes are also included. Emphasis is on the organometallic intermediate as a target and not the final metal-free product of the reaction, since this is covered elsewhere in *Science of Synthesis*.

Carbon compounds of any oxidation state are included and reactions on the coordinated ligand are also covered.

Also, the emphasis is on the organometallic product subclasses and not on inorganic reagents. To the extent that an inorganic reagent is used mainly for metalation, then the principal treatment will come under the organometallic intermediate: its synthesis (using the inorganic reagent) and its further applications in organic synthesis.

5.1.2 **Category 2****Science of Synthesis Volumes 9–17  
Hetarenes and Related Ring Systems**

Examples:



Coverage:

- Fully Unsaturated Small-Ring Heterocycles and Monocyclic Five-Membered Hetarenes with One Heteroatom
- Fused Five-Membered Hetarenes with One Heteroatom
- Five-Membered Hetarenes with One Chalcogen and One Additional Heteroatom
- Five-Membered Hetarenes with Two Nitrogen or Phosphorus Atoms
- Five-Membered Hetarenes with Three or More Heteroatoms
- Six-Membered Hetarenes with One Chalcogen
- Six-Membered Hetarenes with One Nitrogen or Phosphorus Atom
- Six-Membered Hetarenes with Two Identical Heteroatoms
- Six-Membered Hetarenes with Two Unlike or More than Two Heteroatoms and Fully Unsaturated Larger-Ring Heterocycles

Of the over 6 million heterocyclic compounds representing about 70 000 known heterocyclic systems, only a small number can be considered as product classes or subclasses in *Science of Synthesis*. The systems covered are limited to those that are important synthetic targets, for which the synthetic methodology needs to be covered. Systems that are rare or unstable are not generally synthetically significant and are not usually covered in *Science of Synthesis*.

Category 2 includes fully unsaturated heterocycles with no  $sp^3$  carbon or heteroatoms incapable of conjugation, e.g.  $S\lambda^4$  or  $P\lambda^5$  in a five-membered ring. Compounds with a formal charge, such as the pyrylium ion, are included. Compounds that satisfy the  $4n + 2$  rule via tautomeric forms and mesoionic compounds are also included. Systems that cannot be aromatic because of saturated carbon in the ring, such as 1,3-dioxin or oxete, as well as saturated or partially unsaturated heterocycles, are not covered in Category 2. Such systems are integrated into the coverage in Categories 3–5 where appropriate.

The hetarene volumes deal with:

- making and breaking bonds in or to the hetarene
- heteroatom manipulations on the hetarene ring
- chemistry at the  $\alpha$  position to the hetarene ring (emphasis on chemistry influenced by the hetarene, not elaboration on standard modifications)
- chemistry at groups in conjugation with the hetarene ring

*Science of Synthesis* organizes hetarenes in the order of preference:

1. ring size, from smaller to larger,
2. number of heteroatoms, from less to more,
3. type of heteroatoms in the order of preference: O, S, Se, Te, N, P,
4. valence of like heteroatoms, from higher to lower, such as  $P\lambda^5 > P\lambda^3$  and  $S\lambda^4 > S\lambda^2$ ,
5. annulated hetarenes directly after the corresponding monocyclic hetarene, e.g. oxazole then benzoxazole.

When the number and kind of heteroatoms are the same, the order follows the lowest numbers in the name from left to right until a difference is found, i.e. 1,2,3 then 1,2,4

then 1,3,2 then 1,4,2 etc. When trivial names are used, which do not contain numbers in the name, the order follows the lowest numbers for the heteroatoms; e.g., isoxazole (1,2-oxazole) then oxazole (1,3-oxazole).

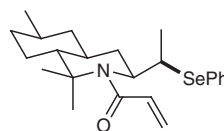
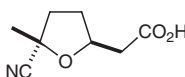
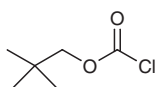
Note that B, Si, and As are classified as metals in *Science of Synthesis* and not as heteroatoms. Metal-containing compounds are covered in Category 1.

Those fused heteroarenes that are covered in *Science of Synthesis* are organized according to the ring size of the smallest heteroarene component and the number and kind of heteroatoms in that ring, from less to more, as above for monocyclic heteroarenes.

### 5.1.3 Category 3

#### Science of Synthesis Volumes 18–24 Compounds with Four and Three Carbon—Heteroatom Bonds

Examples:



Coverage:

- Four Carbon—Heteroatom Bonds
- Three Carbon—Heteroatom Bonds: Nitriles, Isocyanides, and Derivatives
- Three Carbon—Heteroatom Bonds: Acid Halides; Carboxylic Acids and Acid Salts; Esters and Lactones; Peroxy Acids and R(CO)OX Compounds; R(CO)X, X = S, Se, Te
- Three Carbon—Heteroatom Bonds: Amides and Derivatives; Peptides; Lactams
- Three Carbon—Heteroatom Bonds; Thio-, Seleno-, and Tellurocarboxylic Acids and Derivatives; Imidic Acids and Derivatives; Ortho Acid Derivatives
- Three Carbon—Heteroatom Bonds: Ketenes and Derivatives
- Three Carbon—Heteroatom Bonds: Ketene Acetals and Yne—X Compounds

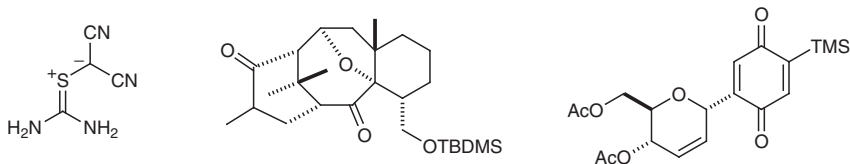
This category presents the methods for the synthesis of organic compounds organized according to the functional group or groups prepared in the product. The underlying organizational principle is the oxidation state, i.e. all compounds are organized into product classes and product subclasses according to descending oxidation state.

For some compounds, the principal interest to the synthetic chemist is their use as reagents, synthetic building blocks, catalysts, promoters, ligands, and auxiliaries. Some reagents may also be highly reactive intermediates, which are not isolated (e.g., some ylides and ketenes). In such cases, synthesis of the product class (or product subclass) and applications of the product class (or product subclass) in organic synthesis are described. The methods for their application give products that belong to other product classes within other categories of *Science of Synthesis*, but in the section in question the emphasis is placed on the role of the product class or product subclass covered.

NOTE: Extent of Polymer Coverage in Category 3 – Polymers are considered to be an important class of compounds although they are not traditional target molecules for chemists working in the field of organic synthesis. However, a thorough, synthetic, and comprehensive treatment of polymers is beyond the scope of the *Science of Synthesis* series. The focus of *Science of Synthesis* is on the synthesis of important monomeric molecular species. A compromise has been reached by covering the most important methods for polymer synthesis including introductory text together with leading references to more comprehensive reviews, handbooks, and the original literature.

5.1.4 **Category 4****Science of Synthesis Volumes 25–33  
Compounds with Two Carbon–Heteroatom Bonds**

Examples:



Coverage:

- Aldehydes
- Ketones
- Heteroatom Analogues of Aldehydes and Ketones
- Quinones and Heteroatom Analogues
- Acetals: Hal/X and O/O, S, Se, Te
- Acetals: O/N, S/S, S/N, and N/N and Higher Heteroatom Analogues
- Arene—X Compounds
- X—Ene—X, Ene—Hal, and Ene—O Compounds
- Ene—X Compounds (X ≠ Hal, O)

This category presents the methods for the synthesis of organic compounds organized according to the functional group or groups prepared in the product. The underlying organizational principle is the oxidation state, i.e. all compounds are organized into product classes and product subclasses according to descending oxidation state.

For some compounds, the principal interest to the synthetic chemist is their use as reagents, synthetic building blocks, catalysts, promoters, ligands, and auxiliaries. Some reagents may also be highly reactive intermediates, which are not isolated. In such cases, synthesis of the product class (or product subclass) and applications of the product class (or product subclass) in organic synthesis are described. The methods for their application give products that belong to other product classes within other categories of *Science of Synthesis*, but in the section in question the emphasis is placed on the role of the product class or product subclass covered.

NOTE: Extent of Polymer Coverage in Category 4 – Polymers are considered to be an important class of compounds although they are not traditional target molecules for chemists working in the field of organic synthesis. However, a thorough, synthetic, and comprehensive treatment of polymers is beyond the scope of the *Science of Synthesis* series. The focus of *Science of Synthesis* is on the synthesis of important monomeric molecular species. A compromise has been reached by covering the most important methods for polymer synthesis including introductory text together with leading references to more comprehensive reviews, handbooks, and the original literature.

**5.1.5 Category 5****Science of Synthesis Volumes 34–42  
Compounds with One Carbon–Heteroatom Bond**

Examples:



Coverage:

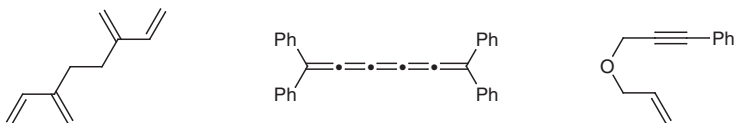
- Fluorine
- Chlorine, Bromine, and Iodine
- Alcohols
- Ethers
- Peroxides
- Sulfides, Selenides, and Tellurides
- Amines, Ammonium Salts, Amine N-Oxides, Haloamines, Hydroxylamines, and Hydrazines
- Nitro, Nitroso, Azo, Azoxy, and Diazonium Compounds, Azides, Triazenes, and Tetrazenes
- Organophosphorus Compounds

This category presents the methods for the synthesis of organic compounds organized according to the functional group or groups prepared in the product. The underlying organizational principle is the oxidation state, i.e. all compounds are organized into product classes and product subclasses according to descending oxidation state.

For some compounds, the principal interest to the synthetic chemist is their use as reagents, synthetic building blocks, catalysts, promoters, ligands, and auxiliaries. Some reagents may also be highly reactive intermediates, which are not isolated. In such cases, synthesis of the product class (or product subclass) and applications of the product class (or product subclass) in organic synthesis are described. The methods for their application give products that belong to other product classes within other categories of *Science of Synthesis*, but in the section in question the emphasis is placed on the role of the product class or product subclass covered.

5.1.6 **Category 6****Science of Synthesis Volumes 43–48  
Compounds with All-Carbon Functions**

Examples:



Coverage:

- Polyynes, Arynes, Enynes, and Alkynes
- Cumulenes and Allenes
- Arenes, Quasiarenes, Annulenes, and Polyenes
- 1,3-Dienes
- Alkenes
- Alkanes

This category presents the methods for the synthesis of organic compounds organized according to the functional group or groups prepared in the product. The underlying organizational principle is the oxidation state, i.e. all compounds are organized into product classes and product subclasses according to descending oxidation state.

For some compounds, the principal interest to the synthetic chemist is their use as reagents, synthetic building blocks, catalysts, promoters, ligands, and auxiliaries. Some reagents may also be highly reactive intermediates, which are not isolated. In such cases, synthesis of the product class (or product subclass) and applications of the product class (or product subclass) in organic synthesis are described. The methods for their application give products that belong to other product classes within other categories of *Science of Synthesis*, but in the section in question the emphasis is placed on the role of the product class or product subclass covered.

NOTE: Extent of Polymer Coverage in Category 6 – Polymers are considered to be an important class of compounds although they are not traditional target molecules for chemists working in the field of organic synthesis. However, a thorough, synthetic, and comprehensive treatment of polymers is beyond the scope of the *Science of Synthesis* series. The focus of *Science of Synthesis* is on the synthesis of important monomeric molecular species. A compromise has been reached by covering the most important methods for polymer synthesis including introductory text together with leading references to more comprehensive reviews, handbooks, and the original literature.



## 5.2 Organizational Principles of *Science of Synthesis*, *Houben–Weyl* Methods of Molecular Transformations

The following organizational principles are designed to serve as guidelines for volume editors, authors, and users in deciding where in *Science of Synthesis* a given topic will be treated. These rules of classification will not, however, take precedence over chemical common sense in the organization of individual volumes, since it is the ultimate goal that the material be organized for the benefit of the user in a manner that is as simple and intuitive as possible.

### 5.2.1 Classification Principles

The organization of *Science of Synthesis* is based on the structural unit or functional group (for example, a heteroaromatic ring or an enone) that is to be constructed. That is to say **the classification is based on the product** (how do I make something?) as opposed to the reaction (what is the Horner–Emmons reaction?), the reagent (what can I do with organo-copper reagents?), or the starting material (what reactions do 1,2-diols undergo?). Thus, a synthetic method, such as catalytic hydrogenation, that can be employed for a variety of product types, will be found throughout the work, depending on the structure of the compound produced. Likewise, the various reactions of a given compound class, such as alcohols, are located throughout the work on the basis of the product.

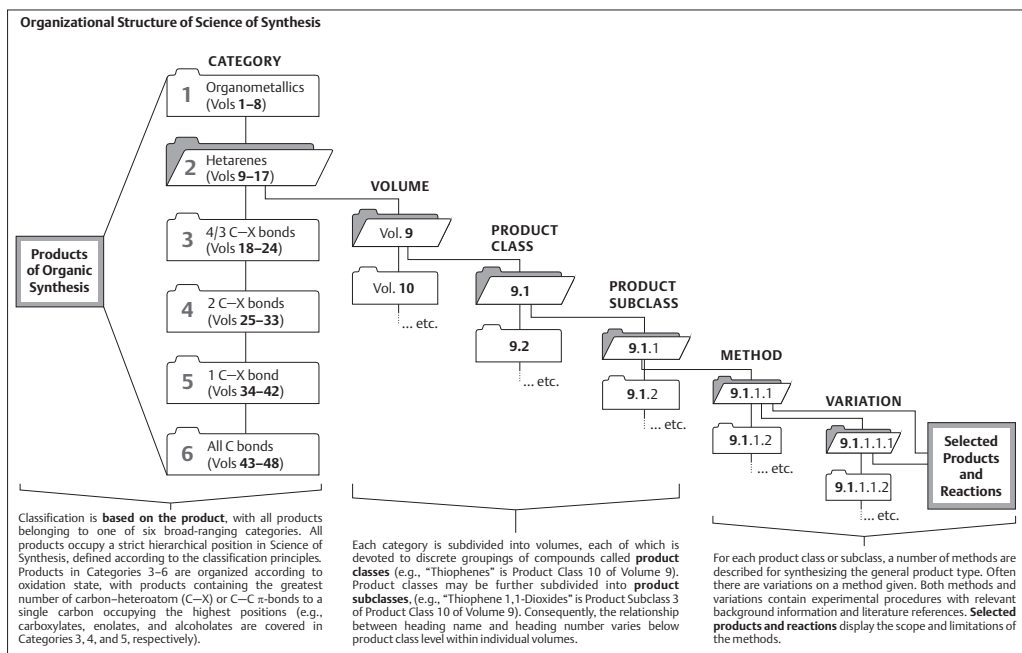
The purpose of this classification system is to organize all synthetically useful reactions so that practicing chemists can readily find a solution to their synthetic problem, and to ensure a minimum of overlap in the presentation throughout the entire work. Unfortunately, there is no universal organizational principle for all organic and organometallic chemistry that is simple and at the same time corresponds to generally accepted chemical common sense. Therefore, the following rules have not been rigorously derived from physical or chemical principles.

A classification scheme is employed that corresponds to the general notion of oxidation state (carbonic acid derivatives, carboxylic acid derivatives, etc.). It is of interest to note that the number of heteroatom bonds to carbon, which is a rough indication of oxidation state, has been the underlying organizational principle of *Houben–Weyl* since the first edition. For organometallic and heteroaromatic compounds the editors have created two separate categories, in accordance with common chemical usage and the fact that these compound classes have unique chemical properties. Partially or fully saturated heterocyclics are, however, classified with the corresponding acyclic compounds (e.g., tetrahydrofuran with ethers).

The result is a group of six categories (see Section 6.2.3). When only one functionality is present in the target, the classification into one of the six categories is evident. This is also true with targets containing mutually remote functionalities in which only one functionality is formed by the method under consideration, since the classification is based solely on the functionality formed. However, with multifunctional targets, in which functionalities are directly bonded or in which more than one functionality is formed by the method under consideration, more elaborate classification rules are needed in order to determine in which category the target belongs and where within the category it will be treated (for an overview see Scheme 1). As with the Cahn–Ingold–Prelog system, all functional groups and structural units must be given an order of priority for the purposes of classification. In each case where multiple functions are formed at the same time, the decision has to be made as to which functional group has the higher priority. For example, is the lithiation of pyridine covered under organometallics or heteroarenes, i.e. which functionality has the higher priority, C–Li or pyridine? The following rules attempt to answer all such questions.

Scheme 1 gives an overview of the classification principles of *Science of Synthesis*.

Scheme 1



## 5.2.2 Overall Organization of the Content of *Science of Synthesis*

### Rule 1 Hierarchical Organization of the Content of *Science of Synthesis*

The content of *Science of Synthesis* will be organized hierarchically into:

- Categories,
- Volumes,
- Product Classes,
- Product Subclasses,
- Methods,
- Variations.

Each product class can be divided into product subclasses if necessary. Methods will be ranked according to the organizational principles (e.g., in the case of allylstannanes, the synthesis of these products by formation of the C–Sn bond via a Grignard reaction has a higher priority than the synthesis by formation of the allylic C=C bond via a Wittig reaction, see Rule 14). *Science of Synthesis* will focus on selected and reliable methods that have proved to be useful for the synthesis of a given product class. For each method a scheme and, if necessary, a table (with, in general, 5 to 10 examples) will be given. An experimental procedure, plus safety and environmental aspects, will further illustrate the method. Alterations to a method, e.g. changes in catalysts or reagents, the running of a reaction as a one-pot reaction, generation of reagents in situ, etc., which have a significant influence on the outcome of a reaction, will result in a variation. A variation will be described in the same way as a method. If there are several variations of a method, Method *n* as a heading (with introductory text only) is followed by Variation 1 (including introductory text, scheme, table of examples, experimental procedure), Variation 2, etc.

An example of how to organize the text will be provided which will reflect the organization of the category concerned.

### 5.2.3 Classification of Products into Compound Categories

#### Rule 2 Categories

All organic compounds are organized into six categories:

- Category 1: *Organometallics (Vols 1–8)*
- Category 2: *Hetarenes and Related Ring Systems (Vols 9–17)*
- Category 3: *Four and Three Carbon–Heteroatom Bonds (Vols 18–24)*
- Category 4: *Two Carbon–Heteroatom Bonds (Vols 25–33)*
- Category 5: *One Carbon–Heteroatom Bond (Vols 34–42)*
- Category 6: *All-Carbon Functions (Vols 43–48)*

The priority among the categories corresponds to their order, with organometallics at the top. Category 1 focuses on organometallic and other metal-containing species that are important for synthetic transformations. The assignment of a functional group to Categories 3–5 is determined by the highest number of carbon–heteroatom (C–X) bonds to a single carbon atom, which can be either the carbon atom of attachment (e.g., C–OH, Category 5) or one in the functional group (e.g., CO<sub>2</sub>H, Category 3). This corresponds roughly to the standard classification by oxidation state into carbonic acid derivatives, carboxylic acid derivatives, ketone derivatives, etc.

*Example:* Compounds with a carbon–metal bond formed are treated in Category 1. Organic compounds with a heteroatom–metal bond formed, however, are treated in Categories 2–5 with the corresponding heteroatom functional group; carboxylates, enolates, and alcoholates, for example, are covered in Categories 3, 4, and 5, respectively.

### 5.2.4 General Rules for the Classification of Products within Categories

#### Rule 3 Isolable Products

In general, only isolable products are included in the organizational scheme; intermediates are dealt with under mechanistic considerations for individual synthetic methods. Exceptions are key organometallic intermediates in reactions that form a metal-free product and important reactive intermediates that are formed in situ (e.g., some ylides and ketenes).

#### Rule 4 Heteroatoms

For the purposes of classification in *Science of Synthesis*, the following elements are considered to be “heteroatoms”: F, Cl, Br, I, O, S, Se, Te, N, P (Scheme 2).

Scheme 2

1												18					
1 H	2											13	14	15	16	17	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	3	4	5	6	7	8	9	10	11	12	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 #La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 §Ac	104 Unq	105 Unp	106 Unh												

# Lanthanide Series

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
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§ Actinide Series

90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr
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All other elements (except C and H) are classified as metals and their compounds with carbon are found in Category 1 (note that B, Si, and As are classified with the metals).

#### Rule 5 Multifunctional Compounds

In multifunctional compounds, the functional group produced by a given method determines the location of that compound in *Science of Synthesis*; other remote functional groups within this compound that remain unchanged are neglected in the classification, even if they have a higher priority.

*Exception:* See Rule 10 below for the geminal attachment of two functional groups to one carbon.

#### Rule 6 Two or More Functional Groups

When two or more functional groups are produced at the same time, the assignment to one of the six categories is determined by the functional group with the highest priority.

#### Rule 7 C–X and C–C $\pi$ -Bonds

Functional groups containing C–X and C–C  $\pi$ -bonds (e.g., C=C–X) are classified according to the highest number of both of these types of bonds to a single carbon atom, i.e. the C–C  $\pi$ -bond is treated as an additional C–X bond.

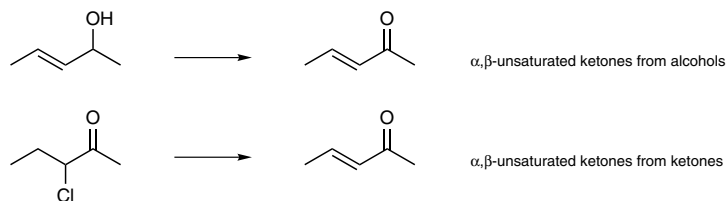
*Example:* Enol derivatives are found in the same category as ketones (Category 4). 1,2-Dihaloalkenes (X–C=C–X) are also found in Category 4, while 1,1,2-trihaloalkenes (X–C=CX<sub>2</sub>) are found in Category 3.

Within a category, the true C–X bond takes precedence over the C–C  $\pi$ -bond, e.g. CX<sub>2</sub> > C=C–X within Category 4 (see Rule 12).

**Rule 8 Extended  $\pi$ -Conjugation**

Structural units with extended  $\pi$ -conjugation are considered as a single functional group and are usually treated in a separate section.

*Example:* Syntheses of  $\alpha,\beta$ -unsaturated ketones are found in Category 4, regardless of which part of the structural unit is produced by the method (Scheme 3).

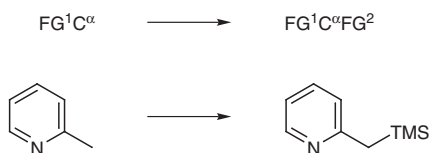
**Scheme 3****Rule 9 Conjugated Functional Group**

When a conjugated functional group reacts, the classification is determined by the functional group in the product with the higher priority.

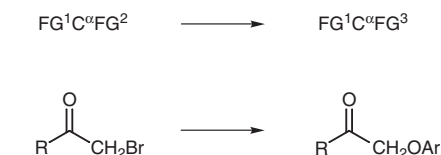
*Example:* The reduction of the C=C bond of an  $\alpha,\beta$ -unsaturated ketone is covered under “ketones from  $\alpha,\beta$ -unsaturated ketones” and not under “alkanes from alkenes”.

**Rule 10 The  $\alpha$ -Rule**

For reactions at the carbon  $\alpha$  to a  $\pi$ -functional group (FG<sup>1</sup>, e.g., arene, heteroarene, CO<sub>2</sub>H, C=O, C=N, C=C, Scheme 4) resulting in the formation of any second functional group (FG<sup>2</sup>, e.g., OH, SR)

**Scheme 4**

or transforming a second functional group (FG<sup>2</sup>, Scheme 5),

**Scheme 5**

the choice of higher priority between FG<sup>1</sup> and FG<sup>2</sup> or between FG<sup>1</sup> and FG<sup>3</sup> in the product determines the classification. In Scheme 4, silicon has the higher priority, while in Scheme 5 the ketone has the higher priority.

*Example:* All reactions  $\alpha$  to a heteroaromatic ring, except the formation of a C–M product, are found in Category 2 with the heteroarene under consideration. Monohalogenation of ketones is covered under ketones (Category 4), not under halides (Category 5), while  $\alpha$ -alkoxycarbonylation of ketones is covered under esters (Category 3). Syntheses of allylic and benzylic alcohols are covered with alcohols in Category 5.

### 5.2.5 Organization of Product Classes within the Categories

The organization within the six categories is based on the following priority rules:

#### Rule 11 Priority Among Elements

All metals have a higher priority than all heteroatoms (see Rule 4). With this in mind, the groups of elements of the periodic table have decreasing priority from right to left and then within each group decreasing priority from top to bottom.

*Example:* O > S > Se > N > P

#### Rule 12 Priority Among Functional Groups

Priority among functional groups is determined firstly by the highest number of true C–X (or C–M) bonds to a single carbon atom and secondly by the highest number of  $\pi$ -bonds to a single carbon atom (i.e.,  $sp > sp^2 > sp^3$ ). If two functional groups are equal according to the above, further carbon atoms in the functional groups are compared until a difference is found.

*Example:* C=X > C=C–X and C≡X > C≡C–X (more true C–X bonds to one carbon); C≡X > CX<sub>3</sub> (hybridization); X–C=C–X > C=C–X (number of C–X bonds to further carbon atoms); C=C–C=C > C=C and C≡C > C=C=C (hybridization of further carbon atoms).

#### Rule 13 Priority for a Carbon-Bound Heteroatom

The priority for a carbon-bound heteroatom X is generally determined by the sequence –X–H > –X–M (metal priorities as above) > –X–C > –X–Y (priorities of heteroatoms Y as above) and the oxidation state of heteroatom X. The order in specific volumes, however, may deviate from this rule, based on the nature of the compound class under consideration. Therefore, the tables of contents of the individual volumes covering organosulfur, organonitrogen, and organophosphorus compounds should be referred to.

*Example:* ROH > ROM > ROR > ROOH and R–SO<sub>3</sub>–H > R–SO<sub>2</sub>–H > RSOH.

### 5.2.6 Organization of Methods and Variations within the Product Classes

#### Rule 14 Organization of Methods and Variations

In Categories 1 and 3–6, methods and variations within a given product class or product subclass are organized where applicable in the hierarchical fashion presented below (x: volume, y: product class, z: product subclass). The headings/subheadings are guidelines for the organization of the various methods, and need not be adopted verbatim in the text. For the purpose of prioritizing reactions involving more than one component (e.g., exchange and addition reactions), the component which is to be modified is defined as the one containing the functional group belonging to the product class y, irrespective of the priority of other groups involved (actively or passively) in the transformation. For methods which in most respects are similar (e.g., substitution reactions involving the transformation of identical highest priority components), chemical common sense should take precedence and further ordering is left to the discretion of the author and/or volume editor.

**Synthesis by Substitution**

- x.y.z.1 Of Hydrogen (includes oxidation  $C-H \rightarrow C-OH$ )
- x.y.z.2 Of Organometallic Groups
- x.y.z.3 Of Carbon Functionalities (if two functionalities are involved, the one of highest rank decides)
- x.y.z.4 Of Heteroatoms

**Synthesis by Elimination**

- x.y.z.5 Of Hydrogen Priority: (1)  $H_2$ , (2)  $H-M$ , (3)  $H-R$ , (4)  $H-X$
- x.y.z.6 Of Organometallic Groups ( $M-C$  or  $M-X$ )
- x.y.z.7 Of Carbon Functionalities
- x.y.z.8 Of Heteroatoms (includes Wittig reaction)

**Synthesis by Addition Reactions** (includes  $C-C$  cleavage)

- x.y.z.9 Of Hydrogen Priority: (1)  $H_2$ , (2)  $H-M$ , (3)  $H-R$ , (4)  $H-X$
- x.y.z.10 Of Organometallic Groups ( $M-C$  or  $M-X$ )
- x.y.z.11 Of Carbon Functionalities
- x.y.z.12 Of Heteroatoms (includes carbonyl  $\rightarrow$  acetal)

**Synthesis by Rearrangement**

- x.y.z.13
- x.y.z.14 **Synthesis with Retention of the Functional Group** (e.g., introduction or elimination of a second group, chain elongation, transesterification)

**Rule 15 Organization of Methods and Variations within Category 1**

The following points should be taken into consideration when preparing a manuscript for the organometallics category.

**Product Class:** For each metal there will be a separate product class. However, transition metals with closely related chemistry can be described in one product class to avoid redundancy of the methods described. The introductory texts for each product class should include problems of preparation, stability, and reactivity and be followed by a discussion on the scope of the reactions which employ the described product class, utility/versatility in organic synthesis, and whether the reaction is catalytic or stoichiometric.

**Product Subclass:** Product classes will be divided into product subclasses depending on the ligands of the metal. Product subclasses should be ordered with descending hapticity of the ligands. Charged complexes should be ordered within product subclasses as follows: (1) neutral, (2) anionic, (3) radical anion, (4) radical, (5) radical cation, (6) cationic. It is recognized that the concept of charge of an organometallic species can in some cases only be applied to the extent possible, i.e. for defined conditions (e.g., for a defined polarity of the solvents).

The oxidation state of the metal should be used for the description of the product subclasses.

For each product subclass two aspects can be described: **Synthesis of the Product Subclass** and **Applications of the Product Subclass in Organic Synthesis**. For similar treatment within Categories 3–6, see Rule 17.

**Synthesis of the Product Subclass:** Methods should be organized according to the organizational principles described in Rule 14.

**Applications of the Product Subclass in Organic Synthesis:** In this section typical methods for the use of the product subclass in organic synthesis can be described, if the prod-

uct subclass in question is synthetically important. Reactions involving catalytic amounts of an organometallic complex or an uncharacterized intermediate should be given as methods. These methods usually give products that belong to other product classes within different categories of *Science of Synthesis*. These other product classes will also be discussed extensively in the appropriate category of *Science of Synthesis*, but in the organometallics category emphasis will be placed on the role of the organometallic complex. The organometallic volumes also contain inorganic compounds, metal compounds without a formal metal–carbon bond, that are significant for synthetic chemistry. The inorganic compound is conveniently covered together with true organometallics of similar structure (e.g.,  $\text{AlH}_3$  with  $\text{R}_2\text{AlH}$ ). For those compounds that are readily available commercially, methods for their synthesis can be neglected such that only methods for their applications in organic synthesis are included. To the extent that an inorganic reagent is used mainly for metalation, then the principal treatment will come under the organometallic intermediate: its synthesis (using the inorganic reagent) and its further applications in organic synthesis.

**Ranking of applied methods** should be carried out:

1. according to Rule 14 (preferred)
2. according to the product group being discussed  
(e.g., see *Science of Synthesis*, Volume 4, Section 4.4.12:
  - 4.4.12 Product Subclass 12: Haloorganosilanes...  
Applications of Product Subclass 12 in Organic Synthesis
  - 4.4.12.9 Fluoroorganosilanes
  - 4.4.12.10 Chloroorganosilanes
  - 4.4.12.11 Bromoorganosilanes
  - 4.4.12.12 Iodoorganosilanes)
3. according to the product produced (see Section 6.2.4 and Section 6.2.5)

An example of this would be the synthesis of dialkylzinc compounds and the use of dialkylzinc compounds in the synthesis of secondary alcohols. In *Science of Synthesis* this would be dealt within the organometallics category as follows:

<b>Category 1:</b>	Organometallics
<b>Volume 3:</b>	Compounds of Groups 12 and 11 (Zn, Cd, Hg, Cu, Ag, Au)
<b>Product Class:</b>	Organometallic Complexes of Zinc
<b>Product Subclass:</b>	Metal $\sigma$ -Alkyl Homoleptic Complexes <i>Synthesis of Product Subclass:</i>
<b>Method x:</b>	Synthesis of Dialkylzinc Compounds <i>Applications of Product Subclass in Organic Synthesis:</i>
<b>Method x:</b>	Synthesis of Secondary Alcohols Using Dialkylzinc Compounds

There would also be a duplicate entry present in the one carbon–heteroatom bond category as follows:

<b>Category 5:</b>	Compounds with One Carbon–Heteroatom Bond
<b>Volume 36:</b>	Alcohols
<b>Product Class:</b>	Secondary Alcohols
<b>Method x:</b>	Synthesis of Secondary Alcohols Using Transition Metals



The **table of contents** should take the following format:

	<b>Category 1: Organometallics</b>
<b>x</b>	<b>Volume X</b>
<b>x.y</b>	<b>Product Class Y: Organometallic Complexes of Metal X</b>
<b>x.y.1</b>	<b>Product Subclass 1: Metal–Arene Complexes</b> <i>Synthesis of Product Subclass 1</i>
<b>x.y.1.1</b>	<b>Method 1</b> <i>Applications of Product Subclass 1 in Organic Synthesis</i>
<b>x.y.1.n</b>	<b>Method n</b>
<b>x.y.2</b>	<b>Product Subclass 2: Metal–Triene Complexes</b> <i>Synthesis of Product Subclass 2</i>
<b>x.y.2.1</b>	<b>Method 1</b> <i>Applications of Product Subclass 2 in Organic Synthesis</i>
<b>x.y.2.n</b>	<b>Method n</b>
<b>x.y.3</b>	<b>Product Subclass 3: Metal–Dienyl Complexes</b> <i>Synthesis of Product Subclass 3</i>
<b>x.y.3.1</b>	<b>Method 1</b> <i>Applications of Product Subclass 3 in Organic Synthesis</i>
<b>x.y.3.n</b>	<b>Method n</b>
<b>x.y.4</b>	<b>Product Subclass 4: Metal–Diene Complexes</b> <i>Synthesis of Product Subclass 4</i>
<b>x.y.4.1</b>	<b>Method 1</b> <i>Applications of Product Subclass 4 in Organic Synthesis</i>
<b>x.y.4.n</b>	<b>Method n</b>
<b>x.y.5</b>	<b>Product Subclass 5: Metal–Allyl Complexes</b> <i>Synthesis of Product Subclass 5</i>
<b>x.y.5.1</b>	<b>Method 1</b> <i>Applications of Product Subclass 5 in Organic Synthesis</i>
<b>x.y.5.n</b>	<b>Method n</b>
<b>x.y.6</b>	<b>Product Subclass 6: Metal–Alkyne Complexes</b> <i>Synthesis of Product Subclass 6</i>
<b>x.y.6.1</b>	<b>Method 1</b> <i>Applications of Product Subclass 6 in Organic Synthesis</i>
<b>x.y.6.n</b>	<b>Method n</b>
<b>x.y.7</b>	<b>Product Subclass 7: Metal–Alkene Complexes</b> <i>Synthesis of Product Subclass 7</i>
<b>x.y.7.1</b>	<b>Method 1</b> <i>Applications of Product Subclass 7 in Organic Synthesis</i>
<b>x.y.7.n</b>	<b>Method n</b>
<b>x.y.8</b>	<b>Product Subclass 8: Metal–Carbene Complexes</b> <i>Synthesis of Product Subclass 8</i>
<b>x.y.8.1</b>	<b>Method 1</b> <i>Applications of Product Subclass 8 in Organic Synthesis</i>
<b>x.y.8.n</b>	<b>Method n</b>
<b>x.y.9</b>	<b>Product Subclass 9: Metal–Carbyne Complexes</b> <i>Synthesis of Product Subclass 9</i>
<b>x.y.9.1</b>	<b>Method 1</b> <i>Applications of Product Subclass 9 in Organic Synthesis</i>
<b>x.y.9.n</b>	<b>Method n</b>
<b>x.y.10</b>	<b>Product Subclass 10: Metal <math>\sigma</math>-Alkyl Homoleptic Complexes</b> <i>Synthesis of Product Subclass 10</i>

x.y.10.1	<b>Method 1</b> <i>Applications of Product Subclass 10 in Organic Synthesis</i>
x.y.10.n	<b>Method n</b>
x.y.11	<b>Product Subclass 11: Metal <math>\sigma</math>-Alkyl Non-Homoleptic Complexes</b> <i>Synthesis of Product Subclass 11</i>
x.y.11.1	<b>Method 1</b> <i>Applications of Product Subclass 11 in Organic Synthesis</i>
x.y.11.n	<b>Method n</b>
x.y.12	<b>Product Subclass 12: Miscellaneous Complexes</b> (i.e., carbonyl complexes, amine complexes, etc.) <i>Synthesis of Product Subclass 12</i>
x.y.12.1	<b>Method 1</b> <i>Applications of Product Subclass 12 in Organic Synthesis</i>
x.y.12.n	<b>Method n</b>

#### Rule 16      **Organization of Methods and Variations within Category 2**

Category 2 includes fully unsaturated heterocycles with no  $sp^3$  carbon or heteroatoms not capable of conjugation, such as  $P\lambda^5$  or  $S\lambda^6$  in a five-membered ring. Compounds with a formal charge, such as pyrylium ion, are included. Compounds that satisfy the  $4n + 2$  rule via tautomeric forms and mesoionic compounds are also included. Systems that cannot be aromatic because of saturated carbon in the ring, such as 1,3-dioxine or oxete, as well as saturated or partially unsaturated heterocycles, are not covered in Category 2. Such systems are integrated into the coverage in Categories 3–5 where appropriate.

*Science of Synthesis* organizes hetarenes in the order of preference:

1. ring size, from smaller to larger,
2. number of heteroatoms, from less to more,
3. kind of heteroatoms in the order of preference: O, S, Se, Te, N, P,
4. valence of like heteroatoms, from higher to lower, such as  $P\lambda^5 > P\lambda^3$  and  $S\lambda^4 > S\lambda^2$ ,
5. annulated hetarenes directly after the corresponding monocyclic hetarene, e.g. oxazole, then benzoxazole,
6. (1) neutral, (2) anionic, (3) radical anion, (4) radical, (5) radical cation, (6) cationic.

Those fused hetarenes that are covered in *Science of Synthesis* as Product Classes or Subclasses are organized according to the ring size of the smallest hetarene component and the number and kind of heteroatoms in that ring, from less to more, as above for monocyclic hetarenes.

When the number and kind of heteroatoms are the same, the order follows the lowest numbers in the name from left to right until a difference is found, i.e. 1,2,3 then 1,2,4 then 1,3,2 then 1,4,2 etc. When trivial names are used, which do not contain numbers in the name, the order follows the lowest numbers for the heteroatoms; e.g. isoxazole (1,2-oxazole) then oxazole (1,3-oxazole).

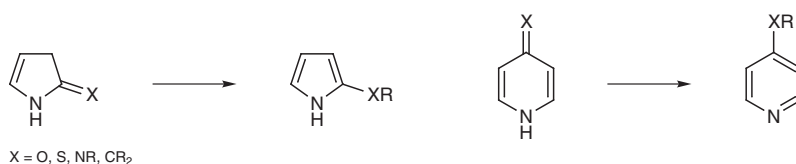
Coverage should concentrate on the synthesis of the heterocyclic system in question. The main subdivisions for a given Product Class or Subclass are “Synthesis by Ring-Closure Reactions”, “Synthesis by Ring Transformation”, “Aromatization”, and “Synthesis by Substituent Modification”, as shown below. The methods involving ring closure are organized according to the number and kinds of bonds formed; in cases of ambiguity arising from the presence of intermediates, it is at the discretion of the author to decide how many bonds are formed. The methods involving substituent modification are restricted to those relevant to the synthesis of specifically functionalized compounds.

In the coverage of an annulated hetarene, the examples chosen to illustrate a given method could include not only the benzo derivative, but also other areno and hetareno derivatives to the extent that this inclusion helps to show the scope and limitations of the method.

This leads to the following general arrangement for a **monocyclic hetarene**:

<b>x.y</b>	<b>Product Class Y</b>
	<b>Introductory Text</b>
	Nomenclature, history, applications, reviews (including location in <i>Houben–Weyl</i> ), structure (including tautomerism, ring–chain equilibrium), stability (thermally, towards oxidation/reduction), reactivity (including acidity/basicity, ease of addition and substitution reactions), physical properties, spectroscopic characteristics, safety and environmental aspects
<b>x.y.1</b>	<b>Synthesis by Ring-Closure Reactions</b>
<b>x.y.1.1</b>	By Formation of Three Bonds [Priority: (1) Hetero–Hetero Bond, (2) Hetero–Carbon Bond, (3) Carbon–Carbon Bond; priority of heteroatoms follows Rule 4 and Rule 11]
<b>x.y.1.2</b>	By Formation of Two Hetero–Hetero Bonds (includes cycloadditions; if more than one type of Hetero–Hetero Bond then further ranking according to <i>Science of Synthesis</i> priority rules; further subdivision according to starting material following <i>Science of Synthesis</i> priority rules, e.g. synthesis from CX <sub>4</sub> -, CX <sub>3</sub> -, CX <sub>2</sub> -, CX-hydrocarbon. Reactions involving a final aromatization step are also included here)
<b>x.y.1.3</b>	By Formation of One Heteroatom–Heteroatom and One Heteroatom–Carbon Bond
<b>x.y.1.4</b>	By Formation of Two Heteroatom–Carbon Bonds
<b>x.y.1.5</b>	By Formation of Two C–C Bonds
<b>x.y.1.6</b>	By Formation of One Heteroatom–Heteroatom Bond
<b>x.y.1.7</b>	By Formation of One Heteroatom–Carbon Bond
<b>x.y.1.8</b>	By Formation of One C–C Bond (order of subsections following the nomenclature of the heterocycle, i.e. C1–C2 first, then C2–C3, etc.)
<b>x.y.2</b>	<b>Synthesis by Ring Transformation</b> [ring enlargement, formal exchange of ring members with retention of ring size, ring contraction; ranking of hetarenes according to the priorities given above]
<b>x.y.3</b>	<b>Aromatization (by Oxidation of Dehydro Compounds or Elimination Reactions)</b>
<b>x.y.4</b>	<b>Synthesis by Substituent Modification</b>
<b>x.y.4.1</b>	Substitution of Existing Substituents
<b>x.y.4.1.1</b>	Of Hydrogen [Priority: (1) H/D exchange, (2) metalation, (3) Friedel–Crafts and the like, (4) halogenation, chalcogens, N, P. In tautomeric systems possible loss of the aromatic character.]
<b>x.y.4.1.2</b>	Of Metals [Priority: (1) M → H, (2) transmetalation (cross-reference to Category 1), (3) M → C, (4) M → heteroatom]
<b>x.y.4.1.3</b>	Of Carbon Functionalities (e.g., decarboxylation ... dealkylation, following <i>Science of Synthesis</i> priority rules)
<b>x.y.4.1.4</b>	Of Heteroatoms
<b>x.y.4.2</b>	Addition Reactions (not involving ring modification since this should be included elsewhere, i.e. in the chapter on the ring system which is obtained)
<b>x.y.4.2.1</b>	Protonation

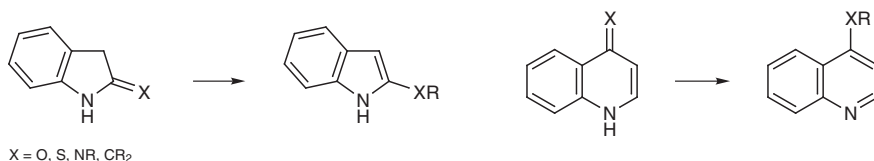
- x.y.4.2.2** Addition of Organic Groups  
(e.g., N-alkylation)
- x.y.4.2.3** Addition of Heteroatoms  
(e.g., N-oxidation)
- x.y.4.3** Rearrangement of Substituents
- x.y.4.4** Modification of Substituents  
[typically only at the  $\alpha$ -atom since modification at other sites would not be expected to be dependent on the heterocyclic ring system, e.g. oxidation at the  $\alpha$ -carbon; reactions converting an exocyclic double bond into an endocyclic double bond are also included here (Scheme 6), unless they are part of the ring-closure-reaction sequences covered in Section x.y.1]

**Scheme 6**

Similarly, this leads to the following general arrangement for an **annulated hetarene**:

- x.y** **Product Class Y**  
**Introductory Text**  
Nomenclature, history, applications, reviews (including location in *Houben-Weyl*), structure (including tautomerism, ring-chain equilibrium), stability (thermally, towards oxidation/reduction), reactivity (including acidity/basicity, ease of addition and substitution reactions), physical properties, spectroscopic characteristics, safety and environmental aspects
- x.y.1** **Synthesis by Ring-Closure Reactions**
- x.y.1.1** By Annulation to an Arene
- x.y.1.1.1** By Formation of Three Bonds  
[Priority: (1) Heteroatom—Heteroatom Bond, (2) Heteroatom—Carbon Bond, (3) C—C Bond; priority of heteroatoms follows Rule 4 and Rule 11]
- x.y.1.1.2** By Formation of Two Heteroatom—Heteroatom Bonds  
(includes cycloadditions; if more than one type of Hetero—Hetero Bond then further ranking according to *Science of Synthesis* priority rules; further subdivision according to starting material following *Science of Synthesis* priority rules, e.g. synthesis from CX<sub>4</sub>-, CX<sub>3</sub>-, CX<sub>2</sub>-, CX-hydrocarbon. Also reactions involving a final aromatization step are included here)
- x.y.1.1.3** By Formation of One Heteroatom—Heteroatom and One Heteroatom—Carbon Bond
- x.y.1.1.4** By Formation of Two Heteroatom—Carbon Bonds
- x.y.1.1.5** By Formation of Two C—C Bonds
- x.y.1.1.6** By Formation of One Heteroatom—Heteroatom Bond
- x.y.1.1.7** By Formation of One Heteroatom—Carbon Bond
- x.y.1.1.8** By Formation of One C—C Bond  
(order of subsections following nomenclature of the heterocycle, i.e. C1—C2 first, then C2—C3, etc.)
- x.y.1.2** By Annulation to the Heterocyclic Ring
- x.y.2** **Synthesis by Ring Transformation**  
[ring enlargement, formal exchange of ring members with retention of the ring size, ring contraction, ranking of hetarenes according to the priorities given above]
- x.y.3** **Aromatization (by Oxidation of Dehydro Compounds or Elimination Reactions)**

- x.y.4**            **Synthesis by Substituent Modification**
- x.y.4.1**            Substitution of Existing Substituents
- x.y.4.1.1**            Of Hydrogen  
[Priority: (1) H/D exchange, (2) metalation, (3) Friedel–Crafts and the like, (4) halogenation, chalcogens, N, P. In tautomeric systems possible loss of the aromatic character.]
- x.y.4.1.2**            Of Metals  
[Priority: (1) M → H, (2) transmetalation (cross-reference to Category 1), (3) M → C, (4) M → heteroatom]
- x.y.4.1.3**            Of Carbon Functionalities  
(e.g., decarboxylation ... dealkylation, following *Science of Synthesis* priority rules)
- x.y.4.1.4**            Of Heteroatoms
- x.y.4.2**            Addition Reactions  
(not involving ring modification since this should be included elsewhere, i.e. in the chapter on the ring system which is obtained)
- x.y.4.2.1**            Protonation
- x.y.4.2.2**            Addition of Organic Groups  
(e.g., N-alkylation)
- x.y.4.2.3**            Addition of Heteroatoms  
(e.g., N-oxidation)
- x.y.4.3**            Rearrangement of Substituents
- x.y.4.4**            Modification of Substituents  
[typically only at the  $\alpha$ -atom since modification at other sites would not be expected to be dependent on the heterocyclic ring system, e.g. oxidation at the  $\alpha$ -carbon; reactions converting an exocyclic double bond into an endocyclic double bond are also included here (Scheme 7), unless they are part of the ring-closure-reaction sequences covered in Section x.y.1]

**Scheme 7****Rule 17            Organization of Methods and Variations within Categories 3–6**

Categories 3–6 present the methods for the synthesis of organic compounds organized according to the functional group or groups prepared in the product. The underlying organizational principle is the oxidation state, i.e. all compounds are organized into product classes and product subclasses according to descending oxidation state (see Classification Principles, Section 6.2.1).

Methods and variations within those product classes and subclasses are organized according to Rule 14 (Section 6.2.6).

For some compounds, the principal interest to the synthetic chemist is their use as reagents, synthetic building blocks, catalysts, promoters, ligands, or auxiliaries. Some reagents may also be highly reactive intermediates, which are not isolated (e.g., some ylides and ketenes). In such cases, synthesis of the product class (or product subclass) and applications of the product class (or product subclass) in organic synthesis should be described. The methods for their application will give products that belong to other product classes within other categories of *Science of Synthesis*, but in the section in question the emphasis will be placed on the role of the product class or product subclass covered.

**Ranking of applied methods** should be carried out:

1. according to the product produced (preferred; see Section 6.2.4 and Section 6.2.5)
2. according to Rule 14
3. according to the product being discussed (e.g., see *Science of Synthesis*, Volume 4, Section 4.4.12:
  - 4.4.12 Product Subclass 12: Haloorganosilanes...
    - 4.4.12.9 Applications of Product Subclass 12 in Organic Synthesis
      - 4.4.12.9 Fluoroorganosilanes
      - 4.4.12.10 Chloroorganosilanes
      - 4.4.12.11 Bromoorganosilanes
      - 4.4.12.12 Iodoorganosilanes

The **table of contents** should take the following format:

<b>x</b>	<b>Volume x</b>
<b>x.y</b>	<b>Product Class y</b>
<b>x.y.1</b>	<b>Product Subclass 1</b>
<b>x.y.1.1</b>	<b>Synthesis of Product Subclass 1</b>
<b>x.y.1.1.1</b>	<b>Method 1</b>
<b>x.y.1.1.n</b>	<b>Method n</b>
<b>x.y.1.2</b>	<b>Applications of Product Subclass 1 in Organic Synthesis</b>
<b>x.y.1.2.1</b>	<b>Method 1</b>
<b>x.y.1.2.n</b>	<b>Method n</b>
<b>x.y.2</b>	<b>Product Subclass 2</b>
<b>x.y.n</b>	<b>Product Subclass n</b>
<b>x.n</b>	<b>Product Class n</b>

Note this is a similar format to Category 1 (see Rule 15), except section numbers are included for Synthesis of Product Subclass and Applications of Product Subclass headings.

### 5.2.7 Examples within Methods and Variations

The scope and limitations of a method or variation should be illustrated with several examples. The accompanying reaction scheme(s) should be made as general as possible by the use of X, R<sup>1</sup>, R<sup>2</sup>, etc. as substituents. If individual examples from a general scheme need to be discussed in the main text, then a table should be employed to present relevant data (e.g., R-groups, reaction conditions, solvents, chemical yield, optical purity, etc.) for the examples. If individual examples are not actively referred to in the main text, they should be presented in a scheme table if six or more examples are chosen, or they should simply be illustrated within the scheme itself if only a few examples are employed. Full details of the use, construction, and placement within the manuscript of tables, scheme tables, and schemes are given in the **Manuscript Preparation** section.

#### Rule 18 Organization of Examples within Methods and Variations

Irrespective of the mode of presentation (see above), individual examples used to highlight methods and variations should be listed in an order which the author and/or volume editor believe best illustrates the scope and limitations of each method or variation (e.g., they may be listed in increasing order of substituent/reagent complexity, or in increasing order of chemical or optical yield).

**Rule 19      Extent of Polymer Coverage**

Polymers are considered to be an important class of compounds although they are not traditional target molecules for chemists working in the field of organic synthesis. However, a thorough, synthetic, and comprehensive treatment of polymers is beyond the scope of the *Science of Synthesis* series. The focus of *Science of Synthesis* is on the synthesis of important monomeric molecular species. A compromise has been reached by covering the most important methods for polymer synthesis including introductory text together with leading references to more comprehensive reviews, handbooks, and the original literature.

## 5.3

## Chemical and General Abbreviations Used in *Science of Synthesis*

### Chemical

Name Used in Text	Abbreviation Used in Tables and on Arrow in Schemes	Abbreviation Used in Experimental Procedures
( <i>R</i> )-1-amino-2-(methoxymethyl)pyrrolidine	RAMP	RAMP
( <i>S</i> )-1-amino-2-(methoxymethyl)pyrrolidine	SAMP	SAMP
ammonium cerium(IV) nitrate	CAN	CAN
2,2'-azobisisobutyronitrile	AIBN	AIBN
barbituric acid	BBA	BBA
benzyltriethylammonium bromide	TEBAB	TEBAB
benzyltriethylammonium chloride	TEBAC	TEBAC
<i>N,O</i> -bis(trimethylsilyl)acetamide	BSA	BSA
9-borabicyclo[3.3.1]nonane	9-BBNH	9-BBNH
borane–dimethyl sulfide complex	BMS	BMS
<i>N</i> -bromosuccinimide	NBS	NBS
<i>tert</i> -butyldimethylsilyl chloride	TBDMSCI	TBDMSCI
<i>tert</i> -butyl peroxybenzoate	TBPB	<i>tert</i> -butyl peroxybenzoate
10-camphorsulfonic acid	CSA	CSA
chlorosulfonyl isocyanate	CSI	chlorosulfonyl isocyanate
3-chloroperoxybenzoic acid	MCPBA	MCPBA
<i>N</i> -chlorosuccinimide	NCS	NCS
chlorotrimethylsilane	TMSCI	TMSCI
1,4-diazabicyclo[2.2.2]octane	DABCO	DABCO
1,5-diazabicyclo[4.3.0]non-5-ene	DBN	DBN
1,8-diazabicyclo[5.4.0]undec-7-ene	DBU	DBU
dibenzoyl peroxide	DBPO	dibenzoyl peroxide
dibenzylideneacetone	dba	dba
di- <i>tert</i> -butyl azodicarboxylate	DBAD	di- <i>tert</i> -butyl azo-dicarboxylate
2,3-dichloro-5,6-dicyanobenzo-1,4-quinone	DDQ	DDQ
dichloromethyl methyl ether	DCME	DCME
dicyclohexylcarbodiimide	DCC	DCC
<i>N,N</i> -diethylaminosulfur trifluoride	DAST	DAST
diethyl azodicarboxylate	DEAD	DEAD
diethyl tartrate	DET	DET
2,2'-dihydroxy-1,1'-binaphthyllithium aluminum hydride	BINAL-H	BINAL-H
diisobutylaluminum hydride	DIBAL-H	DIBAL-H
diisopropyl tartrate	DIPT	DIPT
1,2-dimethoxyethane	DME	DME



**Chemical** (cont.)

Name Used in Text	Abbreviation Used in Tables and on Arrow in Schemes	Abbreviation Used in Experimental Procedures
dimethylacetamide	DMA	DMA
dimethyl acetylenedicarboxylate	DMAD	DMAD
2-(dimethylamino)ethanol	Me <sub>2</sub> N(CH <sub>2</sub> ) <sub>2</sub> OH	2-(dimethylamino)ethanol
4-(dimethylamino)pyridine	DMAP	DMAP
dimethylformamide	DMF	DMF
dimethyl sulfide	DMS	DMS
dimethyl sulfoxide	DMSO	DMSO
di- <i>tert</i> -butyl peroxide	DTBP	DTBP
1,3-dimethyl-3,4,5,6-tetrahydro-pyrimidin-2(1 <i>H</i> )-one	DMPU	DMPU
ethyl diazoacetate	EDA	EDA
ethylenediaminetetraacetic acid	edta	edta
hexamethylphosphoric triamide	HMPA	HMPA
hexamethylphosphorous triamide	HMPT	HMPT
iodomethane	MeI	MeI
<i>N</i> -iodosuccinimide	NIS	NIS
lithium diisopropylamide	LDA	LDA
lithium hexamethyldisilazane	LiHMDS	LiHMDS
lithium isopropylcyclohexylamide	LICA	LICA
lithium 2,2,6,6-tetramethylpiperidide	LTMP	LTMP
lutidine	lut	lut
methylaluminum bis(2,6-di- <i>tert</i> -butyl-4-methylphenoxide)	MAD	MAD
methyl ethyl ketone	MEK	methyl ethyl ketone
<i>N</i> -methylmaleimide	NMM	NMM
4-methylmorpholine <i>N</i> -oxide	NMO	NMO
1-methylpyrrolidin-2-one	NMP	NMP
methyl vinyl ketone	MVK	methyl vinyl ketone
petroleum ether	PE <sup>a</sup>	petroleum ether
<i>N</i> -phenylmaleimide	NPM	NPM
polyphosphoric acid	PPA	PPA
polyphosphate ester	PPE	polyphosphate ester
potassium hexamethyldisilazane	KHMDS	KHMDS
pyridine	pyridine <sup>b</sup>	pyridine
pyridinium chlorochromate	PCC	PCC
pyridinium dichromate	PDC	PDC
pyridinium 4-toluenesulfonate	PPTS	PPTS
sodium bis(2-methoxyethoxy)aluminum hydride	Red-Al	Red-Al
tetrabutylammonium bromide	TBAB	TBAB

<sup>a</sup> Used to save space; abbreviation must be defined in a footnote.<sup>b</sup> py used on arrow in schemes.

**Chemical** (cont.)

Name Used in Text	Abbreviation Used in Tables and on Arrow in Schemes	Abbreviation Used in Experimental Procedures
tetrabutylammonium chloride	TBACl	TBACl
tetrabutylammonium fluoride	TBAF	TBAF
tetrabutylammonium iodide	TBAI	TBAI
tetracyanoethene	TCNE	tetracyanoethene
tetrahydrofuran	THF	THF
tetrahydropyran	THP	THP
2,2,6,6-tetramethylpiperidine	TMP	TMP
trimethylamine <i>N</i> -oxide	TMANO	trimethylamine <i>N</i> -oxide
<i>N,N,N',N'</i> -tetramethylethylenediamine	TMEDA	TMEDA
tosylmethyl isocyanide	TosMIC	TosMIC
trifluoroacetic acid	TFA	TFA
trifluoroacetic anhydride	TFAA	TFAA
trimethylsilyl cyanide	TMSCN	TMSCN

**Ligands**

acetylacetonato	acac
2,2'-bipyridyl	bipy
1,2-bis(dimethylphosphino)ethane	DMPE
2,3-bis(diphenylphosphino)bicyclo[2.2.1]hept-5-ene	NORPHOS
2,2'-bis(diphenylphosphino)-1,1'-binaphthyl	BINAP
1,2-bis(diphenylphosphino)ethane	dppe (not diphos)
1,1'-bis(diphenylphosphino)ferrocene	dppf
bis(diphenylphosphino)methane	dppm
1,3-bis(diphenylphosphino)propane	dppp
1,4-bis(diphenylphosphino)butane	dppb
2,3-bis(diphenylphosphino)butane	Chiraphos
bis(salicylidene)ethylenediamine	salen
cyclooctadiene	cod
cyclooctatetraene	cot
cyclooctatriene	cte
$\eta^5$ -cyclopentadienyl	Cp
dibenzylideneacetone	dba
6,6-dimethylcyclohexadienyl	dmch
2,4-dimethylpentadienyl	dmpd
ethylenediaminetetraacetic acid	edta
isopinocampheyl	lpc
2,3- <i>O</i> -isopropylidene-2,3-dihydroxy-1,4-bis(diphenylphosphino)butane	Diop
norbornadiene (bicyclo[2.2.1]hepta-2,5-diene)	nbd
$\eta^5$ -pentamethylcyclopentadienyl	Cp*

**Radicals**

acetyl	Ac
aryl	Ar
benzotriazol-1-yl	Bt
benzoyl	Bz
benzyl	Bn
benzyloxycarbonyl	Cbz
benzyloxymethyl	BOM
9-borabicyclo[3.3.1]nonyl	9-BBN
<i>tert</i> -butoxycarbonyl	Boc
butyl	Bu
<i>sec</i> -butyl	<i>s</i> -Bu
<i>tert</i> -butyl	<i>t</i> -Bu
<i>tert</i> -butyldimethylsilyl	TBDMS
<i>tert</i> -butyldiphenylsilyl	TBDPS
cyclohexyl	Cy
3,4-dimethoxybenzyl	DMB
ethyl	Et
ferrocenyl	Fc
9-fluorenylmethoxycarbonyl	Fmoc
isobutyl	iBu
mesityl	Mes
mesyl	Ms
4-methoxybenzyl	PMB
(2-methoxyethoxy)methyl	MEM
methoxymethyl	MOM
methyl	Me
4-nitrobenzyl	PNB
phenyl	Ph
phthaloyl	Phth
phthalimido	NPhth
propyl	Pr
isopropyl	iPr
tetrahydropyranyl	THP
tolyl	Tol
tosyl	Ts
triethylsilyl	TES
triflyl, trifluoromethanesulfonyl	Tf
triisopropylsilyl	TIPS
trimethylsilyl	TMS
2-(trimethylsilyl)ethoxymethyl	SEM
trityl [triphenylmethyl]	Tr

**General**

absolute	abs
anhydrous	anhyd
aqueous	aq
boiling point	bp
catalyst	no abbreviation
catalytic	cat.
chemical shift	$\delta$
circular dichroism	CD
column chromatography	no abbreviation
concentrated	concd
configuration (in tables)	Config
coupling constant	<i>J</i>
day	d
density	<i>d</i>
decomposed	dec
degrees Celsius	°C
diastereomeric ratio	dr
dilute	dil
electron-donating group	EDG
electron-withdrawing group	EWG
electrophile	E <sup>+</sup>
enantiomeric excess	ee
enantiomeric ratio	er
equation	eq
equivalent(s)	equiv
flash-vacuum pyrolysis	FVP
gas chromatography	GC
gas chromatography–mass spectrometry	GC/MS
gas–liquid chromatography	GLC
gram	g
highest occupied molecular orbital	HOMO
high-performance liquid chromatography	HPLC
hour(s)	h
infrared	IR
in situ	in situ
in vacuo	in vacuo
lethal dosage, e.g. to 50% of animals tested	LD <sub>50</sub>
liquid	liq
liter	L
lowest unoccupied molecular orbital	LUMO
mass spectrometry	MS
medium-pressure liquid chromatography	MPLC
melting point	mp
milliliter	mL
millimole(s)	mmol
millimoles per liter	mM
minute(s)	min
mole(s)	mol
nuclear magnetic resonance	NMR
nucleophile	Nu <sup>-</sup>
optical purity	op
phase-transfer catalysis	PTC
proton NMR	<sup>1</sup> H NMR

**General** (cont.)

quantitative	quant
reference (in tables)	Ref
retention factor (for TLC)	$R_f$
retention time (chromatography)	$t_R$
room temperature	rt
saturated	sat.
solution	soln
temperature (in tables)	Temp (°C)
thin layer chromatography	TLC
ultraviolet	UV
volume (literature)	Vol.
via	via
vide infra	<i>vide infra</i>
vide supra	<i>vide supra</i>
yield (in tables)	Yield (%)

## 5.4 Journal Abbreviations

- Acc. Chem. Res.  
 Acta Biochim. Pol.  
 Acta Chem. Scand.  
 Acta Chem. Scand., Ser. A  
 Acta Chem. Scand., Ser. B  
 Acta Chim. Acad. Sci. Hung.  
 Acta Chim. Hung.  
 Acta Chim. Sin. (Engl. Ed.)  
 Acta Chim. Slov.  
 Acta Crystallogr.  
 Acta Crystallogr., Sect. A  
 Acta Crystallogr., Sect. B  
 Acta Crystallogr., Sect. C  
 Acta Pharm. Hung.  
 Acta Pharm. Jugosl.  
 Acta Pharm. Nord.  
 Acta Pharm. Suec.  
 Acta Pharm. Turc.  
 Acta Pol. Pharm.  
 Acta Univ. Palack. Olomuc.  
 Actual. Chim.  
 Actual. Chim. Ther.  
 Adv. Carbohydr. Chem.  
 Adv. Carbohydr. Chem. Biochem.  
 Adv. Catal.  
 Adv. Chem. Ser.  
 Adv. Cyloaddit.  
 Adv. Drug Res.  
 Adv. Exp. Med. Biol.  
 Adv. Free-Radical Chem. (London)  
 Adv. Heterocycl. Chem.  
 Adv. Heterocycl. Chem., Suppl. 1  
 Adv. Heterocycl. Chem., Suppl. 2  
 Adv. Inorg. Chem. Radiochem.  
 Adv. Mater. (Weinheim, Ger.)  
 Adv. Met.-Org. Chem.  
 Adv. Mol. Struct. Res.  
 Adv. Nitrogen Heterocycl.  
 Adv. Org. Chem.  
 Adv. Organomet. Chem.  
 Adv. Polym. Sci.  
 Adv. Prostaglandin, Thromboxane,  
   Leukotriene Res.  
 Adv. Protein Chem.  
 Adv. Silicon Chem.  
 Adv. Strain Org. Chem.  
 Adv. Strained Interesting Org. Mol.  
 Adv. Synth. Catal.  
 Adv. Ther.  
 Adv. Urethane Sci. Technol.  
 Aerosol Sci. Technol.  
 Afinidad  
 Agents Actions  
 Agra Univ. J. Res., Sci.  
 Agric. Biol. Chem.  
 Agrokem. Talajtan  
 Aldrichimica Acta  
 Alexandria J. Pharm. Sci.  
 Am. Chem. J.  
 Am. Heart J.  
 Am. J. Bot.  
 Am. J. Hypertens.  
 Am. J. Physiol.  
 Amino Acids  
 An. Asoc. Quim. Argent.  
 An. Fis. Quim.  
 An. Quim.  
 An. Quim. Int. Ed.  
 An. Quim., Ser. C  
 An. R. Acad. Farm.  
 An. R. Soc. Esp. Fis. Quim., Ser. B  
 An. Stiint. Univ. "Al. I. Cuza" Iasi,  
   Sect. 1c  
 An. Univ. Bucuresti, Ser. Stiint. Nat.  
 Anal. Biochem.  
 Anal. Chem.  
 Anal. Chim. Acta  
 Anal. Sci.  
 Analyst  
 Angew. Chem.  
 Angew. Chem. Int. Ed.  
 Angew. Chem. Int. Ed. Engl.  
 Angew. Chem. Suppl.  
 Angew. Makromol. Chem.  
 Ann. Chim. (Paris)  
 Ann. Chim. (Rome)  
 Ann. Chim. Phys.  
 Ann. N.Y. Acad. Sci.  
 Ann. Pharm. (Lemgo, Ger.)  
 Ann. Pharm. Fr.  
 Ann. Phys. (Paris)  
 Ann. Univ. Mariae Curie-Sklodowska,  
   Sect. AA: Chem.  
 Annu. Rep. NMR Spectrosc.  
 Annu. Rep. Sankyo Res. Lab.  
 Annu. Rev. Biochem.  
 Annu. Rev. Biophys. Biomol. Struct.  
 Annu. Rev. Mater. Sci.  
 Antibiot. Annu.  
 Antibiot. Chemother.  
   (Washington, D. C.)  
 Anti-Cancer Drug Des.  
 Anti-Cancer Drugs  
 Anticancer Res.  
 Antimicrob. Agents Chemother.  
 Antiviral Chem. Chemother.  
 Appl. Catal., A  
 Appl. Fluoresc. Technol.  
 Appl. Geochem.  
 Appl. Microbiol. Biotechnol.  
 Appl. Organomet. Chem.  
 Appl. Phys. A  
 Appl. Phys. B  
 Appl. Phys. Lett.  
 Aquat. Toxicol.  
 Arch. Biochem. Biophys.  
 Arch. Gesamte Virusforsch.  
 Arch. Med. Res.  
 Arch. Microbiol.  
 Arch. Pharm. (Weinheim, Ger.)  
 Arch. Pharm. Ber. Dtsch. Pharm. Ges.  
 Arch. Pharmacol. Res.  
 Ark. Kemi  
 ARKIVOC  
 Arm. Khim. Zh.  
 Arzneimittel-Forsch.  
 Asian J. Chem.  
 Asian J. Spectrosc.  
 Astrophys. J.  
 Aswan Sci. Technol. Bull.  
 Atti Accad. Naz. Lincei, Cl. Sci. Fis.,  
   Mat. Nat., Rend.  
 Atti Accad. Sci., Lett. Arti Palermo,  
   Parte 1  
 Atti V. Congr. Naz. Chim. Pura Appl.  
   Sardinien  
 Aust. J. Chem.  
 Azerb. Khim. Zh.  
 Barwniki, Srodki Pomocnicze  
 Basic Life Sci.  
 Beijing Huagong Daxue Xuebao  
 Beijing Yike Daxue Xuebao  
 Ber. Bunsen-Ges.  
 Ber. Dtsch. Chem. Ges.  
 Ber. Dtsch. Chem. Ges. A  
 Ber. Dtsch. Chem. Ges. B  
 Biocatalysis  
 Biochem. Biophys. Res. Commun.  
 Biochem. J.  
 Biochem. Pharmacol.  
 Biochem. Physiol. Pflanz.  
 Biochem. Prep.  
 Biochem. Soc. Trans.  
 Biochemistry  
 Biochim. Biophys. Acta  
 Bioconjugate Chem.  
 Biol. Akt. Soedin., Akad. Nauk SSSR  
 Biol. Met.  
 Biol. Pharm. Bull.  
 Biol. Trace Elem. Res.  
 BioMetals  
 Bioorg. Chem.  
 Bioorg. Khim.  
 Bioorg. Med. Chem.  
 Bioorg. Med. Chem. Lett.  
 Biopolymers  
 Biosci., Biotechnol., Biochem.  
 Biotechnol. Bioeng.  
 Biotechnol. Lett.  
 Biul. Inf.: Barwniki, Srodki Pomoc-  
   nicze  
 Boll. Chim. Farm.  
 Boll. Sci. Fac. Chim. Ind. Bologna  
 Boll. Sedute Accad. Gioenia Sci. Nat.  
   Catania  
 Bone (N.Y.)  
 Br. J. Cancer  
 Br. J. Clin. Pharmacol.  
 Br. J. Pharmacol.  
 Brennst.-Chem. (1920–1969)  
 Bull. Acad. Pol. Sci., Ser. Sci. Chim.  
 Bull. Acad. R. Belg.  
 Bull. Acad. Sci. USSR, Div. Chem. Sci.  
   (Engl. Transl.)  
 Bull. Chem. Soc. Jpn.  
 Bull. Electrochem.  
 Bull. Fac. Pharm. (Cairo Univ.)  
 Bull. Fac. Sci., Assiut Univ.  
 Bull. Inst. Chem. Res., Kyoto Univ.  
 Bull. Korean Chem. Soc.  
 Bull. Pol. Acad. Sci., Chem.  
 Bull. Sci. (Cons. Acad. RSF Yougosl.)  
 Bull. Soc. Chim. Belg.  
 Bull. Soc. Chim. Biol.  
 Bull. Soc. Chim. Fr.  
 Bull. Soc. Chim. Romania  
 Bull. Soc. R. Sci. Liege

- Bull. Univ. Osaka Prefect., Ser. A  
Burns
- C. R. (Dokl.) Acad. Sci. URSS  
C. R. Acad. Sci., Ser. IIB  
C. R. Hebd. Seances Acad. Sci.  
C. R. Seances Acad. Sci., Ser. 2  
C. R. Seances Acad. Sci., Ser. 3  
C. R. Seances Acad. Sci., Ser. C  
Calcif. Tissue Int.  
Can. J. Biochem.  
Can. J. Chem.  
Can. J. Chem. Eng.  
Can. J. Phys.  
Can. J. Spectrosc.  
Can. Med. Assoc. J.  
Cancer Chemother. Pharmacol.  
Cancer Invest.  
Cancer Lett.  
Cancer Res.  
Carbohydr. Res.  
Carcinogenesis  
Catal. Lett.  
Catal. Org. React.  
Catal. Rev.  
Catal. Today  
Cell Biochem. Biophys.  
Cell. Mol. Biol. (Paris)  
Cell. Signalling  
Cesko-Slov. Farm.  
Chem. Abstr.  
Chem. Anal. (Warsaw)  
Chem. Ber.  
Chem. Ber./Recl.  
Chem. Biol.  
Chem. Br.  
Chem. Chron. A  
Chem. Commun.  
Chem. Commun. (Cambridge)  
Chem. Eng. Commun.  
Chem. Eng. News  
Chem. Eng. Sci.  
Chem. Express  
Chem. Heterocycl. Compd. (Engl. Transl.)  
Chem. Ind. (London)  
Chem. Lett.  
Chem. Listy  
Chem. Mater.  
Chem. News  
Chem. Org. Sulfur Compd.  
Chem. Pap.  
Chem. Pharm. Bull.  
Chem. Phys.  
Chem. Phys. Lett.  
Chem. Phys. Lipids  
Chem. Prum.  
Chem. Res. Toxicol.  
Chem. Rev.  
Chem. Scr.  
Chem. Soc. Rev.  
Chem. Stosow., Ser. A  
Chem. Technol.  
Chem. Unserer Zeit  
Chem. Weekbl.  
Chem. Zentralbl.  
Chem. Zvesti  
Chem.-Biol. Interact.  
Chem.-Eur. J.  
Chem.-Ing.-Tech.
- Chem.-Ztg.  
ChemBioChem  
Chemical Industries (Dekker)  
Chemistry & Biodiversity  
Chemistry (Rajkot, India)  
Chemosphere  
Chemother. J.  
Chemotherapy (Basel)  
Chemtracts  
Chemtracts: Org. Chem.  
Chemtronics  
Chim. Acta Turc.  
Chim. Chron.  
Chim. Ind. (Milan)  
Chim. Oggi  
Chim. Ther.  
Chimia  
Chin. Chem. Lett.  
Chin. J. Chem.  
Chirality  
Chromatography  
Circ.-Calif. Agric. Exp. Stn.  
Clin. Cancer Res.  
Clin. Colorectal Cancer  
Clin. Exp. Allergy  
Clin. Pharmacol. Ther.  
Clin. Res.  
CNS Drugs  
Cold Spring Harbor Symp. Quant. Biol.  
Collect. Czech. Chem. Commun.  
Comb. Chem. High Throughput Screening  
Combust. Flame  
Comments Inorg. Chem.  
Commun. Fac. Sci. Univ. Ankara, Ser. B: Chem. Chem. Eng.  
Contemp. Org. Synth.  
Coord. Chem. Rev.  
Corsi Semin. Chim.  
Croat. Chem. Acta  
Cryst. Eng.  
Cryst. Struct. Commun.  
Curr. Med. Chem.  
Curr. Med. Chem.: Anti-Cancer Agents  
Curr. Opin. Oncol. Endocr. Metab. Invest. Drugs  
Curr. Org. Chem.  
Curr. Pharm. Des.  
Curr. Probl. Epilepsy  
Curr. Sci.  
Curr. Ther. Res.  
Curr. Top. Phytochem.
- Dalian Ligong Daxue Xuebao  
Dalton Trans.  
Dangerous Prop. Ind. Mater. Rep.  
Daxue Huaxue  
Delta J. Sci.  
Diagn. Microbiol. Infect. Dis.  
Diss. Abstr.  
Diss. Abstr. Int., B  
Diss. Pharm.  
Doga Bilim Derg., Seri A1  
Dokl. Akad. Nauk  
Dokl. Akad. Nauk Belarusi  
Dokl. Akad. Nauk BSSR  
Dokl. Akad. Nauk Resp. Uzb.  
Dokl. Akad. Nauk SSSR  
Dokl. Akad. Nauk Ukr. SSR, Ser. B: Geol., Khim. Biol. Nauki
- Dokl. Akad. Nauk UzSSR  
Dokl. Bolg. Akad. Nauk  
Dokl. Chem. (Engl. Transl.)  
Dokl. Vses. Konf. Khim. Atsetilena, 4th  
Dokl.-Akad. Nauk Az. SSR  
Dopov. Akad. Nauk Ukr. RSR, Ser. B: Geol., Khim. Biol. Nauki  
Drug Des. Discovery  
Drug Dev. Res.  
Drug Metab. Dispos.  
Drugs  
Drugs Exp. Clin. Res.  
Drugs Future  
Dtsch. Apoth. Ztg.  
Dyes Pigm.
- Egypt. J. Chem.  
Egypt. J. Pharm. Sci.  
Eisei Shikensho Hokoku  
Electrochem. Commun.  
Electrochim. Acta  
Enantiomer  
Elektrokimiya  
Enantiomer  
Encycl. Polym. Sci. Technol.  
Endocr. Res.  
Energy Fuels  
Environ. Health Perspect.  
Environ. Sci. Technol.  
Environ. Toxicol. Chem.  
Epilepsia  
Eur. J. Cancer  
Eur. J. Cell Biol.  
Eur. J. Inorg. Chem.  
Eur. J. Med. Chem.  
Eur. J. Neurosci.  
Eur. J. Org. Chem.  
Eur. J. Pharmacol.  
Eur. J. Phycol.  
Eur. J. Solid State Inorg. Chem.  
Eur. Polym. J.  
Eur. Urol.  
Exp. Parasitol.  
Experientia  
Expert Opin. Pharmacother.  
Explosion
- Faraday Discuss. Chem. Soc.  
Farbe + Lack  
Farm. Nueva  
Farmaco  
Farmaco, Ed. Sci.  
Farmatsiya (Sofia)  
FEBS Lett.  
FEMS Microbiol. Lett.  
Fette, Seifen, Anstrichm.  
Fiziol. Aktiv. Veshchestva, Akad. Nauk Ukr. SSR, Respub. Mezhvedom. Sb.  
Food Chem.  
Food Chem. Toxicol.  
Food Sci. Technol. (London)  
Forensic Sci. Soc.  
Fortschr. Chem. Forsch.  
Fortschr. Chem. Org. Naturst.  
Free Radical Biol. Med.  
Fresenius' Z. Anal. Chem.  
Fuel  
Fukui Daigaku Kokagaku Kenkyu Hokoku

- Gaodeng Xuexiao Huaxue Xuebao  
 Gazz. Chim. Ital.  
 Genetika (Moscow)  
 Gifu Yakka Daigaku Kiyō  
 Glas. Hem. Drus. Beograd  
 Green Chem.  
 Guangpu Shiyanshi  
 Guangzhou Huagong  
  
 Hacettepe Bull. Nat. Sci. Eng.  
 Handb. Exp. Pharmacol.  
 Han'guk Susan Hakhoechi  
 Helv. Chim. Acta  
 Herba Pol.  
 Heteroat. Chem.  
 Heterocycl. Chem.  
 Heterocycl. Commun.  
 Heterocycles  
 High Perform. Polym.  
 Hoppe-Seyler's Z. Physiol. Chem.  
 Horm. Metab. Res.  
 Huagong Jinzhan  
 Huaxue Shiji  
 Huaxue Xuebao  
 Hukusokan Kagaku Toronkai Koen  
 Yoshishu 8th  
 Hum. Gene Ther.  
 Hum. Reprod.  
 Hunan Daxue Xuebao, Ziran Kexue-  
 ban  
 Hung. J. Ind. Chem.  
 Hydrocarbon Process. Pet. Refin.  
  
 IARC Sci. Publ.  
 Igong Nonjip  
 Ind. Chem. Libr.  
 Ind. Chim. Belge  
 Ind. Eng. Chem.  
 Ind. Eng. Chem. Prod. Res. Dev.  
 Ind. Eng. Chem. Res.  
 Indian J. Appl. Chem.  
 Indian J. Chem.  
 Indian J. Chem., Sect. A  
 Indian J. Chem., Sect. B  
 Indian J. Exp. Biol.  
 Indian J. Fibre Text. Res.  
 Indian J. Heterocycl. Chem.  
 Indian J. Nat. Prod.  
 Indian J. Pharm.  
 Indian J. Pharm. Sci.  
 Inf. Chim.  
 Inorg. Chem.  
 Inorg. Chem. Commun.  
 Inorg. Chim. Acta  
 Inorg. Chim. Acta, Rev.  
 Inorg. Nucl. Chem. Lett.  
 Inorg. Synth.  
 Int. J. Biochem.  
 Int. J. Chem. Kinet.  
 Int. J. Environ. Anal. Chem.  
 Int. J. Mass Spectrom. Ion Phys.  
 Int. J. Miner. Process.  
 Int. J. Mol. Med.  
 Int. J. Pept. Protein Res.  
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 Zh. Prikl. Khim. (Leningrad)  
 Zh. Prikl. Khim. (S.-Peterburg)  
 Zh. Prikl. Spektrosk.  
 Zh. Russ. Fiz.-Khim. O-va., Chast  
   Khim.  
 Zh. Strukt. Khim.  
 Zh. Vses. Khim. O-va. im. D.I. Mende-  
   leeva  
 Zhongguo Jishui Paishui  
 Zhongguo Kangshengsu Zazhi  
 Zhongguo Xitu Xuebao  
 Zhongguo Yaowu Huaxue Zazhi  
 Zhonghua Yaouxue Zazhi

## 5.5 *Science of Synthesis: Complete Volume List*

Category and Year	Vol.	Category/Volume Title	Number of Pages	Knowledge Updates: Responsible Member of the Editorial Board	Original Responsible Member of the Editorial Board	Original Volume Editor(s)
<b>1</b>	<b>1–8</b>	<b>Organometallics</b>	<b>8868</b>			
2001	1	Compounds with Transition Metal–Carbon $\pi$ -Bonds and Compounds of Groups 10–8 (Ni, Pd, Pt, Co, Rh, Ir, Fe, Ru, Os)	1112	Trost	Trost	Lautens
2002	2	Compounds of Groups 7–3 (Mn..., Cr..., V..., Ti..., Sc..., La..., Ac...)	1070	Shibasaki	Noyori	Imamoto
2004	3	Compounds of Groups 12 and 11 (Zn, Cd, Hg, Cu, Ag, Au)	846	Fürstner	Ley	O'Neil
2002	4	Compounds of Group 15 (As, Sb, Bi) and Silicon Compounds	1060	Trost	Ley	Fleming
2003	5	Compounds of Group 14 (Ge, Sn, Pb)	864	Thomas	Thomas	Moloney
2005	6	Boron Compounds	1408	Molander	Regitz/Schau- mann	Kaufmann/ Matteson
2004	7	Compounds of Groups 13 and 2 (Al, Ga, In, Tl, Be...Ba)	802	Fürstner	Noyori	H. Yamamoto
2006	8a	Compounds of Group 1 (Li...Cs)	952	Shibasaki	Trost	Snieckus/ Majewski
2006	8b	Compounds of Group 1 (Li...Cs)	754	Shibasaki	Trost	Snieckus/ Majewski
<b>2</b>	<b>9–17</b>	<b>Hetarenes and Related Ring Systems</b>	<b>9944</b>			
2001	9	Fully Unsaturated Small-Ring Heterocycles and Monocyclic Five-Membered Hetarenes with One Heteroatom	664	Fürstner	Regitz	Maas
2000	10	Fused Five-Membered Hetarenes with One Heteroatom	916	Thomas	Thomas	Thomas
2002	11	Five-Membered Hetarenes with One Chalcogen and One Additional Heteroatom	1160	Schaumann	Schaumann	Schaumann
2002	12	Five-Membered Hetarenes with Two Nitrogen or Phosphorus Atoms	796	Carreira	Bellus	Neier
2004	13	Five-Membered Hetarenes with Three or More Heteroatoms	1010	Molander	Shinkai	Storr/Gil- christ
2003	14	Six-Membered Hetarenes with One Chalcogen	1010	Thomas	Thomas	Thomas
2005	15	Six-Membered Hetarenes with One Nitrogen or Phosphorus Atom	1320	Thomas	Regitz	Black
2004	16	Six-Membered Hetarenes with Two Identical Heteroatoms	1568	Molander	Shinkai	Y. Yamamoto
2004	17	Six-Membered Hetarenes with Two Unlike or More than Two Heteroatoms and Fully Unsaturated Larger-Ring Heterocycles	1500	Schaumann	Schaumann	Weinreb

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Category and Year	Vol.	Category/Volume Title	Number of Pages	Knowledge Updates: Responsible Member of the Editorial Board	Original Responsible Member of the Editorial Board	Original Volume Editor(s)
<b>3</b>	<b>18–24</b>	<b>Compounds with Four and Three Carbon–Heteroatom Bonds</b>	<b>8109</b>			
2005	<b>18</b>	Four Carbon–Heteroatom Bonds: X–C≡X, X=C=X, X <sub>2</sub> C=X, CX <sub>4</sub>	1404	Schaumann	Ley	Knight
2004	<b>19</b>	Three Carbon–Heteroatom Bonds: Nitriles, Isocyanides, and Derivatives	594	Shibasaki	Shinkai	Murahashi
2006	<b>20a</b>	Three Carbon–Heteroatom Bonds: Acid Halides; Carboxylic Acids and Acid Salts	710	Carreira	Jacobsen	Panek
2007	<b>20b</b>	Esters, and Lactones; Peroxy Acids and R(CO)OX Compounds; R(CO)X, X = S, Se, Te	1164	Carreira	Jacobsen	Panek
2005	<b>21</b>	Three Carbon–Heteroatom Bonds: Amides and Derivatives; Peptides; Lactams	1039	Molander	Shinkai	Weinreb
2005	<b>22</b>	Three Carbon–Heteroatom Bonds: Thio-, Seleno-, and Tellurocarboxylic Acids and Derivatives; Imidic Acids and Derivatives; Ortho Acid Derivatives	950	Carreira	Thomas	Charette
2006	<b>23</b>	Three Carbon–Heteroatom Bonds: Ketenes and Derivatives	1054	Trost	Bellus	Danheiser
2006	<b>24</b>	Three Carbon–Heteroatom Bonds: Ketene Acetals and Yne–X Compounds	1194	Schaumann	Schaumann	de Meijere
<b>4</b>	<b>25–33</b>	<b>Compounds with Two Carbon–Heteroatom Bonds</b>	<b>10774</b>			
2007	<b>25</b>	Aldehydes	902	Fürstner	Schaumann	Brückner
2005	<b>26</b>	Ketones	1422	Thomas	Thomas	Cossy
2004	<b>27</b>	Heteroatom Analogues of Aldehydes and Ketones	1174	Schaumann	Bellus	Padwa
2006	<b>28</b>	Quinones and Heteroatom Analogues	1006	Carreira	Bellus	Griesbeck
2007	<b>29</b>	Acetals: Hal/X and O/O, S, Se, Te	1286	Molander	Ley	Warriner
2007	<b>30</b>	Acetals: O/N, S/S, S/N, and N/N and Higher Heteroatom Analogues	800	Fürstner	Noyori	Otera
2007	<b>31a</b>	Arene–X (X = Hal, O, S, Se, Te)	1312	Thomas	Bellus	Ramsden
2007	<b>31b</b>	Arene–X (X = N, P)	1092	Thomas	Bellus	Ramsden
2008	<b>32</b>	X–Ene–X (X = F, Cl, Br, I, O, S, Se, Te, N, P), Ene–Hal, and Ene–O Compounds	914	Schaumann	Schaumann	Mulzer
2007	<b>33</b>	Ene–X Compounds (X = S, Se, Te, N, P)	866	Shibasaki	Trost	Molander

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<b>5</b>	<b>34–42</b>	<b>Compounds with One Saturated Carbon–Heteroatom Bond</b>	<b>7933</b>			
2006	<b>34</b>	Fluorine	424	Carreira	Ley	Percy
2007	<b>35</b>	Chlorine, Bromine, and Iodine	850	Schaumann	Schaumann	Schaumann
2008	<b>36</b>	Alcohols	1294	Decicco	Thomas	Clayden
2008	<b>37</b>	Ethers	735	Thomas	Jacobsen	Forsyth
2009	<b>38</b>	Peroxides	480	Molander	Shinkai	Berkessel
2008	<b>39</b>	Sulfur, Selenium, and Tellurium	1384	Molander	Noyori	Kambe
2009	<b>40a</b>	Amines and Ammonium Salts	844	Schaumann	Schaumann	Enders/ Schaumann
2009	<b>40b</b>	Amine <i>N</i> -Oxides, Haloamines, Hydroxylamines and Sulfur Analogues, and Hydrazines	532	Schaumann	Schaumann	Enders/ Schaumann
2009	<b>41</b>	Nitro, Nitroso, Azo, Azoxy, and Diazonium Compounds, Azides, Triazenes, and Tetrazenes	860	Shibasaki	Shinkai	Banert
2009	<b>42</b>	Organophosphorus Compounds (incl. RO–P and RN–P)	530	Shibasaki	Trost	Mathey
<b>6</b>	<b>43–48</b>	<b>Compounds with All-Carbon Functions</b>	<b>4563</b>			
2008	<b>43</b>	Polyynes, Arynes, Eynes, and Alkynes	744	Thomas	Thomas	Hopf
2008	<b>44</b>	Cumulenes and Allenes	508	Fürstner	Bellus	Krause
2009	<b>45a</b>	Monocyclic Arenes, Quasiarenes, and Annulenes	489	Trost	Shinkai	Siegel/Tobe
2009	<b>45b</b>	Aromatic Ring Assemblies, Polycyclic Aromatic Hydrocarbons, and Conjugated Polyenes	662	Trost	Shinkai	Siegel/Tobe
2009	<b>46</b>	1,3-Dienes	600	Trost	Trost	Rawal/ Kozmin
2009	<b>47a</b>	Alkenes	500	Fürstner	Jacobsen	de Meijere
2009	<b>47b</b>	Alkenes	460	Fürstner	Jacobsen	de Meijere
2009	<b>48</b>	Alkanes	600	Decicco	Schaumann	Hiemstra

**5.6 Author Checklist**

- Have you had your table of contents evaluated?
- Have you had your draft manuscript evaluated?
- Have you provided a graphical abstract and keywords?
- Have you included the title page showing
  - the chapter's full title,
  - the author(s) title(s), name(s), position(s), and full postal address(es)?
- Have you supplied all the schemes and tables and their captions?
- Have you cross-checked all the *references*? All the references that appear in the text must also appear in the reference list and vice versa.
- Have you applied for and received *permission* to reproduce previously published material and is all the relevant correspondence included with the manuscript?
- Have you retained an electronic copy of the manuscript for your records?