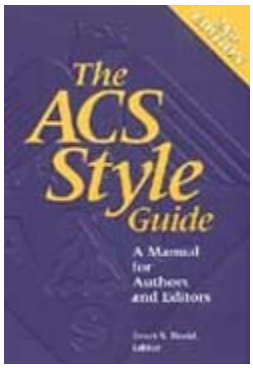

New from ACS Books

The ACS Style Guide

A Manual for Authors and Editors
Second Edition

Janet S. Dodd, Editor

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Chapter 1

Writing a Scientific Paper

This chapter is a general guide to writing a scientific paper. Specific guidelines for text length, preparation of figures and tables, and instructions on how to submit your paper differ from journal to journal and publisher to publisher. For ACS journals and special publications, read the Guide, Notes, Notice, or Instructions for Authors that appear in each publication's first issue of the year and on the World Wide Web at **http://pubs.acs.org/** For ACS books, consult the brochure “How To Prepare Your Manuscript for the ACS Symposium Series” or “Instructions for Authors”, available from the Books Department or on the World Wide Web at the same address.

Getting Started

Although there is no fixed set of “writing rules” to be followed like a cookbook recipe or an experimental procedure, some guidelines can be helpful. Start by answering some questions:

- What is the function or purpose of this paper? Are you describing original and significant research results? Are you reviewing the literature? Are you providing an overview of the topic? Something else?
- How is your work different from that described in other reports on the same subject? (Unless you are writing a review, be sure that your paper will make an original contribution. Some publishers, including ACS, do not publish previously published material.)

- What is the best place for this paper to be published--in a journal or as part of a book? If a journal, which journal is most appropriate? (Appendix I, "ACS Publications", describes ACS journals and books.)
- Who is the audience? What will you need to tell them to help them understand your work?

Answering these questions will clarify your goals and thus make it easier for you to write the paper with the proper amount of detail. It will also make it easier for editors to determine the paper's suitability for their publications. Writing is like so many other things: if you clarify your overall goal, the details fall into place.

Once you know the function of your paper and have identified its audience, review your material for completeness or excess. Then, organize your material into the standard format: introduction, experimental details or theoretical basis, results, discussion, and conclusions. This format has become standard because it is suitable for most reports of original research, it is basically logical, and it is easy to use. The reason it accommodates most reports of original research is that it parallels the scientific method of deductive reasoning: define the problem, create a hypothesis, devise an experiment to test the hypothesis, conduct the experiment, and draw conclusions. Furthermore, this format enables the reader to understand quickly what is being presented and to find specific information easily. This ability is crucial now more than ever because scientists, if not all professionals, must read much more material than their time seems to allow.

Even if your results are more suited to one of the shorter types of presentation, the logic of the standard format applies, although you might omit the standard headings or one or more entire sections. As you write, you can modify, delete, or add sections and subsections as appropriate.

An extremely important step is to check the specific requirements of the publication you have targeted and follow them. Most publications require revisions of manuscripts that are not in their requested format. Thus, not following a publication's requirements can delay publication and make more work for you. Finally, your paper will be peer-reviewed, so a good idea is to pay attention to the aspects that the reviewers will be considering. Chapter 10 presents the opinions of many reviewers.

Writing Style and Word Usage

Short declarative sentences are the easiest to write and the easiest to read, and they are usually clear. However, too many short sentences in a row can sound abrupt or monotonous. To add sentence variety, it is better to start with simple declarative sentences and then combine some of them than to start with long rambling sentences and then try to shorten them.

You and your colleagues probably have been discussing the project for months, so the words seem familiar, common, and clear to you. However, the readers will not have been part of these discussions. That is where copy editors can help. Their job is to make sure that readers understand the material you are presenting.

By all means, write in your own personal style, but keep in mind that scientific writing is not literary writing. Scientific writing serves a purpose completely different from that of literary writing, and it must therefore be precise and unambiguous.

If English is not your first language, ask an English-speaking colleague--if possible, a native English speaker--for help with grammar and diction.

Choosing the Correct Word or Phrase

Use words in their primary meanings; do not use a word to express a thought if such usage is uncommon, informal, or primarily literary. Examples are using “since” when you mean “because”, and “while” when you mean “although”. Many words are clear when youare speaking because you can amplify your meaning with gestures, expressions, and vocal inflections--but when these same words are written, they may be clear only to you.

Use appropriate verb tenses.

- Simple past tense is correct for stating what was done, either by others or by you: “The solutions were heated to boiling.” “The spectra were recorded.” “Jones reviewed the literature and gathered much of this information.” “We recently found that relativistic effects enhance the bond strength.” “The structures were determined by neutron diffraction methods.”
- Present tense is correct for statements of fact: “Absolute rate constants for a wide variety of reactions are available.” “Hyperbranched compounds are macromolecular compounds that contain a branching point in each structural repeat unit.”
- Present and simple past tenses may both be correct for results, discussion, and conclusions: “The characteristics of the voltammetric wave indicate that electron transfer and breaking of the carbon-iodine bond are concerted.” “The absence of substitution was confirmed by preparative-scale electrolysis at a potential located at the foot of the voltammetric wave.” “IR spectroscopy shows that nitrates are adsorbed and are not removed by washing with distilled water.”

Use the active voice when it is less wordy and more direct than the passive.

> ***Poor:*** The fact that such processes are under strict stereoelectronic control is demonstrated by our work in this area.
> ***Better:*** Our work in this area demonstrates that such processes are under strict stereoelectronic control.

Use first person when it helps to keep your meaning clear and to express a purpose or a decision.

> Jones reported xyz, but I (or we) found . . .
> I (or we) present here a detailed study . . .
> My (or our) recent work demonstrated . . .
> To determine the effects of structure on photophysics, I (or we) . . .

However, avoid phrases such as “we believe”, “we feel”, “we concluded”, and “we can see”, as well as personal opinions.

Use an affirmative sentence rather than a double negative.

Instead of	***Consider using***
This reaction is not uncommon	This reaction is common This reaction is rare This reaction occurs about 40% of the time

This transition was not unexpected	This transition was expected We knew that such transitions were possible
This strategy is not infrequently used	This strategy is frequently used This strategy is occasionally used
This result is not unlikely to occur	This result is likely to occur This result is possible

Watch the placement of the word “only”. It has different meanings in different places in the sentence.

> Only the largest group was injected with the test compound. (Meaning: and no other group)
>
> The largest group was only injected with the test compound. (Meaning: and not given the compound in any other way)
>
> The largest group was injected with only the test compound. (Meaning: and no other compounds)
>
> The largest group was injected with the only test compound. (Meaning: there were no other test compounds)

Be sure that the antecedents of the pronouns “this” and “that” are clear. If there is a chance of ambiguity, use a noun to clarify your meaning.

> ***Ambiguous:*** The photochemistry of transition-metal carbonyl complexes has been the focus of many investigations. This is due to the central role that metal carbonyl complexes play in various reactions.
>
> ***Unambiguous:*** The photochemistry of transition-metal carbonyl complexes has been the focus of many investigations. This interest is due to the central role that metal carbonyl complexes play in various reactions.

Use the proper subordinating conjunctions. “While” and “since” have strong connotations of time. Do not use them where you mean “although”, “because”, or “whereas”.

> ***Poor:*** Since solvent reorganization is a potential contributor, the selection of data is very important.
> ***Better:*** Because solvent reorganization is a potential contributor, the selection of data is very important.
>
> ***Poor:*** While the reactions of the anion were solvent-dependent, the corresponding reactions of the substituted derivatives were not.
> ***Better:*** Although the reactions of the anion were solvent-dependent, the corresponding reactions of the substituted derivatives were not.
>
> ***Also:*** The reactions of the anion were solvent-dependent, but (or whereas) the corresponding reactions of the substituted derivatives were not.

Use “respectively” to relate two or more sequences in the same sentence.

The excitation and emission were measured at 360 and 440 nm, respectively.(That is, the excitation was measured at 360 nm and the emission was measured at 440 nm.)

Use the more accurate terms “greater than” or “more than” rather than the imprecise “over” or “in excess of”.

greater than 50%, *not* in excess of 50%
more than 100 samples, *not* over 100 samples
more than 25 mg, *not* in excess of 25 mg, *not* over 25 mg

Use “fewer” to refer to number; use “less” to refer to quantity.

fewer than 50 animals
fewer than 100 samples

less product
less time
less work

However, use “less” with number and unit of measure combinations because they are regarded as singular.

less than 5 mg
less than 3 days

Use “between” with two named objects; use “among” with three or more named or implied objects.

Communication between scientists and the public is essential.
Communication among scientists, educators, and the public is essential.
Communication among scientists is essential.

Choose “assure”, “ensure”, and “insure” depending on your meaning. To assure is to affirm; to ensure is to make certain; to insure is to indemnify for money.

He assured me that the work had been completed.
The procedure ensures that clear guidelines have been established.
You cannot get a mortgage unless you insure your home.

Choose “affect”, “effect”, and “impact” depending on your meaning. “Affect” is a verb meaning to influence, modify, or change. “Effect” as a verb means to bring about, but as a noun it means consequence, outcome, or result. “Impact” is a noun meaning a significant effect.

The increased use of pesticides affects agricultural productivity.
The use of polychlorinated benzenes has an effect on the cancer rate.
The effect of the added acid was negligible.
The new procedure effected a 50% increase in yield.
The impact of pesticide use on health is felt throughout the world.
The acid did not have a great impact on the reaction rate.

It is acceptable to use split infinitives to avoid awkwardness or ambiguity.

Awkward: The program is designed to assist financially the student who is considering a career in chemistry.
Better: The program is designed to financially assist the student who is considering a career in chemistry.

Ambiguous: The bonded phases allowed us to investigate fully permanent gases.
Better: The bonded phases allowed us to fully investigate permanent gases.

Use "whether" to introduce at least two alternatives, either stated or implied.

I am not sure whether I should repeat the experiment.
I am not sure whether I should repeat the experiment or use a different statistical treatment.
I am going to repeat the experiment whether the results are positive or negative.

Use "whether or not" to mean "regardless of whether".

Incorrect: I am not sure whether or not to repeat the experiment.
Correct: I am not sure whether to repeat the experiment.
Also correct: Whether or not the results are positive, I will repeat the experiment.
Also correct: Whether or not I repeat the experiment, I will probably leave the laboratory late tonight.

Use "to comprise" to mean "to contain" or "to consist of"; it is not a synonym for "to compose". The whole comprises the parts, or the whole is composed of the parts, but the whole is not comprised of the parts. Never use "is comprised of".

Incorrect: A book is comprised of chapters.
Correct: A book comprises chapters.
Also correct: A book is composed of chapters.

Incorrect: Our research was comprised of three stages.
Correct: Our research comprised three stages.

Articles

Choose the articles "a" and "an" according to the pronunciation of the words or abbreviations they precede.

a nuclear magnetic resonance spectrometer
an NMR spectrometer

Use "a" before an aspirated "h"; use "an" before the vowel sounds of a, e, i, o, "soft" u, and y.

a house	*but*	an hour
a history		an honor

a union	*but*	an ultimate
a U-^{14}C		an ylide
		an yttrium compound

Choose the proper article to precede B.A., B.S., M.A., M.S., and Ph.D., according to pronunciation of the first letter.

a B.S. degree
an M.S. degree
a Ph.D.

Comparisons

Introductory phrases that imply comparisons should refer to the subject of the sentence and be followed by a comma.

Incorrect: Unlike alkali-metal or alkaline-earth-metal cations, hydrolysis of trivalent lanthanides proceeds significantly at this pH.
Correct: Unlike that of alkali-metal or alkaline-earth-metal cations, hydrolysis of trivalent lanthanides proceeds significantly at this pH.
Also correct: Unlike alkali-metal or alkaline-earth-metal cations, trivalent lanthanides hydrolyze significantly at this pH.

Incorrect: In contrast to bromide anion, there is strong distortion of the free fluoride anion on the vibrational spectroscopy time scale.
Correct: In contrast to bromide anion, the free fluoride anion is strongly distorted on the vibrational spectroscopy time scale.

Use the verb "compare" followed by the preposition "to" when similarities are being noted. Use "compare" followed by the preposition "with" when differences are being noted. Only things of the same class should be compared.

Compared to compound **3**, compound **4** shows an NMR spectrum with corresponding peaks.
Compared with compound **3**, compound **4** shows a more complex NMR spectrum.

Do not omit words needed to complete comparisons, and do not use confusing word order. The subordinating conjunction "than" is often used to introduce the second element in a comparison, following an adjective or adverb in the comparative degree.

Incorrect: The alkyne stretching bands for the complexes are all lower than the uncoordinated alkyne ligands.
Correct: The alkyne stretching bands for the complexes are all lower than those for the uncoordinated alkyne ligands.
Also correct: The alkyne stretching bands are all lower for the complexes than for the uncoordinated alkyne ligands.

Incorrect: The decrease in isomer shift for compound **1** is greater in a given pressure increment than for compound **2**.

Correct: The decrease in isomer shift for compound **1** is greater in a given pressure increment than that for compound **2**.
Also correct: The decrease in isomer shift in a given pressure increment is greater for compound **1** than for compound **2**.

Idioms often used in comparisons are “different from”, “similar to”, “identical to”, and “identical with”. Generally these idioms should not be split.

Incorrect: The complex shows a significantly different NMR resonance from that of compound **1**.
Correct: The complex shows an NMR resonance significantly different from that of compound **1**.

Incorrect: Compound **5** does not catalyze hydrogenation under similar conditions to compound **6**.
Correct: Compound **5** does not catalyze hydrogenation under conditions similar to those for compound **6**.

Exception: These idioms can be split if an intervening prepositional phrase modifies the first word in the idiom.

The single crystals are all similar in structure to the crystals of compound **7**.
Solution A is identical in appearance with solution B.

Phrases such as “relative to”, “as compared to”, and “as compared with” and words such as “versus” are also used to introduce the second element in a comparison. The things being compared must be in parallel structure (that is, grammatically equal).

The greater acidity of nitric acid relative to nitrous acid is due to the initial-state charge distribution in the molecules.
The lowering of the vibronic coupling constants for Ni as compared with Cu is due to configuration interaction.
This behavior is analogous to the reduced Wittig-like reactivity in thiolate versus phenoxide complexes.

Parallelism

Use coordinating conjunctions (“and”, “but”, “or”, “nor”, “yet”, “for”, and sometimes “so”), correlative conjunctions (“either, or”; “neither, nor”; “both, and”; “not only, but also”; “not, but”), and correlative constructions (“as well as”; e.g., “as well as”) to connect words or groups of words of equal grammatical rank.

Incorrect: Compound **12** was prepared analogously and by Lee's method (*5*).
Correct: Compound **12** was prepared in an analogous manner and by Lee's method (*5*).

Incorrect: It is best to use alternative methods both because of the condensation reaction and because the amount of water in the solvent increases with time.
Correct: It is best to use alternative methods both because of the condensation reaction and because of the increase in the amount of water in the solvent with time.

Incorrect: The product was washed either with alcohol or acetone.
Correct: The product was washed with either alcohol or acetone.
Also correct: The product was washed either with alcohol or with acetone.

Incorrect: Not only was the NiH functionality active toward the C-donor derivatives but also toward the N donors.
Correct: The NiH functionality was active not only toward the C-donor derivatives but also toward the N donors.
Also correct: The NiH functionality was not only active toward the C-donor derivatives but also active toward the N donors.
Also correct: Not only was the NiH functionality active toward the C-donor derivatives, but it was also active toward the N donors.

Use parallel constructions in series and lists, including section headings and subheadings in text and tables and listings in figure captions.

Do not try to use parallel construction around the word “but” when it is not used as a coordinating conjunction.

Increasing the number of fluorine atoms on the adjacent boron atom decreases the chemical shift, but only by a small amount.
The reaction proceeded readily, but with some decomposition of the product.

Words and Phrases To Avoid

Avoid slang and jargon.

If you have already presented your results at a symposium or other meeting and are now writing the paper for publication in a book or journal, delete all references to the meeting or symposium such as “Good afternoon, ladies and gentlemen”, “This morning we heard”, “in this symposium”, “at this meeting”, and “I am pleased to be here”. Such phrases would be appropriate only if you were asked to provide an exact transcript of a speech.

Be brief. Wordiness obscures your message, annoys the reader, and displeases the publisher because the resulting lengthy paper is more expensive to produce and to print.

- Omit phrases such as

  As already stated
  It has been found that
  It has long been known that
  It is interesting to note that
  It is worth mentioning at this point
  It may be said that
  It was demonstrated that

- Omit excess words.

Instead of	***Use***

It is a procedure that is often used.	This procedure is often used.
There are seven steps that must be completed.	Seven steps must be completed.
This is a problem that is...	This problem is...
These results are preliminary in nature.	These results are preliminary.

- Use single words instead of phrases.

Instead of	***Use***
a number of	many, several
a small number of	a few
are in agreement	agree
are found to be	are
are known to be	are
at present	now
at the present time	now
based on the fact that	because
by means of	by
despite the fact that	although
due to the fact that	because
during that time	while
fewer in number	fewer
for the reason that	because
has been shown to be	is
if it is assumed that	if
in color, e.g., red in color	*just state the color*, e.g., red
in consequence of this fact	therefore, consequently
in length	long
in order to	to
in shape, e.g., round in shape	*just state the shape*, e.g., round
in size, e.g., small in size	*just state the size*, e.g., small
in spite of the fact that	although
in the case of...	in..., for...
in the near future	soon
in view of the fact that	because
is known to be	is
it appears that	apparently
it is clear that	clearly

it is likely that	likely
it is possible that	possibly
it would appear that	apparently
of great importance	important
on the order of	about
owing to the fact that	because
prior to	before
reported in the literature	reported
subsequent to	after

Do not use contractions in scientific papers.

Incorrect: The identification wasn't confirmed by mass spectrometry.
Correct: The identification was not confirmed by mass spectrometry.

Do not use the word “plus” or the plus sign as a synonym for “and”.

Incorrect: Two bacterial enzymes were used in a linked-enzyme assay for heroin plus metabolites.
Correct: Two bacterial enzymes were used in a linked-enzyme assay for heroin and its metabolites.

Do not use “respectively” when you mean “separately” or “independently”.

Incorrect: The electrochemical oxidations of chromium and tungsten tricarbonyl complexes, respectively, were studied.
Correct: The electrochemical oxidations of chromium and tungsten tricarbonyl complexes were studied separately.

Avoid misuse of prepositional phrases introduced by “with”.

Poor: Nine deaths from leukemia occurred, with six expected.
Better: Nine deaths from leukemia occurred, and six had been expected.

Poor: Of the 20 compounds tested, 12 gave positive reactions, with three being greater than 75%.
Better: Of the 20 compounds tested, 12 gave positive reactions; three of these were greater than 75%.

Poor: Two weeks later, six more animals died, with the total rising to 25.
Better: Two weeks later, six more animals died, and the total was then 25.

Do not use a slash to mean “and” or “or”.

Incorrect: Hot/cold extremes will damage the samples.
Correct: Hot and cold extremes will damage the samples.

Replace “and/or” with either “and” or “or”, depending on your meaning.

> ***Incorrect:*** Our goal was to confirm the presence of the alkaloid in the leaves and/or roots.
> ***Correct:*** Our goal was to confirm the presence of the alkaloid in the leaves and roots.
> ***Also correct:*** Our goal was to confirm the presence of the alkaloid in either the leaves or the roots.
> ***Also correct:*** Our goal was to confirm the presence of the alkaloid in the leaves, the roots, or both.

Gender-Neutral Language

The U.S. government and many publishers have gone to great effort to encourage the use of gender-neutral language in their publications. Gender-neutral language is also a goal of many chemists. Recent style guides and writing guides urge copy editors and writers to choose terms that do not reinforce outdated sex roles. Gender-neutral language can be accurate and unbiased and not necessarily awkward.

The most problematic words are the noun “man” and the pronouns “he” and “his”, but there are usually several satisfactory gender-neutral alternatives for these words. Choose an alternative carefully and keep it consistent with the context.

Instead of “man”, use “people”, “humans”, “human beings”, or “human species”, depending on your meaning.

> ***Outdated:*** The effects of compounds **I-X** were studied in rats and man.
> ***Gender-neutral:*** The effects of compounds **I-X** were studied in rats and humans.

> ***Outdated:*** Men working in hazardous environments are often unaware of their rights and responsibilities.
> ***Gender-neutral:*** People working in hazardous environments are often unaware of their rights and responsibilities.

> ***Outdated:*** Man's search for beauty and truth has resulted in some of his greatest accomplishments.
> ***Gender-neutral:*** The search for beauty and truth has resulted in some of our greatest accomplishments.

Instead of “manpower”, use “workers”, “staff”, “work force”, “labor”, “crew”, “employees”, or “personnel”, depending on your meaning.

Instead of “manmade”, use “synthetic”, “artificial”, “built”, “constructed”, “manufactured”, or even “factory-made”.

Instead of “he” and “his”, change the construction to a plural form (“they” and “theirs”) or first person (“we”, “us”, and “ours”). Alternatively, delete “his” and replace it with “a”, “the”, or nothing at all. “His or her”, if not overused, is not terribly unpleasant.

> ***Outdated:*** The principal investigator should place an asterisk after his name.
> ***Gender-neutral:*** Principal investigators should place asterisks after their names.

Gender-neutral: If you are the principal investigator, place an asterisk after your name.
Gender-neutral: The name of the principal investigator should be followed by an asterisk.

However, do not use a plural pronoun with a singular antecedent.

Incorrect: The principal investigator should place an asterisk after their name.

 Instead of “wife”, use “family” or “spouse” where appropriate.

Outdated: The work of professionals such as chemists and doctors is often so time-consuming that their wives are neglected.
Gender-neutral: The work of professionals such as chemists and doctors is often so time-consuming that their families are neglected.

Outdated: the society member and his wife
Gender-neutral: the society member and spouse

Components of a Paper

Use the standard format, which is described next, for reports of original research but not necessarily for literature reviews or theoretical papers. Present all parts of your paper as concisely as possible.

Title

The best time to determine the title is after you have written the text, so that the title will reflect the paper's content and emphasis accurately and clearly. The title must be brief and grammatically correct but accurate and complete enough to stand alone. A two- or three-word title may be too vague, but a 14- or 15-word title is unnecessarily long. Choose terms that are as specific as the text permits: “a vanadium-iron alloy” rather than “a magnetic alloy”. Avoid phrases such as “on the”, “a study of”, “research on”, “report on”, “regarding”, and “use of”. In most cases, omit “the” at the beginning of the title. Avoid nonquantitative, meaningless words such as “rapid” and “new”.

Spell out all terms in the title, and avoid jargon, symbols, formulas, and abbreviations. Whenever possible, use words rather than expressions containing superscripts, subscripts, or other special notations. Do not cite company names, specific trademarks, or brand names of chemicals, drugs, materials, or instruments.

The title serves two main purposes: (1) to attract the potential audience and (2) to aid retrieval and indexing. Therefore, be sure to include several keywords. The title should provide the maximum information for a computerized title search.

Series titles are of little value. Some publications do not permit them at all. If consecutive papers in a series are published simultaneously, a series title may be relevant, but in a long series, paper 42 probably bears so limited a relationship to paper 1 that they do not warrant a common title. In addition, an editor or reviewer seeing the same title repeatedly may reject it on the grounds that it is only one more publication on a general topic that has already been discussed at length.

If you cannot create a title that is short, consider breaking it into title and subtitle.

Byline and Affiliation

Include in the byline all those, and only those, who made substantial contributions to the work, even if the paper was actually written by only one person. Appendix III, “Ethical Guidelines to Publication of Chemical Research” is more explicit on this topic.

Many ACS publications specifically request at least one full given name for each author, rather than only initials. Use your first name, initial, and surname (e.g., John R. Smith) or your first initial, second name, and surname (e.g., J. Robert Smith). Whatever byline you use, be consistent. Papers by John R. Smith, Jr., J. Smith, J. R. Smith, Jack Smith, and J. R. Smith, Jr., will not be indexed in the same place; the bibliographic citations may be listed in five different locations, and ascribing the work to a single author will therefore be difficult if not impossible.

Do not include professional, religious, or official titles or academic degrees.

The affiliation is the institution (or institutions) at which the work was conducted. If there is more than one author, use an asterisk or superscript (check the specific publication's style) to indicate the author or authors to whom correspondence should be addressed. Clarify all corresponding authors' addresses by accompanying footnotes if they are not apparent. If the current address of a corresponding author differs from that at which the work was done, give the author's current address in a footnote.

Also provide the corresponding author's e-mail address and fax number, in addition to postal address and telephone number.

Abstract

Most publications require an informative abstract for every paper, even if they do not publish abstracts. For a research paper, briefly state the problem or the purpose of the research, indicate the theoretical or experimental plan used, summarize the principal findings, and point out major conclusions. Include chemical safety information when applicable. Do not supplement or evaluate the conclusions in the text. For a review paper, the abstract describes the topic, the scope, the sources reviewed, an the conclusions. Write the abstract last to be sure that it accurately reflects the content of the paper.

The abstract allows the reader to determine the nature and scope of the paper and helps editors identify key features for indexing and retrieval.

Although an abstract is not a substitute for the article itself, it must be concise, self-contained, and complete enough to appear separately in abstract publications. Often, authors' abstracts are used in *Chemical Abstracts*. Furthermore, abstracts of full papers submitted to ACS journals will be published in *Advance ACS Abstracts* several weeks before the journal is published.

The optimal length is one paragraph, but it could be as short as two sentences. The length of the abstract depends on the subject matter and the length of the paper. Between 80 and 200 words is usually adequate.

Do not cite references, tables, figures, or sections of the paper in the abstract. You may refer to equations or structures presented in the body of the paper if they occupy only a single line and can readily be incorporated into the running text when the abstract is used in the secondary

literature (e.g.,*Chemical Abstracts*). Do not include equations and structures that take up more than one line.

Use abbreviations and acronyms only when it is necessary to prevent awkward construction or needless repetition. Define abbreviations at first use in the abstract (and again at first use in the text).

Introduction

A good introduction is a clear statement of the problem or project and the reasons that you are studying it. This information should be contained in the first few sentences. Give a concise and appropriate background discussion of the problem and the significance, scope, and limits of your work. Outline what has been done before by citing truly pertinent literature, but do not include a general survey of semirelevant literature. State how your work differs from or is related to work previously published. Demonstrate the continuity from the previous work to yours. The introduction can be one or two paragraphs long. Often, the heading "Introduction" is not used because it is superfluous; opening paragraphs are usually introductory.

Experimental Details or Theoretical Basis

In research reports, this section can also be called "Experimental Methods", "Experimental Section", or "Materials and Methods". Check the specific publication. For experimental work, give sufficient detail about your materials and methods so that other experienced workers can repeat your work and obtain comparable results. When using a standard method, cite the appropriate literature and give only the details needed.

Identify the materials used, and give information on the degree of and criteria for purity, but do not reference standard laboratory reagents. Give the chemical names of all compounds and the chemical formulas of compounds that are new or uncommon. Use meaningful nomenclature; that is, use standard systematic nomenclature where specificity and complexity require, or use trivial nomenclature where it will adequately and unambiguously define a well-established compound.

Describe apparatus only if it is not standard or not commercially available. Giving a company name and model number in parentheses is nondistracting and adequate to identify standard equipment.

Avoid using trademarks and brand names of equipment and reagents. Use generic names; include the trademark in parentheses after the generic name only if the material or product you used is somehow different from others. Remember that trademarks often are recognized and available as such only in the country of origin. In ACS publications, *do not use* trademark (™) and registered trademark (®) symbols.

Describe the procedures used, unless they are established and standard.

Note and emphasize any hazards, such as explosive or pyrophoric tendencies and toxicity, in a separate paragraph introduced by the word "Caution:". Include precautionary handling procedures, special waste disposal procedures, and any other safety considerations in adequate detail so that workers repeating the experiments can take appropriate safety measures. Some ACS journals also indicate hazards as footnotes on their contents pages.

In theoretical reports, this section is called, for example, "Theoretical Basis" or "Theoretical Calculations" instead of "Experimental Details" and includes sufficient mathematical detail to

enable other researchers to reproduce derivations and verify numerical results. Include all background data, equations, and formulas necessary to the arguments, but lengthy derivations are best presented as Supporting Information.

Results

Summarize the data collected and their statistical treatment. Include only relevant data, but give sufficient detail to justify your conclusions. Use equations, figures, and tables only where necessary for clarity and brevity.

Discussion

The purpose of the discussion is to interpret and compare the results. Be objective; point out the features and limitations of the work. Relate your results to current knowledge in the field and to your original purpose in undertaking the project: Have you resolved the problem? What exactly have you contributed? Briefly state the logical implications of your results. Suggest further study or applications if warranted.

Present your results and discussion either as two separate sections or as one combined section if it is more logical to do so. Do not repeat information given elsewhere in the manuscript.

Conclusions

The purpose of the Conclusions section is to put the interpretation into the context of the original problem. Do not repeat discussion points or include irrelevant material. Your conclusions should be based on the evidence presented.

Summary

A summary is unnecessary in most papers. In long papers, a summary of the main points can be helpful, if you stick to the main points only. If the summary itself is too long, its purpose is defeated.

Acknowledgments

Generally, the last paragraph of the paper is the place to acknowledge people, organizations, and financing. As simply as possible, thank those persons, other than coauthors, who added substantially to the work, provided advice or technical assistance, or aided materially by providing equipment or supplies. Do not include their titles. If applicable, state grant numbers and sponsors here, as well as auspices under which the work was done, including permission to publish.

Follow the journal's guidelines on what to include in the Acknowledgments section. Some journals permit financial aid to be mentioned in acknowledgments, but not meeting references. Some journals put financial aid and meeting references together, but not in the Acknowledgments section.

References

In many journals and books, references are placed at the end of the article or chapter; in others,

they are treated as footnotes. In any case, place your list of references at the end of the manuscript.

In ACS books and most journals, the style and content of references are standard regardless of where they are located. Follow the reference style presented in Chapter 6.

The accuracy of the references is the author's responsibility. If you copy citations from another source, check the original reference for accuracy and appropriate content.

Special Sections

This discussion on format applies to most manuscripts, but it is not a set of rigid rules and headings. If your paper is well organized, scientifically sound, and appropriate to the publication for which you are preparing it, you may include other sections and subsections. For example, an appendix contains material that is not critical to understanding the text but provides important background information.

Supporting Information

Material that may be essential to the specialized reader but not require elaboration in the paper itself is published as Supporting Information. Examples are large tables, extensive figures, lengthy experimental procedures, mathematical derivations, analytical and spectral characterization data, biological test data for a series, molecular modeling coordinates, modeling programs, crystallographic information files (CIF), instrument and circuit diagrams, and expanded discussions of peripheral findings. More journals are encouraging this type of publishing to keep printed papers shorter.

For complete instructions on how to prepare this material for publication, check the Guide, Notes, Notice, or Instructions for Authors that appear in each publication's first issue of the year and on the World Wide Web at **http://pubs.acs.org/**

When you include supporting information, place a statement to that effect at the end of the paper using the format specified in the author instructions for the specific journal.

ACS publishes this material in the CD-ROM, microfilm, and microfiche editions of its journals. For many papers published in ACS journals, Supporting Information is also available electronically on the World Wide Web at **http://pubs.acs.org/**

Types of Presentations

The following are general descriptions; Appendix I discusses each type of presentation with specific reference to ACS publications.

Articles

Articles, also called full papers, are definitive accounts of significant, original studies. They present important new data or provide a fresh approach to an established subject.

The organization and length of an article should be determined by the amount of new information to be presented and by space restrictions within the publication. The standard format is suitable

for most papers in this category.

Notes

Notes are concise accounts of original research of a limited scope. They may also be preliminary reports of special significance. The material reported must be definitive and may not be published again later. Appropriate subjects for notes include improved procedures of wide applicability or interest, accounts of novel observations or of compounds of special interest, and development of new techniques. Notes are subject to the same editorial appraisal as full-length articles.

Communications

Communications, called “Letters” or “Correspondence” in some publications, are usually preliminary reports of special significance and urgency that are given expedited publication. They are accepted if the editor believes that their rapid publication will be a service to the scientific community. They may also be comments on the work of others, in which case the original authors' rebuttal may be published at the same time. Communications are subject to strict length limitations; they must contain specific results to support their conclusions, but they may not contain polemics or nonessential experimental details.

The same rigorous standards of acceptance that apply to full-length papers also apply to communications. Communications are submitted to review, and they are not accepted if the editor believes that the principal content has been published elsewhere. In many cases, authors are expected to publish complete details (not necessarily in the same journal) after their communications have been published. Acceptance of a communication, however, does not guarantee acceptance of the detailed manuscript.

Reviews

Reviews integrate, correlate, and evaluate results from published literature on a particular subject. They seldom report new experimental findings. Effective review articles have a well-defined theme, are usually critical, and present novel theoretical interpretations. Ordinarily, they do not give experimental details, but in special cases (as when a technique is of central interest), experimental procedures may be included. An important function of reviews is to serve as a guide to the original literature; for this reason, accuracy and completeness of references cited are essential. Reviews critically analyze the literature.

Book Chapters

In multiauthored books, chapters may be accounts of original research or literature reviews (like journal articles), but they may also be topical overviews. They may be developed and expanded from presentations given at symposia, or they may be written especially for the book in which they will be published. Multiauthored books should contain at least one chapter that reviews the subject thoroughly and also provides an overview to unify the chapters into a coherent treatment of the subject. In a longer book that is divided into sections, each section may need a short overview chapter.

In books entirely written by one author or collaboratively by more than one author, each chapter treats one subdivision of the broader topic, and each is a review and overview.

Advice from the Authorities

The Elements of Style
by William Strunk, Jr., and E. B. White

Omit needless words. Vigorous writing is concise. A sentence should contain no unnecessary words, a paragraph no unnecessary sentences, for the same reason that a drawing should have no unnecessary lines and a machine no unnecessary parts. This requires not that the writer make all his sentences short, or that he avoid all detail and treat his subjects only in outline, but that every word tell.

Avoid fancy words. Avoid the elaborate, the pretentious, the coy, and the cute. Do not be tempted by a twenty-dollar word when there is a ten-center handy, ready, and able.... All [words] are good, but some are better than others.

Writing Successfully in Science
by Maeve O'Connor

When you start writing the draft, or your share of it, you should, ideally, cut yourself off from the outside world. Try to find a time when you can remain undisturbed for several hours and a place where no one will interrupt you. Write at the time of day when you feel freshest and most alert.

If you find it difficult to start writing on the blank page or screen in front of you, leave the introduction for later and start with any section you have already drafted or made detailed notes about. The materials and methods section is often the easiest place to begin, and the results section the next easiest. Once you get going, write as quickly as you can. If the article is short, try to finish it in one sitting, to give it as much unity as possible.

Long words and complicated sentences are not essential features of good scientific writing, although they are often thought to be so. The best writing in science, as elsewhere, is simple, clear, precise, and vigorous. Decide what you want to say and say it as simply, informatively, and directly as possible.

Line by Line: How To Improve Your Own Writing
by Claire Kehrwald Cook

You probably should delete all intensive adverbs--very, really, truly, actually, and the like. If you've chosen the right word, adding a very defeats your purpose. If you haven't got the right word, the very offers poor compensation. Readers pay no attention to this overused word. If you want to put a very in front of a large, you should consider substituting enormous, huge, gigantic, or massive.

Writing To Learn
by William Zinsser

I would say this to everyone who feels that his main aptitude is for science or technology, or for any other field that lies outside the humanities, and that therefore he can't write: Learn to use the tools without fear. They are not some kind of secret apparatus owned by the English teacher or any other teacher. They are simple mechanisms for putting your thoughts on paper. Enjoy finding out how they work. Take as much pleasure in what an active verb will do for you as in what a

mathematical formula will do, or a computer, or a centrifuge.

The Scientist as Editor
by Maeve O'Connor

Write simply and concisely.... Use short words rather than long ones, and concrete rather than abstract terms; where appropriate, prefer the first person singular or plural to the third person, and the active to the passive voice. Avoid vague statements, jargon and laboratory slang, and words not defined in dictionaries.

Errors in English and Ways To Correct Them
by Harry Shaw

No standards can be absolute. Our language is constantly changing. Also, diction, like fashions in dress and food, is influenced by changes in taste. Again, what is acceptable in daily speech and conversation may not be suitable in written form. The use of this or that word cannot be justified by saying that it is often heard or seen in print. Advertisements, newspapers, magazines, and even some “good” books may exhibit faulty diction.

Scientific English: A Guide for Scientists and Other Professionals
by Robert A. Day

Scientists (and perhaps scholars in all fields) should learn to use English simply. Short, simple words--in short, straightforward sentences--usually convey meaning more clearly than do esoteric words and convoluted sentences. This concept is a bit controversial, because the skilled writer, using that wonderful, massive vocabulary we have available in English, can paint word pictures of overwhelming beauty. On the other hand, clarity and meaning can easily fade into the background.

The Chemist's English
by Robert Schoenfeld

Don't be frightened of grammar. When you sit down to write your paper or thesis or report, your most dangerous enemy is not the split infinitive--it is ambiguity. A split infinitive is very often acceptable anyway, but where it needs correcting it can be corrected by a copy editor. However, the copy editor, unless he is a mind-reader, cannot correct an ambiguity. So, even if you are not a smooth writer, don't sit there staring at the blank page: get your facts down first and fix up the dangling participles afterwards.

Scientists Must Write: A Guide to Better Writing for Scientists,Engineers, and Students
by Robert Barrass

In science, every statement should be based on evidence and not on unsupported opinion. Speculation cannot take the place of evidence. The scientist should therefore avoid excessive qualification. Words and phrases such as possible, probably, perhaps, it is likely to, and is better referred to perhaps should cause you to think again. Have I considered the evidence sufficiently? Is there enough evidence for the qualification to be omitted? If not, are further investigations needed before the work is ready for publication?

On Writing Well
by William Zinsser

Clutter is the disease of American writing. We are a society strangling in unnecessary words, circular constructions, pompous frills, and meaningless jargon.... But the secret of good writing is to strip every sentence to its cleanest components. Every word that serves no function, every long word that could be a short word, every adverb which carries the same meaning that is already in the verb, every passive construction that leaves the reader unsure of who is doing what--these are the thousand and one adulterants that weaken the strength of a sentence. And they usually occur, ironically, in proportion to education and rank.

"The Development of Research Writing" (from *Scholarly Publishing*, January 1989) by Robert A. Day

A scientific experiment is not complete until the results have been published. Therefore, to do science, one must also write science. Realizing this, scientists should weigh the words in their manuscripts as carefully as they weigh the reagents in their laboratories.

In scientific writing, there is no room for and no need for ornamentation. The flowery literary embellishments, the metaphors, the similes, and the idiomatic expressions are very likely to cause confusion and should seldom be used in writing research papers. Science is simply too important to be communicated in anything other than words of certain meaning. The meaning should be clear not only to peers of the author, but also to students just embarking on their careers, to scientists reading outside their narrow discipline, and especially to those readers (the majority of readers today) whose native language is other than English.

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