Guidelines for Writing a Scientific Paper

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1. INTRODUCTION

This document contains guidelines intended to help (beginning) scientists to prepare a scientific paper. This document is principally based on the book by Day (1), combined with several additions taken from other sources (2-4). Most of the text is a literal reproduction of the above sources, sometimes with minor adaptations in the text, a few personal remarks and examples of DOs and DO NOTs. Examples of *DOs are printed in black italics*, examples of *DO NOTs in grey italics*.

A complementary document especially intended for Dutch Ph.D. students has been made by J.J. Kettenes-van den Bosch (5).

2. HOW TO START

It is a wise policy to begin writing the paper while the work is still in progress. Define your objectives and collect the results to present. The writing process is likely to point to inconsistencies in the results or perhaps to suggest interesting sidelines that might be followed. Thus, start writing while the experimental apparatus and materials are still available.

It is advisable to start the writing process with the Materials and Methods section, because it is relatively easy to write. Next, write the Results, including the figures and tables. Start then with the Discussion. Experienced writers usually prepare the Title and Abstract after their paper is written. To settle on a title before the paper is written is like naming the baby before it is born – you may end up with a girl's name for a boy baby. You should, however, have in mind (if not on paper) a provisional title and an outline of the paper that you propose to 'write up'. If you don't have clear purposes in mind, you might go writing off in six directions at once.

3. STRUCTURE OF THE PAPER

3.1. HOW TO PREPARE THE TITLE

Few people, if any, will read the entire paper, but many people will read the Title, either in the original journal or in one of the secondary (abstracting and indexing) services. Therefore, all words in the Title should be chosen with great care. The Title should be the fewest possible words that accurately describe the content of the paper. *Few* titles are too short. An example of such a title:

> *Action of Antibiotics on Bacteria*

In form, it is a good title: it is short and carries no excess baggage ('waste' words). However, a title should be specific, not general: a reader, attracted by the title, may be disappointed to find that the paper is about only one specialised aspect of the subject promised. Certainly, the above title would not be improved by changing it to:

> *Preliminary Observations on the Effect of Certain Antibiotics on Various Species of Bacteria*

Examples of more acceptable titles are:

Action of Streptomycin on Mycobacterium tuberculosis or

Action of Polyene Antibiotics on Plant-Pathogenic Bacteria

If the *Action of* can be easily defined in the title, the title can be made even more meaningful, for instance:

Inhibition of Growth of Mycobacterium tuberculosis by Streptomycin

Many titles are too long. An example:

On the addition to the method of microscopic research by a new way of producing colour-contrast between an object and its background or between definite parts of the object itself

Most overly long titles are overly long for only one reason: the use of 'waste' words such as *Studies on*, *Investigations on*, *Observations on*, *The*, etc. Let the first word be a key word if possible.

3.2. AFFILIATIONS

Make sure that you use the correct affiliations for all authors. For members of our department, the following affiliations must be used:

Department of Pharmaceutics, Utrecht Institute for Pharmaceutical Sciences (UIPS), Utrecht University, P.O. Box 80082, 3508 TB Utrecht, The Netherlands

3.3. HOW TO PREPARE THE ABSTRACT

A well-prepared Abstract enables readers to identify the basic content of a paper quickly and accurately, to determine its relevance to their interests, and thus to decide whether they need to read the entire document. The Abstract is usually the first part of the manuscript that is read by journal referees. If you cannot attract the interest of the referees in your Abstract, your cause may be lost. In my own experience as a referee, a good Abstract is usually followed by a good manuscript, whereas a bad one is likely to be followed by a poor one, provoking a check in the 'reject' box on the evaluation form.

Thus, when writing the Abstract, examine every word with care. If you can tell your story in 100 words, do not use 200. The Abstract should state the principal objectives and scope of the investigation, describe the methodology employed, summarise the results, and state the principal conclusions.

The Abstract should never contain any information or conclusion that is not stated in the paper. Write the paper before you write the Abstract. Write the Abstract in the past tense, except perhaps the last paragraph. The Abstract should be self-contained, *i.e.*, it should contain no bibliographic, figure, or table references. The language should be familiar to the potential reader. Omit obscure abbreviations and acronyms.

3.4. HOW TO WRITE THE INTRODUCTION

The purpose of the Introduction is to provide the rationale for the present study. The Introduction should also supply sufficient background information to allow the reader to understand and evaluate the results of the present study without needing to refer to previous publications on the topic. Choose references carefully to provide the most salient background rather than an exhaustive review of the topic. Refer to papers that, taken together, show that a problem exists and that your objectives are sound. If closely related papers have been or are about to be published elsewhere, this should also be mentioned in the Introduction.

Suggested rules for a good Introduction are as follows:

1. It should present, with all possible clarity, the nature and scope of the problem investigated.
2. To orient the reader, the pertinent literature should be reviewed.
3. The method of investigation should be stated. If deemed necessary, the reasons for the choice of a particular method should be stated.
4. The last paragraph should contain the main objectives as well as the principal results of the investigation.

Keep in mind that the purpose of the Introduction is to *introduce* (the paper). Thus the first rule (definition of the problem) is the cardinal one. If the problem is not stated in a reasonable, understandable way, readers will have no interest in your solution.

The second and third rules relate to the first. The literature review and choice of method must be presented in such a way that the reader will understand what the problem was and how you attempted to resolve it.

These three rules then lead naturally to the fourth, the statement of the principle results. Do not leave the reader in suspense; let him follow the development of the evidence. Many authors, especially beginning authors, make the mistake of holding up their most important findings until late in the paper. In extreme cases, authors have sometimes omitted important findings from the Abstract, presumably in the hope of building suspense while proceeding to a well-concealed, dramatic climax. The problem with the surprise ending is that the readers may become bored and stop reading long before they get to the punch line.

The conclusion may appear three times: In the Abstract, the Introduction and the Discussion. Do not repeat the wording; paraphrase it. If the reader has not understood one version, another may help. Use the shortest version for the Abstract.

3.5. How to write the Materials and Methods

Give the full detail. The main purpose of this section is to provide enough detail that a competent researcher can replicate the experiments. Careful writing of this section is critically important because the cornerstone of the scientific method *requires* that your results, to be of scientific merit, must be reproducible; you must provide the basis for repetition of the experiments by others. The potential for producing the same or similar results *must* exist, or your paper does not represent good science.

3.5.1. Materials

Include the exact technical specifications and source or method of preparation. Avoid the use of trade names. However, if there are known differences among proprietary products and if these differences may be critical, then use of the trade name, plus the name of the manufacturer, is essential. If the description of Materials is short it may be included in Methods.

Experimental animals and micro-organisms should be identified accurately, usually by genus, species, and strain designations. Sources should be listed and special characteristics (sex, age, genetic and physiological status) described.

3.5.2. Methods

The usual order of presentation is chronological. Obviously, however, related methods should be described together, and straight chronological order cannot always be followed.

Be precise. Questions such as “How much?”, “For how long?” and “How many times?” should be answered with exact specifications. Indefinite words such as ‘frequently’ or ‘occasionally’ have no place in the Methods section. If you used “alcohol”, say which alcohol. If a reaction mixture was heated, give the temperature. If you used control experiments, permit no doubt about their nature. Write what you did in operational order. Invert *The liposomes were freeze-dried after extrusion* by *The liposomes were extruded, then freeze-dried*, or *After extrusion, the liposomes were freeze-dried*.

If your method is new (unpublished), you must provide *all* of the needed detail. However, if a method has been previously published in an established journal, only the literature reference should be given. If several alternative methods are commonly employed, it is useful to identify the method briefly as well as to cite the reference. For example, it is preferable to state *Protein contents were determined by HPLC as previously described (9)* rather than stating *Protein contents were determined as previously described (9)*.

Statistical analyses are often necessary, but you should feature and discuss the data, not the statistics. Generally, a lengthy description of the statistical methods is an indication that the writer has recently acquired this information himself and believes that the reader needs similar enlightenment. Ordinary statistical methods should be used without comment; advanced statistical methods may require a literature citation.

3.6. HOW TO WRITE THE RESULTS

There are usually two ingredients of this section. First, you should give some kind of overall description of the experiments, providing the “big picture”, without, however, repeating the experimental details previously provided in Materials and Methods. Second, you should present the data. Although the Results section of a paper is the most important one, it is often the shortest, particularly if it is preceded by a well-written Materials and Methods section and followed by a well-written Discussion.

Be selective! Present the data in the text, or in a table, or in a figure. *Never* present the data in more than one way. Present representative data rather than endlessly repetitive data. The data should be arranged in such a way that the reader can quickly identify the main results. If one or only a few determinations are to be presented, they should be treated descriptively in the text. Repetitive determinations should be given in tables or graphs (see section 3.8). The text should not simply repeat the information in the tables and figures, but should be used to guide the reader. Brief comments on the meaning and relevance of the data are also appropriate. While detailed discussions of the data and the implications should be reserved for the Discussion, some explanation will help the reader see relationships.

Any determinations, repetitive or otherwise, should be meaningful. Suppose that, in a particular group of experiments, a number of variables were tested. Those variables that affected the reaction become determinations of data and, if extensive, are tabulated or graphed. Those variables that do not seem to affect the reaction need not be tabulated or presented. However, it is often important to define even the negative aspects of your experiments, *i.e.*, to state what you did *not* find under the conditions of your experiments. Someone else may find different results under different conditions. Absence of evidence is not evidence of absence.

Replicate observations should not usually be given. Instead, offer the mean and a measure of the variability if you can. Make clear what you mean by the indicated variability. Consider the following sentence:

> *The average molecular weight of the polymer was 120 ± 14 kDa as determined by GPC.*

Is the indicated variability the estimated standard deviation, standard error of the mean, coefficient of variation or otherwise? Also, give the number of observations within parentheses: *120 ± 14 kDa* ($M_w \pm SD$; $n = 5$). Moreover, don't let the reader guess what level of variation you are indicating: does it reflect (1) the reproducibility of the synthesis, (2) of the homogeneity of the batch, (3) of the GPC method or (4) does it perhaps represent the size distribution?

In presenting numbers, do not use more significant figures than necessary. Too many figures can mislead the reader by creating a false sense of precision.

Occasionally the Results and Discussion are combined. This is done when the Discussion is brief and can easily be gathered from the Results.

3.7. HOW TO WRITE THE DISCUSSION

The Discussion is harder to define than the other sections. As a result, it is usually the hardest section to write. The true meaning of the data may be completely obscured by the interpretation presented in the Discussion. Many Discussions are too long and verbose, which has been called the squid technique: the author is doubtful about his facts or reasoning, and retreats behind a protective cloud of ink.

In simple terms, the primary purpose of the Discussion is to show that the objectives are met by the data. Also, the *relationships among observed facts* must be shown through logical argument. Furthermore, is important to examine the specific findings of the investigation in the broader context of the field of study.

Many papers are rejected by journal editors because of a faulty Discussion, even though the data of the paper might be both valid and interesting. An old story of the professor and the flea may serve to emphasise this:

> After training the flea for many months, each time the professor shouted the command "Jump!" the flea would leap into the air. On other commands, the flea did not react. In the manner of the true scientist, the professor decided to take his experiments one step further. He sought the location of the receptor organ involved. In one experiment, he removed the legs of the flea, one at a

> time. The flea continued to jump on command, but as each successive leg was removed, its jumps became less spectacular. Finally, with the removal of the last leg, the flea remained motionless. Time after time the command failed to get the usual response. The professor decided that at last he could publish his finding. His conclusion: When the legs of a flea are removed, the flea can no longer hear. [The manuscript was rejected for publication.]

So, think critically about your own work. For instance, ask yourself “Can my hypothesis be refuted?” or “Can my results have another explanation?”

Some essential features of a good Discussion are:

1. Try to present the principles, relationships, and generalisations shown by the results. In a good Discussion, you *discuss*; do not recapitulate the results. You may have formulated your problem as a question or hypothesis. In the Discussion you may refer to the purpose of the study and indicate whether your findings support the hypotheses.
2. Point out any exceptions or any lack of correlation, and define unsettled points.
3. Show how your results and interpretations agree (or contrast) with previously published work.
4. Summarise your evidence for *each* conclusion.
5. Discuss the theoretical implications of your work, as well as any possible practical applications. If the *significance* of your results is not discussed adequately, the reader may be left with the question “So what?”.
6. End the Discussion with a short summary or conclusion regarding the significance of the work. Many a paper loses much of its effect because the clear stream of the Discussion ends in a swampy delta.
7. Recommendations for future research are optional.

3.8. HOW TO PREPARE THE LITERATURE CITED

Simply follow the convention of the journal. Most of you will use literature databases such as EndNote. Such programmes permit automatic insertion of citations in the desired way in a Word file, which should make life easy. Applying automatic insertion, however, automatically results in a faulty reference list if the settings are incorrect or if the input of the references (including punctuation errors) is not exact. For instance, the EndNote files in our literature database (g:\literatuur) contain numerous mistakes. Never blame the computers, because “computer mistakes” originate from input by humans, most probably you. So, always check the final reference list accurately before submitting your manuscript to a journal. The few readers who are really interested in your work are the ones most likely to take the effort to consult references; do not punish them by giving wrong or incomplete ones.

3.9. HOW TO PREPARE EFFECTIVE TABLES AND FIGURES

The results of many experiments can be presented either as tables or as graphs. How do we decide which is preferable? This is often a difficult decision. A good rule might be this: if the data show pronounced trends, making an interesting picture, use a graph. If the numbers just sit there, with no exciting trend in evidence, a table should be satisfactory. If you want to impart the readers exact numerical data, a table may be necessary.

Provide enough information in legends or footnotes that the meaning of the data presented in graphs or tables are clear without reference to the text. However, it is improper to provide the experimental detail that would be required to repeat the experiments. Rather, provide concise explanation in legends or footnotes, explain abbreviations, and avoid repetition in the text and other legends.

3.9.1. Tables

Once you have decided to tabulate, you should ask yourself exactly what should go into the table and in what form. As a general rule, do not construct a table unless repetitive data *must* be presented. It is simply not good science to list arrays of data just because you have them in your laboratory notebook. If only a few determinations were made (or need to be presented), give them in the text. Tables 1 and 2 are useless, yet they are typical of many tables that are submitted to journals.

Table 1. Effect of hydrogen peroxide on the oxidation of Met^{104} in recombinant human IL-2 [a]

Temperature (℃)	*No. of experiments*	*H_2O_2 concentration (mM)*	*Oxidised Met^{104} (%)* [b]
37	*5*	*0*	*0*
37	*5*	*10*	*78*

[a] *Incubation was performed in PBS (pH 7.4) for 1 h.*
[b] *As determined by HPLC.*

Table 1 has two faults. The first fault is that two of the columns give standard conditions, not variables and not data. If temperature is a variable in the experiments, it can have its column. If all experiments were done at the same temperature, however, this single bit of information should be noted in Materials and Methods and perhaps as a footnote to the table. The second fault is that the data can be presented in the text itself in a form that is readily comprehensible to the reader: *After incubation of recombinant human IL-2 with 10 mM hydrogen peroxide in PBS (pH 7.4) for 1 h at 37 ℃, 78% of Met^{104} was oxidised, as determined by HPLC. No oxidation was evident in the absence of hydrogen peroxide.*

Table 2 has no columns of identical readings, and it looks like a better table. The independent variable column (temperature) looks reasonable enough. However, The dependent variable column (relative transfection) has a serious number of zeros. Any table with a large number of zeros (whatever the unit of measurement) or a large number of 100s when percentages are used should be questioned. Table 2 is certainly a useless table, because all it tells us is that *The targeted polyplexes were able to transfect COS-7 cells at temperatures between 34 and 38 ℃ with an efficiency comparable to that of non-targeted polyplexes. No measurable transfection occurred at temperatures below 34 ℃ or above 38 ℃*. Whenever a table, or a column within a table, can be readily put into words, do it.

Table 2. Effect of temperature on the relative transfection of COS-7 cells by targeted polyplexes [a]

Temperature (℃)	*Relative transfection* [b]
20	*0*
22	*0*
24	*0*
26	*0*
28	*0*
30	*0*
32	*0*
34	*0.72 ± 0.18*
36	*1.11 ± 0.32*
37	*0.96 ± 0.13*
38	*0.90 ± 0.23*
40	*0*
44	*0*
50	*0*

[a] *Transfection experiments were performed as described in* Materials and methods.
[b] *Transfection efficiency ± SD (n = 4) relative to that of non-targeted polyplexes at 37 ℃.*

3.9.2. Figures

Much of what has been mentioned for tables is also true for graphs. Basically, a graph is a pictorial table. Sparse data or data that are monotonously repetitive do not need to be brought in a table or graph. If there is only one curve on a graph, it might be described in words. Possibly only one value is really significant, either a maximum or minimum, the rest is window dressing. If you determined that maximum growth of an organism occurred at 37 °C, a simple statement to that effect is better economics and better science than a graph showing the same thing.

Photographs may be part of a paper. The value of a photograph can range from essentially zero (in which case, like useless tables and graphs, they should not be submitted) to a value that transcends the text itself. In many studies of cell ultrastructure, for example, the significance of the papers lies in the photographs. In contrast, a picture of an SDS-PAGE gel showing monomeric protein bands for all formulations tested is useless as the results are easily summarised in the text.

4. ABOUT GRAMMAR, STYLE AND SPELLING

Follow rules of grammar and punctuate carefully. English grammar is simpler than that of many other languages, yet some writers are careless about the small amount that does exist.

The best advice about style is: keep it simple! Keep sentences short. Language need not to be difficult. The best English is that which gives the sense in the fewest short words. Literary tricks, metaphors and the like, divert attention from the message to the style. They should be used rarely, if at all, in scientific writing. In scientific writing a good rule is: Use the <u>specific</u> word, the <u>familiar</u> word, the <u>short</u> word.

4.1. VERB TENSE

Your own present work must be referred to in the past tense. If you determined that the optimal temperature for a certain polymerisation reaction is 80 °C, you should say *Polymerisation occurred most efficiently at 80 °C*. However, whenever you cite or quote previously published work, you should use the present tense; you are quoting established knowledge. So, it is correct to say *Polymerisation occurs most efficiently at 80 °C (13)*.

In the typical paper, you will normally go back and forth between the past and present tenses. Most of the Abstract should be in the past tense, because you are referring to your own present results. Likewise, the Materials and Methods and the Results sections should be in the past tense, as you describe what you did and what you found. On the other hand, most of the Introduction and much of the Discussion should be in the present tense, because these sections usually emphasise previously established knowledge.

In short, you should normally use the present tense when you refer to previously published work, and you should use the past tense when referring to your present results. The principle exception to this rule is in the area of attribution and presentation. It is correct to say that say *Table 4 shows that polymerisation occurred most efficiently at 80 °C*. It is also correct to say *Johnson (13) showed that polymerisation occurs most efficiently at 80 °C*. The latter is an example of findings of an individual study, which are always introduced in the past tense: *De Smit (1990) reported…*; *Storm et al. (2001) showed….*

The present perfect tense is used to introduce a number of studies or to discuss the level of research activity in a field: *A number of researchers have shown…(4-12)*; *Few researchers have studied…*

4.2. JARGON AND VERBOSITY

Avoid <u>jargon</u>, which is characterised, in extreme cases, by the total omission of one-syllable words. Writers with this affliction never *use* anything – they *utilise*. They never *do* – they *perform*. They never *start* – they *initiate*. They never *end* – they *finalise* (or *terminate*). They use *initial* for *first*, *ultimate* for *last*, *prior to* for *before*, *subsequent to* for *after*, *sufficient* for *enough*, *methodology* for *method*, and *plethora* for *too much*. An occasional author will slip and use the word *drug*, but most will salivate like Pavlov's dog in anticipation of using *chemotherapeutic agent*. Who would use the three-letter word *now* when they can use the elegant expression *at this point in time*?

Be alert for <u>empty words</u>. For instance, *It is worth pointing out in this context* may be deleted without affecting the sense. The same holds true for expressions such as *It is significant to note the fact that* and *It is known that*. Appendix 1 lists a few words and expressions that should be avoided. It is not necessarily improper to use some of these words or expressions on occasion; simply don't use them repeatedly and use the alternatives given in Appendix 1.

Be modest. I once read a manuscript in which the term *unique properties* *(of a polymer)* was used twelve times. *Great importance*, *interesting findings*, *significant conclusions* and similar expressions should be restrained. Instead of announcing that what you are about to tell is interesting, make it so.

Avoid verbosity resulting from the use of abstract nouns. This is corrected by turning the nouns into verbs. *Examination of the mice was carried out* should be changed to the more direct *The mice were examined*; *Separation of the compounds was accomplished* can be changed to *The compounds were separated*.

Avoid clusters of nouns (noun adjectives). *Tissue culture response* is awkward; *infected tissue culture response* is incomprehensible (unless responses can be infected). A phrase like *We devised a novel long chain plasmid binding polymer transfection system* is difficult to comprehend; the reader finds that each successive noun is not the real noun. There is no suggestion here that nouns should never be used adjectivally. Many are used satisfactorily, such as *hydrogen bond, steel plate, SI units*.

4.3. MISUSE OF WORDS

Watch for self-cancelling or redundant words. A newspaper referred to *young juveniles*. A sign in a stamp and coin dealer's shop read *authentic replicas*. Appendix 2 lists other redundant expressions.

Certain words are wrongly used thousands of times in scientific writing. Examples of such misused words are listed in Appendix 3.

4.4. WRONGLY ATTACHED PARTICIPLES

Wrongly attached participles are often seen in manuscripts and even in published papers. *The samples were heated, using a stove.* Did the samples really use the stove? Even more painful: *After standing in boiling water for an hour, examine the flask.* Another example: *Goggles are required to perform the experiments.*

A participle may become a kind of noun (called a gerund), as in *Writing a paper*. If the adding of 'the' and 'of' (*e.g.*, before and after 'adding' in this sentence) makes grammatical sense, the -ing word is a gerund. Applying this test, you can see that *Using a thermocouple, the temperature was measured* is not allowed, because 'Using' is a wrongly attached verb here, not a gerund, being wrongly attached to 'temperature'. Change the sentence to *Using a thermocouple, we measured the temperature* or to *A thermocouple was used for measuring the temperature* or add 'by': *By using a thermocouple, the temperature was measured*.

4.5. VARIETIES OF STANDARD ENGLISH

Many varieties of Standard English exist (4). In the scientific literature UK English and USA English are commonly used. Be consistent in using either of the two varieties. Look at the instructions to authors what the journal prescribes.

Avoid the use of words that have a different meaning in the UK and the USA. For instance, 'clever' is a common word in UK English, but is uncommon in USA English where it usually has a negative connotation (*i.e.*, 'sly'). In USA English 'quite' is used positively, whereas in UK English it has a neutral or negative connotation; 'corn' means grain or cereal (UK), or maize (USA). To 'quit' means to go away from, to leave; in the USA the word is used to mean cease. A 'referee' reads a paper and makes recommendations to the editor; a 'reviewer' writes reviews for publications. In the USA, *reviewer* is used for both meanings.

Several words, especially word endings, have a different spelling in USA English and UK English. Be consistent in the use of either spelling. Consider the following part of a rebuttal letter to an editor:

We agree with the judgement of the reviewer that the use of color labelled lines, which are different than symbols, is not favourable to the color blind. We apologise for this and corrected the graph. Also, we added the correct unit (gram/litre) to the axis showing sulfate contents.

This sentence contains several spelling inconsistencies. Better is either UK English:

We agree with the judgement of the referee that using colour labelled lines, which are different from symbols, is not favourable to the colour blind. We apologise for this and corrected the graph. Also, we added the correct unit (gram/litre) to the axis showing sulphate contents.

or USA English:

We agree with the judgment of the reviewer that using color labeled lines, which are different than symbols, is not favorable to the color blind. We apologize for this and corrected the graph. Also, we added the correct unit (gram/liter) to the axis showing sulfate contents.

Appendix 4 lists examples of words that are commonly used in scientific papers and have a different spelling in the UK and the USA.

4.6. PUNCTUATION

The following example may serve to stress the importance of punctuation: *Woman without her man is a savage.* The average male chauvinist will quickly respond that the sentence needs no punctuation, and he is correct. There will be a few pedants among the male chauvinists who will place balancing commas around the prepositional phrase: *Woman, without her man, is a savage.* Grammatically, this is also correct. The truly liberated woman, however, and an occasional liberated man, will place a dash after ‘woman’ and a comma after ‘her’. Then we have *Woman – without her, man is a savage.*

5. REFERENCES

1. Day, R.A. (1988) *How to Write and Publish a Scientific Paper*, ISI Press, Philadelphia, USA.
2. Booth, V. (1993) *Communicating in Science*, 2nd ed., Cambridge University Press, Cambridge, UK.
3. Sanders, M., Tingloo, A., Verhulst, H. (1993*) Advanced Writing in English: A Guide for Dutch Authors*, 2nd ed., Garant, Apeldoorn, The Netherlands.
4. Trudgill, P., Hannah, J. (1985) International English. A guide to Varieties of Standard English, 2nd ed., Edward Arnold, London, UK.
5. Kettenes-van den Bosch, J.J. (2001) *Aanwijzingen voor het schrijven van verslagen, scripties, publicaties en dissertaties.* Utrecht University, Utrecht.

APPENDIX 1

Words and expressions to avoid

Jargon	**Preferred Usage**
a majority of	most
a number of	many
are of the same opinion	agree
as a consequence of	because
as a matter of fact	in fact (*or leave out*)
at the present time	now
based on the fact that	because
because of the fact that	because
by means of	with, by
despite the fact that	although
due to the fact that	because
during the time that	while
first of all	first
for the purpose of	for
from the point of view of	for
has the capability of	can
in no case	never
in order to	to
in some cases	sometimes
in terms of	about
in this case	here
it has been reported by Hennink	Hennink reported
it has been shown to be	it is
it has long been known that	I haven't bothered to look up the reference
it is apparent that	apparently
it is believed that	I think
it is clear that much additional work will be required for a complete understanding	I don't understand it
it is clearly shown in Table 2 that	Table 2 shows that
it is doubtful that	possibly
it is evident that	(*leave out*)
it is interesting to note that	(*leave out*)
it is worth pointing out in this context that	note that
it may, however, be noted that	but
lacked the ability to	couldn't
methodology	method
needless to say that	(*so, don't say it*)
of great theoretical and practical importance	useful
owing to the fact that	since, because
perform	do
prior to	before
proved to be	were
subsequently to	after
the great majority of	most
there is reason to believe	I think
we wish to thank	we thank (*if you wish, do so*)
with the possible exception of	except

APPENDIX 2

Examples of redundancies that must be avoided

7 a.m. in the morning
absolute minimum
all of
completely full
exactly true
final outcome
half of
may be probable
necessary requisite
red in colour
significant finding
total extinction
very similar
a viable alternative
actual truth
as to whether
definitely proved
fewer in number
future plans
join together
mutual co-operation
original source
round in shape
small in size
useless waste of time
would appear

APPENDIX 3

Misuse of words

Amount. Use this word only when you refer to a mass or aggregate. *An amount of cash* is all right. *An amount of coins* is wrong. Whether the noun is countable or uncountable determines how you express quantity. Similarly, do not mix up *many* and *much*, (*a*) *few* and (*a*) *little*.

Case. Better and shorter usage should be substituted: *in this case* means *here*; *in most cases* means *usually*; *in all cases* means *always*; *in no case* means *never*.

Column. In chromatography, a column of adsorbent, sometimes called the bed, is held in a tube. The tube is the support, not the column.

Different. *Different* is used too often. If two methods were used, *different* is not needed; if the methods were not different there would not be two. In *…applied different pressures* replace *different* by *various*. From *4 different kinds* omit *different*.

Due to and **owing to**. *Due to* has the sense of *caused by* and should only be used after a form of *to be*. So, never start a sentence with *Due to*. *Owing to* means *because of*. Consider the sentence *Cardiac disease due to the use of drugs is not always fatal*. This implies that the disease is caused by drugs. If *due to* be replaced by *owing to,* we have the opposite meaning: the disease is not always fatal, because drugs are used. Commas make the meaning clear: *Cardiac disease, owing to the use of drugs, is not always fatal*.

Efficient describes processes whose efficiency can be measured. A writer may mean *effective*. You may have devised a shaking machine or a warning device. Can you determine that it is efficient?

Fact. When you write *fact*, do you truly mean undisputed knowledge? *Effect*, *hypothesis*, *observation*, *value*, *result*, *phenomenon* or *finding* may be more modest. Write *because* instead of *due to the fact that*. A 'fact' reported by an author may be contraindicated by results from another. This often happens.

Flammable is preferred to **inflammable**. People sometimes take the latter to mean it will not burn. The sequel could be disastrous.

In vitro and ***in vivo*** are not adjectives. Write 'test *in vitro*', not '*in vitro* test'. People would not write 'in glass test'. Similarly, e*xcess* and *de novo* must not be used as adjective.

Literature. The body of published materials in a field is normally referred to as *the literature*. The definite article is required. So, *as shown in literature* is incorrect.

Minimal means *lowest*, *smallest*, and should not be written for *small*.

Owing to. See *Due to*.

Quite. This word is often used in scientific writing. Next time you notice it in one of your manuscripts, delete the word and read the sentence again. You will notice that, without exception, "quite" is *quite* unnecessary. Examples of similarly vague qualifiers are *relatively*, *somewhat*, *rather*.

That and **which**. Although *which* and *that* can often be used interchangeably, sometimes they cannot. To be safe, follow the rule: *that* defines, *which* describes. Compare *The protein formulations that contained aggregates were immunogenic*. with *The protein formulations, which contained aggregates, were immunogenic.* Both sentences are correct, but have a different meaning. The first sentence says that only aggregate-containing protein formulations were immunogenic; the others were not. The second one means that all protein formulations contained aggregates and were immunogenic. Note that *which* is preceded by a comma, *that* is not (except in this sentence).

Thus. *Thus* is often used where *hence, so, therefore* or *evidently* might be better. The original meaning of *thus* was *in that way*. Should we not keep it thus?

Varying. The word means “changing”. It is often used erroneously when “various” is meant. *Various* concentrations are defined concentrations, which do not vary.

While. When a temporal relationship exists, *while* is correct; otherwise, *whereas* would be a better choice. *Nero fiddled while Rome burned* is fine. *Nero fiddled while I wrote a scientific paper* is not.

APPENDIX 4

Examples of words spelt differently in UK English and USA English

-our/-or

UK English	*USA English*
behaviour	behavior
colour	color
favour	favor
flavour	flavor
labour	labor
vapour	vapor

-ae/oe-/-e-

UK English	*USA English*
anaesthesia	anesthesia
amoeba	ameba
foetal/foetus	fetal/fetus

en-/in-

UK English	*USA English*
encase	incase
enclose	inclose
endorse	indorse
ensure	insure

-dgement/-dgment

UK English	*USA English*
abridgement	abridgment
acknowledgement	acknowledgment
judgement	judgment

-re/-er

UK English	*USA English*
centre	center
fibre	fiber
litre	liter
metre	meter

-ce/-se

UK English	*USA English*
defence	defense
licence (*noun*)	license (*noun and verb*)
offence	offense
practice (*noun*)	practise or practice (*noun*)

-s-/-z-

UK English	*USA English*	
analyse	analyze	(*-z- is also possible*
cyclise, cyclisation	cyclize, cyclization	*in UK English*)
derivatise	derivatize	
dialyse	dialyze	
emphasise	emphasize	
functionalise, functionalisation	functionalize, functionalization	
generalise, generalisation	generalize, generalization	
hydrolyse	hydrolyze	
optimise, optimisation	optimize, optimization	
oxidise	oxidize	
racemise, racemisation	racemize, racemization	
summarise	summarize	
symbolise	symbolize	
synthesise	synthesize	
utilise	utilize	

-xion/-ction

UK English	*USA English*
connexion	connection
deflexion	deflection
inflexion	inflection

doubled consonant/single consonant

UK English	*USA English*
labelled, labelling	labeled, labeling
levelled, levelling	leveled, leveling
modelled, modelling	modeled, modeling

single –l-/double –l-

UK English	*USA English*
fulfil(ment)	fulfill(ment)
instalment	installment
instil	instill
skilful	skillful

miscellaneous

UK English	*USA English*
aluminium	aluminum
analogue	analog
burnt	burned
co-operate	cooperate
fitted	fit (*past*), fitted (*past participle*)
mould	mold
programme	program
speciality	specialty
spelt	spelled
sulphate, sulphur	sulfate, sulfur