Handbook of Biomedical Research Writing: The Introduction Section

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This is a self-study guide written to help graduate students and researchers at Hanyang University in Seoul, Korea, write for publication in English in biomedical and life sciences. Parts may be helpful to other non-native speaking scientists writing in English as well as other novice researchers. Any part may be freely distributed in electronic or print form for non-commercial, educational purposes either for self-study or classroom use **as long as information indicating attribution is included as follows**:

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3.0 The Introduction Section

The introduction section of the paper is complex, but it is possible to break it down into steps and follow a fairly predictable pattern. Once you understand the purpose, audience, and structure of a typical introduction section, you should be able to write your own. Keep in mind that the introduction should not repeat the same words as the abstract and should contain your own unique interpretation of the literature. Unlike the method section, it is not appropriate to "borrow" sentences from other papers for your introduction section. However, you should study how other authors organize their introductions and follow the customs of your own field of study.

3.1 The Purpose of the Introduction Section

The traditional journal article in the sciences consists of four parts: Introduction, Methods, Results, and Discussion/Conclusion (IMRD). As mentioned in the previous chapter, these sections answer the following questions:

- Why do we care about the problem and the results?
- What problem are you trying to solve?
- How did you go about solving or making progress on the problem?
- What's the answer?
- What are the implications of your answer?

The first two questions are the object of the introduction section.

3.2 The Audience of the Introduction Section

The potential readers of your journal article may include the following groups:

- Researchers in your discipline
- Researchers doing similar work
- Graduate students
- Researchers in other disciplines (sometimes)

Therefore, the audience includes people who need a lot of background information to understand your work, and also includes people who understand your work without much background information. Assume that you are writing your introduction especially for those who do need the background information.

If you publish in a more specialized journal, you can expect an audience that shares more of your background knowledge. That means your introduction will be different than one for an interdisciplinary journal like *Science* or *Nature,* or even one of the more generalized journals of your own field.

3.3 The Structure of the Introduction Section

An introduction section is not a simple list of article summaries. When you discuss other articles, you should mention only the most interesting and relevant information from each article. Show how other authors' ideas and findings relate to your own research or argument.

Your citation of other papers should not usually include summaries of all sections of those papers. Instead, as you cite other papers, you may focus on whatever is relevant from another author's article:

- Main argument
- One minor argument
- Main results

- One of the results
- All or part of the method

You can position yourself in various ways relative to each author you cite:

- Following
- Building on
- Comparing to
- Contrasting with
- Disproving

One technique for organizing and taking notes on a collection of articles before writing the introduction to your paper is a literature review matrix. This is a chart that lists each article you have read. Next to each title, summarize the key points, then indicate how the article is related to your paper. For example, “results agree with mine, but the method is problematic” or “disagree with this author’s analysis of the problem.”

Here are two links to examples of literature review matrices online:

http://cimh.networkofcare.org/downloads/handouts/January%2019%202006%20Summary%20Matrix%209-15-05%20v.11.doc

http://www.scotland.gov.uk/Publications/2004/08/19843/42012

As you collect information, you may wish to highlight text copied from the article in a different color, so that you don’t accidentally use it as your own words later. The author’s exact words must be rephrased in your paper.

Once you have collected the information about each article, consider how all the studies fit together. In your introduction, discuss the big picture, grouping articles in one citation when they have something important in common. You may discuss some studies in more detail, while only mentioning other articles briefly.

Tip

According to Turner,(2006) introduction sections in the sciences typically have three main parts. As detailed below, some of the subsections are optional. Subsections K and L below are rare in biomedical articles, except biomedical engineering. Note that the main three steps are typically in this order, but the subsections may be in any logical order.

STEP 1. State the importance of the topic

A) Give background information on the topic.
B) OR Clearly define the research problem and its importance.
C) SUGGESTED: Define the key terms.
D) OPTIONAL: Classify previous approaches.
E) AND Review previous research in the field.

Note: The background information serves to indirectly argue that the topic is important and helps the reader understand the context for the research.

STEP 2. Show problems with previous research, methods, or theories

F) Criticize previous research or methods by showing the weaknesses of a method or theory.
G) AND/OR Indicate a “gap,” knowledge that is missing in your field.

STEP 3. Introduce your paper as a solution to these problems or missing areas of research

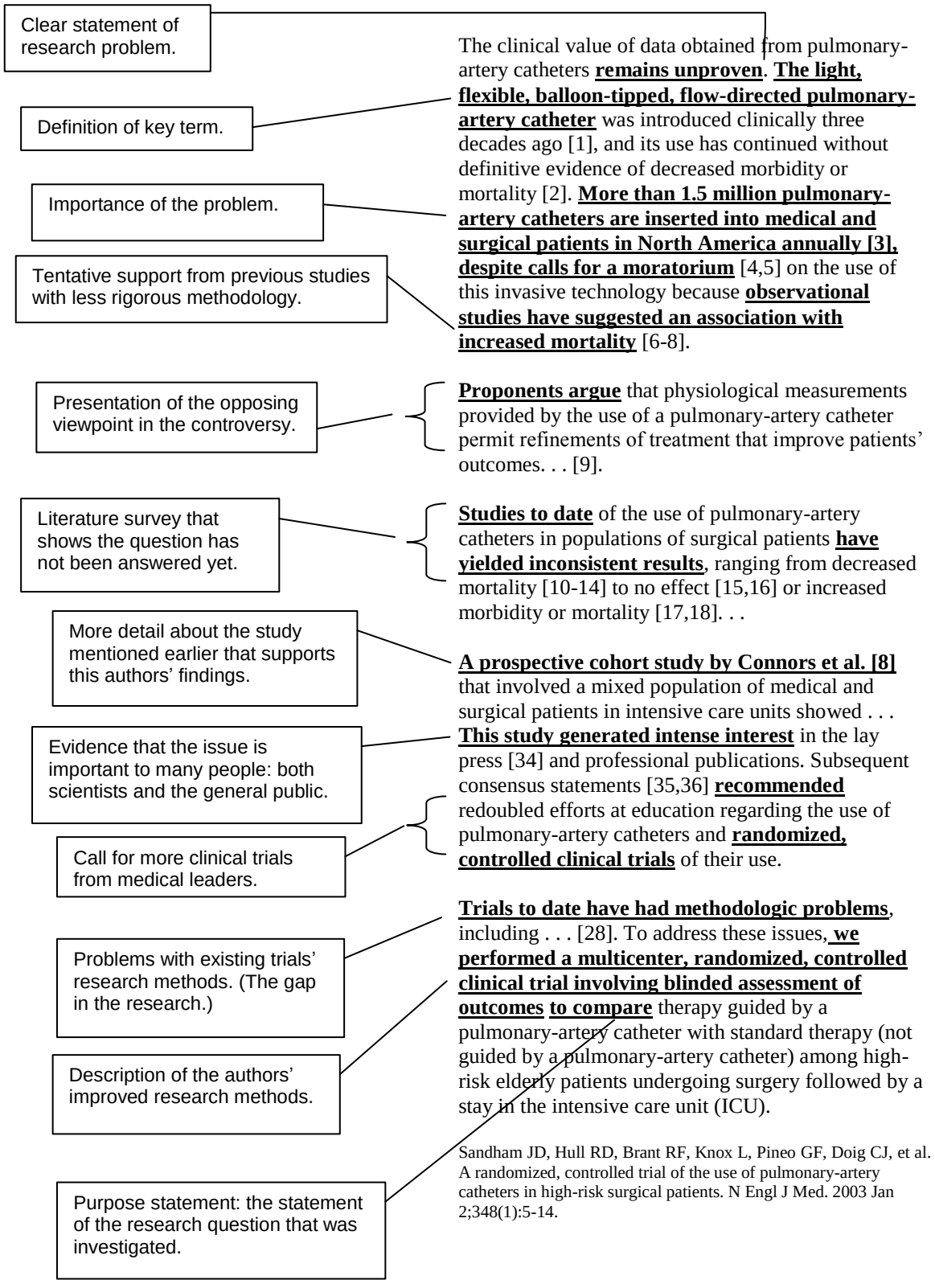
H) Clearly indicate how the purpose of your paper is to solve a problem or fill a gap in knowledge in your field by introducing the objective of your paper.
I) OR Clearly indicate how your approach is different from previous papers.

J) Optional: introduce the basic methodology used in the paper.
K) Optional: Summarize your main results (only in some fields).
L) Optional: indicate the organization of each section of your paper (only in some fields).

Turner A. *English Solutions for Engineering Research Writing*. 2006. p. 142.

3.3.1 What Makes a Good Introduction?

Below is an example of an introduction section from a clinical article. It contains many of the parts from the suggested outline above. Notice how this example aims for a more general audience than just researchers in the same field. Surely the field's own researchers would know the definition of "pulmonary-artery catheter," but the authors define the term in the second sentence. The authors focus on citing articles that prepare the reader to learn about the authors' own research. If some of the articles also mention information relevant to the authors' own results, they may cite those articles again in the discussion section.



3.3.2 Variations of the Standard Introduction Structure

Sometimes several parts of the suggested structure are not needed. Here is an extreme example. In this article, the problem is very simple. A device in the hospital is causing infections. There is no potential disagreement with other researchers. The authors simply had to find the cause of the increased infections and report on it. The only necessary literature to review is other reports of similar outbreaks.

Example:

Although infectious complications of flexible bronchoscopy are uncommon, [1,2] nosocomial outbreaks related to bronchoscopy have been reported, [3-10] and endoscopes, including brochoscopes, are the medical devices most commonly linked to outbreaks. At Johns Hopkins Hospital, between June 2001 and January 2002, the rate of isolation of Pseudomonas aeruginosa from bronchoalveolar-lavage specimens was three times as high as the usual rate. We investigated the cause of the increase and implemented control measures.

Srinivasan A, Wolfenden LL, Song X, Mackie K, Hartsell TL, Jones HD, et al. An outbreak of pseudomonas aeruginosa infections associated with flexible bronchoscopes. N Engl J Med. 2003 Jan 16;348(3):221-7.

3.4 Getting Started

(adapted from Swales, 1990)

The first sentence is the most difficult to write. Writing the method section of your journal article first is recommended. However, it is still necessary to begin the introduction eventually. Here are some expressions you can modify to create a first sentence.

Examples:

Expressions for a journal article's first sentence

- Recently, there has been a **growing** interest in . . .
- The possibility of . . . has generated **wide** interest in . . .
- The development of . . . is a **classic** problem in . . .
- The development of . . .has led to the hope that . . .
- Knowledge of . . . has a **great** importance for . . .
- The study of . . . has become an **important** aspect of . . .
- A **central** issue in . . . is . . .
- The . . . has been **extensively** studied in recent years.
- **Many** investigators have recently turned to . . .
- The relationship between . . . and . . . has been investigated by **many** researchers.
- **Many** recent studies have focused on . . .

Two other types of sentences are common near the beginning of an introduction. Both make generalizations.

Examples:

Expressions that make a generalization about the current state of knowledge or practice

- The aetiology and pathology of . . . is **well-**known.
- There is now **much** evidence to support the hypothesis that . . .
- The . . . properties of . . . are **still** not completely understood.
- A standard procedure for assessing . . . has been . . .
- . . . are **often** criticized for . . .

Examples:

Expressions that make a generalization about phenomena, focusing on frequency or complexity:

- . . . is a **common** finding in patients with . . .
- An **elaborate** system of . . . is found in . . .
- There are **many** situations where . . .
- . . . is a **rich** source of . . .

Swales JM. *Genre: English in academic and research settings*. Cambridge: Cambridge U Press; 1990. p. 144-146.

Note how the underlined words in the examples above strengthen the author's argument. For more examples of expressions for strengthening and weakening an argument, see the Results and Discussion chapter.

Keep in mind that while most research reports begin by showing why a research question is important or a problem is common, in clinical case studies, the introduction should do the opposite: show that the phenomenon is rare. See the Clinical Case Reports chapter for examples.

3.5 Writing Definitions

Tip
Although they may appear anywhere in a research report, definitions are common in the introduction section. In particular, they are one strategy for starting the first paragraph.

According to Swales and Feak, definitions can be a single sentence, just part of a sentence, or several sentences long. Each kind of definition is presented below.

Swales JM, Feak CB. *Academic Writing for Graduate Students, 2nd ed*. Ann Arbor: U of Michigan; 2004.

3.5.1 Sentence Definitions

Here is the pattern for definitions within a single sentence:

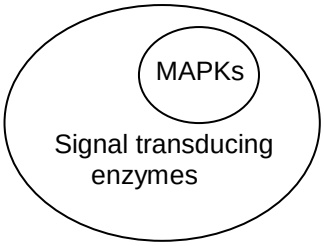
[Term] is/are [member of class] that [distinguishing characteristic].

Term: word defined
Class: a group in which the defined item belongs
Distinguishing Characteristic(s): what makes this item different from other similar items

Example:

Mitogen-activated protein kinases (MAPKs) are important signal transducing enzymes, unique to eukaryotes, that are involved in many facets of cellular regulation.

Chang L, Karin M. Mammalian MAP kinase signalling cascades. Nature. 2001 Mar 1;410(6824):37-40. Review.



In the example above, the **term** is "MAPKs." The **class** is "signal transducing enzymes." The **distinguishing characteristics** that make MAPKs different from other signal transducing enzymes are the following: they are "unique to eukaryotes" and they "are involved in many facets of cellular regulation."

Tip:
Try to be as specific as possible when choosing a class name for a definition. “Something” is not a useful class name. A few common class names are the following: technique, method, process, device, system.

Swales and Feak also mention a few other expressions that can be included in definition sentences:

- commonly referred to as
- is known as
- is defined as

Examples:

These mass immunization campaigns have taken place across large swathes of northern Uganda, southern Sudan and the east of the Democratic Republic of Congo (DRC), countries which make up part of what **is known as** the "meningitis belt."

Doctors without Borders. “Over 1.5 million to be immunized against meningitis.” http://www.doctorswithoutborders.org/. Retrieved 29 September 2006.

Dental erosion **is defined as** a progressive loss of hard dental tissues by a chemical process without bacterial action.

Brunton PA, Hussain A. The erosive effect of herbal tea on dental enamel. J Dent. 2001 Nov;29(8):517-20.

3.5.2 Short Definitions

Short definitions are simply a parenthetical comment in a sentence.

Examples:

Canis familiaris **(**the domestic dog**)** can transmit rabies to humans if not vaccinated.

Canis familiaris, **commonly referred to as** the domestic dog, can transmit rabies to humans if not vaccinated.

Atopic dermatitis, **commonly referred to as** eczema, is a chronic skin disorder categorized by scaly and itching rashes.

MedlinePlus Medical Encyclopedia. http://www.nlm.nih.gov/medlineplus/ency/article/000853.htm/. Retrieved 29 September 2006.

Short definitions may be surrounded by commas, or may be introduced by these expressions:

- ,that is,
- ,i.e.,
- ,or
- ,which is
- ,known as
- ,referred to as

Note that all of these expressions are preceded by a comma (,). However, “that is” is both preceded and followed by a comma. The expression “i.e.” is equivalent to “that is.” Also note that “known as” and “referred to as” were mentioned earlier as variations of the sentence definition. Here, they are used to introduce a short definition, and then the sentence continues with other information.

3.5.3 Extended Definitions

Extended definitions contain multiple sentences or even multiple paragraphs. Often, the first sentence is itself a sentence definition, as described above.

Tip
Types of Information in Extended Definitions
(adapted from Reinhart, 2002)

- An enumeration (numbered list) of the characteristics or features
- A discussion of different types or kinds
- A description of the structure of components
- A list of one or more examples
- A description of how something is made
- A discussion of how something works or is carried out
- A description of applications
- A discussion of the history or evolution of the concept, including its future potential
- A comparison/contrast with a similar concept

Reinhart S. *Giving Academic Presentations*. Ann Arbor: U of Michigan; 2002.

Here is an example of an extended definition at the end of the introduction section of a review article. After an introductory sentence definition, the remaining sentences focus on application of the plant to traditional medicine.

Example:

St John's wort is the common name for the flowering plant, *Hypericum perforatum*, which grows as a common weed in much of the United States. Extracts of the plant have been used for centuries as a therapy for "insomnia and other nervous conditions" [6]. Its yellow flower was traditionally gathered for the feast of St John the Baptist, and "wort" is the Old English word for plant—hence, the derivation of its common name.

In the past few years, the use of St John's wort in the United States has been rising exponentially, with annual sales increasing from $20 million to $200 million between 1995 and 1997 alone [7]. It has long been a popular antidepressant in Germany [8].

Gaster B, Holroyd J. St John's wort for depression: a systematic review. Arch Intern Med. 2000 Jan 24;160(2):152-6. Review.

3.6 Writing Research Questions as Statements

Experimental papers present a research question in the introduction sections, followed by an answer to that question in the results and discussion sections. However, typically, the research question or problem is not in question form.

Here are a number of common ways to write a question in a research report. Note that, grammatically, none of them are in a question form and none have a question mark at the end. Obviously, the question “What time is it?” is not a biomedical research topic; however, it serves as a simple example of the question forms. Replace it with your own research questions.

3.6.1 Common Forms of Question Restatement

Examples:

We don’t know the time.

Investigations so far have been unable to determine the time.

It is unclear what time it is.

The research is inconclusive as to what time it is.

There is some question as to what time it is.

It might also be of interest to investigate the time.

Until researchers develop a more accurate clock, we will be uncertain of the time.

In the following examples, replace "measured" with your own research method and replace "time" with your research subject.

Examples:

We investigated the time.

The second experiment measured the time.

The time was measured.

Examples:
Other questions:

"Can we know the time?"
"How can we measure the time?"

The question remains how we can measure the time, or even whether we can know it at all.

It has not been determined whether the time can be known and, if so, how it can be measured.

"To what extent can we measure the time?"

Another issue raised by this study is whether and to what extent we can measure the time.

3.6.2 Grammar of questions

1. YES/NO questions

YES/NO questions use "whether" (and sometimes "if"). These questions can be answered "yes" or "no." Many hypotheses in research fall into this category.

Example:

. . . we sought to determine **if** Treg cells could control the activation of autoreactive cells . . ."

Tang Q, Adams JY, Tooley AJ. Bi M, Fife BT, Serra P, et al. Visualizing regulatory T cell control of autoimmune responses in nonobese diabetic mice. Nat Immunol. 2006 Jan;7(1):83-92.

In the example above, the research question is: "Can Treg cells control the activation of autoreactive cells?" The answer may be "Yes, they can" or "No, they cannot."

2. Wh- questions

Wh- questions use “who,” “what,” “when,” “where,” “why,” “how.” “How” can be followed by “much,” “many,” “long,” “few,” etc. Wh- words can sometimes be preceded by a preposition (to what extent, for what purpose, by what means, to where, etc.).

Examples:

1. <u>What</u> is the main differentiation regulator? (Wh-question)

Today many researchers are investigating **<u>what</u>** the main differentiation regulator is.

2. How exact is the molecular mechanism? (Wh-question)

It has not yet been determined **<u>how exact</u>** the molecular mechanism **<u>is</u>**.

3. Will systems biology be the key for solving the secret of life? (Yes/No question)

The question remains **<u>whether</u>** systems biology will be the key for solving the secret of life.

4. Is LIF important to mES cells? (Yes/No question)

Investigations so far have been unable to determine the **<u>importance</u>** of LIF to mES cells.

These four examples were written by the author’s graduate students.

In the second example above, note the movement of “is” after the subject “molecular mechanism.” In the fourth example, note how the writer changed the adjective “important” to the noun “importance.”

3.7 Reporting Verbs

When you report on someone else’s research or ideas, you will often use a reporting verb. You can use many of the same verbs to describe your own ideas and data.

Examples:

Lee (2008) states/claims/argues/maintains/suggests/asserts/hypothesizes/concludes that . . .

We believe/argue/maintain/would suggest that . . .

Note: Some reporting verbs show an objective attitude toward the reported information (e.g. describe, examine, propose, recommend, theorize, support). Other verbs show an evaluative attitude—either positive or negative (e.g. claim, assume, contend).

Also note: some reporting verbs can be followed by “that” (e.g. recommend that, claim that, assume that, contend that, propose that, theorize that). Others cannot be followed by “that” (e.g. describe, support, examine).

Over 400 reporting verbs have been identified across disciplines (Hyland, 1999 as cited in Swales & Feak, 2004), but only a few are used most of the time. According to Hyland (1999) and Maynard (n.d.), the most common reporting verbs in biology, epidemiology and nursing include the following: describe, find, report, show, suggest, observe, examine, demonstrate, and propose (as cited in Swales & Feak, 2004). Next time you read an article in your field, note which reporting verbs are most common.

Swales JM, Feak CB. *Academic Writing for Graduate Students, 2nd ed*. Ann Arbor: U of Michigan Press; 2004.

3.8 Verb Tense in Introduction Sections

According to Turner (unpublished), verb tense in journal article writing is not simply about time. Many verb tenses work together to paint a picture of the current state of research in the field in the introduction section.

1. **Present tense:** A fact or a practice that is generally accepted in the field.
2. **Present perfect tense:** (have + PP) a summary of generalization about research in the field or general trends in society. No specific time or date. In citations many studies are usually summarized.
3. **Past tense:** Results of individual experimental papers. Finished events in the past with a specific time.
4. **Other structures**

Example:

Interruptions of antiretroviral treatment **are increasingly being used** for treatment failure and to …