1 General Features of a Scientific Paper
Structure and Format

A research article is the *final product* of an investigation. It is a report that tells the world what you have done and found. On this account, it must be presented in the best possible way so that its message is to the point, clear and succinct.

1.1 Introduction: Why We Publish

The publication of your findings as a paper in a respected journal is the product of your research. It may seem a chore, but scientific endeavour is wasted if it is not presented to the world in the best possible manner.

All scientists want to present evidence for or against new ideas (hypotheses). There can be several motives:

- **Altruistic**. You see your work as contributing to the sum total of knowledge and a better understanding of nature. As scientists, we all want to construct reliable theories that stand the test of time: to be able to describe how a cell divides, what makes the economy tick, or how a drug works.
- **Personal**. In the interests of your personal reputation and your future in science, you want to claim a discovery. Publications meet the needs for recognition amongst peers, career advancement and the pursuit of higher degrees.
- **Research funding**. A good publication record is also crucial for attracting funding for future research – your own, and perhaps your colleagues' and your institution's. This is a major motive for scientific publication.
- **Commercial**. Your results might lend themselves to exploitation, in which case you need to establish intellectual property rights and perhaps secure a patent.

https://doi.org/10.1017/9781108891899.003 Published online by Cambridge University Press

We would all like to draft our papers quickly and accurately, and then revise them effectively so they can be published and made available to the widest possible readership. However, many scientists dread writing. The purpose of this book is to help dissipate the dread and help you learn the necessary skills. Discovering how to organize the writing process will quickly improve your confidence.

In this first chapter we look at the structure of a typical paper. Later chapters will deal with the finer details of each component.

Nota bene: Some information, instructions and advice in this manual will be seen as repetitive. I am aware that this is not normally good practice, but it is *not unintentional*. Readers of a manual looking for guidance delve into different chapters/sections for specific information at different times. A manual is consulted, not read from cover to cover. Repetition in these circumstances will not be so self-evident; indeed, it can help to emphasize and reinforce many different points during the learning process.

Getting started

Have the right mind-set before attempting to write a first draft.

- People want to be told what you have found in the fewest possible words.
- You need to tell them at the start what you have added to the sum of knowledge.
- You need to decide the readership, i.e. which journal is likely to be most appropriate. This will ensure that you deliver your message in the right context for your readers.

1.2 The Framework of a Research Paper

The first question is always:

> What message do you have for your readers? What new idea or information do you wish to share?

Originality is essential. Your message has to be placed up front, usually in the Abstract, without the need for much background. The message should

https://doi.org/10.1017/9781108891899.003 Published online by Cambridge University Press

be simple, short and straightforward, without conditional phrases. Avoid 'ifs' and 'buts' here; they can be considered later in the paper. Try to avoid in any place writing that you have 'demonstrated for the first time. . .'; if your paper has nothing original (new/novel) to tell, you should not be submitting it for publication. Should you submit it with the above phrase being written in the text, the editor should remove it as his or her job is to assure that papers provide new information – it is implicit.

Neither the Abstract nor the Title of the paper is the first thing to be drafted – see the end of this chapter (Section 1.9).

You will normally be expected to write the following sections: *Introduction, Materials and Methods, Results* and *Discussion.* Then you reiterate the main *Conclusions*. Appended to the draft will be *Acknowledgements, References, Figures* and *Tables*, and sometimes *Supplementary Material*. More and more journals now require you to include *Conflicts of Interest* statements and *Contributions* of the different authors.

These are the standard components of a typical research paper. The format has stood the test of time, though it has drawbacks and could no doubt be improved. (Some journals place certain sections in a different order, but the foregoing remains most common.) However, to get the best results, this is not normally the order you should adopt while you are writing the paper.

As we will see in later chapters, once you have decided on your key message, it is usually best to start with the Results section. However, at this stage, we are concerned only with the general outline of a research paper and the overall character of each section.

Below the Abstract there are usually two lists: a set of *Keywords* that indicate the subject matter and the field of the research; and the set of *Abbreviations* used in the paper. Keywords help readers to search databases and journal archives for related publications; the list is usually restricted to five to six items. The Abbreviations listed should not include commonly known items such as DNA.

A historical note about succinctness

Until well into the twentieth century, papers were printed on heavy mechanical presses. A compositor assembled the text letter by letter on little lead blocks, which were packed together by hand in an arrangement (back to front) that ensured they would produce the correct text when they were inked and pressed. For the compositor, succinctness was a virtue.

https://doi.org/10.1017/9781108891899.003 Published online by Cambridge University Press

If the old method were still in use, only a fraction of the millions of papers now published each year would be printed. The electronic revolution and the Internet have changed the situation; words can be typed in quickly and directly by the author. However, succinctness should still be the rule, though for other reasons: editors and publishers do not want to face the laborious task of preparing long papers for publication, and you should expect the reader to be busy and have limited time. Readers do not want to wade through masses of verbiage – and they won't. Unless your paper is succinct it runs the risk of not being published, and even if it is published it might not be read. See this chapter's Appendix 1.1 regarding Word Reduction.

1.3 Introducing Your Paper

The main text of the paper begins with a brief Introduction. This sets the paper's aims in the appropriate context and prepares the reader to grasp the significance of the novel findings you will present. It should focus narrowly on the subject. (Sometimes it is difficult to identify the 'novelty', but we will deal with that in a later chapter.) If you have insufficient new data to communicate it is better not to proceed, except perhaps as a Preliminary Communication. This should state a hypothesis about the topic you are investigating and explain why your evidence to date supports that hypothesis (or otherwise).

A lengthy Introduction dilutes the message and reduces the impact on the reader. Beware of including anything that will be repeated in the Discussion (see below). Include only the most relevant background in the Introduction.

Remember who your reader is

Here is another reason why your Introduction should be brief and circumspect: most of your readers will already know at least as much about previous work in your chosen field as you do. A full review of the history (background) would be pointless and tedious for those readers. They don't want to be told what they already know.

https://doi.org/10.1017/9781108891899.003 Published online by Cambridge University Press

1.4 How the Hypothesis Is Tested: Materials and Methods

For most people this is the most tedious part of the paper, but it is indispensable. Readers may want to compare and/or repeat what you have done and to develop the findings in their own way. Corroboration and refutation are the means by which science progresses; they depend on a precise grasp of the methods of investigation that have been used.

Many technical procedures are now routine. When possible, cite previous papers detailing accepted methods; you need not provide every last detail, but you must specify any modifications you have used. Accuracy is essential, so check the details – a wrong unit or a decimal point out of place can create problems. The SI system for units should be universal, and many units have accepted abbreviations (e.g. cm for centimetre, h for hour). These should be used – but not included in your Abbreviations list, which is for less commonly known items. Unless your paper is purely descriptive the Results section will be rich in numerical data, so the Materials and Methods must include the statistical procedures you have applied. Materials and Methods sections have a characteristic structure that has become almost universal; for example, the 'Materials' subsection is written first and 'Statistics' last.

How much detail do you need?

The least that can be said in this section the better. All the essential information must be there, but full details of techniques now in regular use are not required. For example, antigen–antibody reactions are so commonly used that one would not dream of explaining the chemistry of antigen–antibody binding in a Materials and Methods section, or indeed anywhere in the paper.

1.5 Results: the Pivot of the Paper

Readers want to see the new data you are offering to support or refute your hypothesis. The Results section ought not to be embellished with discourses on each finding, so include as little discussion here as possible.

https://doi.org/10.1017/9781108891899.003 Published online by Cambridge University Press

Almost everything requiring further explanation can safely be left to the next section, where the findings will be discussed in themselves and in the light of previous publications. The clearer and punchier the Results section, the happier your reader will be. It is sometimes useful to summarize the essence of your findings in one or two sentences at the end of the section to prepare readers for the Discussion, especially when you have presented numerous data, but no more is required at this stage.

Presenting the data

Data relevant to sustaining or refuting your hypothesis need to be presented as straightforwardly as possible. Remember, some data will not fit comfortably with your idea, and may not yet be explicable. There may even have been some controversy or negative evidence. It is best to include such information, an issue we will deal with in a later chapter.

1.6 Discussing the Findings

It is pointless to reiterate the results when you open the Discussion, especially if you have summarized them at the end of the previous section. Unfortunately, this habit is becoming more widespread. The purpose of the Discussion is to tell the reader whether your data are likely to prove or disprove your (the) hypothesis, to present the relevant arguments, and to consider them in relation to previous publications. Indicate where caution in interpretation is needed, and qualify your conclusions as necessary. Few findings ever become solid fact – 'set in stone' – so there will always be 'ifs' and 'buts'. A paper is a state-of-the-art communication, a small step in the progress of knowledge.

A long-winded Discussion, occupying pages of text with little or no structure, should be avoided. A lengthy Discussion that lacks an internal logical sequence of arguments is disliked by referees, editors and readers. Succinct points score better than tedious rationalizations and ramifications that go down to minutiae. Small points will be understood by inference if the main points are clear and stated with due emphasis in the right context.

https://doi.org/10.1017/9781108891899.003 Published online by Cambridge University Press

So before you draft the Discussion, list the main points you want to make; these can often be used as subheadings, making the structure of the text explicit.

The making of a good Discussion

The best plan is to identify the most salient points (five or fewer if possible) that emerge from your results. Deal with each clearly, discussing it in relation to other findings and in the context of your hypothesis. Put them under separate subheadings.

Marshalling your evidence and arguments in this way will allow you to draw the clearest conclusions and reiterate your message at the end of the Discussion. If your results have real substance, some of them should be able to stand alone as self-evident, needing little if any discussion. Very few papers have more than a single message to impart.

It is best to round off with a general statement. It is seldom helpful to say more than a few words about where your research might now lead, unless you are reporting a truly major breakthrough (which is very rare) or the findings call for a new research direction. Your paper will not be the final statement on the subject; everyone knows that 'further investigations will be needed'.

1.7 Acknowledging Others

We must always acknowledge the source of funding that made the work possible; to omit this is bad practice and will not help you to obtain further funding. You must also include in your Acknowledgements all the people, within reason, who have contributed materially and intellectually to the paper, or have gifted materials. Others will have criticized your drafts, and there may have been gifts of materials from different sources. It is often difficult to decide where to draw the line – but few if any authors need to go so far as to acknowledge the safety officer or security personnel in their laboratory!

Each author's contribution is intimated in no more than a sentence under Authors' Contributions. When many authors have made

https://doi.org/10.1017/9781108891899.003 Published online by Cambridge University Press

substantially the same contribution to the work, they should be mentioned together in the same sentence. Again, brevity is paramount.

1.8 The Relevant Literature

You should have gathered the References as you drafted the paper. Modern software packages such as Endnote have made this job far easier than it was in the past. But you should review the list and see that it includes only the most relevant publications. It should not aim to be comprehensive unless you are writing a review article. Remember that your readers are probably as knowledgeable as you on the subject and already know the relevant literature.

The style of the reference list will depend on the journal to which you will submit the manuscript, and most software can adapt the style without much extra work. Always check the required order of authors, title, journal, volume number and so on. Each reference has to be set out with the right spacing, correct font, exact punctuation, etc.

1.9 Missing Components

I have not forgotten the *Title*! As I said in the Introduction, the order in which a draft is produced is not the order in which it is finally presented. Imagine a newspaper editor has 'put to bed' the next day's copy. The thing he/she is likely to do last is to decide the headline – after all, a new sensational story could break at the eleventh hour. Then and only then can the decision be made as to what will appeal to the potential reader, hopefully a purchaser. Similarly, you will be able to produce the best title (headline) for your paper after you have finished rather than before you start drafting the manuscript. One type of headline that is frowned upon by editors is the 'declarative' title, which spills the beans – gives the answer to the question being researched, e.g. 'Very high testosterone levels in man increase the incidence of double-tailed sperms' – that might be enough for many readers, who will not bother to read the evidence presented in the paper. A good title, like a newspaper headline, should catch the attention and draw the reader into assessing the paper for what it contains.

https://doi.org/10.1017/9781108891899.003 Published online by Cambridge University Press

Let us now return to the Abstract. You will find it much easier to write an Abstract when your first draft is otherwise complete. By then you have put everything in place in the article and can distil its real core. The advice is therefore to prepare the Abstract as the penultimate job in paper drafting, the final job being to decide the Title.

The next chapter will explore a typical paper. It will inform you as to how publishers like to set out articles in sections, in line with modern conventions. There is little diversity in how papers appear in different journals from different publishers. There seems to be quite strict conformity. This makes life easier for publishers, but often makes the scientific and medical literature look dull and tedious.

This is another reason for writing short, succinct papers that set out their messages clearly. For editors, it is a joy to read one of these when most of the other submissions are comparatively ponderous! For this reason Appendix 1.1 presents an actual case of how a verbose passage from a paper can be reduced to almost half its original length without loss of information, while also making it both easier to read and clearer to understand.

Appendix 1.1 Word Reduction

Here are two examples of an Introduction. The first (unpublished and prior to editing) version is overlong and lacks clarity.

Draft Version

Polyamines, such as putrescine (PUT), spermidine (SPD) and spermine (SPM), are polycationic compounds, and known to be widely distributed in every living organism. Previously, they have been reported to play an essential role in the cell proliferation. Recently, the biological actions of polyamines have been studied at the molecular levels, and these compounds have been suggested to be connected with the modulation of chromatin structures, the transcription and translation of the genes and the stabilization of the DNA as well as the functions of specific cellular proteins (Igarashi and Kashiwagi, 2000; Igarashi and Kashiwagi, 2010). Further studies have shown that polyamines can preferentially bind to the GC-rich regions of DNA and RNA, and the effects of these compounds on the GC-rich region of the DNA in a cell-free system have also been suggested to contribute to their *in vivo* effects (Igarashi *et al.*, 1982; Watanabe *et al.*, 1991; Yuki *et al.*, 1996). On the other hand, the previous

https://doi.org/10.1017/9781108891899.003 Published online by Cambridge University Press

studies have suggested that polyamines may be implicated in mental disorders (Fiori and Turecki, 2008), and also shown that polyamines can protect neurons against mechanical injuries, neurotoxic insults and ischemic damage (Clarkson *et al*., 2004; Ferchmin *et al*., 2000; Gilad and Gilad, 1999). Specifically, the genetic variants in the polyaminergic genes have been suggested to be associated with the psychiatric conditions, thereby proposing a possible connection between polyamine metabolism and mood disorders, such as anxiety, depression and attempted suicide (Fiori and Turecki, 2008). Further studies have provided evidence for suggesting the possibility that polyamines can probably contribute to the adult neurogenesis, the aged-related hippocampal neurogenesis and the learning and memory functions (Liu *et al*., 2008; Malaterre *et al*., 2004).

Previously, polyamines and their metabolizing enzymes have been reported to be localized in the different region of the brain or the different types of the cells, and therefore it seems possible to consider that polyamine synthesis and storage may occur at different locations in the brain [Bernstein, 1999]. On the other hand, polyamines have recently been shown to be preferably accumulated in astrocytes, thereby suggesting a possible role of polyamines in the regulation of the glial network under normal and pathological conditions (Benedikt *et al*., 2012). These findings are considered to propose the possibility that polyamines may be able to cause the modulation of neuronal cell function as a consequence of acting directly on glial cells in the brain, but little is known about the biological or the physiological actions of polyamines on the glial cell functions and metabolism. On the other hand, neuroactive 5α-reduced steroids have previously been reported to enhance the ability of C6 glioma cells to produce brain-derived neurotrophic factor (BDNF) through the promotion of their differentiation, thereby playing a putative role in protecting and reviving the functions of neuronal cells as well as maintaining the integrity of neural network in the brain (Morita *et al*., 2009; Morita and Her, 2008). Furthermore, the neurosteroid-mediated differentiation of the glioma cells has also been suggested to induce the enhancement of glutamate transporter GLT-1 gene expression, and therefore speculated to reduce the excitotoxic damage to neuronal cells as a consequence of facilitating the removal of glutamate from the brain tissue (Itoh *et al*., 2013). Based on these previous findings, it seemed possible to hypothesize that polyamines might cause the modulation of neuronal cell function probably through the enhancement of BDNF production in glial cells, which might be closely connected with the neurosteroid-mediated differentiation of glial cells in the brain. Then, as the first step for verifying this hypothesis, the direct effects of polyamines on 5α-R

gene expression in rat C6 glioma cells were examined to obtain further evidence for suggesting their potential abilities to stimulate the biosynthesis of neuroactive 5α-reduced steroids, which can promote the differentiation of glial cells, thereby resulting in the enhancement of their potencies to enhance the BDNF production in the brain.

(644 words)

What follows shows how this Introduction can be made *clear and more succinct* using far fewer words.

Final Version

Polyamines, putrescene (PUT), spermidine (SPD) and spermine (SPM) – polycationics widely distributed in nature – are involved in cell proliferation, preferentially binding to GC-rich regions of DNA and RNA. They seem to modify chromatin, transcription and translation of genes, and are involved in the stabilization of DNA and the functioning of certain proteins (Igarashi and Kashiwagi, 2000; 2010). Their effects on nucleic acids in cell-free systems seem to correspond with those *in vivo* (Igarashi *et al*., 1982; Watanabe *et al*., 1991; Yuki *et al*., 1996).

Polyamines have been implicated in mental disorders (Fiori and Turecki, 2008), possibly protecting neurons from mechanical, neurotoxic and ischemic damage (Clarkson *et al*., 2004; Ferchmin *et al*., 2000; Gilad and Gilad, 1999). Variants of polyaminergic genes may be associated with psychiatric conditions, indicating a connection between their metabolism and mood disorders, e.g. anxiety, depression and attempted suicide (Fiori and Turecki, 2008). Polyamines are involved in adult neurogenesis, age-related hippocampal neurogenesis, learning and memory (Liu *et al*., 2008; Malaterre *et al*., 2004).

Polyamines and their metabolizing enzymes occur in different regions of the brain, where their synthesis and storage probably take place (Bernstein, 1999). Polyamines might preferentially accumulate in astrocytes, suggesting involvement in regulating glial networks under normal and pathological conditions (Benedikt *et al*., 2012). They may modulate neuronal functioning by acting directly on glial cells, but little is known.

Neuroactive 5α-reduced steroids may enhance the ability of C6 glioma cells to produce brain-derived neurotrophic factor (BDNF) by promoting their differentiation, thereby protecting and reviving the functions of neuronal cells as well as maintaining neural network integrity (Morita *et al*., 2009; Morita and Her, 2008). Neurosteroid-mediated differentiation of glioma cells may enhance glutamate transporter GLT-1 gene expression, reducing excitotoxic damage by facilitating glutamate removal from brain tissue (Itoh *et al*., 2013).

Thus, we hypothesized that polyamines modulate neuronal functioning by enhancing BDNF production in glial cells, possibly connected with neurosteroid-mediated differentiation. In a pilot experiment, the effect of polyamines on 5α-R gene expression in rat C6 glioma cells examined their ability to stimulate neuroactive 5α-reduced steroid biosynthesis, which promotes glial cell differentiation thereby enhancing BDNF production.

(354 words; a 45 per cent reduction)

https://doi.org/10.1017/9781108891899.003 Published online by Cambridge University Press