6 A Journal Paper

This chapter covers:

- The general structure of a journal paper
- How to start writing a journal paper
- How to write the following sections:
  - Title, Abstract, Running Title, Authorship and Affiliation, Keywords, Abstract, Introduction, Materials and Methods *or* Procedure, Results, Discussion, Results and Discussion, Conclusions/Conclusion
- The process of publishing a paper
- General guidelines for figures
- Collected checklists
- Planning a journal paper: Question sheet

The General Structure of a Journal Paper

A journal paper will usually follow the classic *TAIMRAD* basic skeleton of sections (*Title, Abstract, Introduction, Materials and Methods, Results* and *Discussion*) in its general format. Many papers will need these actual sections: some journals with high impact factors, e.g. *Nature* and *Science*, will require a more narrative structure but will need to follow the basic skeleton's scheme in its overall plan.

The following elements are generally found in a journal paper:

Title (and **Running Title** if needed)
Authors(s) and Affiliation(s)
Abstract
Keywords
Introduction
Materials and Methods
Results
Discussion
Sometimes: **Results and Discussion** combined as one section
Sometimes: **Conclusions, Recommendations**
Acknowledgements
List of References

Writing for Science and Engineering.
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The following table shows the purpose of each element. See also Chapter 2: *The Core Chapter*, for further information that is less specific to a journal paper.

Section	*Purpose in a Journal Paper*
Title	To adequately describe the contents of your document in the fewest possible words.
Running Title (if needed)	The short title required by journals for the tops of the pages. Running titles can use abbreviations.
Authors(s) and Affiliation(s)	To show the people who did the work presented in the paper, the institutions where it was done and, if necessary, the present addresses of the authors.
Abstract	To give the reader a *brief* overview of all of the key information in the paper: objective, methods, results, conclusions.
Keywords	This is a short list of words relevant to your work that will be used by electronic services.
Introduction	• To clearly state the purpose of the study. • To allow readers to understand the background to and motivation of the study, without needing to consult the literature themselves. • To indicate the authors who have worked or are working in this area, and to describe their chief contributions. • To indicate correlations, contradictions and gaps in the knowledge, and to outline the approach you will take with respect to them. • To provide a context for the later discussion of the results.
Materials and Methods	To describe your experimental procedures. Aim: repeatability by another competent worker.
Results	To present your results but not to discuss them.
Discussion	To show the relationships among the observed facts that you have presented in your paper and to draw conclusions.
Results and Discussion	This section is a useful way of structuring the results and their significance.
Sometimes: **Conclusions**	To give an overview of the conclusions that you have already drawn previously in the paper.
Recommendations	To propose a series of recommendations for action.
Acknowledgements	To thank the people who have given you help in your work and in the preparation of your paper.
List of References	A list of the works that you have cited in the text. Strong conventions govern this process.
Illustrations (Figures and tables)	

How to Start Writing a Journal Paper

Most supervisors will recommend the following sequence of stages:

1. **Choose the journal.**
2. **Establish the particular type of document you are writing, and the journal's allowed number of figures, tables and words/characters for that type.**

3. **Work out the illustrations – the figures and tables –** that you want to include, particularly those in the *Results* section. Many science graduate students are happier to think more in images than words, and this first step enables you to start planning the logical thread in terms other than the written word. Each figure should convey at least one obvious take-home message of your paper.
4. **Then write a 'working abstract' with a clear logical thread running through it.** This won't be the final abstract for your paper: write it without a word limit but keep it brief. This will force you into creating the logical pathway of your results and the conclusions you want to bring out from them. This is the main part of your paper, the part that your readers will be most interested in. The logic needs to be clearly thought through before you start to write anything else.
5. **Create the final versions of your illustrations, figure titles and captions (legends).** Make sure that the important points are all clearly contained in the illustrations. It's well known that readers of a paper look at the figures very early in the process of reading a paper. Carefully consider which information is to be placed in the main body of the text and which in the figure captions (legends). Consider using schematics to give an overview of a complex hypothesis or procedure.

   Test Points 4 and 5 before you go any further: the entire logical story of your paper should be clear from your working abstract and your illustrations.
6. **Write the *Methods* section.** Most people find this the easiest section to write and always start the writing process here. Supervisors may say that they want you to write this section while you are doing the experiments; however, most graduate students are reluctant to do this, preferring to write only when they must. Moreover, if it's written too early, you may find it needs to be rewritten. It is always much more difficult to do a major rewrite than to write it when you are more sure about what is needed.

See also: *Planning a Journal Paper: Question Sheet*, this chapter, page 108.

Guidelines: Writing the Various Elements of a Journal Paper

This section gives suggestions – some of them are almost formulae – for writing the various sections or elements of a journal paper. These formulae are not necessarily followed in all good papers, but they are designed to give you an objective way of obtaining an effective structure.

Also listed are the common mistakes that graduate students most dislike in published papers that they need to read. You'll already realise that in some papers, the information is more difficult to access than in others. This is often due to poor structure or lack of specific information in that section.

We'll deal with these sections or elements in the usual order in which they appear in a paper.

Journal Paper Title

Purpose of the title

- To give readers immediate access to the subject matter.
- To give informative, not generalised, information: to reflect the important content of the paper.
- To describe the contents of the paper in the fewest possible words. Note: This can lead to clumsy strings of nouns (see *Noun Trains*, Chapter 18: *Problems of Style*, page 214).

Formulae for effective titles

Ask yourself these two questions:

What is the single most important point made in this paper?
How would I convey that to another scientist in one short sentence or phrase?

Stating the conclusions in the title

Many experimentally based papers, particularly those in the biological and medical sciences, use a short, declarative sentence that gives the major conclusion. Some authors like them, some don't; take advice from your supervisor. This type of title has a verb in it (underlined in the following examples):

Serotonin neuron transplants exacerbate l-DOPA-induced dyskinesias in a rat model of Parkinson's disease
TAK1 inhibition promotes apoptosis in KRAS-dependent colon cancers

However, effective titles can be very informative without giving the major conclusion:

A multi-axial fatigue model for fibre-reinforced composite laminates based on Puck's criterion
Regulation of circadian behavioural output via a microRNA-JAK/STAT circuit

Using a colon in a title: a hanging title

Readers' preferences for colons in titles vary. However, if you have lot of information that you need to include in a title, you can try making it more readily understandable by using a colon. In such a title (a 'hanging title'), one part of it – usually the first – describes the general area of work, the other part gives the specific information.

Inelastic interface damage modelling with friction effects: application to Z-pinning reinforcement in carbon fibre epoxy matrix laminates
First part is the general area; the second part is the specific information.

Trying to include all of this information without the colon makes it much more difficult to read:

The application to Z-pinning reinforcement in carbon fibre epoxy matrix laminates of inelastic interface damage modelling with friction effects

Ineffective titles often too generalised

They don't give immediate access to the main point. Here is a series of titles describing the same information, ascending from too general (not useful) to highly specific (very effective):

Genetic control of changes in root architecture
Too generalised, not enough information.

Genetic control of nutrient-induced changes in root architecture
Improved slightly, with one additional item of specific information.

An Arabidopsis MADS gene that controls nutrient-induced changes in root architecture
Fully informative, with very specific information.

Title: common mistakes

- Does not give immediate access to the subject matter of the paper.
- Too generalised: not enough information for readers to assess whether they need to read it.
- Too much detail.
- Too long and clumsy; made up of long strings of words (noun trains, see page 214) that are awkward to read or even ambiguous.

Title: checklist

☐ Does it give the reader immediate access to the subject matter?
☐ Is it informative, not generalised: Does it reflect the important content of the paper?
☐ Is it too long/too detailed?
☐ Is it too short and uninformative?
☐ Is the wording clumsy? Does it make sense?
☐ Is its meaning absolutely clear?

Running title

This is the short version of the title requested by some journals. It will appear at the top of the page of the inner pages of the printed paper. The journal will limit the number of characters. In the running title, you can use abbreviations that you may not want – or be allowed to use – in the main title:

***Main title*: Facile atom transfer radical polymerisation of methoxy-capped oligo (ethylene glycol) methacrylate in aqueous media at ambient temperature**
***Running title*: ATRP of methoxy-capped OEGMA**

Authorship and Affiliation

Purpose

To show the people who did the work; the institution(s) where it was done; current addresses of authors.

For formatting, see the journal's *Instructions to Authors.*

Keywords

This is a short list of words relevant to your work, required by only some journals. These will be used by readers to search online.

It is important to work out the most likely keywords a potential reader might use to search for information. They should include both general and specific items.

***Title*: Subretinal electronic chips allow blind patients to read letters and combine them into words**
***Keywords*: Subretinal neural-prosthetics; retinal implant; retinitis pigmentosa; blindness; artificial vision; bionic vision**

Abstract

For more general material about Abstracts, see *Abstract*, Chapter 2: *The Core Chapter*, page 54.

Journal paper Abstract: purpose

1. Students usually say that an abstract's main function is to save time, determine whether it is relevant to their interests or help them decide whether they need to read the whole paper. That's true, but an often unrealised function of a well-written abstract is that it helps the brain assess and better understand the complex material in the rest of the paper. Efficient readers will always read the abstract first.
2. Effective abstracts have become crucial in a journal paper. People obtain the main points of your work from your online abstract, and from that information, they decide whether they need to read the whole of your paper. If the *Abstract* is weak, your work won't get the advertising that it may deserve.

An abstract should therefore be a miniaturised, fully informative version of the whole paper.

Journal paper Abstract: ineffective abstracts

Abstracts that are not fully informative are not suitable for a journal paper abstract. See Chapter 3: *An Abstract, a Summary, An Executive Summary*, page 54, for a description of the differences between the informative abstracts needed in journal papers and the uninformative, descriptive abstracts used in review papers.

Journal paper Abstract: difficulties in writing

- Deciding on the core information
- Making sure that all aspects are covered
- Linking the information up into a coherent story
- Making the final reduction to the required word count

Journal paper Abstract: format

The most usual format is from 200 to 300 words as one paragraph of continuous text. Some journals require their abstracts to have a given set of headings, e.g. *New England Journal of Medicine*, which requires Background, Methods, Results and Conclusions.

Journal paper Abstract: how to write it

General guidelines

1. Make the description of the methods brief unless you are presenting a new method. Many excellent abstracts do not mention well-established methods.
2. The results usually make up most of the *Abstract*. Make them as quantitative as possible.
3. Do not use non-standard abbreviations, use them only if they are widely recognised in your field.

Journal paper Abstract: formula for an effective structure

Many excellent abstracts do not slavishly follow this formula. However, if you are relatively new to the process of writing a journal paper, this formula will give you a straightforward structure for an effective *Abstract*:

1. **A brief statement of the context** (the *specific field* of your work)
2. **The gap in the knowledge that your work aims to fill** (*why* you are doing the work, the *motivation*)
3. **A brief description of your methods** (often not needed) (*how* you did the work)
4. **Your results**, which should take up most of the *Abstract* (*what* you found)
5. **Clearly signalled main conclusion** (the *overall significance* of your work)

Then ask yourself: Is it a miniaturised, fully informative version of the whole paper?

Example

We'll take a very clearly structured brief abstract. It is only 124 words but clearly shows all five elements listed above, apart from the methods. It uses signalling words or phrases for the gap in the knowledge (*why* you are doing the work, the *motivation*), the results and the main conclusion.

A reader will find that an abstract structured and signalled in this way is very intelligible and useful.

The generation of protective memory-like CD8+ T cells during homeostatic proliferation requires CD4+ T cells

Antigen-specific memory T cells are a critical component of protective immunity because of their increased frequency and enhanced reactivity after restimulation. However, it is unclear whether 'memory-like' T cells generated during lymphopenia-induced homeostatic proliferation can also offer protection against pathogens. Here we show that homeostatic proliferation-induced memory (HP-memory) CD8(+) T cells controlled bacterial infection as effectively as 'true' memory CD8(+) T cells, but their protective capacity required the presence of CD4(+) T cells during homeostatic proliferation. The necessity for CD4 help was overcome, however, if the HP-memory CD8(+) T cells lacked expression of TRAIL (tumour necrosis factor-related apoptosis-inducing ligand, also called Apo-2L). Thus, like conventional CD8(+) memory T cells, the protective function of HP-memory CD8(+) T cells shows dependence on CD4(+) T cell help.

124 words

First sentence: brief statement of context.
Second sentence: signals the gap in the knowledge.
Signalling phrase: *However, it is unclear*
Third and Fourth sentences: the results.
Signalling phrase: *Here we show*
Final sentence: clear statement of main conclusion.
Signalling word: *Thus*

Note: No methods

Hamilton, S. E., Wolkers, M. C., Schoenberger, S. P., Jameson, S. C. (2006). The generation of protective memory-like CD8+ T cells during homeostatic proliferation requires CD4+ T cells. Nature Immunology **7**, 475.

Here is a list of the signalling words and phrases useful in a journal paper *Abstract*. They should appear in this order at the beginning of the sentence or near to it:

1. **Brief statement of context**	No signalling words
2. **Gap in the knowledge** (*why* you are doing the work, the *motivation*)	*However…* *It is unclear…* *It is not yet known…* or combinations of them
3. **Results** (*what* you found out)	*Here we show…* *The results show that…* *It was found that…*
4. **Main conclusion** (the work's *significance*)	*Thus…* *Therefore…* *It is concluded that…* *We conclude that…* *Our results suggest…*

Journal paper Abstract: common mistakes

- No clearly stated conclusions.
- No clearly obvious purpose or motivation of the study.
- The information is too generalised: vague and imprecise.
- No obvious structure; an illogically presented story.
- Non-quantitative description of the results.
- Too many small facts, unnecessary details.
- Unfamiliar abbreviations.
- Important information often missing, e.g. a clear description of the methods, a quantitative description of the results.
- A descriptive abstract (see Chapter 3: *An Abstract, a Summary, an Executive Summary*, page 55): describes only the structure of the document, and gives no real information.

Abstract: checklist

- ☐ Is it a miniaturised, fully informative version of the whole paper?
- ☐ Is it really informative? No use of descriptive phrases?
- ☐ Is the main conclusion clearly stated?
- ☐ Is the story presented logically?
- ☐ Is there a clear logical flow: a beginning (*the context and motivation*), a middle (*methods and results*) and an end (*the conclusions or outcome*)?
- ☐ Does it contain the sort of information that a reader doing an online search would like to find?
- ☐ Have you avoided using non-standard abbreviations?
- ☐ Are there no citations?
- ☐ Is it too short and uninformative?

Journal Paper *Introduction*

Introduction: general guidelines: how to write it

1. **How long should it be?** Without a coherent plan, many people spend far too long writing an *Introduction* section and then find that it needs to be severely cut. Remember, the *Introduction* section in a journal paper is not intended to show the breadth and depth of your knowledge, as expected in a thesis.
2. Clearly show the **main objective** of the work. In a journal paper, this is best done in the last or next to last paragraph of the *Introduction* (see below).
3. **Review the literature and show the relationships between the various areas of work.** Show the contributions of others, with reference citations of their work. The references that you cite should be carefully chosen to provide the background information relevant to your paper.
4. **Show where there are correlations, contradictions, ambiguities and gaps in the knowledge.**
5. **Define the specialist terms used in the document.** The *Introduction* is the correct place for definitions of terms. Don't assume that if you've defined them in the *Abstract*, you don't need to define them again in the *Introduction*.
6. **Structure the *Introduction.*** The *Introduction* tells a story. It should have an obvious logical flow running through the development of the information in it (see box, *Introduction: Formula for an Effective Structure*, below).

Journal paper Introduction: formula for an effective structure

If you are relatively new to the process of writing a journal paper, this formula will give you a straightforward structure for an *Introduction*. However, experienced authors in cutting-edge science papers may not strictly follow points 1 and 2 of this formula but instead may choose to blend them.

1. ***The Beginning*:**
   Briefly summarise the relevant current knowledge: link it together as a coherent story and support it with references as necessary.
2. ***The Middle*:**
   Now move on to the gap in the knowledge: areas where there is less or no knowledge, or where the evidence is conflicting. This should follow logically from the material in Point 1 (The Beginning). The same signalling words can be used for the gap in the knowledge as in the *Abstract*:
   However…
   It is unclear…
   It is not yet known…
   or combinations of them
3. ***The End*:**
   (a) **State the objective of your work.** In the final paragraph or next to last paragraph, make a brief, clear statement of the objective of your work, i.e. the gap in the knowledge that your work is meant to fill and the research question specific to the work in the paper. Make the objective arise out of the gap in the knowledge; don't state it clumsily, e.g. *The reason for doing this study was…*

(b) **Then, briefly summarise your approach.** Many excellent papers do this. This is an effective way of rounding off the *Introduction* and moreover helps the reader's understanding of the work.
(c) **If appropriate, briefly summarise your results.** Some people approve of making a brief statement of the results; some do not. Check it with your supervisor.

Signalling phrases for the results (as in an *Abstract*):
Here we show…
The results show that…
It was found that…

Journal paper Introduction: how to start writing it

Using the formula above, here are guidelines for writing the *Introduction* so that the logical thread is clear:

1. Start by writing the last paragraph first (The End, Point 3 above): the research question you are answering followed by your means of answering it.
2. Then in this last paragraph, identify all of the concepts that you'll need to develop in the preceding paragraphs (Points 1 and 2 above). Thus, your final paragraph will determine the logical thread that will need to be developed in the first part of the *Introduction*.

Journal Paper Introduction: Tense of the Verb

See *The Correct Form of the Verb*, page 224, Chapter 18, *Problems of Style*, for guidelines on using tense in technical documents, together with examples of the various forms of the tenses of the verb. See also Appendix 2: Tenses and forms of the verb, page 261.

You should use a mixture of present and past tenses in their various forms, because you are describing both the established body of knowledge (*present tense*) and what people have discovered (*past tense*).

If you have doubts, read it aloud to yourself and use your instinct about whether to put it in the past or the present tense, and the appropriate form of the verb to use. It's often surprisingly accurate.

Example of past and present tenses in a journal paper *Introduction*

Restoration of function… has been explored (*past*) in clinical trials in patients with advanced Parkinson's disease (PD). The results have been (*past*) highly variable, with some patients showing a substantial recovery in motor function, and others showing little or no improvement. These discrepancies have been suggested (*past*)… to be attributable to the differences in dissection and

preparation of the fetal tissue, in which tissue clumps, tissue stripes, or single-cell suspensions have been used (*past*). It is known (*present*) that transplanted ventral mesencephalic tissue… contains (*present, established knowledge*) also other neuronal cell types… and variations in tissue dissection are (*present*) likely to result in varying numbers of different cell types in the graft cell preparation. The serotonin neurons are (*present*) of particular interest in this regard because they have the capacity to…

Adapted from Carlsson *et al.*, Serotonin Neuron Transplants Exacerbate L-DOPA Induced Dyskinesias in a Rat Model of Parkinson's Disease. *The Journal of Neuroscience*, 2007, **27(30):** 8011–8022; doi: 10.1523/JNEUROSCI.2079-07.2007.

Journal paper Introduction: common mistakes

- No clearly stated aim/objective/purpose of the study.
- The literature has not been adequately reviewed. For example: the pivotal references may not have been cited; only a few references may have been cited for a thoroughly researched area of work; the gaps or inconsistencies in the knowledge may not have been clearly pointed out and so on.
- Too detailed, rambling, unspecific, unstructured, irrelevant material.
- Too long.
- Too short and general.
- Same as other papers: the material and the references cited are frequently identical to those in papers from the same work group.
- If the author/date citation system is being used (see Chapter 15: *Referencing*, page 169), sentences are split by large numbers of references.

Introduction: checklist

- ☐ In the final paragraphs, does it *clearly* state the objective of the study?
- ☐ Following the objective, does it give a summary of your approach? Possibly: the results?
- ☐ Does it adequately review other people's work?
- ☐ Does it identify the correlations, contradictions, ambiguities and gaps in the knowledge in this area of research?
- ☐ Does it place your study into the context of other people's work?
- ☐ Does it have a clear logical structure with an obvious red thread of logic running through it: a beginning, a middle and an end?
- ☐ Does it define the specialist terms?
- ☐ *If appropriate*, does it give a historical account of the area's development?

Methods (also called Materials and Methods or Procedure)

Purpose

- To describe your experimental procedures
- To give enough detail for a competent worker to repeat your work

- To describe your experimental design
- To enable readers to judge the validity of your results in the context of the methods you used

Difficulties

- **Not many.** Describing experimental methods is usually very straightforward.
- **Therefore, it is often the best place to start writing.** Writing a document is often difficult, and it's not usually the best tactic to write it in sequence from beginning to end. Start with the section that is going to give you the fewest problems. **See *How to Start Writing a Journal Paper*, page 84.**

How to write it

- **You should have already worked out the illustrations needed in your paper** (see *How to Start Writing a Journal Paper*, page 84). Make sure that the description of your methods is consistent with any of the illustrations in this section, e.g. schematics, tables.
- **Logically describe the series of experimental steps so that the whole procedure could be repeated by a competent worker in your field.** You need to tread a fine line between giving the right amount of detail for a colleague and giving the sort of superfluous detail that such a person would not need. Think in terms of describing only the essentials.
- **Ask yourself whether you might be too familiar with the techniques.** You might make the mistake of leaving out elements of procedure descriptions that are essential but which you take for granted. If you think this is the case, give your description to a colleague to read.
- **You also need to give the rationale behind your experimental design**. This section should not just be a list of the experimental steps you took. A reader must be able to understand from the *Introduction* and the *Materials and Methods* sections why you chose to do it this way.
- **Make sure that you don't introduce some of the results.** It is quite easy to do this accidentally. The *Methods* and the *Results* sections need to be very strongly separated from each other in their contents.
- **Should it be written in chronological order?** Inexperienced people sometimes present this section chronologically. However, sometimes it is only convenience that determines the order of experiments. The methods section should not be a diary of what you did; it should have a logical flow.
- **How much detail?**
  Established techniques don't need a detailed description; however, novel techniques or variations of a previous one do. Don't forget to state sources of chemicals, model numbers of equipment and so on; these are important in evaluating the results, e.g.

  The surgery was performed under injectable anaesthesia (20:1 mixture of fentanyl and Dormitor, intraperitoneal; Apoteksbolaget, Stockholm, Sweden).

- ***We* is usually acceptable. *I* is rarely acceptable.** The occasional use of *We* in an active construction is acceptable, e.g.

  Using detailed 3D kinematics and body mass distributions, we examined net aerodynamic forces and body orientations in slowly flying pigeons (*Columba livia*) executing level 90° turns.

Beware, however, of using *We* too often. It could sound child-like: *We did this, then we did that.*

- **Referencing in the *Materials and Methods* section.** If you have to refer to literature to explain a technique, give enough brief information for the reader to get an outline of the technique.

  Good*: *Cells were broken by ultrasonic treatment as previously described (Smith, 20xx).
  Poor*: *Cells were broken as previously described (Smith, 20xx).

- **If you cite a previous paper for a method, make sure that it does indeed contain a description of that method.** Many postgraduates complain of citations that refer back to a previous one for details of the technique, only to find that this citation doesn't give the details either – and so on backwards through the literature until it all fades away.

Tense of the verb

See *The Correct Form of the Verb*, page 224, Chapter 18, *Problems of Style*, for guidelines on using tense in technical documents, together with examples of the various forms of the tenses of the verb. See also Appendix 2: *Tenses and forms of the verb*, page 261.

For experimental work: Use a form of the past tense. You are describing work that you did.

Correct: **Nickel ammonium sulphate (2.5 mg/ml) was used (*past tense*) to intensify the staining.**
Incorrect: **Nickel ammonium sulphate (2.5 mg/ml) is used (*present tense*) to intensify the staining.**

For description of morphological, geographical or geological features: Use the present tense.

The eucervical sclerites are connected to the postcervical sclerites, each of which is differentiated (*present tense*) into a relatively hard sclerotised base and a flexible distal part. All three paleosols show (*present*) a greater degree of development than the surface soils. Better development is displayed (*present tense*) in terms of greater clay accumulation, higher structural grade, harder consistency and thicker profiles.

Materials and Methods/Procedure: common mistakes

- Not enough critical detail to enable someone unfamiliar with the method to repeat it. Conversely, too much trivial detail.
- Detailed text, where an illustration would be more appropriate.
- Illogical description. This can happen when several procedures are described together.
- Being referred back to the literature with not enough summarised information to be able to recognise the technique. *For example:…* as described previously (Brown, 20xx).
- Citing a paper for a technique that does not contain a description of that technique.
- Introducing some of the results.

Checklist for the Materials and Methods/Procedure

- ☐ Does it provide enough information to allow another competent worker in your field to repeat your work?
- ☐ Is all of the necessary detail given about the equipment used, e.g. the model number of an instrument?
- ☐ Are there no detailed descriptions of standard instrumentation and techniques?
- ☐ Are the necessary details provided for the following:
  - ☐ Modifications to standard instrumentation and techniques
  - ☐ New techniques
  - ☐ Any organisms used, e.g. species, variety, age, weight
- ☐ Does it state precise treatment/drug regimens?

Results

Purpose

- To present your results but not to discuss them
- To give readers enough data to draw their own conclusions about the meaning of your work

Difficulties

- Deciding how much detail to include

General comments

- **Your results need to be clearly and simply stated.** This is the core section of the paper: the new knowledge that you are presenting to the world.
- **It needs to be presented as a logical story.** If it is interrupted by material that is too detailed or is not directly relevant, your readers are going to become disorientated and lose the thread.
- **The need for excellent illustrations.** Readers familiar with the topic will usually visit the illustrations in the *Results* section very early in the reading process. This highlights the need for illustrations to be as self-explanatory as possible, with informative titles and captions (legends).

How to write it

- **Write your *Results* section around the illustrations. They will have already been planned in detail** (see *How to Start Writing a Journal* Paper, page 84, and *Designing Figures and Tables*, Chapter 2: *The Core Chapter*, page 47). You should have already ensured the following:
  - They have been carefully chosen to illustrate the points you are trying to make.
  - The titles and captions (legends) make the illustrations as self-explanatory as possible.
  - Each one conveys at least one obvious take-home message.
  - They have been prepared according to the journal's instructions.
- **In the text, describe the most important aspects of the results.** You need to guide the concerning reader what to look for in the tables and figures. A *Results* section is not just made up of a series of graphs and tables; there must be explanatory text linking the illustrations.

- **Amount of detail:** It should not be a detailed diary-like account of your results. In any piece of research, there will inevitably be results that are not worth presenting.
- **Dealing with repetitive data.** Do not give them all. Present representative data, and state that they are representative. If needed, present the other data in the journal's online supplementary information.
- **It is important to include anomalous results that do not support your hypothesis.**
- **Do not discuss the results.**
- **The *Results* section is the next easiest section to write, after the *Methods* section.** It is efficient to be able to write the *Results* when you have finished writing the *Methods*. See *How to Start Writing a Journal Paper*, page 84.

Results: common mistakes

- Illustrations that are not self-explanatory.
- Inadequate titles and captions.
- Poorly selected illustrations that do not illustrate the main results.
- Illustrations not prepared according to the journal's instructions.
- Inadequate explanation in the text. The main points are not well described; readers are left to deduce the results from only the illustrations.
- Repetition in the text of large amounts of material that are already shown in the figures and tables. Only key material should be pointed out in the text.
- Too much detail. Readers do not need every item of data collected.

Tense of the verb

See *The Correct Form of the Verb*, page 224, Chapter 18, *Problems of Style*, for guidelines on using tense in technical documents, together with examples of the various forms of the tenses of the verb. See also Appendix 2: *Tenses and forms of the verb*, page 261.

Use the past tense. You are describing the results you obtained.

Example:

In the DA-wide grafts, there was (past tense) an enrichment of serotonin neurons compared with the DA-narrow group.

Checklist for the *Results*

- ☐ Are your illustrations well chosen, i.e. to show your most important results?
- ☐ Are the illustrations presented well and self-explanatory as far as possible, with thoughtfully written titles and captions (legends)?
- ☐ Is there explanatory text pointing out the key results and trends?
- ☐ Have you avoided giving a diary-like account of the data?
- ☐ Have you avoided discussing the results?

☐ If you have repetitive data, have you included only representative data in the *Results?*
☐ Are the figures prepared exactly according to the journal's *Instructions to Authors*?

Journal Paper *Discussion*

Purpose

- To state clear conclusions
- To show the significance of your results and how your results lead to your conclusions
- To give the answer to the gap in the knowledge – the research objective – stated in the *Introduction*
- To explain how your results support the answer
- To show the relationships among your observations
- To put the results into context, particularly with reference to other people's work

Difficulties

- Being unsure where to start
- Now knowing what or how much to put in it
- Challenge of getting a logical flow

Overall guidelines: how to write it

1. In a good *Discussion*, you present the *significance* of the work described in the rest of the document. You don't just restate the material; you need to answer the question:
   How does the work described in this paper add to the existing body of knowledge?
2. Your conclusions need to be clearly stated.
3. Most authors believe that conclusions are best placed towards the end of the *Discussion*; you therefore present your material and build up to them. However, other authors start the discussion with their conclusions and then present the evidence for them. If you are not yet experienced in writing a paper, you are likely to find it more acceptable to place them at the end and build up to them.
4. Show how your results and interpretations agree or contrast with previously published work.
5. Each conclusion should have a sound basis of evidence. Make sure that each one is well supported by the facts.
6. Describe other studies' findings accurately, fairly and objectively.
7. Don't be afraid to defend your conclusions. But in doing this, treat other studies with respect.
8. State any limitations of your methods or study design.
9. State any important implications of the work.
10. Make sure there is a clear logical thread through it. It should not be an unstructured brain dump.
11. Point out in your own work any exceptions or any lack of correlation, and define unsettled points.

    Be open and honest about inconsistencies or gaps in the data. Never try to cover up data that do not quite fit; it will be obvious to an expert reader that you are fudging. Do not avoid mentioning them, either.
12. Avoid any far-fetched hypotheses: keep all your speculation within reasonable bounds.

Journal paper Discussion: formula for structure

Lead readers through a logical sequence as follows:

1. Provide a very brief statement of the objective of the work, i.e. the research question you stated in the final paragraphs of the *Introduction*.
2. Include a very brief statement of your results. Some authors prefer the results not to be restated here; check with your supervisor.
3. Provide a very brief statement of the conclusions that don't need discussion, followed by those that do. *Numbers 1, 2 and 3 should* ***together be very succinct, i.e. no more than one paragraph***.
4. Discuss the significance of your results and put them into context of other people's. Show how your results and interpretations agree or contrast with previously published work.
5. Build up in the final paragraph(s) to a summary of all the conclusions, very clearly stated.
6. State any implications of your work. You may also like to include the direction of your future work. However, check this with your supervisor; because of scientific competitiveness some do not like this to be given.

Word choice in a journal paper Discussion

- ***Prove*** **is too strong a word**; apart from mathematical proofs, nothing can be assumed to be fully proven in science. Your assessors will prefer you to state your conclusions less equivocally. Instead, use **show, demonstrate** or ***indicate*****.** To a native English speaker, *indicate* has slightly less positive ring than *show* or *demonstrate*, but to all intents, the three words are synonymous.
- ***Appear*** sounds weak but can be used so that it is equivalent to *show/demonstrate/indicate* as in the following:
  Thus, CD9 appears to be essential for sperm–egg fusion.
  This is a positive statement and is more acceptable to a journal than the unequivocal:
  Thus, CD9 is essential for sperm–egg fusion.
- ***Reveal*** has an element of showmanship display to it and has been overused by the tabloid press. It is therefore best to avoid frequent use.
- **Hedging words:** ***May be, might be, could be, probably, possibly*** It is acceptable to use hedging words; science is rarely cut-and-dried.
  But don't go to extremes of hedging:
  Acceptable: **These results suggest that A is the cause of B.**
  Acceptable: **These results suggest that A may be the cause of B.**
  Too cautious: **These results suggest the possibility that A may be the cause of B.**

Discussion: tense of the verb

See *The Correct Form of the Verb*, page 224, Chapter 18, *Problems of Style*, for guidelines on using tense in technical documents, together with examples of the various forms of the tenses of the verb. See also Appendix 2: *Tenses and forms of the verb*, page 261.

As in the *Introduction*, the verbs here should be a mixture of past and present tenses. If you have doubts, read it aloud to yourself and use your instinct. It's often surprisingly accurate.

Use the past tense for results (yours and those of others), but use present tense for established fact, to describe existing situations and for your answers to the research question.

Example

The bacterial biofilms were found (*past: your results*) to vary in structure over time. A possible reason for this variation is (*present*) that they could have been (*past*) subject to predation. The presence of protozoa has (*present: established fact*) a significant impact on biofilm structure. For example, Brown (20xx) found (*past*) that the numbers of protozoa increased (*past: other people's results*) in mature biofilm…

The results of this study suggest (*present*) that *Nitrosomonas* species are (*present: your answer to the research question*) slow-growing and very sensitive to environmental change.

Discussion: common mistakes

1. **Main conclusions not clear.** A poorly planned *Discussion* runs the risk of obscuring the main conclusions of the work.
2. **Conclusions are insufficiently supported.** Unspecified assumptions are made, leading to unjustified conclusions. Each conclusion that is drawn should have a sound basis of evidence.
3. **The significance of the material is not adequately discussed.** You should not just restate the material; you need to discuss its significance, interpret it in the context of other work and then draw conclusions from it.
4. **Too long, unstructured and wordy.** A *Discussion* should not be an unstructured brain-dump. You need to thoroughly plan the points you want to make and the logical thread running through it, and then state the points as clearly and concisely as possible.
5. **Too short.** If your *Discussion* is described as being too short and limited, this probably means one or both of the following:
   - You haven't thought out all of the implications of your work.
   - You aren't familiar enough with the literature to be able to place your work in context.
6. **You have ignored some of your results or anomalies.** This will be obvious to an expert reader.
7. **Don't hypothesise too wildly.** Make sure that all of your hypothesising is within the realms of possibility.

Checklist for the *Discussion*

☐ Is each conclusion well supported? Do you give sound evidence for each one?
☐ Is the whole *Discussion* well structured?
☐ Is there a red thread of logic running clearly through it?

- ☐ Does it give an interpretation of the results, rather than a restatement of them?
- ☐ Does it show how your results and interpretations agree or contrast with previously published work?
- ☐ Is it frank in acknowledging anomalies in your work, and are they explained?
- ☐ Is the *Discussion* free of vague statements?
- ☐ Is it accurate, fair and objective regarding other studies' findings?
- ☐ Have you avoided far-fetched hypotheses?

Results and Discussion

A *Results and Discussion* section is often easier to write and more accessible for the reader than separate *Results* and *Discussion* sections.

Formula for an efficient *Results and Discussion* section:

First set of results
  Discussion
Second set of results
  Discussion
  etc.
Overall *Discussion* incorporating the conclusions

Conclusions/Conclusion

Some journals require one or other of these sections; most expect conclusions to be incorporated into the *Discussion*.

Purpose

To present your conclusions and their significance based on the previous material in the document.

How to write it

1. *Important*: there should be no new findings in this section. Each conclusion must be based on material that has already been presented previously in the document.
2. Each conclusion should be related to specific material.
3. Each conclusion should be briefly stated.
4. The *Conclusions* section not only reviews the results or observations but it also interprets them. In this section, you can therefore point out the following:
   - What is important and significant
   - Why the results or observations are valid
   - Any criticisms or qualifications you may have of your own work

5. A numbered or bullet-pointed list can be used if appropriate. Start with your main conclusion, and then present the other conclusions in descending order.
6. A *Conclusion* section is required by some journals. This is usually written as one or two paragraphs (i.e. not as a list) and serves the purpose of rounding off the document and summing up your conclusions and opinions.

Conclusions: *common mistakes*

- **Vague, generalised statements.** Important: you are stating the conclusions you can draw from your results and your interpretation of their significance.
- **Poor or no basis of evidence for each conclusion.** Each conclusion *must* be soundly based on material previously stated in the document.

Checklist for the *Conclusions*

☐ Is each conclusion based on material that appears elsewhere in the document?
☐ Is there a sound basis of evidence for each of your conclusions?
☐ *If necessary*, do you point out the importance, significance, validity, criticisms or qualifications of your work?

Acknowledgements

See *Acknowledgements*, Chapter 2: *The Core Chapter*, page 23.

References

See Chapter 15: *Referencing*, page 169.

Figures for a Journal Paper: General Guidelines

See also *Illustrations*, Chapter 2: *The Core Chapter*, page 44, for further guidelines and comprehensive checklists.

1. **Follow the *Instructions to Authors* very carefully.** Journals give detailed instructions on how figures should be set out.
2. **The journal will not publish the same data in both figure and table form.** Use the most appropriate form.
3. **You may have to submit backup data for figures.** Some journals ask for the data to be submitted in table form as backup to the figures. This gives the reviewers the value for data points, instead of having to interpolate them from the graphs. However, this does not mean

that the data will be published. Check with the *Instructions for Authors* to see if the journal requires this.

4. **Keys.** The *Instructions to Authors* usually include instructions on where to insert the key to a figure. It is usually in the figure itself, but in some journals, it is included in the figure caption.
5. **Use of an already published figure.** See also *Copying and Adapting Illustrations*, Chapter 15: *Referencing*, page 169.

   If you need to reproduce a figure that has already been published by another author, you must get permission in writing to use it. Write to the editor of the journal in which the original publication appeared, asking for permission to reproduce it, and saying in which journal you plan to publish it. Journals usually give such permission. You may be asked to write to the original author as well.

   The journal will usually require you to use, at the end of the caption to the reproduced figure, a standard wording in acknowledgement, e.g. *Reproduced with permission from…*

   Some journals have rules concerning whether figures can be adapted or redrawn in any way. The usual form of acknowledgement is at the end of the figure caption: *Adapted from* (reference), or *Redrawn from* (reference).

The Process of Publishing a Paper

Choosing a journal

We'll assume that your supervisor will have suggested an appropriate journal. If not, you will need to consider the following factors:

- **The journal's impact factor.** This is calculated yearly and is a measure of the frequency that the journal's articles are cited in the literature. It's frequently used as a measure for the relative importance of a journal within its field, with journals with higher impact factors usually judged as more important than those with lower ones.

  The impact factor is based on the number of readers: high impact factor journals publish papers with the broadest general interest and therefore have the greatest number of readers. Journals that are increasingly specialised have a smaller readership and therefore a lower impact factor, but the quality of the papers might well be the same.

  Your supervisor will have the knowledge to choose a journal in which the paper has a reasonable chance of acceptance. If you aim too high, there is a greater possibility of rejection and the repeated revising and resubmission to another journal will increase your frustration and also the waiting time to publication.
- **The level of prestige of the journal.** Those of greater prestige will have a higher standard and a greater rejection rate than those lower on the scale, but acceptance will increase your professional standing.
- **The lead time to publication.** Some journals have extensive delays before publishing. This can be due to a slow refereeing process, editorial delays and the difficulties of production schedules. You can find this out by asking other people who have published in a specific journal or by contacting the editor.
- **Whether the journal has page charges.** Some journals publish papers with no charge to the author. Others have a rate per page (e.g. electronic version of the *Astronomical Journal 2011*, US$110, with pages that use colour at US$350 per page), all of which can mean a substantial cost.

Submitting the manuscript

You'll need to meticulously follow the journal's instructions even if you don't like the results. They will specify things such as the font type and size, margins and equations.

1. ***Style and formatting of the manuscript***
   Journals have reasonably straightforward online instructions to authors. In most journals, they are available online under headings such as Instructions to Authors.
2. **Submitting the manuscript**
   Manuscripts are submitted online. At the time of submission, you will need to send the editor appropriate comments.

The most frequently needed comment is an explanation of the importance of this work. A formula for dealing with the possible other comments is as follows:

1. An introductory short paragraph: Attached is our manuscript (title) by (names). We should be grateful if you would consider it for publication in (name of journal).
2. One sentence each for describing:
   - The current state of the field
   - What you did in your study
   - Your results
   - The significance of your results
3. One paragraph describing why your paper would be of interest to the readers of that particular journal.
4. Suggested reviewers and contact details.
5. If you have competitors, state who you would prefer not to review your work.
6. Concluding paragraph thanking the editor for considering your manuscript for publication.

What happens after submission

This depends on the journal, but in general, the following happens:

1. The editor sends the manuscript to the referees, usually two to four.
2. The referees may take a long time to review it, in some cases, 6 months or more.
3. They will then send their comments back to the editor, together with their recommendations about publication. Each referee may recommend any one of the following:
   - **Acceptance with no revision needed.** This is rare.
   - **Acceptance with revisions** (conditional acceptance).
     The manuscript will be published if the referee's recommended alterations are made. Usually no further experiments are needed. The referees may ask for more information, e.g. about the experiments, or a more detailed *Introduction* or *Discussion*, or a further analysis of data by a specified method.
   - **Rejection with offer to reconsider**, with an instruction that more work is needed.
   - **Rejection because the manuscript is not suitable for publication *in this journal*.**

On the basis of all the referees' decisions, the editor then chooses from the following possibilities:

1. Whether to accept your manuscript for publication subject to amendment, *or*
2. To subject it to a further refereeing process after major alteration, *or*
3. To decline it

You will be told the decision in the editor's letter and also be given copies of each of the referees' comments. You will not know the referees' identities. The editor will also send instructions about the resubmission of the manuscript.

How to deal with referees' comments and amend your paper

1. **General advice:** All of the comments should be read with great care. Most referees' evaluations are usually helpful, and you can take advantage of a fresh viewpoint on both your writing and your work. The final version of the paper can be considerably strengthened by using the comments of a good referee.
2. **How to deal with comments that you don't agree with:** If the suggested changes seem unnecessary or, with good reason, unacceptable to you, then the editor can be given a reasoned argument as to why you believe that a particular change need not be made. There are several things you need to address when evaluating a comment from a referee.
   - *Does the fault lie with you or them?* Some referees' comments can show that they have misunderstood or misinterpreted your material. You then have to establish whether this is (1) because you haven't explained it well enough or (2) the referee doesn't know what he or she is talking about. It is easy in the heat of the moment to assume the latter, but it requires careful reflection.
   - *Is the referee possibly not an expert in the field?* The referees may not be the ultimate authorities on your topic. This may be no fault of the editor; it may be difficult to find appropriate referees for each of the hundreds of manuscripts that an editor has to deal with each year.
   - *Is there a political reason for the comments?* Rivalry between research groups and institutions may cause biased refereeing. Your supervisor should be able to advise you on this.
   - *Are the remarks trivial?* In a few cases, you may have just cause to feel peeved. Some referees, if they are unable to make substantial comments, feel the need to justify their appointment by pointing out minor errors such as in the wording. Such comments can often reflect personal quirks and may not make for a valid comment.
   - *Are all of a referee's comments negative?* This may mean that your paper has no worth at all, that the referee is prejudiced or that he or she is trying to impress the editor.

Whatever your conclusions about the referees in terms of these questions, you cannot use words such as *lazy, trivial and useless* in your rebuttal. If you decide not to abide by a referee's suggested amendment, you need to send the editor a calm, well-reasoned and well-written defence that avoids angry terms. Your arguments should be contained in the formal covering comments when you resubmit your amended manuscript to the editor.

The editor will take note of your argument. If your facts are correct and your reasoning is sound, he or she will be able to use your argument as justification for reversing a negative decision.

Proofreading

When your manuscript has been finally accepted, the next stage of the process is to receive the journal's final version to proofread, either as a.pdf or a.doc file, or as online. This needs to be done meticulously, and you may need to use standard proofreading symbols.

If your paper has been rejected

Assess the paper and the rejecting journal's audiences very critically, do more work, alter it so that it is suitable for a different audience and go through the process of submitting it to another carefully chosen journal, probably with a reduced impact factor. Some papers have been submitted a number of times, but obviously you want to minimise this process.

Collected Checklists for a Journal Paper

Title: checklist

- ☐ Does it give the reader immediate access to the subject matter?
- ☐ Is it informative, not generalised: Does it reflect the important content of the paper?
- ☐ Does it describe the contents of paper in the fewest possible words?
- ☐ Is it too long/too detailed?
- ☐ Is it too short and uninformative?
- ☐ Is the wording clumsy? Does is make sense?
- ☐ Is its meaning absolutely clear?

Abstract: checklist

- ☐ Is it a miniaturised, fully informative version of the whole paper?
- ☐ Is it informative (with *real* information), not descriptive?
- ☐ Is the main conclusion clearly stated?
- ☐ Is the story presented logically?
- ☐ Is there a clear logical flow: a beginning (*the context and motivation*), a middle (*methods and results*) and an end (*the conclusions or outcome*)?
- ☐ Does it contain the sort of information that a reader doing an online search would like to find?
- ☐ Have you avoided using non-standard abbreviations?
- ☐ Are there no citations?
- ☐ Conversely, is it too short?

Introduction: checklist

- ☐ In the final paragraphs, does it clearly state the objective of the study?
- ☐ Following the objective, does it give a summary of your approach? Possibly: the results?
- ☐ Does it adequately review other people's work?

- ☐ Does it identify the correlations, contradictions, ambiguities and gaps in the knowledge in this area of research?
- ☐ Does it place your study into the context of other people's work?
- ☐ Does it have a clear logical structure with an obvious red thread of logic running through it: a beginning, a middle and an end?
- ☐ Does it define the specialist terms?
- ☐ If appropriate, does it give a historical account of the area's development?

Materials and Methods/Procedure: checklist

- ☐ Does it provide enough information to allow another competent worker in your field to repeat your work?
- ☐ Is all of the necessary detail given about the equipment used, e.g. the model number of an instrument?
- ☐ Are there no detailed descriptions of standard instrumentation and techniques?
- ☐ Are the necessary details provided for the following:
  - ☐ Modifications to standard instrumentation and techniques
  - ☐ New techniques
  - ☐ Any organisms used, e.g. species, variety, age and weight
- ☐ Does it state precise treatment/drug regimens?

Results: checklist

Do the *Results*:

- ☐ Are your illustrations well chosen, i.e. to show your most important results?
- ☐ Are the illustrations well presented and self-explanatory as far as possible, with well considered titles and captions (legends)?
- ☐ Is there explanatory text pointing out the key results and trends?
- ☐ Have you avoided giving a blow-by-blow account of the data?
- ☐ Have you avoided discussing the results?
- ☐ If you have repetitive data, have you included only representative data in the *Results?*
- ☐ Are the figures prepared exactly according to the journal's *Instructions to Authors*?

Discussion: checklist

- ☐ Is each conclusion well supported? Do you give sound evidence for each one?
- ☐ Is the whole *Discussion* well structured?
- ☐ Is there a red thread of logic running clearly through it?
- ☐ Does it give an interpretation of the results, rather than a restatement of them?

- ☐ Does it show how your results and interpretations agree or contrast with previously published work?
- ☐ Is it frank in acknowledging anomalies in your work, and are they explained?
- ☐ Is the *Discussion* free of vague statements?
- ☐ Is it accurate, fair and objective regarding other studies' findings?
- ☐ Have you avoided far-fetched hypotheses?

Conclusions/Conclusion: checklist

- ☐ Is each conclusion based on material that appears elsewhere in the document?
- ☐ Is there a sound basis of evidence for each of your conclusions?
- ☐ *If necessary*, do you point out the importance, significance, validity, criticisms or qualifications of your work?

Planning a Journal Paper: Question Sheet

Writing a journal paper is obviously an iterative process. This means that you can't write a paper by going only once through the following questions. However, the questions have been devised to enable you to focus on the important information needed for each section.

OVERALL PRINCIPLE: Think all the time about what the readers of your paper will need.

For the first steps, see ***How to Start Writing a Journal Paper***, page 84.

Stage 1: Title

What will this paper be about? What is its main point?
What information in your title would make your readers read your paper?
Which keywords would you like the title to contain?
Would you like to use abbreviations in the title? If so, are you sure that they are well known?
Would it be appropriate to use a hanging title (a title split by a colon)?

Stage 2: Keywords

Which general keywords do you think you should use?
Which specific keywords do you think you should use?

Stage 3: Illustrations. Remember that the illustrations are often looked at very early in the reading process. They need to be self-explanatory; for each illustration, the title, captions (legends) and labelling need to be fully informative.

What illustrations will you use in this paper?
What do you want them to describe?

Stage 4: Methods

What are the main details of the methods? Think about what the reader *most* needs to know.

Stage 5: Results

What are the main points of your results? Are they shown in the illustrations?

Stage 6: Introduction

Why are you doing this work? Why is it important?
What is your main objective in this paper?

For the beginning of the *Introduction*:
What is the main relevant current knowledge?
For the middle of the *Introduction*:
What is unknown (or a problem with what is known)?
For the end of the *Introduction*:
What is your main objective in this paper? (see above)
What methods will you use to achieve it?

Stage 7: Discussion

Beginning:
How would you VERY BRIEFLY restate your aim?
How would you VERY BRIEFLY summarise the results?
Middle:
How would you place your work in the context of other people's work?
Whose does it support?
Whose does it contradict?
How would you build up the arguments towards your conclusions?
End:
What conclusions can you draw?

Stage 8: Abstract

What points do you think a reader would like to see in your *Abstract*? List them as follows:
The beginning:
What is the context (background) of your work?
What is the gap in the knowledge? Why are you doing the work?
What will be the first sentence of your *Abstract*?
The middle (Part 1): Briefly describe your methods (if necessary).
The middle (Part 2): Briefly describe your results.
The end: Briefly describe your main conclusion(s).
Use signalling words for each of these elements.
Next stage: Be very critical here: Is your Abstract really informative? Or does it contain some descriptive elements?