SCIENTIFIC RESEARCH WRITING

A HANDBOOK FOR STUDENTS

KAUST ENGLISH LANGUAGE PROGRAM

Adapted from

Science Research Writing
Hilary Glasman-Deal
Imperial College Press, 2010

Essentials of Good Scientific Writing
Jasmin Holm
M.P. PharmaMed Publishing, 2013

The Chicago Guide to Communicating Science
Scott L. Montgomery
University of Chicago Press, 2003

Communicating in Science
Vernon Booth
Cambridge University Press, 1993

How to Write and Publish a Scientific Paper
Robert A. Day
Oryx Press, 1998

English in Today's Research World
John M. Swales, Christine B. Feak
University of Michigan Press, 2000

ESL Resource Book for Engineers and Scientists
Elaine Campbell
John Wiley & Sons, 1995

Reporting Technical Information
Houp, Pearsall, Tebeaux, Dragga
Oxford University Press, 2006

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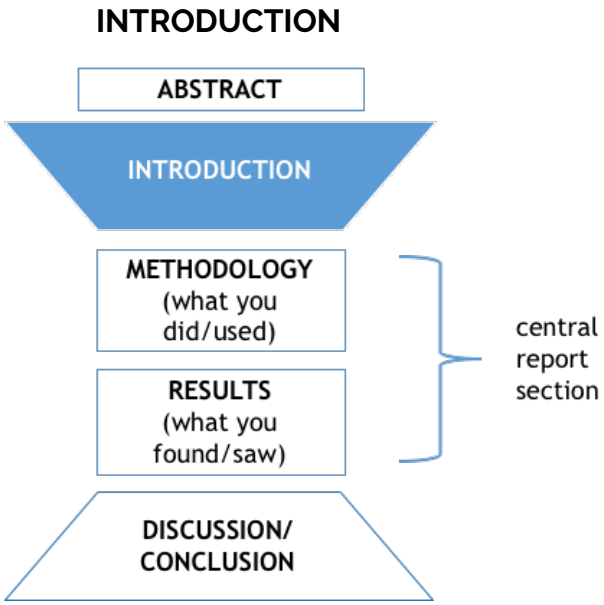
THE STRUCTURE OF A SCIENTIFIC PAPER

Section	**Answers the question:**
Abstract	What did I do?
Introduction	What is the problem?
Methods and Materials	How did I solve it?
Results	What did I find out?
Discussion	What does it mean?



Notice the shape of the diagram—that it narrows towards the central report section, and widens after it. This represents the way information is ordered in the Introduction and the Discussion/Conclusion: in the Introduction, you start out by being fairly general and gradually narrow your focus. Note that the opposite is true in the Discussion/Conclusion.

While the Introduction is presented first in this document, you will usually write it after you have written, or at least drafted, the central report section. You need to be certain about what it is that you have done and what you have found before you write your Introduction.

INTRODUCTION: Grammar and Writing Skills

1. Verb Tense Pairs

a. **Present Simple**: used to express what is generally true and unlikely to change

*The sun **rises** in the east.*

*One way to toughen polymers **is** to incorporate a layer of rubber particles and there has been extensive research regarding the rubber modification of PLA.*

b. **Present Continuous**: used to express present time events which are temporary in nature

*Dr. Jergen is presently **conducting** research in China.*

Question: Which is stronger?

1) *We found that the pressure **increased** as the temperature **rose**, which **indicated** that the temperature **played** a significant role in the process.*

2) *We found that the pressure **increases** as the temperature **rises**, which **indicates** that the temperature **plays** a significant role in the process*

Answer: **2)** We are stating our results as FACTS.
1) Indicates that these are OUR results, but it may not be possible to replicate them.

c. **Past Simple:** used to describe specific actions or events that occurred in the past and are not being linked to the present in the same sentence.

*Watson and Crick **published** their landmark paper on the structure of DNA in 1953.*

d. **Present Perfect:** used to describe events that happened in the past and continue to the present or <u>are still relevant today</u>

*Fluorescent polymers and green fluorescent proteins (GFPs) **have** recently **been Used** for temperature mapping within a living cell.*

Past Simple: *Many researchers **used** this method (in the past and they no longer use it today).*

Present Perfect: *Many researchers **have used** this method (and they are still using it today, or this method is still relevant.)*

Be careful in your use of verb tenses—using the wrong tense can change your intended meaning!

2. Signaling Language

a. **Overlap**: to repeat something from the previous sentence

The pattern of inflammation during an asthma attack is different from that seen in ***stable asthma****. In* ***stable asthma*** *the total number of inflammatory cells does not increase.*

b. **Pronoun use**: using a pronoun (*it,they*) or pro-form (*this method, these systems*) to connect the sentences

Many researchers have suggested ways of reducing cost without affecting the quality of the image. ***These*** *methods rely on data structures built during a preprocessing step.*

c. **Semicolon or relative clause**

1) The procedure for testing whether components are operationally safe usually takes many hours**;** this means that tests are rarely repeated.

2) The procedure for testing whether components are operationally safe usually takes many hours, **which** means that tests are rarely repeated.

TRANSITION SIGNALS AND COHESIVE DEVICES

Listing	**Giving examples**	**Generalizing**
first, second, third	for example	in general
first, furthermore, finally	for instance	generally
to begin, to conclude	as follows	on the whole
next	that is	as a rule
Reinforcement/addition	in this case	for the most part
also	namely	in most cases
furthermore	in other words	usually
too	as evidence of	**Highlighting**
moreover	**Result/consequence**	in particular
what is more	so	particularly
in addition	therefore	especially
besides	as a result/consequence	mainly
above all	accordingly	**Reformulation**
as well (as)	consequently	in other words
in the same way	because of this/that	to put it more simply
not only … but also	thus	rather
again	hence	**Contrast/concession**
indeed	under these circumstances	instead
and then	for this/that reason	conversely
equally important	so that	on the contrary
still	in that case	in contrast
further	**Expressing an alternative**	although
Similarity	alternatively	however
in the same way	rather	but at the same time
equally	on the other hand	even so
likewise	the alternative is	notwithstanding
similarly	another possibility would be	on the other hand
correspondingly	**Deduction**	otherwise
Transition to new point	then	whereas
it follows that	in other words	while
now	in that case	even though
as far as *x* is concerned	otherwise	still

with regard/reference to	this implies that	nevertheless
as for	if so/not	
Summary	**Stating the obvious**	
in conclusion	obviously	
to conclude	clearly	
in brief	naturally	
to summarize	of course	
overall	as can be expected	
therefore	surely	
to sum up	after all	
overall		
In short		

Cause	
due to on account of	The pervasiveness of these random variables is _____ the fact that they model fundamental mechanisms that underlie random behavior.
due to the fact that on account of the fact that	_____the measuring instruments were inaccurate, the experiment was unsuccessful.
as because since	The model cannot be validated experimentally _____ the real system does not exist.
Result	
therefore consequently hence/thus as a result (of which) which is why (it) so	Two events of special interest are the certain event, S, which consists of all outcomes and _____always occurs, and the impossible or null event, which contains no outcomes and hence never occurs.
Contrast/Difference	
whereas while	_____the structure of the enclosing MWCNT is understood, the structure of elemental phosphorous may be significantly more complex.
on the other hand however by contrast	Equation (4.110) shows that the entropy of random variables with finite is always finite. _____, it also shows that as the size of is increased, the entropy can increase without bound.
but	The outcome of a random experiment need not be a single number, _____ can also be an entire function of time.

Unexpectedness	
although even though though	This allows us to compute probabilities involving $\bar{X}_n$ _____ we do not know the distribution of X.
Despite in spite of regardless of notwithstanding	_____ not knowing the distribution of X, this allows us to compute probabilities involving $\bar{X}_n$. _____ statistical dependence, the expected value of a sum of n random variables is equal to the sum of the expected values.
nevertheless however yet nonetheless even so	It should be noted that the joint pdf appears to be a factor; _____ it is not the product of the marginal pdf's.
Addition	
in addition/additionally moreover furthermore apart from that/which also secondly/in the second place what is more besides	Mathematical models are used extensively by engineers in guiding system design and modification decisions. Experimentation is not possible during the initial phases of a system design. _____, the cost of extensive experimentation in existing systems frequently proves to be prohibitive.

3. **Passive/Active Voice**
    a. **Active voice:** we measured, we determined, we discovered, we believe
    b. **Passive voice:** X was measured, it is known, it was determined, it is thought
    c. **When you are the only researcher**
        1) Use ***here*** or ***in this study*** when referring to your own work
        2) Use a substitute subject

        This article *describes an algorithm . . .*
        The present paper *presents a set of criteria*

4. **Paragraphing**
    a. Organizes your writing
    b. Enables your reader to find information quickly: a new paragraph indicates a change or shift of some kind
    c. Two common errors: too short and too long
    d. Each paragraph should contain one main idea.
    e. When a topic or idea moves too far away from the first sentence, the writer begins a new paragraph.

The four basic components of the Introduction:

1	Establish importance/significance Provide background facts/information (possibly from research) Define the terminology in the title/keywords Present the problem area/current research focus
2	Previous and/or current research and contributions
3	Locate a gap in the research Describe the problem you will address Present a prediction to be tested
4	Describe the present paper

VOCABULARY FOR THE INTRODUCTION:

1. ESTABLISHING SIGNIFICANCE

(a) basic issue	economically important	(an) advantage
(a) central problem	(has) focused (on)	attracted much attention
(a) challenging area	for a number of years	benefit/beneficial
(a) classic feature	for many years	commercial interest
(a) common issue	frequent(ly)	during the past (two) decades
(a) considerable number	generally	well-documented
(a) crucial issue	(has been) extensively studied	well-known
(a) current problem	importance/important	widely-recognized
(a) dramatic increase	many	widespread
(an) essential element	most	worthwhile
(a) fundamental issue	much study in recent years	
(a) growth in popularity	nowadays	
(an) increasing number	numerous investigations	
(an) interesting field	of great concern	
(a) key technique	of growing interest	
(a) leading cause (of)	often	
(a) major issue	one of the best known	
(a) popular method	over the past (ten) years	
(a) powerful tool/technique	play a key role (in)	
(a) profitable technology	play a major part (in)	
(a) range (of)	possible benefits	
(a) rapid rise	potential applications	
(a) remarkable variety	recent decades (years)	
(a) significant increase	recent(ly)	
(a) striking feature	today	
(a) useful method	traditional(ly)	
(a) vital aspect	typical(ly)	
(a) worthwhile study	usually	

Examples of how these words/expressions are used when establishing significance:

- A **major current focus** in population management is how to ensure the sustainability of . .
- **Numerous experiments have established** that ionizing radiation causes . . .
- Low-dose responses to radiation have **generated considerable recent research interest**.
- Analysis of change in the transportation sector is **vital** for two **important** reasons . . .
- PDA accounts for **over 95%** of all pancreatic cancers.
- **It is generally accepted that** joints in steel frames operate in a semi-rigid fashion
- Nanocrystalline oxide films **are attracting widespread interest** in fields such as . . .
- Convection heat transfer phenomena **play an important role in** the development of . . .
- **Much research in recent years has focused on** carbon nanotubes.

2. VERBS USED IN THE LITERATURE REVIEW TO PRESENT PREVIOUS AND/OR CURRENT RESEARCH AND CONTRIBUTIONS

achieve	deal with	identify	propose
address	debate	illustrate	prove
adopt	define	implement	provide
analyze	demonstrate	imply	publish
apply	describe	improve	put forward
argue	design	incorporate	realize
assume	detect	indicate	recognize
attempt	determine	interpret	recommend
calculate	develop	introduce	record
categorize	discover	investigate	report
carry out	discuss	measure	reveal
choose	enhance	model	revise
claim	establish	monitor	review
classify	estimate	note	show
collect	evaluate	observe	simulate
compare	examine	prefer	solve
concentrate (on)	explain	obtain	state
conclude	explore	overcome	study
conduct	extend	perform	support
confirm	find	point out	suggest
consider	focus on	predict	test
construct	formulate	present	undertake
correlate	generate	produce	use
			utilize

Examples of how these verbs are used

- This phenomenon **was demonstrated by** . . .
- In their study, expanded T-cells **were found** in . . .
- Initial attempts **focused on identifying** the cause of . . .
- Weather severity **has been shown to** . . .
- Early data **was interpreted** in the study by . . .
- The algorithm **has been proposed** for these applications . . .
- The results on pair dispersion **were reported in** . . .
- Their study **suggested** a possible cause for . . .
- An alternative approach **was developed** by . . .

3. GAP/QUESTION/PROBLEM/CRITICISM

ambiguous	inconclusive	
(an) alternative approach	inconsistent	there is an urgent need
(a) challenge	inconvenient	this is not the case
(a) defect	incorrect	unanswered
(a) a difficulty	ineffective	uncertain
(a) disadvantage	inefficient	unclear
(a) drawback	inferior	uneconomic
(an) error	inflexible	time-consuming
(a) flaw	insufficient	(to be) confined to
(a) gap in our knowledge	it is necessary to…	(to) demand clarification
(a) lack	little evidence is available	(to) disagree
(a) limitation	little work has been done	(to) fail to
(a) need for clarification	meaningless	(to) fall short of
(a) next step	misleading	(to) miscalculate
(an) obstacle	more work is needed	(to) misjudge
(a) problem	no correlation (between)	(to) misunderstand
(a) risk	non-existent	(to) need to re-examine
(a) weakness	not addressed	(to) neglect
confused	not apparent	(to) overlook
deficient	not dealt with	(to) remain unstudied
doubtful	not repeatable	(to) require clarification
expensive	not studied	(to) suffer (from)
false	not sufficiently + adjective	unfortunately
far from perfect	not well understood	unfounded
few studies	not/no longer useful	unlikely
ill-defined	of little value	unnecessary
impractical	over-simplistic	unproven
improbable	poor	unrealistic
inaccurate	problematic	unresolved
inadequate	questionable	unsatisfactory
incapable (of)	redundant	unsolved
incompatible (with)	restricted	unsuccessful
incomplete	(the) absence of	unsupported
few studies have . . .	more work is needed	unfortunately
	there is growing concern	

Examples of how some of these words and phrases are used:

- **Few researchers have addressed the problem** of . . .
- **There remains a need for** . . .
- . . . makes this **an impractical option** for . . .
- **Unfortunately**, these methods do not always . . .
- **An alternative approach** is necessary . . .
- The function of X **remains unclear**. . . .
- **However**, these can be **time-consuming** and **technically difficult** to . . .
- **Although** this approach improves performance, it results in **an unacceptable** number of…
- Previous work has focused **only** on . . .
- However, the experimental configuration was **far from optimal**.

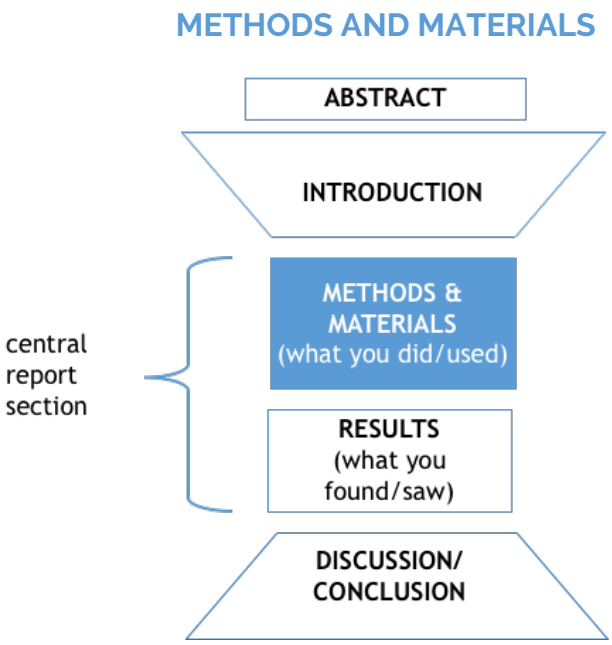
4. THE PRESENT WORK

(to) attempt (to) compare (to) concentrate (on) (to) conclude (to) describe (to) discuss (to) enable (to) evaluate (to) expect (to) facilitate (to) illustrate (to) improve (to) investigate (to) manage to (to) minimize (to) offer	(is/are) organized as follows: (is/are) set out as follows (is/are) presented in detail (our) approach (the) present work (this) paper (this) project (this) report (this) section (this) study (this) work begin by/with close attention is paid to here overview	(is/are) able to accurate/accurately effective/effectively efficient/efficiently excellent results innovation new novel method powerful practical simple straightforward successful valuable
(to) outline (to) predict (to) present (to) propose (to) provide (to) reveal (to) succeed		aim goal intention objective purpose

Examples of how these words/phrases are used:

- **This paper focuses on** . . .
- The **purpose of this study** is to describe and examine . . .
- In order **to investigate** . . .
- **In this paper we present** . . .
- . . . were developed with **excellent results** . . .
- **In the present study** we . . .
- **This paper introduces** . . .
- **The approach we have used in this study** . . .
- This study investigated **the use of . . .**
- **In this report** we test the hypothesis that . . .
- **This paper is organized as follows** . . .

Note: In a thesis, dissertation, or very long research paper, you will use these expressions to say what each chapter or section will do. Don't rely on the same verbs such as *discuss*; some chapters/sections do not 'discuss' anything, and even if they do, their main purpose may be to *compare* things, or *analyze* things, or *describe* things rather than to *discuss* them.



The Methods and Materials section should contain sufficient detail for readers to replicate the work done and obtain similar results.

METHODS AND MATERIALS: Grammar and Writing Skills

1. Passives and verb tense pairs

a. Simple Present Passive

1). A flexible section **is** inserted in the pipe.
2). Communicates what is normally done—the usual procedure

b. Simple Past Passive

1). A flexible section **was** inserted in the pipe.
2). Communicates what I/we did

Note: When you are writing in the passive voice, the sentence has no subject; therefore, the only way the reader can know what is the normal or usual procedure and what was YOUR procedure, is by the verb tense you use.

If you don't pay careful attention to verb tense, your own work may become confused with the standard procedures you are describing. If a reader cannot identify your contribution, that is a BIG PROBLEM.

Challenge: If you use the Simple Past Passive tense to describe what YOU did *(the samples **were collected** using a suction tube)* and you also need to use the same tense to describe a procedure used by another researcher whose work you are citing, this means that unless you are very careful, the reader has no way of separating your work from that of the other researcher.

Solution: You can clearly identify your work with phrases like, ***In this study****, the samples were collected using a suction tube*, or ***In our experiments****, the samples were collected using a suction tube.*

	What do you mean?	**How can you make it clear?**
1	x *was (collected/measured, etc.)* by **me** in the procedure or work that I carried out.	Either choose the active voice *(We collected/measured, etc.)* or add words or phrases such as *here/in this work/in our model* or a substitute subject like *This experiment/The procedure.*
2	x was *(collected/measured, etc.)* by the person whose procedure or work I am using as a basis for, or comparing with, my own	Give a research reference and/or add words/phrases such as *in their work/in that model*
3	x *is (collected/measured, etc.)* normally, i.e. as part of a standard procedure	You may need a research reference even if it is a standard procedure, depending on how well-known it is. Use phrases such as *as in*[5]

2. Article use

RULE: SINGULAR COUNTABLE NOUNS ALL NEED A DETERMINER

Determiners: a, an, the, my, this, one, some, etc.

GENERAL RULES FOR ARTICLE USAGE

THE

1. **THE RULE OF SECOND MENTION**
   There is **a** car in front of my house. **The** car is red.

2. **THE RULE OF SHARED UNDERSTANDING**
   I bought **a** new phone, but **the** camera doesn't work. (You understand that I mean my phone camera.

3. **THE RULE OF ONLY ONE POSSIBLILITY**
   Cairo is **the** capital of Egypt. (Egypt has only one capital.)

A/AN

1. **THE RULE OF IT DOESN'T MATTER**
   A 35 ml glass bottle was used to store the liquid. (Which 35 ml bottle? It doesn't matter.)

2. **THE RULE OF YOU DON'T KNOW**
   A hacker took over my Amazon account. (Who hacked my account? I don't know.)

3. **THE RULE OF THE READER DOESN'T KNOW THE REFERENCE**
   I have **a** new lab partner. (You don't know who my lab partner is.)

4. **THE RULE OF THE SOUND, NOT THE SPELLING**
   An upper level course is too challenging for **a** university student in the first year.

   It's the first sound of the word following the article that determines whether it is '**a**' or '**an**.' The first sound of '**upper**' sounds like '**uh**' which is a **vowel** sound, so **upper** must be preceded by '**an**.' The first sound of **university** is '**you**' which is a consonant sound, so **university** must be preceded by '**a**.'

a. When using *a/an* or *the* can change the meaning of a sentence

1. This effect may hide **a** connection between the two variables.
   There may be a connection between the two variables, but if there is, we can't see it.
2. This effect may hide **the** connection between the two variables.
   There is definitely a connection between the two variables, but we may not be able to see it because of this effect.

b. **Ø (no article) or *the***

1. The nodes should be attached to **ø** two adjacent receptor sites.
   (There are many receptor sites and any two adjacent sites will be fine.)

2. The nodes should be attached to **the** two adjacent receptor sites.
   (There are only two adjacent receptor sites.)

c. When expressing a general truth ***a/an***, ***the***, and **ø** can all be used to the same effect.

1. **The** electroencephalograph is used for measuring brain waves.
2. **An** electroencephalograph is used for measuring brain waves.
3. **Ø** Electroencephalographs are used for measuring brain waves.

Four Basic Components of the Methods and Materials Section

1	• Provide a general introduction and overview of the materials/methods • Restate the purpose of the work • Give the source of materials/equipment used • Supply essential background information
2	• Provide specific and precise details about materials and methods (i.e. quantities, temperatures, duration, sequence, conditions, locations, sizes) • Justify the choices made • Indicate that appropriate care was taken
3	• Relate materials/methods to other studies
4	• Indicate where problems occurred

How to start the Methods and Materials section

Top down (general to specific)

- Start with a general overview
- Follow that with a breakdown with all the details
- If you start with the details, you force the reader to put those details together to create a general picture of what you did and used.
- This is not the reader's job—it is your job to arrange the information in the proper order so it is easy for the reader to process it.

Q and A for the Methods and Materials section

1. Why do I need to introduce the Methods and Materials?

- It makes the entry into that section smoother for the reader.

2. Why should I give reasons for what I did?

- Your reasons may be obvious to you, but may not be obvious to your readers.
- If you don't provide justification for what you did, then the reader may not accept the validity of your choices.
- If you don't explain why you did things then the readers cannot be expected to accept your methods, and this will eventually affect the way they evaluate your whole paper.

3. **Should this section be an impersonal description of what was done and/or used or a persuasive and communicative argument?**
    - A persuasive and communicative argument because you need to communicate not only what you did/used but also justify your decisions. This enables the reader to trust your choices.
4. **Why should I give an overview of the procedure?**
    - Because this creates a general framework into which the details can be easily inserted.
    - So that both the reader and writer share the same clear picture.
5. **How much detail do I need to provide?**
    - If you're not certain that all readers will be familiar with your methods, then a little too much information is better than too little.
    - Sufficient detail must be presented for the reader to replicate your experiment.
6. **Why should I refer to other research in this section?**
    - It is unlikely that you created the entire method all by yourself.
    - If someone else's method is very well-known you can reference the research, but you don't have to give every detail.
7. **When should I stop writing the Methods and Materials section?**
    - It is best to stop after you have provided the basic parameters of your methods.
    - Provide all the details in the RESULTS section.
8. **Why should I mention problems that I experienced?**
    - If you don't mention the imperfections in your work, it might look like you aren't aware of them.
    - You look far more professional if you DO mention them.
    - If you ignore or try to hide the problems, and your readers notice them, they will doubt your legitimacy as a researcher, which affects their acceptance of your results and conclusions.
9. **If I had problems, should I repeat my work and improve my technique?**
    - What if you learn more this time too? Should you delay it again? And again?
    - If you do, you may actually never write anything.
    - A better option is to write up your research and acknowledge the problems or difficulties you encountered. It's better to do it here than wait until the end.
    - It's not appropriate to mention the limitations/ imperfections for the first time in the Discussion.
10. **But won't I look like a failure if I mention the problems I had?**
    - Use vocabulary that minimizes the problem, minimizes your responsibility, maximizes the good aspects, and suggests a solution.
    - This is the standard way of dealing with the need to talk about problems.

Vocabulary for the Methodology section by objective according to the model

PROVIDE A GENERAL INTRODUCTION AND OVERVIEW OF THE MATERIALS/METHODS AND GIVE THE SOURCES OF MATERIALS/EQUIPMENT USED

all (of)	(the) tests	is/are commercially available
both (of)	(the) samples	was/were acquired (from/by)
each (of)	(the) trials	was/were carried out
many (of)	(the) experiments	was/were chosen
most (of)	(the) equipment	was/were conducted
the majority (of	(the) chemicals	was/were collected
	(the) models	was/were devised
	(the) instruments	was/were found in
		was/were generated (by)
		was/were modified
		was/were obtained (from/by)
		was/were performed (by/in)
		was/were purchased (from)
		was/were supplied (by)
		was/were used as supplied
		was/were investigated

Examples of how these words and phrases are used:

- **The impact tests used in this work** were a modified version of . . .
- **All reactions** were performed in a 27 ml glass reactor . . .
- **All cell lines** were generated as previously described in . . .
- **In the majority of the tests**, buffers with a pH of 8 were used in order to . . .
- **Both experiments** were performed in a greenhouse so that . . .
- The substrate **was obtained from** the Mushroom Research Center . . .
- SSCE glass structures **were used** in this study to perform . . .
- The cylindrical lens **was obtained from** Newport USA and is shown in Fig. 3.
- **The material investigated** was a standard aluminum alloy; all melts were modified with sodium.
- Topographical examinations **were carried out** using a 3-D stylus instrument.
- **The experiments were conducted** at a temperature of 0.5°C.

SUPPLY ESSENTIAL BACKGROUND INFORMATION

opposite	facing		
out of range (of)	within range (of)		
below	under	underneath	
above	over	on top of	
parallel (to/with)	perpendicular (to)	adjacent (to)	
on the right/left	to the right/left		
(to) bisect	(to) converge	(to) intersect	
near side/end	far side/end		
side	edge	tip	end
downstream (of)	upstream (of)		

boundary	margin	border	
on the front/back	at the front/back	in the front/back	in front (of)
higher/lower	upper/lower	inner/outer	
horizontal	vertical	lateral	
circular	rectangular	conical	
equidistant	equally spaced		
on either side	on both sides	on each side	
is placed	is situated	is located	occupies
is mounted (on)	is coupled (onto)	is fastened (to)	is positioned
is aligned (with)	is connected (to)	is fixed (to)	is embedded
extends	is surrounded (by)	is fitted (with)	is encased (in)
is attached to	is covered (with/by)	is joined (to)	

Examples of how these words and phrases are used:

- Porosity was measured **at the near end and at the far end** of the polished surface.
- The compression axis **is aligned with** the rolling direction . . .
- The source light was polarized **horizontally** and the sample beam can be scanned **laterally**.
- The mirrors are **positioned near** the focal plane.
- Electrodes comprised a 4 mm diameter disk of substrate material **embedded in** a Teflon disk of 15 mm diameter.
- The intercooler **was mounted on top of** the engine . . .
- The concentration of barium decreases **towards the edge** . . .
- Similar loads were applied to **the front and side of** the box . . .
- A laminar flow element **was located downstream of** the test section of the wind tunnel.

PROVIDE THE SPECIFIC AND PRECISE DETAILS ABOUT MATERIALS AND METHODS

was adapted	was divided	was operated
was added	was eliminated	was optimized
was adopted	was employed	was plotted
was adjusted	was estimated	was positioned
was applied	was exposed	was prepared
was arranged	was extracted	was quantified
was assembled	was filtered	was recorded
was assumed	was formulated	was regulated
was attached	was generated	was removed
was calculated	was immersed	was repeated
was calibrated	was inhibited	was restricted
was carried out	was incorporated	was retained
was characterized	was included	was sampled
was collected	was inserted	was scored
was combined	was installed	was selected
was computed	was inverted	was separated
was consolidated	was isolated	was simulated
was constructed	was located	was stabilized
was controlled	was maintained	was substituted

was converted	was maximized	was tracked
was created	was measured	was transferred
was designed	was minimized	was treated
was derived	was modified	was varied
was discarded	was normalized	was utilized
was distributed	was obtained	

JUSTIFY CHOICES MADE

because	provide a way of (+ -ing)
by doing . . . , we were able to	selected on the basis of . . .
chosen for (+ noun)	so as to (+ infinitive)
chosen to (+ infinitive)	so/such that
for the purpose of (+ -ing or noun)	so (+ -ing)
for the sake of (+ -ing or noun)	thereby (+ -ing)
in an attempt to (+ infinitive)	therefore
in order to (+ infinitive)	thus (+ -ing)
it was possible to (+ infinitive)	to (+ infinitive)
offer a means of (+ -ing)	to take advantage of
one way to avoid . . .	which/this allows/allowed
our aim was to (+ infinitive)	with the intention of (+ -ing)

INFINITIVE	-ING FORM	NOUN FORM
achieve	achieving	achievement
allow	allowing	Ø
assess	assessing	assessment
avoid	avoiding	avoidance
compensate for	compensating for	compensation for
confirm	confirming	confirmation
determine	determining	determination
enable	enabling	Ø
enhance	enhancing	enhancement
ensure	ensuring	Ø
establish	establishing	establishment
facilitate	facilitating	facilitation
guarantee	guaranteeing	guarantee
identify	identifying	identification
improve	improving	improvement
include	including	inclusion
increase	increasing	increase
limit	limiting	limitation
minimize	minimizing	Ø
obtain	obtaining	Ø
overcome	overcoming	Ø
permit	permitting	Ø
prevent	preventing	prevention
provide	providing	provision
reduce	reducing	reduction
remove	removing	removal
validate	validating	validation

Examples of how these words and phrases are used:

- **To valida**te the results from the metroscale model, samples were collected from all groups.
- The method of false nearest neighbors was selected **in order to determine** the embedding dimension.
- **For the sake o**f simplicity, only a single value was analyzed.
- **By partitioning** the array, all the multipaths could be identified.
- Zinc oxide was drawn into the laminate **with the intention of** enhancing delaminations and cracks.
- **The advantage of** using three-dimensional analysis was that the out-of-plane stress field could be obtained.
- **Because** FITC was used for both probes, enumeration was carried out using two different slides.
- The LVDTs were unrestrained, **allowing** the sample to move freely.
- The cylinder was constructed from steel, **which avoided** problems of water absorption.

INDICATE THAT APPROPRIATE CARE WAS TAKEN

Most of the items in the box below are in adverb form, but they also occur in adjective form (*e.g. accurate)*.

accurately	every/each	immediately	rigorously
always	exactly	independently	separately
appropriately	entirely	individually	smoothly
at least	firmly	never	successfully
both/all	frequently	only	suitably
carefully	freshly	precisely	tightly
completely	fully	randomly	thoroughly
constantly	gently	rapidly	uniformly
correctly	good	reliably	vigorously
directly	identical	repeatedly	well

Examples of how these are used:

- A mechanical fixture was employed to hold the sonic horn **firmly** in place
- After being removed, the mouse lungs were frozen and thawed **at least** three times.
- The specimen was monitored **constantly** for a period of 24 hours.
- They were then placed on ice for **immediate** FACS analysis
- **Frequent** transducer readings were taken to update the stress conditions smoothly.
- The samples were **slowly and carefully** sheared to failure.

RELATE MATERIALS/METHODS TO OTHER STUDIES

There are three ways in which you might want to relate your materials/methods to those used in other studies.

Option 1: The procedure/material you used is **exactly the same** as the one you cite.

according to	as reported by/in	given by/in
as described by/in*	as reported previously	identical to
as explained by/in	as suggested by/in	in accordance with
as in	can be found in	the same as that of/in
as proposed by/in	details are given in	using the method of/in

**by* and *of* are usually followed by the name of the researcher or research team (*by Ross* or *using the method of Ross et al.)* and *in* is usually followed by the work *(in Ross et al. (2003)*). Another option is simply to give the research reference at the appropriate place in the sentence, either in brackets or using a superscript number.

Option 2: The procedure/material you used is **similar or very similar to** the one you cite.

a (modified) version of	(very) similar	(to) adapt
adapted from	almost the same	(to) adjust
based in part/partly on	essentially the same	(to) alter
based on	largely the same	(to) change
essentially identical	practically the same	(to) modify
in line with	virtually the same	(to) refine
in principle	with some adjustments	(to) revise
in essence	with some alterations	(to) vary
more or less identical	with some changes	
slightly modified	with some modifications	

Option 3: The procedure/material you used is significantly different from the one you cite.

a novel step was . . .	although in many ways similar	(to) adapt*
adapted from*	although in some ways similar	(to) adjust*
based on*	although in essence similar	(to) alter*
in line with	with the following	(to) change*
loosely based on	modifications/changes	(to) refine*
partially based on		(to) revise*
partly based on*		(to) vary*
		(to) modify*

*As you can see, these can be used in **Option 2** as well as **Option 3**. When you use them in **Option 2** you may not need to state the differences between the procedure/material you used and the one you cite if they are not significant. In **Option 3** those differences or modifications are significant so you should say what they were, especially if they were modifications which improved the procedure/material.

Examples of how these are used:

- Developmental evaluation was carried out using the Bayley Scales of Infant Development **(Bayley, 1969).**
- The size of the Gaussians was adjusted **as in** Krissian *et al.*, 2000.
- The centrifuge is a **slightly modified** commercially available model, the Beckman J6-HC.
- The protein was overexpressed and purified **as reported previously.**[10,12]

- A **revised version** of the Structured Clinical Interview (4th edition)[6] was used.
- **We modified** the Du and Parker filter to address these shortcomings and we refer to this modified filter as the MaxCurve filter.
- In our implementation **we followed** Sato *et al.* (1998) by using a discrete kernel size.

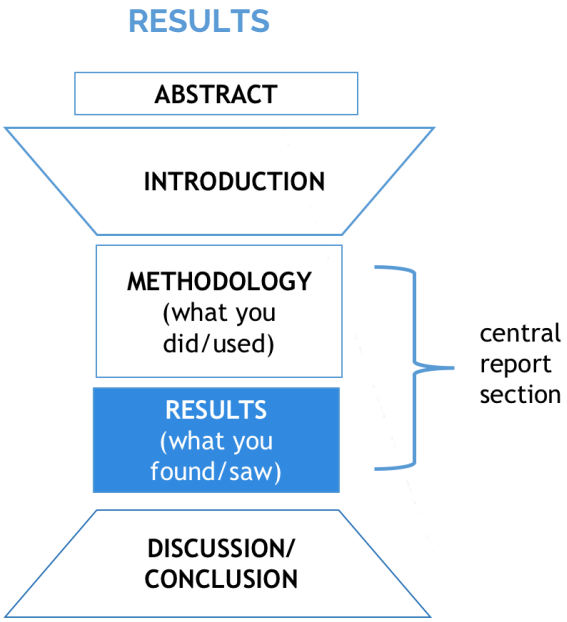
7. INDICATE WHERE PROBLEMS OCCURRED

Minimize problem	**Minimize responsibility**	**Maximize good aspects**
did not align precisely only approximate it is recognized that less than ideal not perfect not identical slightly problematic rather time-consuming minor deficit slightly disappointing negligible unimportant immaterial a preliminary attempt not significant	limited by inevitably necessarily impractical as far as possible (it was) hard to (it was) difficult to unavoidable impossible not possible	quite good reasonably robust however* nevertheless* **Talk about a solution** future work should . . . future work will . . . currently in progress currently underway

*There is an interesting difference between the phrase *future work should* and the phrase f*uture work will*. When you write *future work should* you are suggesting a direction for future work and inviting the research community in your field to take up the challenge and produce the research. When you write *future work will* you are communicating your own plans and intentions to the research community and it should be understood that these plans and intentions belong to *you*.

Examples of how these are used:

- **Inevitably**, considerable computation was involved.
- Only a brief observation was feasible, **however**, given the number in the sample.
- **Although** centrifugation could not remove all of the excess solid drug, the amount remaining was **negligible**.
- Solutions using (q=1) differed **slightly** from the analytical solutions.
- Continuing research **will** examine a string of dc-dc converters to determine if the predicted efficiencies can be achieved in practice.
- While the anode layer was **slightly** thicker than 12 μm, this was a **minor deficit**.



RESULTS: Grammar and Writing Skills

Four language areas that are important in the Results section are SEQUENCE, FREQUENCY, QUANTITY, and CAUSALITY

Words and phrases that communicate SEQUENCE:

1. before the beginning

beforehand earlier	formerly in advance	originally previously	prior to

2. at the beginning/first step

at first at the beginning	at the start first	in the beginning initially	to begin with to start with

3. steps/order

after afterwards	earlier next once	previously prior to	secondly, etc. subsequently then

4. after a short while

before long	shortly after	soon

5. *At a late/later stage; after a while/longer period*

eventually in time	later later on	subsequently	towards the end

6. One point/period occurring almost or exactly at the same time as another

as as soon as at that point at the same time	immediately in the meantime just then	meanwhile simultaneously straight away	upon + -ing when while

7. At the end/last step

at the end	eventually	finally	lastly

8. after the end

afterwards eventually	in the end	later	later on

Words and phrases that communicate FREQUENCY:

1.	each/every time on each/every occasion	always invariably	without exception
2.	habitually normally	as a rule usually	generally
3.	regularly*	repeatedly	
4.	frequently*	often	commonly
5.	more often than not		
6.	as often as not **(neutral frequency)**		
7.	on some occasions	sometimes	at times
8.	occasionally	now and then	from time to time
9.	rarely	seldom	infrequently
10.	hardly ever scarcely ever	barely ever	almost never
11.	on no occasion never	not once	at no time

*The meanings of the items in Categories 3 and 4 are more flexible than those in the other categories.

Words and phrases that communicate QUANTITY:

1. words or phrases that **increase** size/quantity:

a great deal (of)	most
a number (of)	numerous
as many as	over
appreciable	plenty
at least	much
considerable	substantial
greater (than)	significant
marked	upwards of
more (than)	

2. words or phrases which reduce **size**/quantity:	
a few	little
a little	less
as few as	marginal
barely	negligible
below	only
few	slight
fewer (than)	small
hardly	under
infinitesimal	
3. words or phrases which **emphasize** how big/small/high/low the size/quantity is:	
appreciably	extremely (high/low)
by far	far (above/below)
considerably	particularly
easily (over/under)	so (high/low)
even (higher/lower)	substantially
exceptionally (high/low)	well (under/over)
4. words or phrases which communicate that the size/quantity is **similar/close to another**:	
approximately	little (*i.e.* close to none)
close to	nearly
few (*i.e.* close to none)	practically
just (over/under	slightly
	virtually
5. words or phrases which communicate a **reluctance to commit oneself** to an interpretation of the size/quantity:	
fairly	reasonably
in some cases	relatively
moderate	some
quite	somewhat
rather	to some extent

Words and phrases that communicate CAUSALITY:

(be) a/the cause of	create/(be) created
(be) a/the consequence of	derive/(be) derived
(be) a factor in	effect/(be) effected
(be) a/the result of	elicit/(be) elicited
(be) due to	give rise to
accompany/(be) accompanied	generate/(be) generated
account for/(be) accounted for	influence/(be) influenced
affect/(be) affected	initiate/(be) initiated
arise from	link/(be) linked
ascribe to/(be) ascribed to	originate in
associate/(be) associated	produce/(be) produced

attribute to/(be) attributed to bring about/(be) brought about cause/(be) caused come from connect to/(be) connected to contribute to	relate/(be) related result from result in stem from trigger/(be) triggered yield

Ways to reduce risk and responsibility by 'softening' a causal statement:

It appears that . . . It can/may (therefore) be inferred/assumed that . . . It is (very/highly/extremely)probable/likely that . . . It is (widely/generally) accepted that . . . It is/may be reasonable to suppose/assume that . . . It is/may be thought/recognized/believed/felt that . . . It is/may/can be assumed that . . . It seems (very/highly) probable/likely that . . . It seems (likely) that . . . It would seem/appear that . . . The evidence points to the likelihood/probability that . . . The evidence suggests that . . . There is a clear/good/definite/strong possibility that . . . There is evidence to indicate that . . . This implies/seems to imply/may imply that . . . Apparently, (therefore), It is thought/said/recognized that	*x caused y.*

Another option is to add a <u>frequency qualifier</u>:

x often caused y
x rarely caused y

Or a <u>quantity qualifier</u>:

x caused y in many cases
x caused y in some cases/to some extent
x caused y in virtually all cases

Or a <u>modal auxiliary verb</u>:

x may have caused y
x might have caused y
x could have caused y

Four basic components of the RESULTS section

1	Revisit the research aim/existing research Revisit the methodology Provide a general overview of the results
2	Invite readers to view the results (charts, graphs, tables) Provide specific/key results in detail, with or without explanations Compare results with those of other researchers Compare results with model predictions
3	Problems with results
4	Possible implications of results

Vocabulary for the different components of the Results section

REVISITING THE RESEARCH AIM/EXISTING RESEACH

As discussed previously,
As mentioned earlier/before,
As outlined in the Introduction,
As reported,
In order to . . ., we examined . . .
It is important to reiterate that . . .
It is known from the literature that . . .
It was predicted that . . .
Our aim/purpose/intention was to . . .
Since/because . . . , we investigated . . .
The aforementioned theory/aim/prediction, etc.
To investigate . . . , we needed to . . .
We reasoned/predicted that . . . .

- **Since** the angular alignment is critical, the effect of an error in orientation was **investigated experimentally.**
- **We reasoned that** an interaction in one network between proteins that are far apart in the other network may be a technology-specific artifact.
- **In earlier studies** attempts were made to establish degradation constants by undertaking ozonation experiments.
- **The main purpose of this work** was to test algorithm performance.
- **As mentioned previously, the aim** of the tests was to construct a continuous crack propagation history.
- **In this work, we sought to** establish a methodology for the synthesis of a benzoxazine skeleton.
- **It was suggested in the Introduction** that the effective stress paths may be used to define local bounding surfaces.

GENERAL OVERVIEW OF RESULTS

Generally speaking, In general, In most/all cases, In the main, In this section, we compare/evaluate/present . . . It is apparent that in all/most/the majority of cases, It is evident from the results that . . . On the whole, The overall response was . . . The results are divided into two parts as follows: Using the method described above, we obtained . . .

Examples of how these are used:

- **It is apparent that both** films exhibit typical mesoporous structures.
- **It is evident** that these results are in good agreement with their FE counterparts.
- **In general,** coefficients for months close to the mean flowering data were negative.
- Our confidence scores have an **overall** strong concordance with previous predictions.
- **On the whole**, the strains and deflections recorded from the FE model follow similar patterns to those recorded from the vacuum rig tests.
- Levels of weight loss were similar **in all cases**.

INVITATION TO VIEW RESULTS

(data not shown) (fig.1) (see also Fig. 1) (see Fig. 1) (see figs. 1-3) according to Fig. 1 as can be seen from/in* Fig. 1 as detailed in Fig. 1 as evident from/in the figure as illustrated by Fig. 1 as listed in Fig. 1 as shown in Fig. 1 as we can see from/in Fig 1 can be found in Fig. 1 can be identified from/in Fig. 1 can be observed in Fig. 1 can be seen from/in Figure 1 comparing Figs. 1 and 4 shows that . . . data in Fig. 1 suggests that . . . displayed in Fig. 1	Figure 1: contains corresponds (to) demonstrates displays gives illustrates lists plots presents provides reports represents reveals shows summarizes

evidence for this is in Fig. 1 from Fig. 1 it can be seen that . . . inspection of Fig. 1 indicates . . . is/are given in Fig. 1 is/are visible in Fig. 1 in Fig. 1 we compare/present . . . results are given in Fig. 1 we observe from Fig. 1 that	

**from* means 'can be deduced/concluded from' the figure/table whereas *in* means that it actually 'appears in' the figure/table

Examples of how these are used:

- The stress data in Fig. 18 **indicate** a more reasonable relationship.
- Figure 3 **illustrates** the findings of the spatial time activity modelling.
- The overall volume changes are **reported** in Fig. 6 (d).
- Similar results were found after loading GzmA into the cells **(data not shown).**
- Typical cyclic voltammograms **can be seen in Fig. 1**.
- **Comparing Figs. 1 and 4** shows that volumetric strains developed after pore pressure had dissipated.
- The rate constants shown in Table 1 **demonstrate that** reactivity is much greater at neutral pH.
- The results **are summarized** in Table 4.

SPECIFIC RESULTS IN DETAIL

Objective descriptions

accelerate(d)	is/are/was/were constant	match(ed)
all	is/are/was/were different	none
change(d)	is/are/was/were equal	occur(red)
decline(d)	is/are/was/were found	peak(ed)
decrease(d)	is/are/was/were higher	precede(d)
delay(ed)	is/are/was/were highest	produce(d)
drop(ped)	is/are/was/were identical	reduce(d)
exist(ed)	is/are/was/were lower	remain(ed) constant
expand(ed)	is/are/was/were present	remained the same
fall/fell	is/are/was/were seen	rise/rose
find/found	is/are/was/were unaffected	sole/ly
increase(d)	is/are/was/were unchanged	vary/varied
	is/are/was/were uniform	

Examples of how these are used:

- There was a **lower** proportion of large particles present at lower pH.
- As can be seen in Fig. 8, there were **different** horizontal and vertical directional functions.
- As can be seen, in the second trial the level of switching among uniformed travelers **was unchanged.**
- This kind of delamination **did not occur** anywhere else.
- The CTOA **dropped** from its initial high value to a constant angle of 4º.
- It eventually **leveled off** at a terminal velocity of 300 m/s.

Subjective descriptions

abundant(ly)	imperceptible (ibly)	remarkable(ably)
acceptable(ably)	important(ly)	resembling
adequate(ly)	in particular,	satisfactory
almost	in principle	scarce(ly)
appreciable(ably)	inadequate(ly)	serious(ly)
appropriate(ly)	interesting(ly)	severe(ly)
brief(ly)	it appears that	sharp(ly)
clearl(ly)	large(ly)	significant(ly)
comparable (ably)	likelihood	similar
considerable (ably)	low	simple(ply)
consistent(ly)	main(ly)	smooth(ly)
distinct(ly)	marked(ly)	somewhat
dominant(ly)	measurable(ably)	steep(ly)
dramatic(ally)	mild(ly)	striking(ly)
drastic(ally)	minimal(ly)	strong(ly)
equivalent	more or less	substantial(ly)
essential(ly)	most(ly)	sudden(ly)
excellent	negligible	sufficient(ly)
excessive(ly)	noticeable(ably)	suitable (ably)
exceptional(ly)	obvious(ly)	surprising(ly)
extensive(ly)	only	tendency
extreme(ly)	overwhelming(ly)	the majority of
fair(ly)	poor(ly)	too + adjective
few	powerful(ly)	unexpected(ly)
general(ly)	quick(ly)	unusual(ly)
good	radical(ly)	valuable
high(ly)	rapid(ly)	very
immense(ly)		virtual(ly)

(plus all of the rest of the language from the **frequency** and **quantity** lists)

*Examples of how these are used (including examples from the **frequency** and **quantity** lists):*

- In the **majority of** cases, SEM analysis revealed a **considerably** higher percentage of fine material.
- As can be seen, the higher injection rate gave **satisfactory** results from all three methods.
- **Similar** behavior was observed in all cases, with no **sudden** changes.
- It can be seen in Fig. 5 that the Kalman filter gives an **excellent** estimate of the heat released.
- The effect on the relative performance was **dramatic**.
- A **striking** illustration of this can be seen in Fig. 5.
- Comparing Figs. 4 and 5, it is obvious that a **significant** improvement was obtained in **the majority of** cases.
- It can be observed from Fig. 5 that the patterns are **essentially** the same in both cases.
- Figure 1 shows a **fairly** consistent material.
- It was observed that there was **only** a **very small** enhancement when H_2O_2 was present.

COMPARISONS WITH OTHER RESULTS

as anticipated	is/are better than
as expected	is/are in good agreement
as predicted by . . .	is/are identical (to)
as reported by . . .	is/are not dissimilar (to)
compare well with	is/are parallel (to)
concur	is/are similar (to)
confirm	is/are unlike
consistent with	match
contrary to	prove
corroborate	refute
correlate	reinforce
disprove	support
inconsistent with	validate
in line with	verify

Many of these can be modified to match the level of certainty you want to express by adding expressions such as:

It seems that
It appears that
It is likely that

Examples of how these are used:

- **It is evident that** the SFS results obtained here are in exceptionally **good agreement with** existing FE results.
- Distributions are **almost identical** in both cases.
- Our concordance scores **strongly confirm** previous predictions.
- We see that the numerical model tends to give predictions that **are parallel to** the experimental data from corresponding tests.
- These results demonstrate that improved **correlation** with the experimental results was achieved using the new mesh.
- This is **consistent** with results obtained in [1].
- The results are qualitatively **similar** to those of earlier simulation studies.
- These trends are **in line with** the previously discussed structure of the ferrihydrite aggregates.

PROBLEMS WITH RESULTS

minimize the problem/focus on good results	**suggest reasons for the problem**
(a) preliminary attempt	may/could/might have been
despite this,	**or**
however,	was/were:
immaterial	beyond the scope of this study
incomplete	caused by
infinitesimal	difficult to (simulate)
insignificant	due to
less than ideal	hard to (control)

less than perfect (a) minor deficit/limitation negligible nevertheless not always reliable not always accurate not ideal not identical not completely clear not perfect not precise not significant of no consequence of no/little significance only reasonable results were obtained room for improvement slightly (disappointing) (a) slight mismatch/limitation somewhat (problematic) (a) technicality unimportant	inevitable it should be noted that . . . not attempted not examined not explored in this study not investigated not the focus of this paper not within the scope of this study possible source(s) of error unavoidable unexpected unfortunately unpredictable unworkable unavailable **offer a solution** further work is planned future work should . . .* future work will . . . * in the future, care should be taken in the future, it is advised that

*Remember that the phrase *future work should* is used to suggest a direction for the research community, whereas *future work will* tells readers that this is your next project.

Examples of how these are used:

- The correlation between the two methods **was somewhat** less in the case of a central concentrated point load.
- **It should, however, be noted that** in FE methods, the degree of mesh refinement may affect the results.
- **Nevertheless**, this effect is **only** local.
- Full experimental data was **only** obtained at one location.
- **Reasonable results were obtained** in the first case and good results in the second.
- **It is difficult to** simulate the behavior of the joints realistically.
- **Although** this was **not** obtained experimentally, it can be assumed to exist.
- **Future work should** therefore include numerical diffusion effects in the calculation of permeability.
- This type of control saturation is fairly common and therefore **of no significance**.

7. POSSIBLE IMPLICATIONS OF RESULTS

apparently could* be due to could* be explained by could* account for	it is logical that it is thought/believed that it seems that it seems plausible (etc.) that

could* be attributed to	may/might
could* be interpreted as	means that
could* be seen as	perhaps
evidently	possibly/possibility
imply/implies that	potentially
indicate/indicating that	presumably
in some circumstances	probably
is owing to	provide compelling evidence
is/are associated with	seem to
is/are likely	suggest(ing) that
is/are linked to	support the idea that
is/are related to	tend to
is appears that	tendency
it could* be concluded that	unlikely
it could* be inferred that	there is evidence for
it could* be speculated that	we could* infer that
it could* be assumed that	we have confidence that
it is conceivable that	would seem to suggest/indicate
it is evident that	

**could* can be replaced by *may* or *might* or sometimes *can*.

Examples of how these are used:

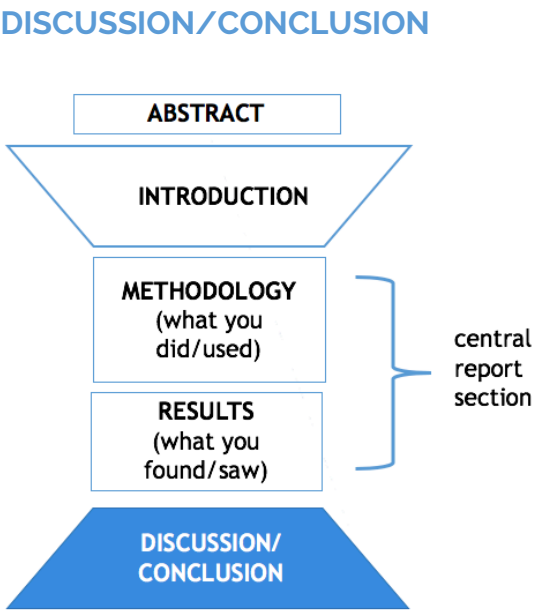
- **This suggests that** silicon is intrinsically involved in the precipitation mechanism.
- These curves **indicate that** the effective breadth is a minimum at the point of application of the load.
- Empirically, **it seems that** alignment is most sensitive to rotation in depth.
- Only the autumn crocus produced a positive response, **suggesting that** other species would flower earlier under climate warming.
- **It could be inferred** therefore that these may have reacted with ozone to form organic acids, such as formic acid.
- **This indicates that** no significant crystalline transformations occurred during sintering.
- **It is therefore speculated that** at pH 75 a major part of the reaction was via hydroxyl radical attack.
- **It is apparent that** this type of controller **may be** more sensitive to plant/model mismatch than was assumed in simulation studies.
- The results **seem to indicate that** this causes the behavior to become extremely volatile.
- **It is evident that** the Ψ at midspan increases with the increasing *r*.

Additional examples of how to communicate a strong statement in a weaker form:

We found that sunbathing causes cancer (very strong claim).

- *We found that sunbathing **is related to** the onset of cancer.*
- *We found that sunbathing **was related to** the onset of cancer.*
- *We found that sunbathing **may have been related to** the onset of cancer.*
- *We found **evidence to suggest that** sunbathing may have been related to the onset of cancer.*

- *We found evidence to suggest that **in some cases/in many cases**, sunbathing may have been related to cancer.*
- *We found evidence to suggest that in some cases, **excessive** sunbathing may have been related to the onset of **certain types of** cancer.*
- ***It is thought that** excessive sunbathing **may sometimes be considered as contributing to** the onset of certain types of cancer.*



The title of this section varies from journal to journal and by discipline. Some journals end with a section titled *Discussion*, some end with a section titled *Results and Discussion*, and others end with a section titled *Conclusions*. Where there is a *Conclusions* section, it is short, usually comprising one or two paragraphs focusing on specific aspects of the *Discussion*.
Many elements of the *Introduction* occur again in the *Discussion/Conclusion* in (approximately) reverse order. The *Introduction* moves from a general, broad focus to the narrower "report" section of paper and the *Discussion/Conclusion* moves away from that narrow section to a wider, more general focus.

Four basic components of the Discussion/Conclusion

1	Revisit previous sections Summarize/revisit general or key results
2	Map relationship to existing research
3	Detail achievement/contribution Refine implications
4	Describe limitations Discuss current and future work Introduce applications

Grammar and Writing Skills: Modal Auxiliary Verbs

1. ABILITY/CABABILITY

Present Simple	CAN	This software **can** distinguish between different viruses.
Present Simple negative	CANNOT	Until 18 months, a child **cannot** use symbols to represent objects.
Past Simple	COULD COULD HAVE	It was found that the gun **could** shoot accurately even at 300 meters. If we had extended the time period, we **could have** produced more crystals.
Past Simple negative	COULD NOT COULD NOT HAVE	In 1990, 80% of households **could not** receive digital television. The subjects reported that they **could not have** fallen asleep without medication.

Notes:

- The modal verb **can** only forms these two tenses when it refers to ABILITY or CAPABILITY. If you need other tenses, you will need to switch to be **capable of** or **be able to**, *i.e. It is believed that this software will eventually **be capable of** distinguishing between different viruses.*
- **could** means 'was generally capable of doing/able to do something in the past,' whereas **was able to** is used in relation to specific past events or past occasions, *i.e. The result suggests that in this case, the viruses **were able to** multiply freely*. If you're not sure whether to use **can** or **be able to**, use **be able to**—it's safer.

2. POSSIBILITY/OPTIONS

Present Simple	MAY MIGHT COULD CAN	A rubble seal **may/might/could/can** be useful at this location.
Present Simple negative	MAY NOT MIGHT NOT (but not COULD NOT or CANNOT)	A rubber seal **may not/might not** be useful at this location.
Past Simple	MAY HAVE MIGHT HAVE COULD HAVE (but not CAN HAVE)	The fall in pressure **may have been/might have been/could have been** caused by leakage.
Past Simple negative	MAY NOT HAVE MIGHT NOT HAVE	The fall in pressure **may not have been/might not have been** caused by leakage.

	(but not COULD NOT HAVE OR CANNOT HAVE)	

Note:

The word 'well' is sometimes added to communicate a stronger belief in the possibility: *This **may well** be due to leakage.*

3. PROBABILITY/BELIEF/EXPECTATION

Present Simple	SHOULD OUGHT TO	The material **should** remain stable if it is kept below 30º C.
Present Simple negative	SHOULD NOT OUGHT NOT TO	The material **should not** decompose unless heated above 30 º C.
Past Simple	SHOULD HAVE OUGHT TO HAVE	By the time the cobalt is added, the crystals **should have** dissolved.
Past Simple negative	SHOULD NOT HAVE OUGHT NOT TO HAVE	This was unexpected; the materials **should not have** decomposed at this temperature.

Note: Although **ought to** means the same as **should**, it is less common in science writing.

4. VIRTUAL CERTAINTY

Present Simple	MUST HAVE TO	Our results indicate that contamination **must** be due to the presence of sea water in the pipe.
Present Simple negative	CANNOT	It is clear that contamination **cannot/could not** be due to the presence of sea water in the pipe.
Past Simple	MUST HAVE	Our results indicate that contamination **must have been** due to the presence of sea water in the pipe.
Past Simple Negative	CANNOT HAVE COULD NOT COULD NOT HAVE	It was clear that contamination **could not be/could not have been** due to the presence of sea water in the pipe.

Notes:

- 'Virtual certainty' modal auxiliaries communicate the fact that no other explanation is possible.
- **Have to** is less common in science writing.
- **Must not** means 'not allowed/permitted'. It doesn't mean 'not possible'.

5. ADVICE/OPINION

Present Simple	SHOULD OUGHT TO	The apparatus **should** be disconnected from the mains during repairs.
Present Simple negative	SHOULD NOT OUGHT NOT TO	This materials **should not** be exposed to sunlight.
Past Simple	SHOULD HAVE OUGHT TO HAVE	The apparatus **should have been** disconnected from the mains during repairs.
Past Simple negative	SHOULD NOT HAVE OUGHT NOT TO HAVE	This material **should not have been** exposed to sunlight.

Notes:

- Although **ought to** means the same as **should**, it is less common in science writing.
- **Should have/ought to have** usually refer to something that didn't occur and **should not have/ought not to have** usually refer to something that did.

6. NECESSITY/OBLIGATION

Present Simple	MUST NEED TO HAVE TO	The apparatus **must/needs to/has to be** disconnected from the mains during repairs.
Present Simple negative	NEED NOT DO NOT NEED TO DO NOT HAVE TO	The apparatus **need not/does not need to/does not have to be** disconnected from the mains during repairs.
Past Simple	NEEDED TO HAD TO	We **needed to/had to** heat the valves before use.
Past Simple negative	DID NOT NEED TO DID NOT HAVE TO NEED NOT HAVE	We **did not need to/did not have** to heat the valves before use. We **need not have** heated the valves before use

Notes:

- We ***did not need to/did not have to*** heat the valves before use does not indicate whether or not you actually heated the valves, whereas we ***need not have*** heated the valves before use implies that you did heat them, but that it wasn't necessary.
- **Must not** means 'not allowed'. It doesn't mean 'not necessary'.

Vocabulary for the different sections of the Discussion/Conclusion

1. REVISITING PREVIOUS SECTIONS
2. SUMMARIZING/REVISITING KEY RESULTS
3. REFINING IMPLICATIONS

Since most of the vocabulary you need for the sections above can be found in previous sections, there is no need for additional vocabulary input here. When you revisit previous sections, don't change the words in the sentences unnecessarily; your aim is to create an 'echo' that will remind the reader of what you said before, so repeating the same words and phrases is advantageous.

4. MAPPING RELATIONSHIP TO EXISTING RESEARCH

This/Our study/method/result/approach is:	This/Our study:
analogous to comparable to compatible with consistent with identical to in contradiction to in contrast to in good agreement with in line with significantly different to/from the first of its kind (very/remarkably) similar to unlike	broadens challenges compares well with confirms contradicts corresponds to corroborates differs from extends expands goes against lends support to mirrors modifies proves provides insight into provides support for supports refutes\tends to refute verify

Note: Don't forget that a simple comparative *(e.g. stronger/more accurate/quicker, etc.)* is an effective way to highlight the difference between your work and other relevant work.

Some examples of how these are used:

- **To the knowledge of the authors**, the data in Figs. 4-6 is the **first of its kind**.
- The results of this simulation therefore **challenge** Laskay's assumption that percentage porosity increases with increasing Mg levels.
- The GMD method provides results that **are comparable to** existing clay hydration processes.
- **Similar** films on gold nanoparticles have also been found to be liquid-like.
- Using this multi-grid solver, load information is propagated **faster** through the mesh.
- Our results are **in general agreement with** previous morphometric and DNA incorporation studies in the rat [2.6].
- Our current findings **expand** prior work.[5]

- The system described in this paper is **far less** sensitive to vibration or mechanical path changes than previous systems.
- **Unlike** McGowan, we did not identify 9-*cis* RA in the mouse lung.

5. ACHIEVEMENT/CONTRIBUTION

Science writing does not generally permit the use of the exclamation mark (!), but the vocabulary used to state your achievement or contribution can still communicate that the achievement is exciting. The list below is divided into two sections; the first is a list of exclamation mark substitutes which can be used when the achievement is exciting, and the second is slightly cooler—but still positive—language.

Exciting achievement!

compelling crucial dramatic excellent exceptional exciting extraordinary ideal invaluable outstanding	overwhelming perfect powerful remarkable striking surprising undeniable unique unusual unprecedented vital

Positive achievement

accurate advantage appropriate attractive beneficial better clear comprehensive convenient convincing correct cost-effective easy effective efficient encouraging evident exact feasible	useful verbs: assist compare well with confirm could lead to enable enhance ensure facilitate help to improve is able to offer an understanding of outperform prove provide a framework provide insight into provide the first evidence remove the need for

flexible important low-cost novel productive realistic relevant robust simple stable straightforward strong successful superior undeniable useful valid valuable	represent a new approach to reveal rule out solve succeed in support yield

Some examples of how these are used:

- The presence of such high levels is a **novel** finding.
- We identify **dramatically** different profiles in adult lungs.
- Our results provide **compelling** evidence that this facilitated infection.
- These preliminary results demonstrate the **feasibility** of using hologram-based RI detectors.
- Our data **rule out** the possibility that this behavior was a result of neurological abnormality.
- The system presented here is a **cost-effective** detection protocol.
- A **straightforward** analysis procedure was presented which **enables** the **accurate** prediction of column behavior.
- Our study **provides the framework** for future studies to assess the performance characteristics.
- We have made the **surprising** observation that Brol-GFP focus accumulation is also pH-dependent.
- We have derived **exact** analytic expressions for the percolation threshold.
- Our results provide a **clear** distinction between the functions of the pathway proteins.

6. LIMITATIONS/CURRENT AND FUTURE RESEARCH

You will normally outline the limitations of your own work, but this is not expressed as a problem with your work, rather it provides suggestions for future work. This invitation to the research community improves the status of your work by communicating that there is much research to be done in this area.

Note that using *will* or the Present Continuous (*e.g. we will integrate/we are integrating this technique with the FEM implementations*) communicates your own intentions or work in progress; should is used to invite research from others (*This technique should be integrated with the FEM implementations*).

a/the need for	possible direction
at present	promising
encouraging	recommend
fruitful	remain to be (identified)
further investigations	research opportunities
further work is needed	should be explored
further work is planned	should be replicated
future work/studies should	should be validated
future work/studies will	should be verified
in the future, care should be taken	starting point
in the future, it is advised that	the next stage
holds promise	urgent
interesting	worthwhile
it would be beneficial/useful	

Some examples of how these are used:

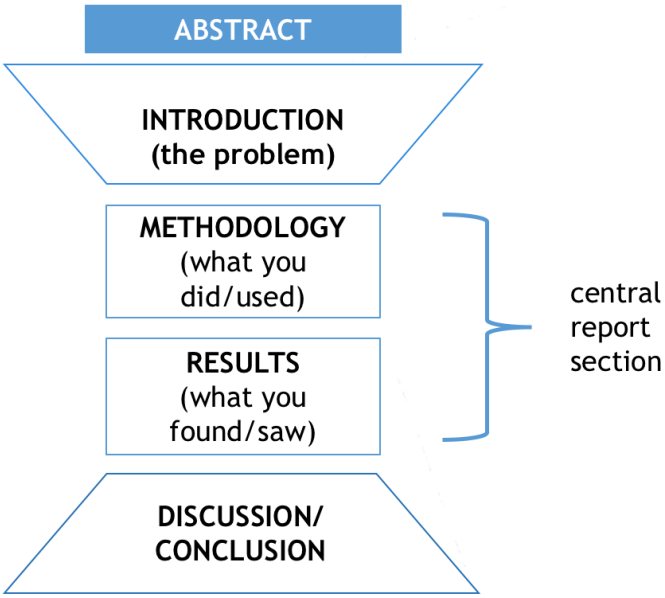
- Our results are **encouraging** and **should be validated** in a larger cohort of women.
- However, the neural mechanisms underlying these effects **remain to be** determined.
- The finding is **promising** and **should be explored** with other eukaryotes.
- **Future work should** focus on the efficacy of ligands synthesized in the Long group.
- An important question for **future studies** is to determine the antidepressant effects of such drugs.

7.APPLICATIONS/APPLICABILITY/IMPLEMENTATION

eventually	apply
in the future	have potential
possible	implement
	lead to
	produce
	use
	utilize

Examples of how these are used:

- Our technique **can be applied** to a wide range of simulation applications.
- The PARSEX reactor therefore could be **used** for the realistic testing of a wide range of control algorithms.
- It **should be possible**, therefore, to integrate the HOE onto a microchip.
- This approach **has potential** in areas such as fluid density measurement.
- The solution method **could be applied** without difficulty to irregularly-shaped slabs.
- Our results mean that in dipping reservoirs, compositional gradients can now **be produced** very quickly.
- This could **eventually lead to** the identification of novel biomarkers.



Many more people will read your title than the Abstract, and many more will read the Abstract than the whole paper. This means that your Abstract must have independent validity. It should make sense as a standalone, self-contained description of the research article, and readers should be able to understand the key points and results of the research even if they never see the whole article. In this sense, the Abstract is a representation of the research article.

What does the Abstract do?

- It provides an overview of your work
- It highlights and/or sells your work
- It convinces a reader to obtain your article or to continue reading
- For a talk, it helps organizers to group it with similar papers

A good abstract should

- Provide the motivation (why you did this research project)
- State the problem (what you did)
- Describe the methods used (how you did it)
- Highlight the results (what you found)
- Discuss the implications (what it means)

The two types of abstracts (This section differs from the slides)

1. Informational

- Summarizes the major sections of a report
- Highlights essential points and findings
- Allows the reader to decide whether they want to read the entire report

2. Descriptive

- Contains less detail
- Does not summarize the results and conclusions
- Introduces the subject to the reader who must read the article to learn the results

Informational abstracts are most common for MS theses, PhD dissertations, and journal articles. Descriptive abstracts are most common for conference papers/sessions.

Abstract DOs and DON'TS

Do:

- Write clearly and simply
- Provide logical connections between the parts
- Write in a manner that is cohesive, coherent and very concise
- Vary the sentence structure and use only complete sentences
- Use active verbs rather than passive verbs
- Choose every word very carefully

Don't

- Repeat the title
- Refer to things outside of the Abstract
- Include references to literature or figures and tables in the paper
- Use abbreviations or acronyms unless they are broadly understood

Six sentence model for writing an informational abstract:

1	Introduce the topic
2	State the problem
3	Summarize what's missing in current literature
4	Explain your idea/approach
5	Explain your methods
6	Discuss the key impact of your work

If you are having trouble getting started, writing a **reverse outline** will help you.

- For each chapter or section, list keywords and draft 1-2 sentences that summarize the central point
- This will give you a framework of your abstract's structure
- Next, revise the sentences and make connections and show how the argument develops

Grammar and Writing Skills

Verb Tense in the Abstract

Gap/problem: normally written in the **Simple Present** tense

- The main problem, however, **is** . . .
- We **examine** why these models have difficulty with . . .
- However, this assumption **is** not valid when . . .
- However, this assessment **cannot be** based solely on . . .

When referring to **what the paper itself does** or what is actually in the paper, also use the **Simple Present** tense:

- This paper **presents** a new methodology for . . .
- In this paper we **apply** . . .
- This study **reports** an improved design for . . .
- We **consider** a novel system of . . .

When referring to your **methodology**, or what you did during the research period, use the **Simple Past** tense:

- Two catalysts **were examined** in order to . . .
- Samples **were prepared** for electron microscopy . . .
- A crystallizer **was constructed** using . . .
- The effect of pH **was investigated** by means of . . .

It is also possible to use the **Simple Present** tense to talk about your **methodology**, especially when you are referring to calculations or equations which can be found in the paper itself:

- Numerical examples **are analyzed** in detail . . .
- The calculated wavelengths **are comp**ared to . . .
- Several models **are created** using . . .
- A detailed comparison **is made** between . . .

Results are most commonly expressed in the **Simple Past** tense:

- The hydrocarbons **showed** a marked increase in . . .
- No dilation **was observ**ed . . .
- This **was** consistent with . . .
- Organized fibers **were found** after six weeks . . .

However, it is also possible to express **Results** in the **Simple Present** tense

- The model consistently underpredicts . . .
- The ratio shifts toward . . .
- The most accurate readings are obtained from . . .
- We find that this does not vary . . .

AND you may choose to use TWO tenses in the same sentence

- The first part of the sentence can be in the **Simple Past** and the finding/result in the **Simple Present** if it is strong enough to be considered a **truth**
- The experiments **demonstrated** there **are** two matrices . . .
- It **was found** that proteins **are produced** from . . .

- This image **suggested** that there **is** a relationship between . . .

Achievements can be expressed in the **Present Perfect** tense (as in the Discussion/Conclusion)

- This investigation **has revealed** that . . .
- We **have devised** a strategy which allows . . .
- A novel material **has been produced** which . . .
- Considerable insight **has been gained** concerning . .

OR

in the **Present Sim**ple tense

- This process can successfully **be combined** with . . .
- The value of our approach **lies** in . . .
- This **provides** a powerful tool for . . .
- The algorithm presented here **ensures** that . . .

Applications are usually stated in the **Simple Present** tense

- This process **is** suitable for the production of . . .
- This framework can **be** used to evaluate . . .
- This approach can b**e** applied to . . .
- These profiles may **serve** as a predictor for . . .

Abstract Q & A

1. **How do I know what kind of background information to provide?**
   The background information that is found at the start of the Abstract is usually derived from the first sentences of the Introduction.

2. **How much background information should I provide?**
   In some journals, the Abstract has subtitles, i.e. Background/Method/Results/Conclusions: if so, the number of words is usually distributed fairly evenly among the different parts, but if not, the distribution is left to the writer and the proportion of the Abstract taken by each part varies considerably. If you feel that a lot of background is necessary to understand the Abstract itself, combine the relevant points and summarize them in as few words as possible. The focus of an Abstract is more likely to be on the methodology or the results, so limit background information to one or two sentences.

3. **How much detail should I give?**
   It depends on how important the details are. If the important contribution of your work really is in the details of the methodology, you can and should provide those details in the Abstract. However, in many other cases the focus of the study—and therefore of the Abstract—is not on methodology, in which case it is given in summary form and details are reserved for the Results.

4. **What do I do if there were problems with my study—do I mention those in the Abstract?**
   If they are really important, yes, and if so, you even briefly say what they were. It is better not to say that something will be discussed. The Abstract should provide/summarize the exact details of your findings. Important implications, data, and findings are included,

NOT left out. This includes problems, if (but only if) they were important, and directions for future work. Both are relatively rare in the Abstract.

5. **How much detail of the results should I give?**
*The results are probably the most important component the Abstract, and you should be specific and give details of key results. Avoid vague words such as 'small' or 'better.' If you provide 'naked numbers' try to include quantitative language such as **only** 38% or **as high as** 15% so that the numbers cannot be misinterpreted.*

SCIENTIFIC WRITING STYLE

Introduction

Good scientific writing is:

- **Concise**—you use as few words as possible
- **Accurate**—you carefully record the facts
- **Coherent**—you are logical and convincing
- **Cohesive**—you connect your ideas
- **Accessible**—your readers can easily locate information
- **Comprehensive**—you include all necessary information
- **Clear**—your meaning is obvious and understood

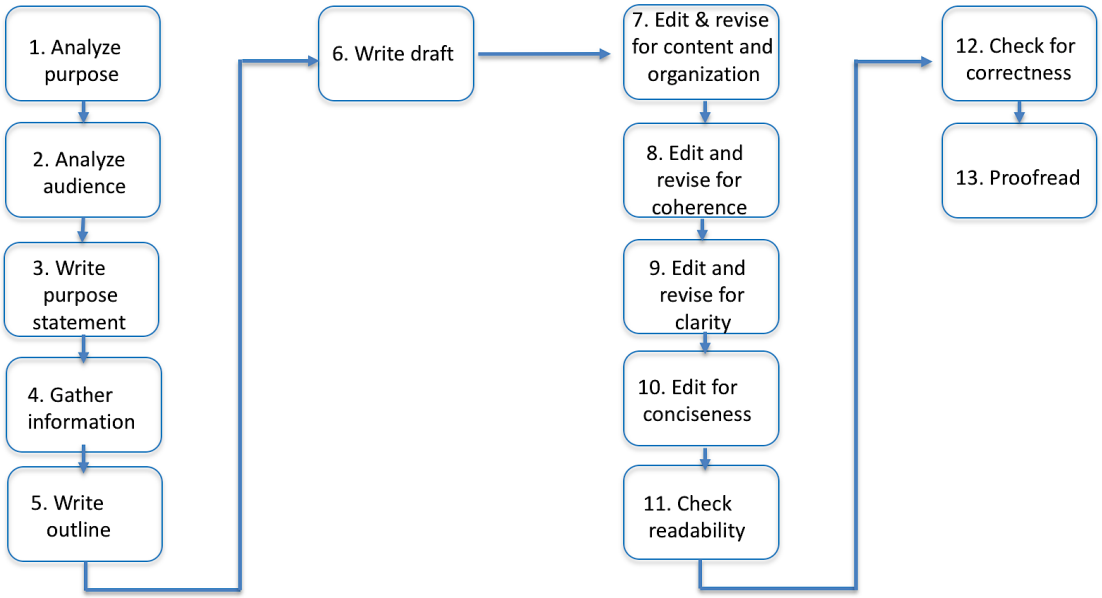
Good scientific writing is **not**

- Informal—do not use contractions, idioms, slang terms, or colloquialisms
- Subjective—do not use adjectives like fantastic, amazing, awesome, astonishing, dismal, depressing, terrible, or miserable
- Emotionally expressive – do not use exclamation marks!

Good scientific writing also aims for **simplicity**

- You use more short sentences than long sentences
- You have minimal or no digressions
- You have minimal embellishment
- You choose your words carefully—be as specific as possible
- You choose simple words—those with few syllables, if possible
- You have linear logical structures, either inductive or deductive

The Writing Process



What two words do you see with the greatest frequency in the writing process diagram? EDIT and REVISE! You must commit yourself to the process of editing and revising many times. This is what all writers of all languages must do to achieve clear, coherent, and cohesive writing.

COHERENCE AND COHESION

- If your paper has **coherence**, it **makes sense** and is **logical.**
- If your paper has **cohesion**, your **ideas are connected** and the writing has a **natural flow**.

The challenge of achieving coherence and cohesion

- Your writing might make sense to you, but not to your reader.
- Connecting your ideas and achieving "flow" in your writing requires you to have a good command of the English language and know how to use transitions and cohesive devices.

Creating coherence

- What you do at the word, sentence and paragraph level determines whether or not your writing makes sense to your readers.

A. Creating coherence at the word and sentence level

1. Word choice

- Don't kill verbs—these are your action words
- Instead, say exactly what you mean

Don't write this (nouns) **Instead write this (verbs)**

- obtain estimates of . . . . . estimate
- take an assessment of . . . . . assess

- provide a review of . . . . . .review
- offer confirmation of . . . . . confirm
- showed cooperation . . . . . cooperated
- provides a description . . . . . .describes

2. Reduce phrases to simple, single words

Replace this **with this**

- has an effect on . . . . . affects
- gives rise to. . . . . .causes
- due to the fact that. . . . . because
- the purpose of this study. . . . . this study
- a majority of. . . . . most
- are of the same opinion. . . . . agree
- less frequently occurring. . . . . rarer

3. Look for repetition in your sentences and look for ways to cut out repeated words

Ex: Due to the fact that the majority of patients showed more positive results with treatment A than with treatment B, we concluded treatment A to be the preferable choice. (28 words) *~ better ~*

***Because** most success occurred with treatment A, we concluded **it** to be the preferable choice. (15 words)*

4. Cut the clutter!

- When you learn how to eliminate non-informative and unnecessary words and phrases, your writing will be more effective
- Clutter: words or phrases that add nothing:
  - basically
  - fundamentally
  - generally
  - actually
  - fortunately
  - frankly
  - really
  - quite
  - very
  - as is known
  - it should be emphasized
  - based on the results

5. Don't bury the main verb

- The readers are waiting for the main verb!
- Keep the subject and main verb close to each other
- Having too much information between the subject and the main verb loses the readers and contributes to incoherence

Example: (**subject bold** and verb underlined)

Sustainable solutions *to the problems associated with continued population growth and development will require environmentally literate citizens.*

~ better ~

To develop sustainable solutions to the problems of human growth and development, ***we*** *will need environmentally literate citizens*

6. Shorten long phrases

High birth rates ~~have been observed to~~ occur in parts of the Midwest that have ~~been determined to have~~ especially high rates of unemployment. (24 words)

~ better ~

High birth rates occur in parts of the Midwest that have especially high rates of unemployment. (16 words)

7. Favor the active voice

a. *This* ***hypothesis*** *is supported by the observation that the timing of spring runoff is significantly different between natural and modified basins (Moore et al. 2011).*

~ better ~

Moore et al. *(2011) support this hypothesis, observing that the timing of spring runoff is significantly different between natural and modified basins.*

b. *The* ***variation*** *in survivorship referred to as density-dependent mortality has also been related to negative plant-soil biota feedback described for a temperate (Parker and Clay 200; Parker and Clay 2002) and tropical tree species (Hood et al. 2004).*

~ better ~

Parker and Clay *(2000, 2002) found that density-dependent mortality in a tropical tree species was related to negative feedback between plants and soil biota.* ***Hood et al.*** *(2004) found a similar relationship in a temperate tree species.*

8. Proper use of the passive voice

⇒ When writing the Methods section

⇒ When it helps you keep the same or similar subjects in a series of sentences in a *paragraph*

⇒ When you are the only author of a paper

- This study *was conducted* at the Red Sea Research Center at KAUST.
- Other options for the subject if you are the only author
  - This paper . . .
  - This project . . .
  - This study . . .
  - This experiment . . .

Summary of how to create <u>coherent sentences</u>

1. Keep the action verbs—do not turn verbs into nouns
2. Shorten long phrases-–reduce phrases to single words and shorten where possible
3. Cut the clutter—eliminate all unnecessary words
4. Don't bury the main verb—keep the subject and main verb close to each other
5. Favor the active voice—it's the clearest way to make a statement

B. Coherent paragraphs: Capitalisation of bullet points?

- Are precise, relatively short, and logical
- Have one main idea
- Include necessary transition words and cohesive devices
- Include a topic sentence

Topic sentences

- Are placed within the first few sentences of the paragraph
- Every other sentence in the paragraph should directly support or develop the topic
- If it doesn't, eliminate it
- This will also help your reader skim and scan your paper for information

Use a logical flow of ideas

- Sequence—the order in which things occur
- Statement of fact followed by support
- General to specific-–start with the main idea and then go into the details
- Logical arguments—if *a* then *b*

Cohesive devices and transitions (No capitalization here)

- fall into many different categories (see pages 4-6)
- link sentences and paragraphs to each other
- help the reader understand the relationship between different pieces of text

Summary of how to create <u>coherent paragraphs</u>

1. Have one main idea
2. Include a topic sentence
3. Use a logical flow of ideas
4. Include necessary transition words and cohesive devices to help your reader understand the relationship between your ideas

Is scientific writing more difficult than general writing? NO!

Scientific writing favors:

✓ clarity

✓ the active voice

✓ short sentences

✓ simplified vocabulary

Your goals as a scientific writer:

- To ensure that your readers can clearly comprehend your subject
- To create a structure that makes information easy to find in your paper
- To reduce your sentences, words, and paragraphs to the absolute minimum so as not to waste the time of your reader
- To become a better and stronger writer with every paper you write