The Scientific Paper

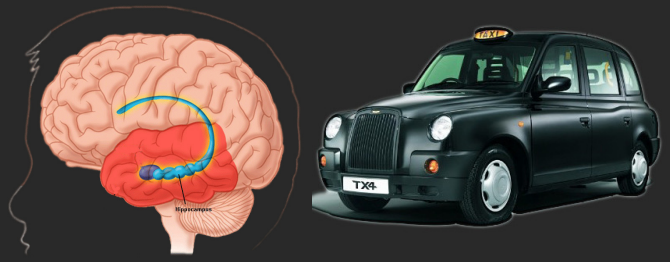
Scientific Writing

- Writing is an integral part of research.
- Research is actualization of scientific thinking, and
  scientific papers are the end-point of that actualization.

So, what might be worth researching and publishing?

After oddee.com (2010)

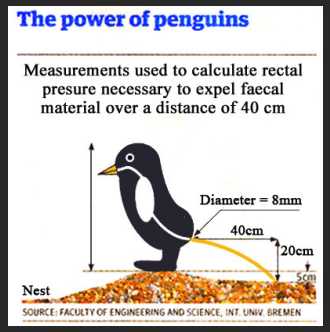
Maguire, EA; Gadian, DG; Johnsrude, IS; Good, CD; Ashburner, J; Frackowiak, RS and Frith, CD (2000) Navigation-related structural change in the hippocampi of taxi drivers.
Proc. of the Natl. Acad. Sci. USA 97 (8): 4398–403.



Stack, S and Gunlach, J (1992)
The effect of country music on suicide.
Social Forces 71(1): 211 – 218.

Ghirlanda, S; Jansson, L; and Enquist, M (2002)
Chickens prefer beautiful humans.
Human Nature 13 (3): 383-389.

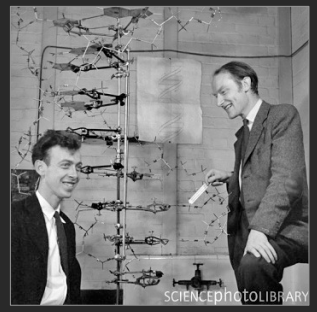
Victor Benno Meyer-Rochow and Jozsef Gal (2003)
Pressures produced when penguins pooh - calculations on avian defaecation.
Polar Biology 27(1): 56-58.

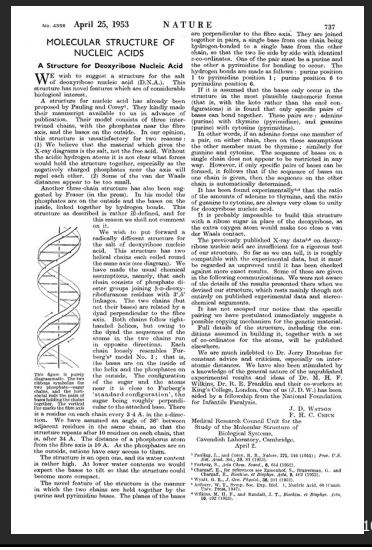


Mara Sidoli (1996)
Farting as a defence against unspeakable dread.
The Journal of Analytical Psychology 41(2): 165-178

Suarez, FL; Springfield, J and Levitt, MD (1998) Identification of gases responsible for the odour of human flatus and evaluation of a device purported to reduce this odour. Gut 43(1):100 – 104.

Watson & Crick's Seminal paper on DNA (1953)





No. 4356 April 25, 1953 NATURE 737

MOLECULAR STRUCTURE OF NUCLEIC ACIDS

A Structure for Deoxyribose Nucleic Acid

We wish to suggest a structure for the salt of deoxyribose nucleic acid (D.N.A.). This structure has novel features which are of considerable biological interest.

A structure for nucleic acid has already been proposed by Pauling and Corey[1]. They kindly made their manuscript available to us in advance of publication. Their model consists of three intertwined chains, with the phosphates near the fibre axis, and the bases on the outside. In our opinion, this structure is unsatisfactory for two reasons: (1) We believe that the material which gives the X-ray diagrams is the salt, not the free acid. Without the acidic hydrogen atoms it is not clear what forces would hold the structure together, especially as the negatively charged phosphates should strongly repel each other. (2) Some of the van der Waals distances appear to be too small.

Another three-chain structure has also been suggested by Fraser (in the press). In his model the phosphates are on the outside and the bases on the inside, linked together by hydrogen bonds. This structure as described is rather ill-defined, and for this reason we shall not comment on it.

We wish to put forward a radically different structure for the salt of deoxyribose nucleic acid. This structure has two helical chains each coiled round the same axis (see diagram). We have made the usual chemical assumptions, namely, that each chain consists of phosphate diester groups joining β-D-deoxyribofuranose residues with 3',5' linkages. The two chains (but not their bases) are related by a dyad perpendicular to the fibre axis. Both chains follow right-handed helices, but owing to the dyad the sequences of the atoms in the two chains run in opposite directions. Each chain loosely resembles Pauling and Corey's model No. 1 in that the bases are on the inside of the helix and the phosphates on the outside. The configuration of the sugar and the atoms near it is close to Furberg's 'standard configuration', the sugar being roughly perpendicular to the attached base. There is a residue on each chain every 3·4 Å. in the z-direction. We have assumed an angle of 36° between adjacent residues in the same chain, so that the structure repeats after 10 residues on each chain, that is, after 34 Å. The distance of a phosphorus atom from the fibre axis is 10 Å. As the phosphates are on the outside, cations have easy access to them.

The structure is an open one, and its water content is rather high. At lower water contents we would expect the bases to tilt so that the structure could become more compact.

The novel feature of the structure is the manner in which the two chains are held together by the purine and pyrimidine bases. The planes of the bases are perpendicular to the fibre axis. They are joined together in pairs, a single base from one chain being hydrogen-bonded to a single base from the other chain, so that the two lie side by side with identical z-co-ordinates. One of the pair must be a purine and the other a pyrimidine for bonding to occur. The hydrogen bonds are made as follows: purine position 1 to pyrimidine position 1; purine position 6 to pyrimidine position 6.

If it is assumed that the bases only occur in the structure in the most plausible tautomeric forms (that is, with the keto rather than the enol configurations) it is found that only specific pairs of bases can bond together. These pairs are: adenine (purine) with thymine (pyrimidine), and guanine (purine) with cytosine (pyrimidine).

In other words, if an adenine forms one member of a pair, on either chain, then on these assumptions the other member must be thymine; similarly for guanine and cytosine. The sequence of bases on a single chain does not appear to be restricted in any way. However, if only specific pairs of bases can be formed, it follows that if the sequence of bases on one chain is given, then the sequence on the other chain is automatically determined.

It has been found experimentally[3] that the ratio of the amounts of adenine to thymine, and the ratio of guanine to cytosine, are always very close to unity for deoxyribose nucleic acid.

It is probably impossible to build this structure with a ribose sugar in place of the deoxyribose, as the extra oxygen atom would make too close a van der Waals contact.

The previously published X-ray data[4,5] on deoxyribose nucleic acid are insufficient for a rigorous test of our structure. So far as we can tell, it is roughly compatible with the experimental data, but it must be regarded as unproved until it has been checked against more exact results. Some of these are given in the following communications. We were not aware of the details of the results presented there when we devised our structure, which rests mainly though not entirely on published experimental data and stereochemical arguments.

It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material.

Full details of the structure, including the conditions assumed in building it, together with a set of co-ordinates for the atoms, will be published elsewhere.

We are much indebted to Dr. Jerry Donohue for constant advice and criticism, especially on interatomic distances. We have also been stimulated by a knowledge of the general nature of the unpublished experimental results and ideas of Dr. M. H. F. Wilkins, Dr. R. E. Franklin and their co-workers at King's College, London. One of us (J. D. W.) has been aided by a fellowship from the National Foundation for Infantile Paralysis.

J. D. WATSON
F. H. C. CRICK
Medical Research Council Unit for the Study of the Molecular Structure of Biological Systems,
Cavendish Laboratory, Cambridge.
April 2.

Based on materials from Lindsay (1995) and Wilkinson, (1991)

The Title of a paper

- The link between the reader and the writer.
- Identifies and describes the contents of a paper accurately, specifically and succinctly.

Informative style

"Lactation increases the efficiency of energy utilization in rats."

Indicative style

"Efficiency of energy utilization in lactating rats."

The Scientific Paper 2

The sections

- Introduction
- Materials and Methods
- Results
- Discussion of Results
- Summary or abstract

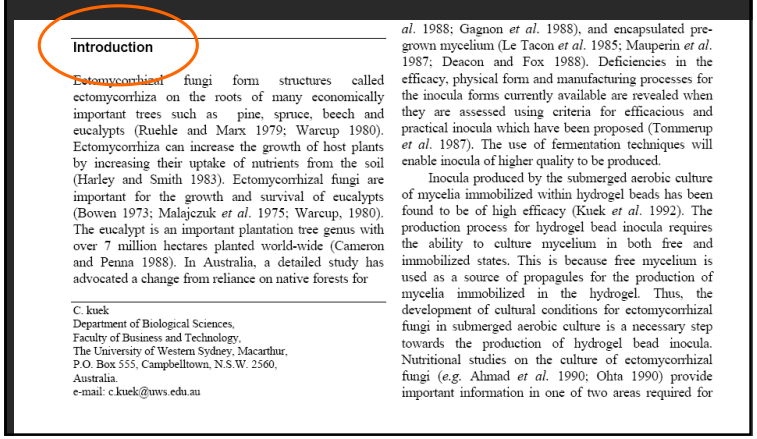
The Scientific Paper 3

What goes in each section?

The Bradford Hill Questions

- Introduction **Why did they start?**
- Materials & Methods **What did they do?**
- Results **What did they find?**
- Discussion of Results **What do the results mean?**

The Introduction



Introduction

Ectomycorrhizal fungi form structures called ectomycorrhiza on the roots of many economically important trees such as pine, spruce, beech and eucalypts (Ruehle and Marx 1979; Warcup 1980). Ectomycorrhiza can increase the growth of host plants by increasing their uptake of nutrients from the soil (Harley and Smith 1983). Ectomycorrhizal fungi are important for the growth and survival of eucalypts (Bowen 1973; Malajczuk *et al.* 1975; Warcup, 1980). The eucalypt is an important plantation tree genus with over 7 million hectares planted world-wide (Cameron and Penna 1988). In Australia, a detailed study has advocated a change from reliance on native forests for

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al. 1988; Gagnon *et al.* 1988), and encapsulated pre-grown mycelium (Le Tacon *et al.* 1985; Mauperin *et al.* 1987; Deacon and Fox 1988). Deficiencies in the efficacy, physical form and manufacturing processes for the inocula forms currently available are revealed when they are assessed using criteria for efficacious and practical inocula which have been proposed (Tommerup *et al.* 1987). The use of fermentation techniques will enable inocula of higher quality to be produced.

Inocula produced by the submerged aerobic culture of mycelia immobilized within hydrogel beads has been found to be of high efficacy (Kuek *et al.* 1992). The production process for hydrogel bead inocula requires the ability to culture mycelium in both free and immobilized states. This is because free mycelium is used as a source of propagules for the production of mycelia immobilized in the hydrogel. Thus, the development of cultural conditions for ectomycorrhizal fungi in submerged aerobic culture is a necessary step towards the production of hydrogel bead inocula. Nutritional studies on the culture of ectomycorrhizal fungi (*e.g.* Ahmad *et al.* 1990; Ohta 1990) provide important information in one of two areas required for

The Introduction

Usually includes at least the following:

- Derivation and statement of the problem and discussion of the nature of the problem.
- Discussion of the background of the problem.
- Derivation and statement of the research question or objective(s) of the research.

The Introduction 2

Structuring the introduction

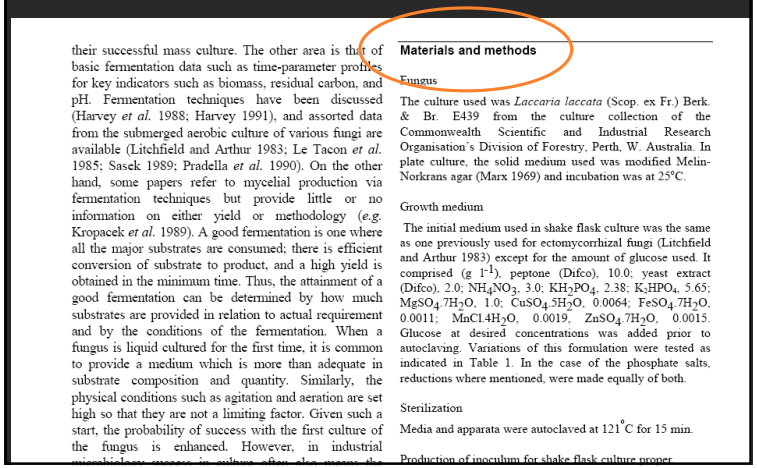
- Problem >> Background >> Question >> Objective
- Background >> Problem >> Question >> Objective
- Question >> Objective >> Problem >> Background

The Introduction 3

Search of the literature

- To avoid repetition of research.
- The problem and its relation to earlier research.
- Development of hypotheses.
- To avoid misinterpretation of results.
- To avoid omission of pertinent references.

Materials and Methods



their successful mass culture. The other area is that of basic fermentation data such as time-parameter profiles for key indicators such as biomass, residual carbon, and pH. Fermentation techniques have been discussed (Harvey *et al.* 1988; Harvey 1991), and assorted data from the submerged aerobic culture of various fungi are available (Litchfield and Arthur 1983; Le Tacon *et al.* 1985; Sasek 1989; Pradella *et al.* 1990). On the other hand, some papers refer to mycelial production via fermentation techniques but provide little or no information on either yield or methodology (*e.g.* Kropacek *et al.* 1989). A good fermentation is one where all the major substrates are consumed; there is efficient conversion of substrate to product, and a high yield is obtained in the minimum time. Thus, the attainment of a good fermentation can be determined by how much substrates are provided in relation to actual requirement and by the conditions of the fermentation. When a fungus is liquid cultured for the first time, it is common to provide a medium which is more than adequate in substrate composition and quantity. Similarly, the physical conditions such as agitation and aeration are set high so that they are not a limiting factor. Given such a start, the probability of success with the first culture of the fungus is enhanced. However, in industrial

Materials and methods

Fungus

The culture used was *Laccaria laccata* (Scop. ex Fr.) Berk. & Br. E439 from the culture collection of the Commonwealth Scientific and Industrial Research Organisation's Division of Forestry, Perth, W. Australia. In plate culture, the solid medium used was modified Melin-Norkrans agar (Marx 1969) and incubation was at 25°C.

Growth medium

The initial medium used in shake flask culture was the same as one previously used for ectomycorrhizal fungi (Litchfield and Arthur 1983) except for the amount of glucose used. It comprised (g l^{-1}), peptone (Difco), 10.0; yeast extract (Difco), 2.0; NH_4NO_3, 3.0; KH_2PO_4, 2.38; K_2HPO_4, 5.65; $MgSO_4.7H_2O$, 1.0; $CuSO_4.5H_2O$, 0.0064; $FeSO_4.7H_2O$, 0.0011; $MnCl.4H_2O$, 0.0019; $ZnSO_4.7H_2O$, 0.0015. Glucose at desired concentrations was added prior to autoclaving. Variations of this formulation were tested as indicated in Table 1. In the case of the phosphate salts, reductions where mentioned, were made equally of both.

Sterilization

Media and apparata were autoclaved at 121°C for 15 min.

Production of inoculum for shake flask culture proper

Remember falsifiability?

A scientific theory or hypothesis has
the important characteristic that it is capable of being subject to experimentation that could show it to be untrue *i.e.* it is falsifiable.

What does this imply for the reporting in Materials & Methods?

Materials and Methods

Interpretation, explanation and meaningfulness of the results depends on a clear and accurate description of materials and methods.

Accurate description is required so that others can:

- replicate the experiments.
- modify the method with assurance that the original is changed in a particular way.
- Apply them under different conditions.
- compare the research reported with others.

Materials and Methods 2

Procedural Versus Chronological Order

Chronological Order

1.Injection of drug
2.Collection of blood sample
3.Analysis or storage of blood sample
4.Injection of drug
5.Analysis or storage of blood samples
6.Injection of drug
7.Collection of blood sample
8.Analysis or storage of blood sample
9.Killing of rats
10.Removal and fixation of liver tissue
11.Preparation of liver for histological study
12.Analysis of stored blood samples
13.Biochemical assays of tissue

Procedural Order

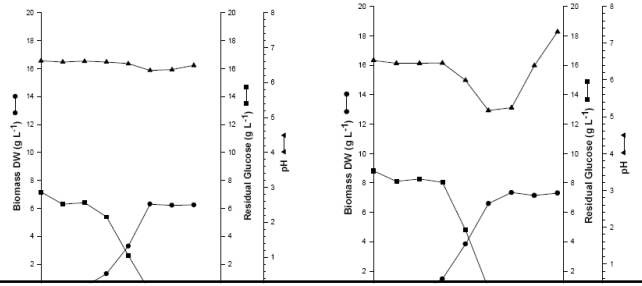
1.Protocol and method for injection of drug
2.Serum studies
   a. Collection and storage of blood samples
   b. Analysis of blood samples
3.Tissue studies
   a. Killing of rats
   b. Removal and fixation of liver
   c. Biochemical assays
   d. Histological preparation of liver tissue

Results

Results

The cultures were characterized by the measurement of residual glucose, biomass yield and pH through the course of the fermentation. The initial medium formulation used proved

(Fig. 3). At the lower shaking speed, when the amount of glucose supplied was doubled to 20 g l^{-1}, again the shape of the glucose consumption and biomass accumulation profiles were not significantly altered (Fig. 4). However, the final yield of biomass was increased by about 1.7



Avoid ending up publishing in this journal

Results

The results of research are the substance of science and are the objective of scientific research.

In reporting results:

- the overriding objective should be accuracy.
- information should be systematically presented.

Results 2

Structure and contents

- The results section must ultimately address the questions raised in the introduction and any hypotheses formulated there.
- Since this section is a direct consequence of the methods, it is most logically organized to correspond to the methods section.

Results 3

The results section should not be:

- **merely a collection of tables and figures.**
  - Illustration of data can constitute and support the development of the argument but must not substitute for it.
  - Tables and figures must be integrated into the text and the integration should consist of more than an announcement.
- **used to interpret the results.**
  - The results consist of bare, dry, unembellished observations and measurements.

Discussion

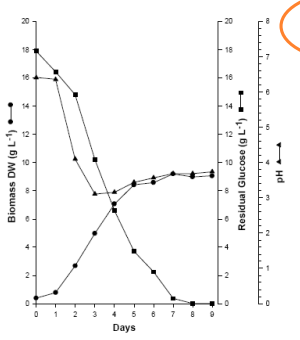


Fig. 10. Run 8. A repeat of Run 4 with the concentration of non-phosphate nutrients in the medium reduced to 1/6th of the original. Other conditions: 1/9th PO_4 salts; glucose 20 g l^{-1}; shaking speed 100 rpm; temperature 25°C.

Discussion

The initial medium used proved satisfactory for the shake flask culture of *Laccaria laccata*. The complete consumption of glucose must have meant that the other medium substrates were adequate in composition and quantity. The buffering capacity of the medium was proved to be good by later data which showed pH swings in contrast to the stability found in the first run. The first manipulation made in the culture conditions was the reduction in the concentration of added phosphate. This was desired because of the requirement in later work to culture the fungi as immobilized mycelia in calcium alginate. The presence of high concentrations of phosphates can dissolve calcium alginate and is thus a situation to avoid. Further, other studies have found that the formation of ectomycorrhiza and their functioning are diminished at high concentrations of soil phosphate (Beckford *et al.* 1985; Shaw *et al.* 1987; Bougher *et al.*1990). Therefore, ectomycorrhizal fungi should be cultured at the lowest possible concentration of phosphate so that they are well adapted to the lower soil phosphate concentrations that will apply in the use of mycorrhizal technology. The lowering of amount of phosphate salts to 1/9th the original was made on the

Discussion

Whilst the results are the substance of science, the discussion allows for the play of ideas that advance science.

The nature of discussion

1. The objective is to give the research, especially the results, meaning.
2. Integration of the results, the method, the related literature, and theoretical context.

The nature of discussion 2

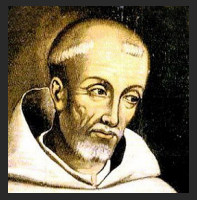
3. Examination of the results to
   - determine whether they resolve the research question.
   - compare them within themselves and to other results.
   - explain and interpret them.
   - draw conclusions or derive generalizations, and make recommendations for applying the new results or further research.

A note about giving explanation
(informed speculation?)
to results in discussion.

Occam's Razor

Oc·cam's razor

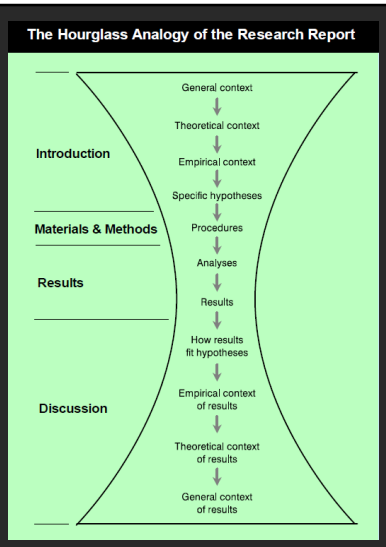
Variant(s): also Ock·ham's razor \ä-kəmz-\
Function: *noun*
Etymology: William of *Occam*
Date: circa 1837



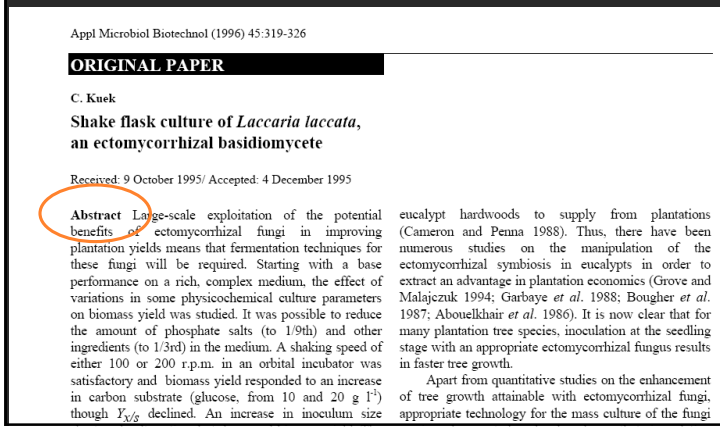
"A scientific and philosophic rule that entities should not be multiplied unnecessarily.

Interpreted as requiring that the simplest of competing theories be preferred to the more complex or that explanations of unknown phenomena be sought first in terms of known quantities."

Merriam-Webster dictionary



Summary or Abstract



Appl Microbiol Biotechnol (1996) 45:319-326

ORIGINAL PAPER

C. Kuek

Shake flask culture of *Laccaria laccata*, an ectomycorrhizal basidiomycete

Received: 9 October 1995/ Accepted: 4 December 1995

Abstract Large-scale exploitation of the potential benefits of ectomycorrhizal fungi in improving plantation yields means that fermentation techniques for these fungi will be required. Starting with a base performance on a rich, complex medium, the effect of variations in some physicochemical culture parameters on biomass yield was studied. It was possible to reduce the amount of phosphate salts (to 1/9th) and other ingredients (to 1/3rd) in the medium. A shaking speed of either 100 or 200 r.p.m. in an orbital incubator was satisfactory and biomass yield responded to an increase in carbon substrate (glucose, from 10 and 20 g l^{-1}) though $Y_{x/s}$ declined. An increase in inoculum size

eucalypt hardwoods to supply from plantations (Cameron and Penna 1988). Thus, there have been numerous studies on the manipulation of the ectomycorrhizal symbiosis in eucalypts in order to extract an advantage in plantation economics (Grove and Malajczuk 1994; Garbaye *et al*. 1988; Bougher *et al*. 1987; Abouelkhair *et al*. 1986). It is now clear that for many plantation tree species, inoculation at the seedling stage with an appropriate ectomycorrhizal fungus results in faster tree growth.

Apart from quantitative studies on the enhancement of tree growth attainable with ectomycorrhizal fungi, appropriate technology for the mass culture of the fungi

Summary /Abstract

Often written last but of great importance.

- Can decide if the paper gets read.
- Gathered by database and abstracting services which are important disseminators of your work.

Summary/Abstract 2

Elements of an effective summary

Broad outline of:

- Why the experiment was done.
- How the experiment was done.
- The main results.
- Main conclusions.

Should be written as a self-supporting section.

Referencing

There are various formats for referencing and citation (these go together)

- Harvard (Author-Date system)
- Vancouver (Number-Citation system)

Consult a journal's "instruction to authors" on specific requirements for citations and referencing.

Allocation of Credit

Allocated in 3 places in a scientific paper:

- List of authors
- Citations
- References section
- Acknowledgements section

Citations

Citations serve to:

- acknowledge conflicts with other works
- acknowledge the work of others
- direct the reader to sources of other information
- provide support for views made or positions taken
  - by one's own results,
  - those of others or,
  - an authoritative statement based on the results of others.

Citations 2

One's position is given by choice of wording in the text

"Beer is good for health (Bloggs, 1976)"
Implication: Accepted concept; Bloggs first to present; the author agrees.

"Bloggs (1976) found that beer is good for health."
Implication: Lesser-known concept deduced by Bloggs; the author agrees.

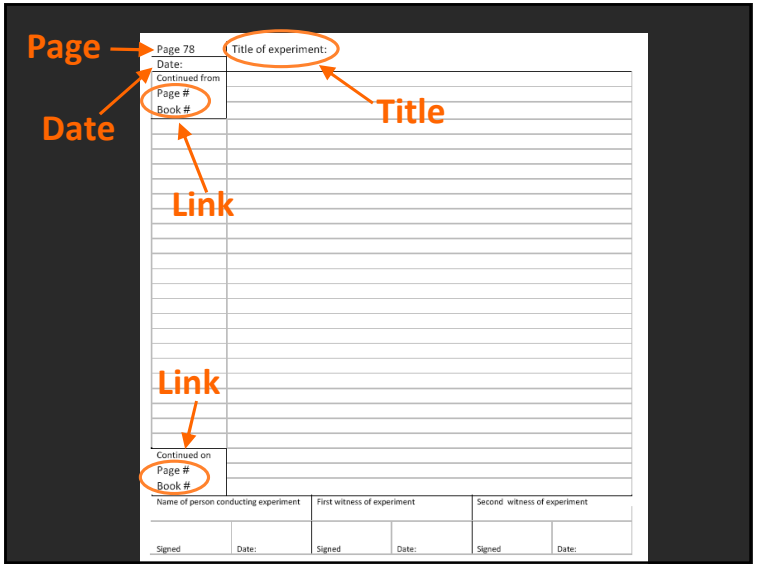
"Bloggs (1976) claimed that beer is good for health."
Implication: The verdict is still out; the author retains an open mind.

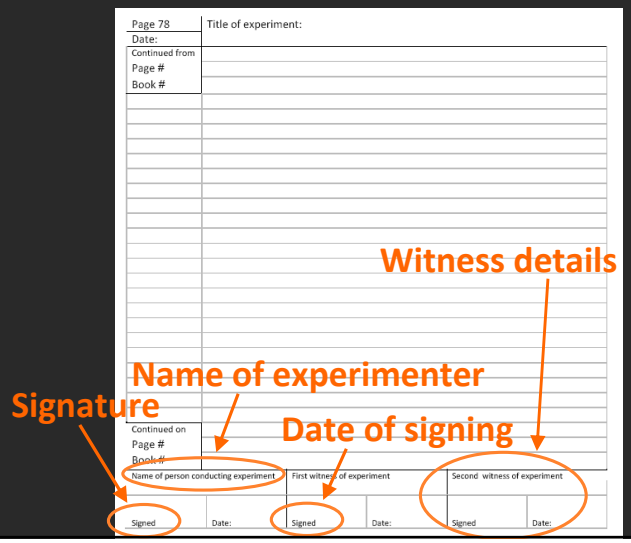
The Lab Record Book

- Is a legal document recording your work
- Proof that you conducted the research
  Disputes; plagiarism
- Required to proof right to own a related patent
  "First to invent invent"; "first to file file"

Required features

- Permanently bound pages.
- Consecutive page numbering.
- Entries in chronological order without blank pages; written clearly.
- Pre-experimental details (work/ideas) recorded.
- Results obtained at a later stage recorded in date order and cross cross-referenced to earlier entry.
- Additional materials (*e.g.* photographs; printouts) is attached with stapling or adhesive.
- Record of equipment details (manufacturer; model); indicate purpose if unclear.





Required features 2

- Sketches used to detail method or equipment setup.
- All errors remain legible e.g. ruled out rather than erased or covered. Provide reason if unclear.
- Alterations (additions; changes) signed and dated.
- Each experiment/work period signed and dated by writer.

Higher level requirement

- Duplicate copy kept separately.
- Witness (not a participant in the work) also to sign off.

The Lab Record Book 2

- Do not fear “writing too much.”
- It is a complete record – treat it like a diary
- How much detail?
  Any knowledgeable person should be able to understand your procedures used to obtain your results.
- The more details, the easier it will be to claim “first to invent .”
- Requirements for patenting provide for a high standard which benefits the writing of scientific papers

Sources

IP Australia (2006) “Good lab book practice for researchers.”

Lindsay, D. (1995) “A Guide to Scientific Writing;” 2nd ed.; Longman, Melbourne.

Wilkinson, A.M. (1991) “The Scientist’s Handbook for Writing Papers and Dissertations;” Prentice Hall, Englewood Cliffs.