



Writing and Publishing Scientific Papers

A Primer for the
Non-English Speaker

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10. How to Write the Material and Methods Section

Although traditionally, this section is only called “Material and Methods” (rarely: Study Site, Material and Methods), it can be composed of the following parts: study site, study organism, material, methods, statistical evaluation.

The aim of this section in scientific papers is to enable readers to assess the reliability of your work, and to be able to repeat it for verification if they want to do so. Science is about unearthing nature’s laws, and the cornerstone of the scientific method requires that experiments are repeatable: if the experiment is repeated under the same conditions, the same result should be obtained. A material and methods section should give enough detail to evaluate and, if needed, to repeat the experiments reported in the article.

You should carefully consider your potential readership. This allows you to provide enough, but not superfluous, information. Once you have reflected on what can be assumed as known by this readership about your setting, organisms, methods, etc., you can give detail accordingly: not too little, and not too much.

During peer review, this section is closely scrutinised. If the reviewer is in any doubt that the experiments are repeatable, or that the methods are appropriate, the manuscript will be rejected as unreliable, no matter how wonderful the findings are.

Study Site

When describing your study site, consider your potential readership and give details accordingly (geographical particulars, history of the site, location, co-ordinates, maps). The aim is not to enable the reader to

find your sampling plot, but to give a general understanding, a “feel” for the environment you worked in. Information on habitat, with photos, maps, drawings, is often useful, or wholly necessary.

Study Organism

Here, you should name all the species, strains, cultivars or races that were used in the experiments. You should also give precise information on their origin, storage or husbandry, including temperatures, photoperiod, feeding regimes, control, etc. Depending on the readership, you should consider giving other background information on life history, and the organism’s distribution in nature. If there is a long list of organisms or strains, consider preparing a table with this information.

Materials

Here, you should list all the materials necessary for your experiments. Give exact names, not generic or trade names, of chemicals used. Give a source (manufacturer with location) if the chemical in question is delicate (e.g. an enzyme), or rare, or its quality is critical. This would give additional information to the reader. This is, however, neither advertisement nor endorsement (for legal reasons, this should often be made explicit in the paper — see, e.g. the US public organisation policy: disclaimer: “The mention of any trade name does not constitute endorsement by XXX organisation”). For equipment used, give the name, specification/type, manufacturer, and conditions of use.

Sampling Methods and Measurements

Here, you should detail the procedures: how did you perform the observations, measurements, experiments? How many times, under what conditions? If you use a new method, give all the details necessary so that the reader can repeat your experiment from reading this section. If you used a published method, a reference to the original publication, preferably the one that first published the method, is usually sufficient with minimum description. If you modified a published method, detail the modification only. If the method is published, you should

cite it — but consider *where* it was published? Is it a frequently used method? When was it published? A rarely-used method, published long ago in an obscure journal, needs a more detailed description than a much-used, current one. If the original publication is not widely available, you will have to provide detailed description. Editors often welcome more detail, especially if the published method is not in very wide use (with the appropriate reference, naturally). If you modified a published method that is widely available, detail the modification only.

When describing the procedure, be aware that only SI (Système International) units of measurement are allowed. A few units in common use are not official SI measurements and they cannot be used. Also, be aware of the precise use of measurement units — for example, in common use, weight is often given as grams, kilograms, etc., but these are units of mass, not of weight.

Any larger set of samples, measurements, or experiments will have the occasional error, a missing sample, a lost or mislaid tube. Do not keep silent about them. Indicate, clearly, how you dealt with errors, missing data, missing traps. This will not decrease your credibility — on the contrary.

Evaluation Methods/Statistics

Data will mostly be evaluated by using a statistical program. In most cases, a reference to the program (indicate the version used) is sufficient; give detail only if the method used is new. However, avoid the neophyte description: what's new for you may not be new for readers. An experienced colleague can give advice on this matter. In general, it is always a good idea to discuss your chosen statistical method with others. Here, you should give a reason for the choice of statistical test, as well as stating how you tested the eventual conditions for using the chosen test (testing for assumptions for a given statistical test). The mention of the use of a commercial statistical program naturally assumes that you have valid access to the program in question. It is not unheard of program developers to search for the mention of their product in the literature to find out about illegal use.

Style

Be careful with details when writing a material and methods section — your reputation is on the line! The reader was not by your side when the studies were done, so she will use the detail and clarity of this section as an indirect indication of your reliability and thoroughness.

A common error in this section is not offering enough detail. This does not happen because of the authors' desire to hide anything — it is simply a mark of routine: many parts of the experimental protocol may become almost routine, and the small details are forgotten as they never change and are taken for granted. When the description is prepared, these details, vital for others, are often not included. A good test is whether a colleague, on reading the section, thinks she can repeat the experiment based on the given description of methods. Such a check is useful, because the writer often is too close to the methods, having done them countless times during the experimental process and, thus, omits some obvious but important, detail.

Specifically, take care with numbers, spelling, and punctuation. In this section, many “strange” names will occur: of chemicals, organisms, strains; concentrations, times and units of measurement are important. Meticulousness is the key word here: if you cannot be trusted to do simple things well, such as describing a method that you used hundreds of times, can you expect the readers to trust you when it comes to more significant and complicated aspects of reporting your research?

The order of description should be chronological; the description of what was done first should precede the later actions. However, you have to first mention all study sites, then all organisms, followed by a full list of all materials used, experiment-by-experiment and so on. Thus, if someone is only interested in all the details of, for example, your second experiment, she will have to jump from one part of this section to another. This seems a small price to pay for a consistent structure, which is followed by most journals.

This section describes your own work and, thus, the past tense is used, mostly, in this section. When describing the details, beware of the syntax. The following description is taken from Day and Gastel's book (Day and Gastel, 2006), who, tongue-in-cheek, called it “the painful method”: “After standing in hot water for an hour, the flasks were examined”. I

hope this was not performed as the sentence implies — probably the flasks, and not the researchers, were standing in hot water that long.

When to Write this Section?

It is best to start writing this section first, possibly even while working on the experiments. Otherwise, many details will be lost. Details and precision are vital here, and they are much easier to document during the work, or soon after, than weeks or months later. Additionally, there is often a practical reason, too. Most scientific work is done in teams; it is much easier to convince the team members to write their respective methods section while they are doing the work, or soon afterwards. Once the experiments are completed, and the team moves on to further projects, writing a complete methods section will take longer, and be done less satisfactorily.

Meticulousness pays, because, as stated above, reviewers are often of the opinion that if you cannot be trusted in doing simple things, you cannot expect trust in significant and complicated aspects of research. Science, in the view of many of its eminent practitioners is, after all, “99% perspiration and 1% inspiration”, so precise work, and the ability to describe things accurately, is a necessary condition of credibility. Science may well comprise a lot of precise work and fewer grand ideas; you prove your mastery of the methods applied by being able to describe them with clarity, in sufficient detail.

