Writing Research Reports in 20.109

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What do you as a reader expect to happen in a research article?

Macrostructure of a Research Article

- ***Introduction*** provides general field or context.
- ***Methods*** follows a particularized path.
- ***Discussion*** moves from specific findings to wider implications.

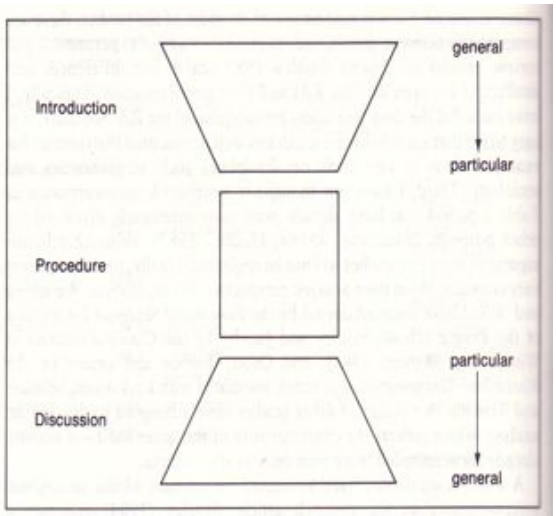
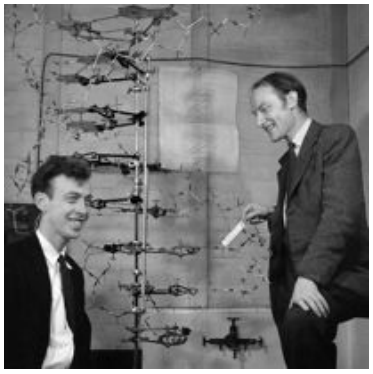


Figure 7 Overall organization of the research paper (Hill et al., 1982).

The goal of scientific writing is to court your audience.

Michael Halloran on Watson & Crick's 1953 "The Structure for DNA"

"The April 1953 paper, then, is really just the initial move in a rhetorical strategy aimed at gaining and holding the attention of an audience. As such, it presumes an understanding of *science as a human community* in which neither facts nor ideas speak for themselves, and the attention of the audience must be courted."



Research article scramble

- For the passages from a student's 20.109 laboratory report on homologous recombination: Which section (Introduction, Methods, Results, Discussion, Figure Captions) does each passage belongs to?

1.0 Introduction

By obtaining a more profound understanding of all aspects of DNA repair pathways, it may be easier for future breakthroughs in creating chemotherapeutic strategies that specifically and effectively attack cancers, and thus radically change modern cancer treatment. In order to contribute to this understanding of homologous recombination, we have created an assay that will enable us to determine when homologous recombination has taken place.

What features of this paragraph identify it as belonging to the Introduction?

http://openwetware.org/wiki/20.109%28F10%29:_System_engineering_research_article

Be sure to end your introduction with a clear description of the problem you're studying and the method(s) you are using. If you would like to preview for the reader your key results and conclusions in the last sentence of your introduction, you may.

The Introduction establishes *context*, *focus*, and *justification*.

Context: Orient your reader to the published literature related to the topic and to essential background information

Focus: Define the research space, stake out territory. What questions are you addressing? What is your hypothesis?

Justification: Show how your work fits into and extends previous work. Argue for the importance of your work.

Swales (1990)

2.0 Methods

In order to perform bacterial transformation, 5 µl of each purification ligation reaction was added to 50 µl of competent bacterial cells, also a positive control was prepared with an uncut pCX-EGFP plasmid. These solutions were then heat shocked in a 42ºC bath for 90 seconds so that the competent cells could uptake the DNA. 0.5 ml of LB media was then added to each reaction, and 200 µl of each tube was plated onto separate LB + AMP plates using a sterile spreader. Each plate was then incubated at 37ºC overnight.

What features of this paragraph identify it as belonging to the Materials & Methods?

http://openwetware.org/wiki/20.109%28F10%29:Guidelines_for_writing_up_your_research

This section is like a cooking recipe and should provide enough detail to allow an independent investigator to repeat any of your experiments. It's common (and helpful!) to include sub-section headings to allow readers to quickly identify experiments of interest to them. The Materials and Methods section should be written in the past tense, since your experiments are completed at the time you are writing your paper. It should also be written in complete sentences and paragraphs, not in bullet point form.

Your research article should contain a Methods Section, not a Protocol.

A Protocol is . . .

- A series of steps to be carried out.
- Written in sequential or temporal order.
- Intended for the reader to achieve a final result.

A Methods Section is . .

- A series of steps already completed and is written in past tense.
- Written in logical order.
- Intended for the reader to replicate the experiment.

3.0 Results

As expected the digestion of plasmid backbone (Lane 2) displayed a band of about 4.8 kbp in length, as digesting with SalI would linearize the DNA. However, two other bands were seen in addition to the expected band, which could be due to poor enzyme efficiency. Lanes 3-5 in Figure 6 also confirm the projected length fragments of 3.7 kbp and 1.6 kbp (from Figure 5). This result indicates that the candidate clones were indeed the desired construct.

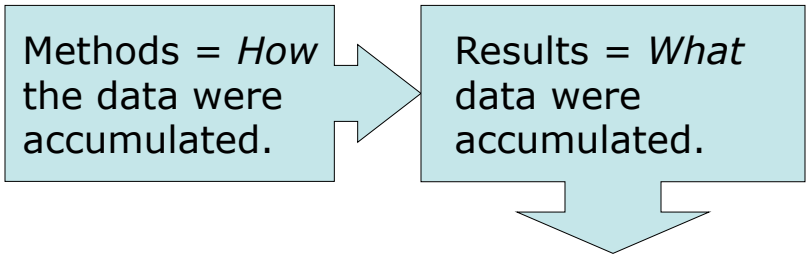
What features of this paragraph identify it as belonging to the Results?

http://openwetware.org/wiki/20.109%28F10%29:Guidelines_for_writing_up_your_research

The purpose of the results section is to present your data in a relatively unbiased way, but with some guiding framework. Begin with a short description of the goal and strategy of your overall experiment, and then delve into specific sub-sections that describe each piece of the work. Titled sub-sections help support your high-level narrative and make dense papers easier to read.

To write the results section, use the figures and tables as a guide. Start by outlining, in point form, what you found, going slowly through each part of the figures. Then take the points and group them into paragraphs, and finally order the points within each paragraph. Present the data as fully as possible, including stuff that at the moment does not quite make sense.

What Differentiates Results from the Methods?



Readers expect to find the "answers" to your research questions in your Results section.

4.0 Figure Caption

Results of gel electrophoresis on 1% agarose gel. Lane 1-4 contain the pCX-NNX backbone. In Lane 1 the vector is uncut. In Lane 2 the plasmid is cut with XbaI (? 4.8 kbp), while in Lane 3 it is cut with EcoRI (? 4.8 kbp). Lane 4 shows the backbone double digest with XbaI and EcoRI (?4.7kbp). Lane 5 is the 10Kb DNA Ladder. Lanes 6-7 contain the ?5-EGFP (PCR Product) insert. Lane 6 is the double digest (?0.66 kp), and Lane 7 shows the uncut insert. Lane 8 is the negative PCR-no template control. (Yellow Group W/F)

What features of this paragraph identify it as belonging to a Figure caption?

http://openwetware.org/wiki/20.109%28F10%29:Guidelines_for_writing_up_your_research

Legends to the figures and tables explain the elements that appear in the illustration. Conclusions about the data are NOT included in the legends. As you write your first draft, state in a short simple sentence, what the point of the figure or table is. In later drafts, make sure each element of the figure or table is explained. Your figure legends should be written in the present tense since you are explaining elements that still exist at the time that you are writing the paper.

Provide context for your illustrations

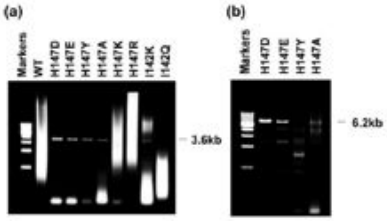


Figure 3. PCR with KOD polymerase mutants. (a) Agarose gel (1%) showing 3.6 kb PCR products. One unit of each mutant or WT enzyme was added to a mixture of 10 ng human genomic DNA and a primer pair designed to yield a 3.6 kb DNA fragment. (b) Long PCR with each mutant. One unit of each mutant was added to a mixture of 50 ng human genomic DNA and a primer pair designed to yield a 6.2 kb DNA fragment.

reactions. Only four mutants (i.e. H147D, H147E, H147Y and H147A) resulted in successful amplification. Although I142K also showed a faint band, conspicuous unexpected bands were amplified at the same time. The other mutants generated only indistinct non-specific bands (Figure 3(a)). This experiment indicates that the 3′-5′exonuclease activity is not the only cause of PCR failure, because some mutants exhibiting similar Exo/Pol ratios (e.g. H147E and I142Q) produced different results. From these experiments, it is concluded that the negative charge or hydrophobicity of the amino acid at position 147 plays an important role for the sensitivity of PCR.

Next, the mutants that showed successful amplification in the above experiments (H147D, H147E, H147Y and H147A) were applied to "long PCR". A DNA fragment of the myosin heavy chain (6.2 kb) was amplified from human genomic DNA (final concentration, 1 ng/μl). As shown in Figure 3(b), H147D and H147E successfully amplified 6.2 kb products. The yield with H147D was higher than that with H147E. The target was not

From Kuroita, et al. "Structural mechanism for coordination of proofreading and polymerase activities in archael DNA polymerases." *JMB* 351, 2005, 291-298.

Table titles on top; figures below!

Heading

Table 1. Concentrations of total particulate matter, particulate calcium, and particulate aluminum in the upper 100 m of the Beaufort Sea.

Sampling date (1989)

Depth (m)	Apr 10	20	30	May 10	20	30	Jun 9	19	29	Jul 9	19
Total particulate matter (μg / liter)											
10	49	180	129	86	45	37	38	61	61	44	60
25	83	116	72	78	105	19	30	68	46	44	37
50	132	108	131	77	43	28	32	19	48	34	36
100	24	20	52	52	28	18	21	25	32	24	26
Particulate calcium (μg / liter)											
10	2.3	11.2	5.4	5.4	0.3	0.3	2.2	2.6	5.4	2.4	3.1
25	3.1	9.1	3.3	3.3	2.4	0.2	1.5	0.8	4.4	2.5	2.5
50	10.5	3.3	3.1	3.1	0.8	0.2	2.1	1.3	4.3	2.6	2.6
100	2.5	16.8	1.5	1.5	0.5	0.1	3.3	3.7	3.1	1.2	3.1
Particulate aluminum (μg / liter)											
10	0.16	0.34	0.29	0.99	0.31	0.48	0.14	0.18	0.12	0.10	0.14
25	0.12	0.27	0.21	0.88	0.50	0.19	0.13	0.44	0.10	0.13	0.10
50	0.19	0.82	0.17	0.17	0.18	0.10	0.93	0.07	0.05	0.05	0.09
100	0.08	0.21	0.04	0.06	0.09	0.17	0.62	0.12	0.60	0.92	0.08

Columnhead
Stubhead
Column
Row
Cell
Rowstub

Figure 5.4
Tables are the simplest visual format and preserve the original data. Each cell represents a full sentence. Tables do not, however, convey visual patterns and may hide significant events or trends.

Paradis and Zimmerman 1988, p 68

Titles and captions allow illustrations to stand on their own.

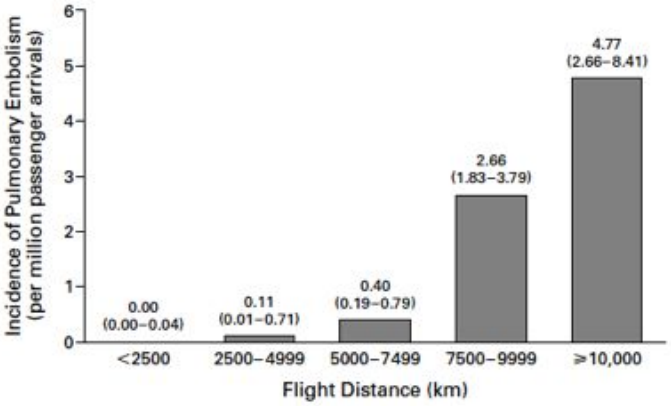


Figure 1. Incidence of Pulmonary Embolism According to Distance Traveled by Air.
Values shown above the bars are numbers of cases per million passenger arrivals, with 95 percent confidence intervals. To convert kilometers to miles, multiply by 0.62.

Does this figure stand on its own?

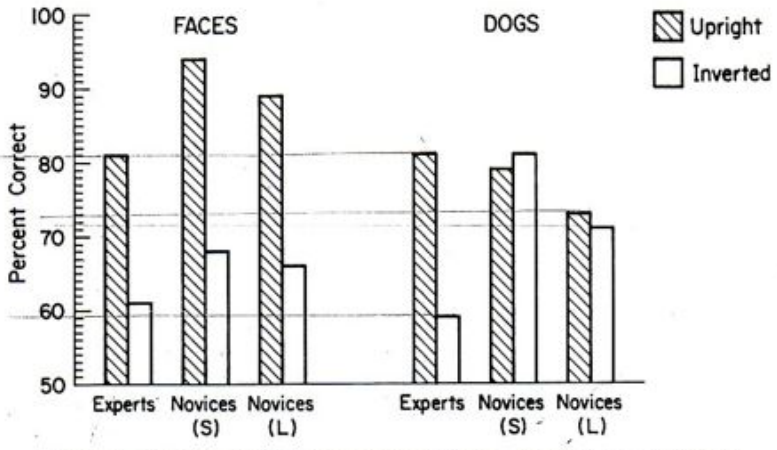
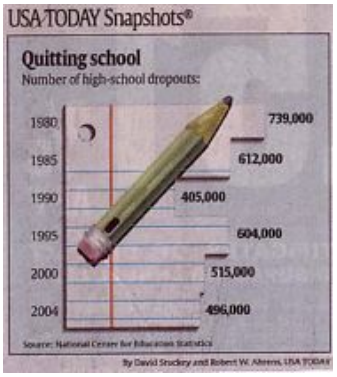


Figure 5. Performance of experts and novices on faces and dogs presented upright and inverted in Experiment 3. Novices (S) were given a small set size on dogs, whereas novices (L) were given the same large set size as were experts.

Effective presentation of data?



USA Today, 11/18/05

5.0 Discussion

With regards to the results obtained from flow cytometry, several unexpected results were observed. To begin with, all the negative controls had some cells that fell to the right of the diagonal line (greater FL1:FL2 ratio), suggesting that they expressed EGFP. This is likely due to the MES cells having background fluorescence or that there was contamination in the samples. However the most surprising result was the almost complete lack of homologous recombination in the ?3+?5SgrAI samples. This was surprising as we hypothesized that an increase in distance of a double strand break would decrease HR; however, we still believed that it would be greater than having no double strand breaks.

What features of this paragraph identify it as belonging to the Discussion?

http://openwetware.org/wiki/20.109%28F10%29:Guidelines_for_writing_up_your_research

This is the section of the paper for you to show off your understanding of the data. You should begin by reiterating the purpose of your research and your major findings. Then you can go to town: you might try connecting your findings to other research (published or that of your peers). You might describe any ambiguities and sources of error in the data. You might describe any conceptual or technical limitations of the research. You might suggest future experiments to resolve uncertainties. You might explain where you expect your work may lead. And you might suggest specific experiments for extending your findings. Finally, you should explain the significance of your findings to basic science and to engineering applications. Like the previous sections, the discussion should have a clear organization and narrative flow, whether or not you use sub-sections.

What Differentiates Results from Discussion?

Results = *Data Presentation*

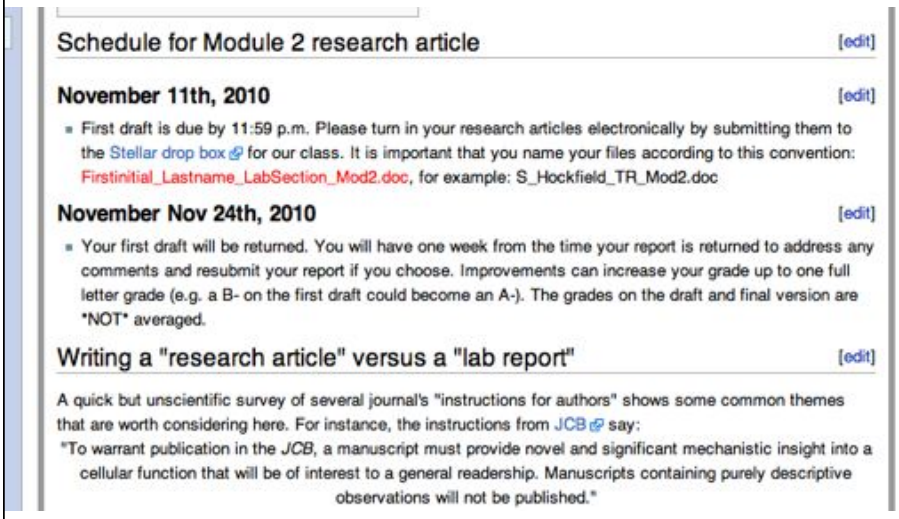
("Experiments showed that . . . .")

Discussion = *Data Interpretation*

("Experiments suggest that . . . .")

Writing Resources on the 20.109 Wiki

http://openwetware.org/wiki/20.109%28F10%29:_System_engineering_research_article



Schedule for Module 2 research article [edit]

November 11th, 2010 [edit]

- First draft is due by 11:59 p.m. Please turn in your research articles electronically by submitting them to the Stellar drop box for our class. It is important that you name your files according to this convention: Firstinitial_Lastname_LabSection_Mod2.doc, for example: S_Hockfield_TR_Mod2.doc

November Nov 24th, 2010 [edit]

- Your first draft will be returned. You will have one week from the time your report is returned to address any comments and resubmit your report if you choose. Improvements can increase your grade up to one full letter grade (e.g. a B- on the first draft could become an A-). The grades on the draft and final version are *NOT* averaged.

Writing a "research article" versus a "lab report" [edit]

A quick but unscientific survey of several journal's "instructions for authors" shows some common themes that are worth considering here. For instance, the instructions from JCB say:

"To warrant publication in the *JCB*, a manuscript must provide novel and significant mechanistic insight into a cellular function that will be of interest to a general readership. Manuscripts containing purely descriptive observations will not be published."

Writing Resources on the 20.109 Wiki

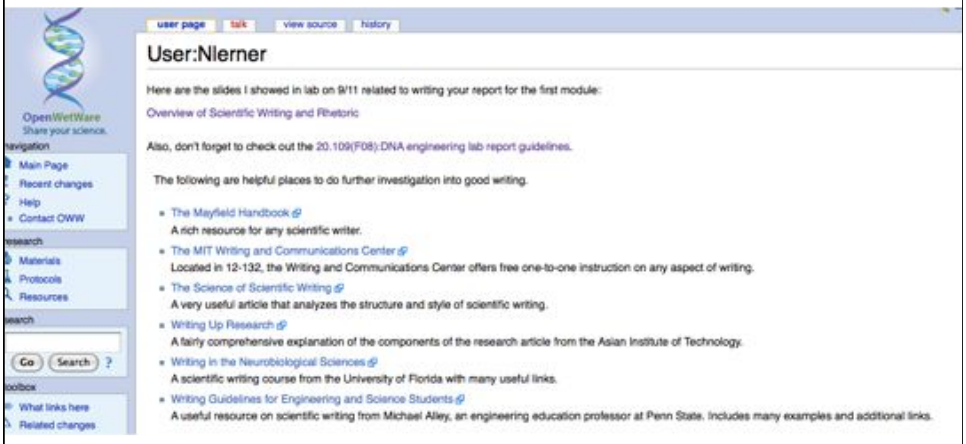
http://openwetware.org/wiki/20.109%28F10%29:Guidelines_for_writing_up_your_research

A formal research article or less formal lab reports are the principal ways scientific data is conveyed to the rest of the scientific community and preserved for future examination. Each scientific journal has its own idiosyncrasies regarding particulars of the research article's format, but the most common elements of a scientific article, in order of presentation, are:

- Title
- List of Authors
- Abstract
- Introduction
- Materials and Methods
- Results, including figures and tables
- Discussion
- References

The requirements for each section are outlined below. NOTE: This information is given in the order that you might actually write up your research, rather than the order in which the parts are presented in the final article. If you want more information, you can find parts of this text in an on-line collection of instructional materials used in the Purdue University Writing Lab (http://owl.english.purdue.edu). Other parts are inspired by Robert A. Day's book, "How to Write and Publish a Scientific Paper" from Oryx Press, a copy of which can be borrowed from the teaching faculty.

Writing Resources on the 20.109 Wiki



Face-to-Face Resources

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