Scientific Writing

20.109

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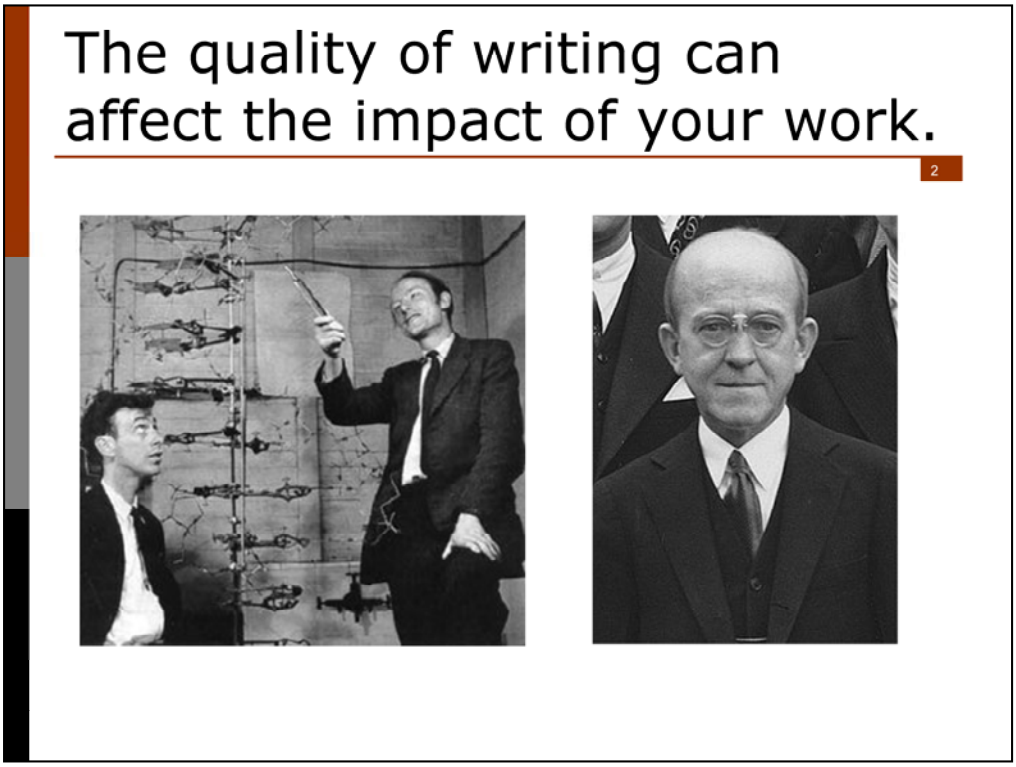
Photo credit: Theresa Walunas, http://www.keyboardbiologist.net/knitblog/



Watson & Crick, 1953: discovered the structure of DNA

Oswald Avery, Colin MacLeod, Maclyn McCarty, 1944: discovered that DNA is responsible for passing on heritable traits

-Long

-Difficult to read

-No claims of importance

-No confidence in work

The goal of scientific writing is to communicate ideas.

"The purpose of a scientific paper is to communicate results and analysis to the wider scientific community. The better a paper is written, the more readers it will attract and the more citations it is likely to receive."

Bredan & van Roy (2006) EMBO 7:846-9.

The IMRaD structure helps you communicate effectively.

- Introduction *(prologue)*
- Methods *(narrative)*
- Results *(proof)*
- Discussion (*epilogue*)

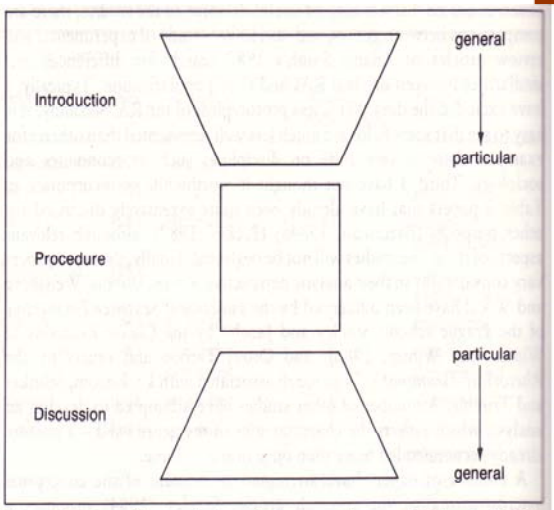


Figure 7 Overall organization of the research paper (Hill et al., 1982).

Article scramble: Identify the section of each passage.

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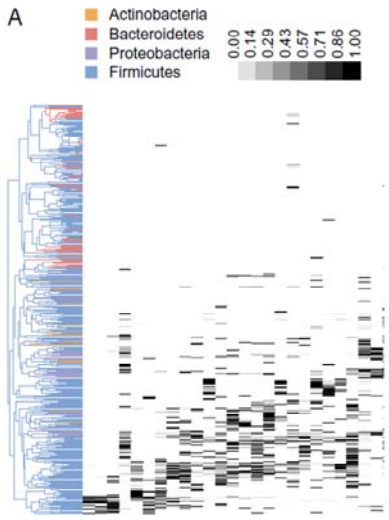
- Introduction
- Methods
- Results
- Discussion
- Figure legend



Source: Koenig et al. PNAS. 108: 4578 (2011).

The large functional and phylogenetic variation observed between infant gut microbiomes may be due to random colonization events, differences in immune responses to the colonizing microbes, changes in host behavior, or other aspects of host lifestyle (4, 6). How each of these factors contributes to shaping the infant microbiome remains unclear.

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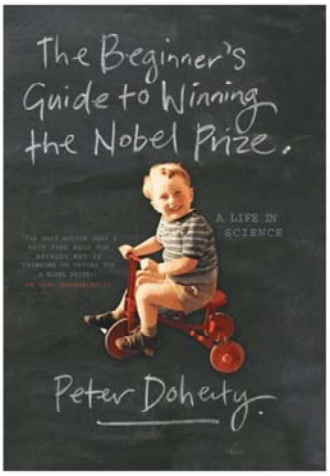
What features of this excerpt identify it as belonging to the Introduction?

- General
- Suggests a hypothesis
- Ends with an open question that the paper could answer
- Proposes different things to explore

The introduction provides a framework for the story you are about to tell, and thus serves two main purposes. For one, you must provide sufficient background information for a reader to understand the forthcoming results. Just as importantly, you must motivate the audience to keep reading! How? Reveal the significance of the work through connections to both prior scientific accomplishments and interesting future applications… [M]ost introductions are "funnel" shaped in terms of content. (20.109 guidelines for scientific writing)

Introduction gives the context, focus, and justification.



- Start broadly; end with your goal
- Identify what is (un)known
- Explain how you will address the unknown

16S rRNA gene sequences were assigned to OTUs using the QIIME implementation of cd-hit (33) and a threshold of 97% pairwise identity. OTUs were classified taxonomically using the Ribosomal Database Project (RDP) classifier 2.0 (34). A single representative from each OTU was aligned using PyNast (35) to build the phylogenetic tree used to for measuring the PD of samples (7) and unweighted UniFrac (36).

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

- No results mentioned or discussed (what they mean)
- Every sentence describes what they did, to the point – not why they did it.
- Simple sentence structure; passive voice (e.g., were assigned).
- High level of detail: many technical terms, specific software used.

The methods section should allow an independent investigator to repeat any of your experiments. Use sub-section headings to allow readers to quickly identify experiments of interest to them… The key to a good methods section is developing your judgement for what information is essential and what is extraneous. Note that the methods section should be written in the past tense… [and] in complete sentences and paragraphs, not in bullet point form. (20.109 guidelines for scientific writing)

The M&M allows replication or interpretation of your work.

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- Provide the right level of detail
- List the methods in logical order
- Use proper grammar

The abundance of operational taxonomic units (OTUs) was assessed across all samples, and OTUs were clustered in a heat map according to their cooccurrence (Fig. 3A). This clustering analysis revealed a succession of bacterial communities that resolved four discrete phases (steps) initiated by life events.

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

- Verbs: assessed, revealed, resolved
- Figure citation
- Describes what happened, not why

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… Note that verbs in the results section are usually in the past tense. (20.109 guidelines for scientific writing)

The Results tells a story about your data.

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- Select data carefully
- Provide context
- Describe illustrations

OTU-based community structure and composition in the gut microbiota. Each vertical lane corresponds to a sample day, and the gray-scale shaded rectangles represent the abundance of the different OTUs. The dendogram on the left shows how the OTUs are clustered according to cooccurrence, and branches are colored to indicate the taxonomical assignment of the OTUs at the phylum level. Samples selected for metagenomic analyses are indicated with asterixes.

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What features of this excerpt identify it as a Figure Legend?

- First "sentence" is incomplete.
- Describes features of the illustration and explains what they represent, e.g. colors, shapes.

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, you might 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. (20.109 guidelines for scientific writing)

Legends allow illustrations to stand on their own.

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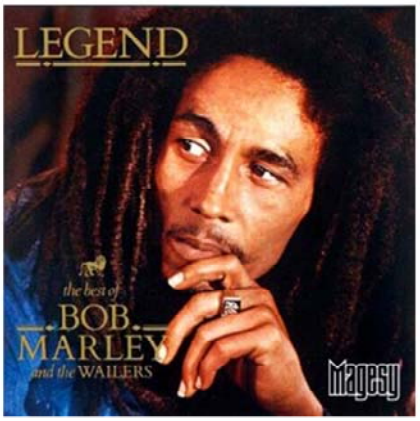
- Describe experiment
- Explain abbrev, symbols
- Do not interpret or describe data



This second observation is consistent with other metagenomic analyses of infant gut microbiomes, which reported microbial enzymes that degrade nondigestible polysaccharides of plant origin (2, 5). Together these studies suggest that the infant microbiome is metabolically ready for receiving simple plant-derived foods, such as rice cereal.

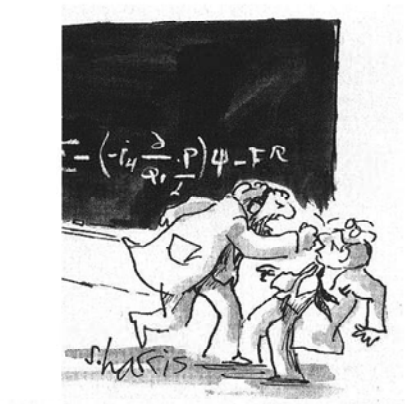
What features of this excerpt identify it as belonging to the Discussion?

- "observation" refers back to the data.
- Last sentence draws a conclusion, and ties paper back to the general purpose of their project.
- Describes how their data compare to other people's data.

The purpose of the discussion section is to interpret and contextualize your data. You should begin by reiterating the purpose of your research and your major findings. Then you might do any or all of the following: connect your findings to other research (published or that of your peers); … suggest specific experiments for extending your findings; describe any conceptual or technical limitations of the research. Finally, you should explain the significance of your findings to basic science and to engineering applications. (20.109 guidelines for scientific writing)

The Discussion is an argument about your data.

- Interpret data
- Explain contribution to field
- Admit limitations and flaws



"YOU WANT PROOF? I'LL GIVE YOU PROOF!"

In sum, understand IMRD to improve scientific writing.

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- Introduction: What did you know?
- M&M: What did you do?
- Results: What did you see?
- Discussion: What does it mean?

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