Technical Writing:
How to translate data into a written presentation of your findings

Quantitative Physiology: Cells and Tissues
Fall 2006

Goals of Technical Writing

Readability:
• Clear, simple prose that is not laden with jargon
• Appropriate use of technical vocabulary

Expected Document Design:
• Standard format makes it easy to locate data and compare experiments (methods, etc.)

Abstract = 1 paragraph summary of report.
1.0 Introduction (< 1 page) offers a rationale for your study.
2.0 Methods describes final approach to experiment.
3.0 Results describes but does not interpret major findings.
4.0 Discussion offers your interpretations of your findings.
5.0 Conclusion summarizes the report and explains future research.
**Step 1: Organize your data**

Writing your lab report begins in the lab. Save all interesting images, figures, plots, tables, ... Did you adequately document your key findings?

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**Step 2: Locate trends in data**

Look at the entire data set & individual plots. What interesting or unexpected trends do you see? → define main technical theme of your report

- $P_n$ proportional to $kn$?
- $P_n$ depends on cell type?
- $P_n$ depends on solute?
Step 3: Design figures that best tell main theme

Develop 2-3 bullet points for each figure.

Methods
• measuring $P_n$
• measuring $k_n$
• fitting straight lines to data
• calculating correlation coefficients

Results
• each dot represents ...
• the line represents ...
• large range of $P_n$
• large range of $k_n$
• regression line: $P_n = 1.14 \log k_n - 3.58$...
• correlation coefficient = 0.8
• most of $M > 160$ below line; all of $M < 160$ above line

Discussion
• correlation: supports dissolve and diffuse theory
• scatter: dissolve/diffuse not the whole story
• outliers: solutes transported by other mechanisms
Step 4: Integrate figures into a ‘story board’

- Assemble figures into a ‘story board’
- Assess how each figure contributes to the major theme
- REVISE figures to focus on the major theme
- REVISE bullet points to focus on the major theme
- Add figures to fill in gaps
- Remove figures to eliminate redundancy

Sample Draft Storyboard

![Sample Draft Storyboard Image]
Background

influx A

influx B

Methods

Results

Discussion
- Developed Theory
- Showed Methods
- Showed Results
- Future Work

Sample Image

- circles are distance markers (250 μm)
- blue dye in left channel, none in right
- blurring of dye in center → diffusion

Characterizing Concentrations
- line = brightness through center row
- brightness ↑ where dye ↓
- measure width from min, max, and slope

Changes with Mixing Distance

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- tabulate blurring statistics
- frames separated by 1 mm

Width Versus Mixing Distance
- log-log plot of w versus d
- w ~ d \sqrt{ d } → consistent with theory
- w ~ d^2 → "edge effects"?
Step 5: Translate bullet points into report text

- Use “story board” as an “outline” of your report.
- Develop bullets into well-supported arguments. Integrate figures with text.
- Read & revise to fill in gaps
- Add abstract, references, and other supporting material.

If you divide the writing process, use the following division:

writer 1: Methods + Results
writer 2: Introduction + Discussion

Together: Conclusion, Title, Abstract, TOC, References, proofreading

How would you improve this results text?

3.0 Results
The bacteria count and the calculated ratios and standard deviations are listed in Appendix C. Figure 5 shows a graph of the ratios of the bacteria counts with errors bars. The lengths of the error bars are the standard deviations.
How would you improve this methods text?

2.0 Methods

A three-input device was used to perform the experiments (Figure 1). The chemorepellent mixture at input 2 of the microfluidic device was varied for each trial. All trials were performed using the same microfluidic device. The device was washed thoroughly with distilled water after each trial. The Camscope program was configured to take 30 pictures at a rate of 30 pictures per second in MONO mode. It was observed that the bacteria rarely moved to the outer walls of the channel. The chemotaxing bacteria in each of the 30 pictures were counted and averaged in order to find the number of bacteria chemotaxing into that area.
Methods describe the final approach to the experiment. Detailed
thoroughly so that a reader could reproduce your experiment.

With clearly labeled device information for trials

Organize Methods by topic, not chronology

3.1 Laboratory Setup
The laboratory setup consisted of a laminar flow chamber and a video microscope as described in the lab manual [1]. The width of the channels was 500 μm and the thickness was 100 μm. ...

3.2 Experimental Procedure
The diffusivities of three food colorings (red #2, blue #6, and green #5) were measured in separate experiments. For each experiment, one input reservoir was filled with food coloring and the other was filled with deionized water. ...

3.3 Data Collection
Images were obtained using the camscope program. The laminar flow chamber was oriented so that the direction of fluid motion was vertical. Static images were obtained to characterize ... Sequences of images were obtained ...

3.4 Data Analysis
Images were analyzed to determine fluid velocities and diffusivities as follows.

3.4.1 Fluid Velocity
Fluid velocities were measured by tracking the motions of microspheres ...

3.4.2 Diffusivity
Concentration profiles along the horizontal direction were constructed by averaging the blue intensity for all the pixels in a column and then plotting that average for each horizontal position as a function of horizontal position. Gradients were calculated from concentration profiles using a regression technique implemented with MATLAB. ... (more details) ...
Introduction offers a rationale for your study

1. Introduction

In recent research, Raman spectroscopy has proven particularly useful in determining the chemical composition of coronary artery walls [1, 2, 3]. The Raman effect is an inelastic scattering phenomenon that occurs when light interacts with matter. While the majority of light that is incident upon a sample will either be directly transmitted through it, or be elastically scattered, there is a small (~10^-9) probability that some of the light will lose energy to the sample, leaving the molecules in an excited vibrational state [4, 5, 6]. Because each molecule has a unique set of bonds, Raman spectroscopy allows quantitative identification of chemicals.

Two problems, however, with in vivo studies of coronary arteries using Raman spectroscopy are catheter size and data acquisition speed. A catheter, or probe, intended to perform in vivo imaging of the coronary artery must be small enough to comfortably fit in the vessel . . . As the size of fibers and probes becomes smaller, it is important to understand the effects of scattering and absorption of laser photons by the tissue, as well the ability of fibers to collect Raman scattered photons which have also diffused through the tissue. To better understand these effects, we created a representation of a side viewing probe to model the path of photons through tissue while maximizing collection.

To achieve this effect we used the optical design program, Zemax. This program allowed us to create a realistic simulation of a Raman probe and then vary certain elements, such as the size and numerical apertures of the excitation and collection fibers, in an attempt to collect as much Raman scattered signal as possible.
Conclusion summarizes results of research & study limitations

4. Conclusion
In this project, we were able to utilize the Zemax optical design program to develop a model of a side-viewing probe for taking Raman spectroscopic measurements of the coronary artery wall. Using the probe in simulations, we determined the scattering and absorption effects that the tissue has on excitation light photons. We were then able to simulate Raman scattering and isotropically send light photons back through the probe while preserving power and distribution at each depth into the tissue to precisely observe collection at the end of the fiber. We observed a retention rate of approximately 1.1% of light photons that experienced Raman scattering in the tissue. These findings further establish that Raman spectroscopy has the potential for in vivo evaluation of tissue compositions. These new methodologies could be used for early detection of coronary heart diagnosis.

Research summary

Future research

Abstract
The abstract is a 1 paragraph (approximately 150 words) summary of the report, including the goal of the study, summary of methods used, principal results obtained, and conclusions.

SAMPLE ABSTRACT
It is generally assumed that the mixing of solutes during flows in microchannels is governed by diffusion alone. To test this assumption, two streams of water were flowed next to each other in laminar flow chambers with widths of 500 micrometers and thicknesses of 100 micrometers. Different size microspheres (1 and 2 micron diameter) were dispersed in each of the two streams. Mixing of the two fluids was assessed by mixing of the different diameters. Results showed an apparent diffusivity of approximately 3 x 10^-4 cm^2/s, which far exceeds that which could be attributed to diffusion. Analysis of flow patterns revealed by tracking the positions of microspheres as a function of time suggest that non-uniformities in the channel walls could contribute to this unexpected mixing. Experiments with different size beads gave similar results. However, experiments with different concentrations of beads showed different levels of unexpected mixing, suggesting that the microspheres may themselves contribute to mixing.
CONTENT: A lab report in 6.021J Quantitative Physiology is a description and analysis of your research. The primary audience of your report is other 6.021J students. It is expected that your research was jointly conducted and authored. We do not expect you to reach grand theories or expect all your research to be successful. We do expect you to offer a rationale that explains why this research is relevant, provide a detailed and accurate methods description, disclose your results, and discuss reasons why your experiment succeeded or failed by linking that discussion to your results and methods.

STYLE: We prefer an informal but not colloquial style of writing to a textbook style or jargon-laden prose. You may use occasional instances of personal pronouns in your report. Your readers, the students and faculty in this course, all have some background in this subject, but only a very small percentage are experts. A clear conceptual discussion is far better than a plethora of technical details that have no overarching meaning or organization.

MANUSCRIPT FORMATTING: All pages should be numbered, starting with the first page of the report body. Please include a Cover Page that includes authors’ names as well as title of your report and submission date. Please include your Abstract on this Cover Page. Do not number the Cover Page. Every report needs to include in the body the following major section headings: Introduction, Methods, Results, Discussion, and Conclusion. Within each of these sections, you may use more descriptive subheadings. A Table of Contents is optional.

LENGTH: Please limit your report to 3,500 words. We prefer single-spaced texts with clear page breaks. Appendices are not included in the word count limit. Avoid lengthy Appendices as most readers will not read them carefully.

FIGURES: We recognize that sometimes “a picture is worth a thousand words,” but please avoid the gratuitous use of figures in your results. Five to 10 figures should be sufficient for your report. Use figures to synthesize results and show trends or comparisons across findings. Integrate your figures with your text to create a “story” between text and figure. Large figures should not run across pages. Each figure needs to be numbered and include a figure caption and label. Please ‘clean up’ your figures from MatLab by removing unnecessary grid lines and shading. In addition, please make figures legible by using a 10 or 12-point font size for captions and axis labels.

REFERENCES: You need at least one reference for your report. Most 6.021J students reference the Weiss text. Many report Introductions also include references to research.


SUBMISSION OF MANUSCRIPTS: Please submit a hard copy of your first draft at your recitation on Thursday, October 19th AND upload a PDF copy of your first draft by Thursday, October 19th at 5pm EST. All drafts should be uploaded to the 6.021J course website at http://umech.mit.edu/temaniff/6.021J2006/php/online.php.

Final Draft (1) Please submit a hard copy of your final draft at your recitation on Thursday, November 2nd. All supporting materials for the Appendix should be submitted with your final report on November 2nd. (2) Please submit a PDF copy of your final draft by Thursday, November 2nd at 5pm EST. All drafts should be uploaded to the 6.021J course website at http://umech.mit.edu/temaniff/6.021J2006/php/online.php.
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| **First draft of report (10%)**.  
A: Complete report, professionally written.  
B: Significant work, but report needs further clarification before final submission.  
C: Incomplete descriptions, missing sections, or poor figures.  
D: Few results, few figures, few discussion points, report not complete.  |
| **Critique of peer report (5%)**.  
A: Several helpful high-level suggestions (e.g., suggesting major restructuring, new figures,...) plus probing questions (could your result be caused by...?) plus appropriate low-level comments (e.g., on grammar or graphics).  
B: At least one helpful high-level suggestion or probing question plus appropriate low-level comments.  
C: Helpful low-level comments.  
D: Few helpful comments.  |
| **Report Structure (15%)**.  
A: All information is present and is well organized in proper sections, using standard scientific report structure. Appropriate use of source materials. Reader can easily follow from section to section of report.  
B: All information is present but poorly organized in no more than one section. Reader may have difficulty following one section of report but generally understands overall report structure.  
C: All information is present but multiple instances of misplaced information, and/or repeated minor organizational problems that interfere with report coherence. Reader struggles to understand relationship between various sections of the report or has difficulty following structure in several sections.  
D: Information is missing from report, report does not follow standard scientific report structure and/or misuse of source materials. Reader cannot follow overall structure of report.  |
| **Technical Clarity and Conciseness (10%)**.  
A: Methods, Results, and Conclusions are technically clear and concise.  
B: Minor lapses in technical clarity or occasional extraneous technical points.  
C: Significant lapses in clarity and conciseness, but clear enough to assess results and conclusions.  
D: So unclear that results or conclusions cannot be assessed.  |
| **Conceptual Correctness (20%)**.  
A: Thorough investigation of at least one topic, authors demonstrate a clear understanding of this topic, and there are no technical errors.  
B: Thorough investigation of at least one topic, and no technical errors.  
C: Thorough investigation of at least one topic, but one or more minor technical errors.  
D: Investigations are insufficiently thorough (e.g., measured too few cases to support a trend) or contained major technical errors.  |
| **Insightfulness (30%)**.  
A: Clever experimental design, compelling experimental results, and imaginative analysis.  
B: Clever experimental design, compelling experimental results, or imaginative analysis.  
C: Acceptable experimental design, adequate experimental results, and acceptable analysis.  
D: Unacceptable experimental design, inadequate experimental results, or unacceptable analysis.  |
| **Clarity and Conciseness of Exposition (10%)**.  
A: Content of each paragraph is readable with clear, simple prose and appropriate use of technical language. Each graph clearly supports the prose.  
B: content is readable with minor slips in clarity or a single unclear passage/graph.  
C: Major slips in clarity and/or multiple unclear passages/graphs.  
D: Repeated wordiness or lack of clarity, poor presentation of visual information, and/or accumulation of stylistic errors that interfere with readability.  |

* Grades may be reduced for reports that unnecessarily exceed the 10 page (3,500 word) limit.