SCHEDULE FOR PAPER
WHAT NEEDS TO BE SENT TO THE STARS ADVISOR AND LAB REP AND WHEN

Week 1: Due Friday by Noon
   Proposal – short and sweet
   I will be studying ....... The approach I will be using is ......

Week 2: Due Friday by Noon
   Introduction /References – the beginnings of this, not complete, show progress

Week 3: Due Friday by Noon
   Introduction/References & METHODS – not complete, show progress

Week 4: Due Friday by Noon
   Introduction/Reference/Methods & start of RESULTS – not complete, show progress

Week 5: Due Friday by Noon
   Introduction/References/Methods/Results & ABSTRACT – close to complete

Week 6: You will receive instructions.

Paper COMPLETE!!!!!!!!!!

WRITING A SCIENTIFIC RESEARCH ARTICLE


FORMAT FOR THE PAPER

Scientific research articles provide a method for scientists to communicate with other scientists about the results of their research. A standard format is used for these articles, in which the author presents the research in an orderly, logical manner. This doesn't necessarily reflect the order in which you did or thought about the work. This format is:

TITLE

1. Make your title specific enough to describe the contents of the paper, but not so technical that only specialists will understand. The title should be appropriate for the intended audience.
2. The title usually describes the subject matter of the article: Effect of Smoking on Academic Performance"
3. Sometimes a title that summarizes the results is more effective: Students Who Smoke Get Lower Grades"
AUTHORS

1. The person who did the work and wrote the paper is generally listed as the first author of a research paper.

2. For published articles, other people who made substantial contributions to the work are also listed as authors. Ask your mentor's permission before including his/her name as co-author.

ABSTRACT

1. An abstract, or summary, is published together with a research article, giving the reader a "preview" of what's to come. Such abstracts may also be published separately in bibliographical sources, such as Biological Abstracts. They allow other scientists to quickly scan the large scientific literature, and decide which articles they want to read in depth. The abstract should be a little less technical than the article itself; you don't want to dissuade your potential audience from reading your paper.

2. Your abstract should be one paragraph, of 100-250 words, which summarizes the purpose, methods, results and conclusions of the paper.

3. It is not easy to include all this information in just a few words. Start by writing a summary that includes whatever you think is important, and then gradually prune it down to size by removing unnecessary words, while still retaining the necessary concepts.

3. Don't use abbreviations or citations in the abstract. It should be able to stand alone without any footnotes.

INTRODUCTION

What question did you ask in your experiment? Why is it interesting? The introduction summarizes the relevant literature so that the reader will understand why you were interested in the question you asked. One to four paragraphs should be enough. End with a sentence explaining the specific question you asked in this experiment.

MATERIALS AND METHODS

1. How did you answer this question? There should be enough information here to allow another scientist to repeat your experiment. Look at other papers that have been published in your field to get some idea of what is included in this section.

2. If you had a complicated protocol, it may helpful to include a diagram, table or flowchart to explain the methods you used.

3. Do not put results in this section. You may, however, include preliminary results that were used to design the main experiment that you are reporting on. (“In a preliminary study, I observed the owls for one week, and found that 73% of their locomotor activity occurred during the night, and so I conducted all subsequent experiments between 11 pm and 6 am.”)

4. Mention relevant ethical considerations. If you used human subjects, did they consent to participate. If you used animals, what measures did you take to minimize pain?
RESULTS

1. This is where you present the results you've gotten. Use graphs and tables if appropriate, but also summarize your main findings in the text. Do NOT discuss the results or speculate as to why something happened; that goes in the Discussion.

2. You don't necessarily have to include all the data you've gotten during the semester. This isn't a diary.

3. Use appropriate methods of showing data. Don't try to manipulate the data to make it look like you did more than you actually did.

"The drug cured 1/3 of the infected mice, another 1/3 were not affected, and the third mouse got away."

TABLES AND GRAPHS

1. If you present your data in a table or graph, include a title describing what's in the table ("Enzyme activity at various temperatures", not "My results"). For graphs, you should also label the x and y axes.

2. Don't use a table or graph just to be "fancy". If you can summarize the information in one sentence, then a table or graph is not necessary.

DISCUSSION

1. Highlight the most significant results, but don't just repeat what you've written in the Results section. How do these results relate to the original question? Do the data support your hypothesis? Are your results consistent with what other investigators have reported? If your results were unexpected, try to explain why. Is there another way to interpret your results? What further research would be necessary to answer the questions raised by your results? How do your results fit into the big picture?

2. End with a one-sentence summary of your conclusion, emphasizing why it is relevant.

ACKNOWLEDGMENTS

This section is optional. You can thank those who either helped with the experiments, or made other important contributions, such as discussing the protocol, commenting on the manuscript, or buying you pizza.

REFERENCES (LITERATURE CITED) STARS reference guidelines – use this approach

There are several possible ways to organize this section. Here is one commonly used way:

1. In the text, cite the literature in the appropriate places:

Scarlet (1990) thought that the gene was present only in yeast, but it has since been identified in the platypus (Indigo and Mauve, 1994) and wombat (Magenta, et al., 1995).

2. In the References section list citations in alphabetical order.


**EDIT YOUR PAPER!!!**

"In my writing, I average about ten pages a day. Unfortunately, they're all the same page."

Michael Alley, The Craft of Scientific Writing

A major part of any writing assignment consists of re-writing.

**Write accurately**

1. Scientific writing must be accurate. Although writing instructors may tell you not to use the same word twice in a sentence, it's okay for scientific writing, which must be accurate. (A student who tried not to repeat the word "hamster" produced this confusing sentence: "When I put the hamster in a cage with the other animals, the little mammals began to play.")

2. Make sure you say what you mean.

   *Instead of:* The rats were injected with the drug. (sounds like a syringe was filled with drug and ground-up rats and both were injected together)  
   *Write:* I injected the drug into the rat.

3. Be careful with commonly confused words:

   Temperature has an *effect* on the reaction.  
   Temperature *affects* the reaction.

   I used solutions in various concentrations. (The solutions were 5 mg/ml, 10 mg/ml, and 15 mg/ml)  
   I used solutions in varying concentrations. (The concentrations I used changed; sometimes they were 5 mg/ml, other times they were 15 mg/ml.)

   Less food (can't count numbers of food)  
   Fewer animals (can count numbers of animals)

   A large amount of food (can't count them)  
   A large number of animals (can count them)

   The erythrocytes, which are in the blood, contain hemoglobin.  
   The erythrocytes that are in the blood contain hemoglobin. (Wrong. This sentence implies that there are erythrocytes elsewhere that don't contain hemoglobin.)

**Write clearly**

1. Write at a level that's appropriate for your audience.
"Like a pigeon, something to admire as long as it isn't over your head." Anonymous

2. Use the active voice. It's clearer and more concise than the passive voice.

Instead of: An increased appetite was manifested by the rats and an increase in body weight was measured.
Write: The rats ate more and gained weight.

3. Use the first person.

Instead of: It is thought
Write: I think

Instead of: The samples were analyzed
Write: I analyzed the samples

4. Avoid dangling participles.

"After incubating at 30 degrees C, we examined the petri plates." (You must've been pretty warm in there.)

Write succinctly

1. Use verbs instead of abstract nouns

Instead of: take into consideration
Write: consider

2. Use strong verbs instead of "to be"

Instead of: The enzyme was found to be the active agent in catalyzing...
Write: The enzyme catalyzed...

3. Use short words.

"I would never use a long word where a short one would answer the purpose. I know there are professors in this country who 'ligate' arteries. Other surgeons tie them, and it stops the bleeding just as well."

Oliver Wendell Holmes, Sr.

Instead of:  Write:

possess     have
sufficient  enough
utilize     use
demonstrate show
assistance  help
terminate   end

4. Use concise terms.
Instead of:                  Write:
prior to                   before
due to the fact that      because
in a considerable number of cases
the vast majority of
during the time that      when
in close proximity to     near
it has long been known that
I'm too lazy to look up the reference

5. Use short sentences. A sentence made of more than 40 words should probably be rewritten as two sentences.

"The conjunction 'and' commonly serves to indicate that the writer's mind still functions even when no signs of the phenomenon are noticeable." Rudolf Virchow, 1928

Check your grammar, spelling and punctuation

1. Use a spellchecker, but be aware that they don't catch all mistakes.

"When we consider the animal as a hole,..." Student's paper

2. Your spellchecker may not recognize scientific terms. For the correct spelling, try Biotech's Life Science Dictionary or one of the technical dictionaries on the reference shelf in the Biology or Health Sciences libraries.

3. Don't, use, unnecessary, commas.

4. Proofread carefully to see if you any words out.

USEFUL BOOKS

The best. On sale for about $18 at Labyrinth Books, 112th Street. On reserve in Biology Library

Jan A. Pechenik, A Short Guide to Writing About Biology, Boston: Little, Brown, 1987

Particularly useful if you need to use statistics to analyze your data. Copy on Reference shelf in Biology Library.

Earlier editions also good. A bit more advanced, intended for those writing papers for publication. Fun to read. Several copies available in Columbia libraries.

Preparing Your Paper in the Style of a Science paper

- **Titles** should be no more than 90 characters.

- **Authors and their affiliated institutions**, linked by superscript numbers, should be listed beneath the title on the opening page of the manuscript. For the STARS papers, this is just the student.

- **Subheadings** are used only in Research Articles, Reviews, and invited special-issue articles. Use descriptive clauses, not full sentences. Two levels of subheadings may be used if warranted; please distinguish them clearly.

- **Abstracts** explain to the general reader why the research was done and why the results are important. They should start with some brief BACKGROUND information: a sentence giving a broad introduction to the field comprehensible to the general reader, and then a sentence of more detailed background specific to your study. This should be followed by the RESULTS, or if the paper is more methods/technique oriented an explanation of OBJECTIVES/METHODS and then the RESULTS. The final sentence should outline the main CONCLUSIONS of the study, in terms that will be comprehensible to all our readers. The abstract should be 125 words or less. For Perspectives and Policy Forums, please include a one-sentence abstract.

- **Text** starts with a brief introduction describing the paper's significance, which should be intelligible to readers in various disciplines. Technical terms should be defined. Symbols, abbreviations, and acronyms should be defined the first time they are used. All tables and figures should be cited in numerical order.

- **References and notes** are in alphabetical order (for examples see Writing a Science Research Article and Reference Style). This differs from the format used by Science. The alphabetical approach was deemed less cumbersome for the STARS papers. Do not use op. cit. or ibid in references.

- **Acknowledgments** are a brief statement at the end of the references and notes labeled "Acknowledgments." STARS students, here is where you profoundly thank your mentor and the lab members who have graciously helped you throughout your time in STARS. This is a very important section for the STARS paper.

- **Tables** should be included after the references and should supplement, not duplicate, the text. Each table should include a legend. The first sentence of the legend should be a brief descriptive title. Every vertical column should have a heading consisting of a title with the unit of measure in parentheses. Units should not change within a column.

- **Figure legends** should be double-spaced in numerical order. No single legend should be longer than about 200 words. Nomenclature, abbreviations, symbols, and units used in a figure should match those used in the text. The figure title should be given as the first line of the legend. Any individually labeled figure parts or panels (A, B, etc.) should be specifically described by part name within the legend.

- **Schemes** (e.g., structural chemical formulas) can have very brief legends or no legend at all. Schemes should be sequentially numbered in the same fashion as figures.
**Figures** Symbols and lettering should be large enough to be legible. Avoid wide variation in type size within a single figure. In the printed version of the figure, letters should be about 7 points (2 mm) high, and not smaller than 5 points. High-resolution images can be included as supporting online material. If possible, use scale bars in place of, or in addition to, magnification numbers; the scale bar units should be specified in the figure legend. In gels, the lanes should be numbered and identified by number in the figure legend. Additional guidelines can be found in *Tips for Preparing Figures*.

**Graphs** should be labeled on the ordinate and abscissa with the parameter or variable being measured, the units of measure, and the scale. Scales with large or small numbers should be presented as powers of 10. Definitions of symbols should usually appear in the figure legend and not in the figure. Simple solid or open symbols (●, ○, ■, □, ▲, △, ◆, and ◇) reproduce well. Avoid the use of light lines and screen shading. Instead, use black-and-white, hatched, and cross-hatched designs for emphasis. Use heavy lines or boxes for emphasizing or marking off areas of the figure. Additional guidelines can be found in *Tips for Preparing Figures*.

**Composite figures** should be labeled A, B, C, etc.

**Lettering** in Helvetica font is preferable for figures. Use boldface type for axis labels and for part labels (A, B, etc.) in composite figures; use italic type only as it would be used in the text (e.g., for variables and genes). The first letter of each entry should be uppercase; otherwise, use uppercase letters as they would be used in the text (e.g., for acronyms).

**Sequences** may be reduced considerably, so the typeface in the original should be clear. There should be about 130 characters and spaces per line for a sequence occupying the full width of the printed page and about 84 characters and spaces per line for a sequence occupying two columns.

**Units** should be metric and follow SI convention.

### Some Notes on Science Style

Following are some general guidelines on preferred style for manuscripts submitted to *Science*.

- Confirm that all numbered citations for references and notes are presented in numerical order, first through the text and then through the references and the table and figure legends.

- Ensure that all notations and symbols in figures (including dashed or dotted lines, color codes, and gradations in color or grayscale) are explained in figure legends. Conversely, ensure that no data mentioned in figure legends (or in the text where the figure is discussed) are missing from the corresponding figures.

- Avoid jargon; explain obscure terms and define acronyms (keep in mind that many potential readers of your work will not be specialists in your field).

- After introducing an acronym, use only the acronym.

- Use active voice when suitable, particularly when necessary for correct syntax (e.g., "To address this possibility, we constructed a λZap library . . .," not "To address this possibility, a λZap library was constructed . . .").
• Write concisely (e.g., "even though," not "in spite of the fact that").

• When two or more similar terms are used throughout text, either make the usage consistent or clarify the distinction(s), as appropriate.

• Avoid using "-fold" because expressions such as "20-fold smaller" are imprecise; use percentages, proportions, orders of magnitude, or "factor of" instead. (Exception: Usage such as "1000-fold excess" is appropriate.)

• Avoid using "times more," "times less" (see above).

• Use "significant" only when discussing statistical significance.

• Avoid using terms such as "novel," "first," or "Our laboratory has pioneered..." to describe the present work. Do not mention your own work in progress within the text (although a numbered reference to specific work submitted for publication is acceptable; see "in preparation" in reference examples below).

• Omit academic or other titles from affiliations and acknowledgments.

**Tips for Preparing Figures**

**Figure layout and scaling**

In laying out information in a figure, the objective is to maximize the space given to presentation of the data. Avoid wasted white space and clutter.

Titles or labels not absolutely necessary for understanding the figure should be removed and explained in the caption. You should, however, include the figure's identifying number (e.g., "Fig. 1") on the same manuscript page that includes the figure.

Keys to symbols, if needed, should be kept as simple as possible and be positioned so they do not needlessly enlarge the figure. Details can be put into the captions.

Panels should be set close to each other, and common axis labels should not be repeated.

Scales or axes should not extend beyond the range of the data plotted.

Do not use minor tick marks in scales or grid lines. Avoid using y-axis labels on the right that repeat those on the left.

Use solid symbols for plotting data if possible (unless data overlap or there are multiple symbols). Size symbols so that they will be distinguishable when the figure is reduced. Line widths should be legible upon reduction (minimum of 0.5 pt at the final reduced size).

**Color-mix and contrast considerations**

Avoid using combinations of red and green together.

Please do not use colors that are close in hue to identify different parts of a figure.

Avoid using grayscale.

Use white type and scale bars over darker areas of images.

**Typefaces and labels:** Please observe the following guidelines for labels on graphs and figures:

Use a sans-serif font whenever possible (we prefer Helvetica).

Capitalize the first letter in a label only, not every word (and proper nouns, of course).

Units should be included in parentheses. Use SI notation. If there is room, write out variables - e.g., Pressure (MPa), Temperature (K).
Variables are always set in *italics* or as plain Greek letters (e.g., \(P, T, \mu\)). The rest of the text in the figure should be plain or bold text.

Type on top of color in a color figure should be in bold face. Avoid using color type.

Use leading zeros on all decimals -- e.g., 0.3, 0.55 -- and only report significant digits.

Use capital letters for part labels in multipart figures -- A, B, C, etc. These should be 9 pt and bold in the final figure. When possible, place part labels at the upper left-hand corner of each figure part; if a part is an image, set labels inside the perimeter so as not to waste space.

Avoid subpart labels within a figure part; instead, maintain the established sequence of part labels [e.g., use A, B, C, D, E instead of A, B, C(a), C(b), C(c)]. If use of subpart labels is unavoidable, use lowercase letters (a, b, c). Use numbers (1, 2, 3) only to represent a time sequence of images.

When reproducing images that include labels with illegible computer-generated type (e.g., units for scale bars), omit such labels and present the information in the legend instead.

**Reference Style**

**Journals**


**Books**


Technical reports


Paper presented at a meeting (not published)
Konishi, M., paper presented at the 14th Annual Meeting of the Society for Neuroscience, Anaheim, CA, 10 October 1984. [sponsoring organization should be mentioned if it is not part of the meeting name]

Theses and personal communications
Reuter, G., personal communication. [Must be accompanied with a letter of permission and must not be used to support a central claim, result, or conclusion.]


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