

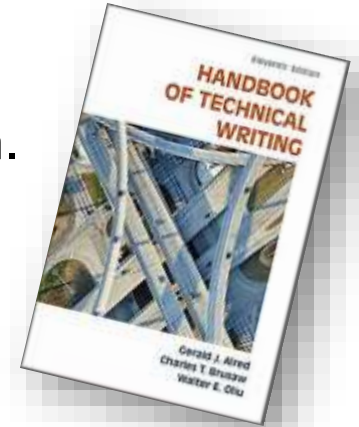
# *Data Sources / Writing the Research Report / Meta-Analysis*

ENGR 361: Scientific Research Communication

<https://www.csulb.edu>

# References

- Alred, G. J., Brusaw, C. T., & Oliu, W. E. (2009). *Handbook of technical writing*. Macmillan.
- Day, R. A., Sakaduski, N., & Day, N. (2011). *Scientific English: A guide for scientists and other professionals*. ABC-CLIO.
- Field, A. P., & Gillett, R. (2010). How to do a meta-analysis. *British Journal of Mathematical and Statistical Psychology*, 63(3), 665-694.



# Source of Data

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## SOURCE DATA ASSIGNMENT

- You will need to specify what data source you plan to use for the report.
  - Write a brief description of how the data was collected (~150 words) and reference work, submit an electronic document.
- If you plan to use published data from the literature (a meta-analysis), attach copy of the publications containing the data you plan to use
  - Be careful to write the report in your own words; you may use data but nothing else from that published paper

# Writing the Research Report

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- Abstract
- Introduction/Background
- Methodology
- Results
- Discussion

# Writing the Methods Section

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- Purpose
  - Describe experimental design
  - Provide sufficient detail so that a competent researcher can repeat the experiment
  - **Reviewer will carefully scrutinize methods**

# Writing the Methods Section

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- Accurate method reporting essential
  - Methods must be reproducible
  - Necessary for results to be considered of scientific merit
  
- **Faulty methods can lead to rejection of the manuscript**

# Writing the Methods Section

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- Include
  - Exact technical specifications
  - Quantities used
  - Source or method of preparation
  - Grade (e.g., reagent-grade)
- Use generic names of reagents
  - Avoid trade names except when proprietary names reflect important differences in the chemical formula or preparation

# Writing the Methods Section

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- Identify experimental subjects groups
- Identify all experimental animals, plants, micro-organisms (genus, species, strain)
- Order of presentation
  - Usually matches general order of experiments in Results
- Related methods should be described together



# Writing the Methods Section

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- Group Methods into headings/sub-headings that are consistent with the Results structure
  - Protein Purification
  - Enzyme Activity Assays
- Write in past tense—you're describing what you did
  - Use of passive voice is acceptable

# Writing the Methods Section

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- Measurements
  - Questions of “how” and “how much” need to be precisely addressed

# Writing the Methods Section

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- Analysis
  - Statistical Analysis of data
    - Keep focus on data, not on the statistical analysis used
    - Specify statistical analysis used—don't elaborate or provide a “primer” for the reader

# Writing the Methods Section

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- Listing Instrumentation
  - Include model, manufacturer of key instruments used in the study
  - *“Spectroscopic measurements were done using a Beckman Coulter DU-830 single-beam UV-vis spectrophotometer equipped with a Peltier temperature control module (Beckman Coulter, Inc., Brea, CA).”*

# Writing the Methods Section

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- Listing Instrumentation
  - General-use lab instruments not crucial to your study (e.g., pH meters, magnetic stirrers, incubators, water baths, etc.) need NOT be listed

# Writing the Methods Section

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- References in Methods

- If method is new (never published), *all* details must be provided
- If method is previously published in standard journal, then just the literature reference is needed
- Good practice to identify the method, then cite the reference
  - e.g., “*The whole immunoglobulin G fraction was purified from sera by Na<sub>2</sub>SO<sub>4</sub> precipitation as described previously (9).*”

# Writing the Methods Section

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- References in Methods
  - Make sure reference cited actually has the method!
  - This approach typically used in MS thesis
  - Ph.D. dissertation requires all methods to be provided in full detail

# Writing the Results Section

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- Not simply copying data from lab notebook to paper
- Present representative data—not endlessly repetitive data
- Data vs Results
  - Data presented in figures and tables
  - Results are a narrative description about the data



# Writing the Results Section

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- Results section is comprised of two parts:
  - The “big picture” of the experiments
    - Not a recap of experimental methods
  - Presentation of the data

# Writing the Results Section

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- How to “handle” numbers

<u>No. of Determinations</u>	<u>Present Where</u>
1 or a few	In text
several, many	In Figure or Table

- Reporting “negative” results

- Variables that indicate no change vs control do NOT need to be included in figures/tables
- Mention these results in the narrative

# Writing the Results Section

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- How to “handle” numbers
  - Use meaningful statistics for data analysis whenever appropriate
  - Common stats: mean, standard deviation,  $t$ -tests,  $F$ -tests, regression analysis, ANOVA, MANOVA, etc.

# Writing the Results Section

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- Write in past tense, except when talking about how data are presented

**past**

- “We examined the effects of  $\text{MnCl}_2$ ,  $\text{ZnCl}_2$ , and  $\text{CuCl}_2$  on continuous ligand uptake by hepatocytes.”

**present**

- “Table I summarizes the effects of transition metals on receptor-mediated endocytosis.”

# Writing the Results Section

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- Strive for clarity, succinctness
  - Results... “short, sweet, and to the point.”
  - Typically shorter than discussion or methods
  - Results constitute *new knowledge*

# Writing the Results Section

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- Other features
  - Use subheadings to break sections
  - Include all control experiments/results
  - Give a clear idea of the magnitude of a response or difference by reporting data as percent change or percent difference rather than just absolute values

# Writing the Results Section

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- Reserve the term “significant” for statistically significant
- Do not discuss rationale for statistical analysis
- Do not present the same data in multiple forms (table, graph) that constitutes redundancy

# Writing the Discussion Section

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- Essential Questions
  - *What do the results mean?*
  - *What conclusions can be drawn from the experiments?*
- Show relationships among the observed facts



# Writing the Discussion Section

## ■ Essential Elements of the Discussion Section

- Present principles, relationships, and other generalizations of the results
- Point out exceptions or lack of correlation; define unsettled points
- Compare, contrast your results with previously published reports

**Do NOT recap results!**

**Don't cover-up or fudge data that don't fit!**

# Writing the Discussion Section

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- Essential Elements of the Discussion Section
  - Discuss theoretical & practical implications of your work

# Writing the Discussion Section

- Importance of the Paper
  - Importance of the results should be adequately discussed



- Finish discussion with a paragraph that summarizes the significance of the findings

# Writing the Discussion Section

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- Things to Avoid in Discussion
  - Do not repeat the Results
  - Do not try to explain every minor flaw
  - Do not try to explain every unexpected result
  - Do not exaggerate or make extravagant claims
  - Do not hedge – state conclusions plainly

# Writing the Discussion Section

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- Verb Tense in Discussion Section
  - Use past tense when referring to study details, results, analyses
    - “Inactive receptors accumulated on hepatocytes...”
    - “All three sulfonamide derivatives blocked enzyme...”
  - Use present tense when talking about what the results mean
    - “The reason for this difference is not clear.”
    - “Possible explanations of these results include...”

# Writing the Conclusion Section

- Clearly and objectively state your conclusion
  - Readers tend to read this section before they read the results and discussion
  - State the main findings of your study precisely
  - Explain how the world is a better place because of the work



# Writing the Conclusion Section

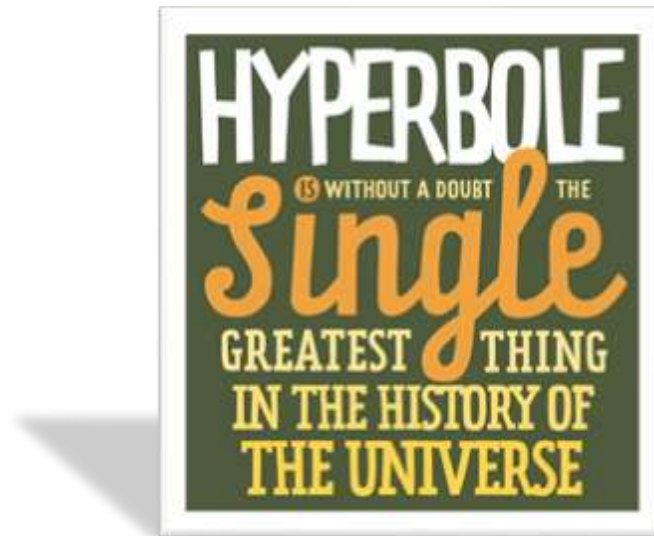
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- State what the data mean and relate directly back to the problem/question stated in the introduction
- Do not offer any reasons for those particular conclusions
  - Reasons were presented in the Discussion section
- By looking at only the Introduction and Conclusions sections, a reader should have a good idea of what has been investigated and discovered

# Writing the Conclusion Section

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- Conclusions must logically flow from the results and discussion
- Do NOT over-extend conclusions past the boundaries of the results





# Writing the Title

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- Important to remember: Title will be read by thousands of people
  - Choose title words with great care!
- Most common error: Faulty word order (syntax)
- Other common errors: Title is too long
  - Look for “unnecessary” words, often in the beginning
    - “Studies on...”, “Investigation on...”, “Observations on...”, “A”, “An”, “The”
  - Analyze this title: “Action of Antibiotics on Bacteria”
    - Is it okay?
    - If not, how might it be changed?

# Writing the Title

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## ■ Label vs Sentences

### **Label:**

- Binding and endocytosis of apo- and holo-lactoferrin by isolated rat hepatocytes
- Copper and zinc ions differentially block asialoglycoprotein receptor-mediated endocytosis in isolated rat hepatocytes

### **Sentence:**

- Some journals disallow sentence-style titles
- Tend to include “waste” words; too assertive

# Writing the Title

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- Title should contain Key Words
  - Alerts potential readers to the general concepts of the paper
  - Key Words used by indexing services to catalog paper
  - *Copper and zinc ions differentially block asialoglycoprotein receptor-mediated endocytosis in isolated rat hepatocytes*

# Writing the Title

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- Avoid abbreviations and jargon in title
  - e.g., hydrochloric acid v. HCl
  - Indexing, searching for paper with “hydrochloric acid” might miss paper with “HCl” in title.
- Most indexing programs will recognize and equate some terms (e.g., deoxyribonucleic acid = DNA)

# Writing the Acknowledgement Section

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- Formal “Thank you” to recognize valuable input from non-authors
- Technical assistance: expertise, use of instrument, materials, etc.
- Helpful discussions, evaluation of manuscript
- Indicate financial support for research (grants, contracts, fellowships)
- The contributors you are acknowledging should have read and approved the document

# Preparing the Reference Section

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- Only list significant published references
- Do not include references to unpublished data, abstracts, theses, other secondary materials
  - If such information is essential, list in separate footnote

# Preparing the Reference Section

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- Check all parts of the reference (authors, year, title, journal, volume, pages) to make certain it is correct
  - Always check against an actual copy of the referenced article
  - Endnote or other referencing software
  - Use Google Scholar cite
- Make certain that all citations match references in the text
- Follow “Instructions to Authors” for citation style

# Meta-Analysis

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- Statistical analysis that combines the results of multiple scientific studies
- Can be performed when there are multiple scientific studies addressing the same question, with each individual study reporting measurements that are expected to have some degree of error



# Meta-Analysis

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- Statistical procedure for combining data from multiple studies
  - When the treatment effect (or effect size) is consistent from one study to the next, meta-analysis can be used to identify this common effect
  - When the effect varies from one study to the next, meta-analysis may be used to identify the reason for the variation

# Meta-Analysis

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- **Why perform a meta-analysis?**

- Decisions about the utility of an intervention or the validity of a hypothesis cannot be based on the results of a single study
- Mechanism to synthesize data across studies
- Meta-analysis applies objective formulas (much as one would apply statistics to data within a single study), and can be used with any number of studies

# Meta-Analysis

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- How to perform a Meta-Analysis
  - 1) Do a Literature Search
  - 2) Determine an Inclusion Criteria
  - 3) Calculate the Effect Size
  - 4) Perform the Meta-Analysis
  - 5) More Advanced Analysis
  - 6) Write it up (following standard research paper formats)

# Meta-Analysis

1. Formulation of the research question, e.g. using the PICO model (Population, Intervention, Comparison, Outcome)
2. Search of literature
3. Selection of studies ('incorporation criteria')
  - Based on quality criteria
  - Selection of specific studies on a well-specified subject
4. Decide which dependent variables or summary measures are allowed. For instance, when considering a meta-analysis of published (aggregate) data:
  - Differences (discrete data)
  - Means (continuous data)
  - Hedges'  $g$  is a popular summary measure for continuous data that is standardized in order to eliminate scale differences, but it incorporates an index of variation between groups:

$\delta = \frac{\mu_t - \mu_c}{\sigma}$  in which  $\mu_t$  is the treatment mean,  $\mu_c$  is the control mean,  $\sigma^2$  the pooled variance

5. Selection of a meta-analysis model, e.g. fixed effect or random effects meta-analysis
6. Examine sources of between-study heterogeneity, e.g. using subgroup analysis or **meta-regression**

# Meta-Analysis

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- If you are performing a Meta-Analysis:
  - Obtain data from at least 4 papers
  - Perform a descriptive statistical analysis on the data
    - Inferential statistical analysis?
  - You must reference additional papers for your Introductions/Background and Discussion sections



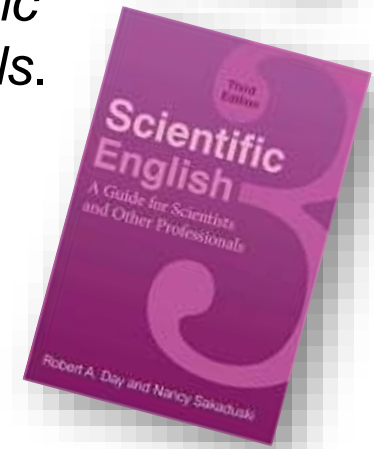
# *Techniques of Scientific Writing*

ENGR 361: Scientific Research Communication

<https://www.csulb.edu>

# References

- Alred, G. J., Brusaw, C. T., & Oliu, W. E. (2009). *Handbook of technical writing*. Macmillan.
- Day, R. A., Sakaduski, N., & Day, N. (2011). *Scientific English: A guide for scientists and other professionals*. ABC-CLIO.





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*The finest language is mostly made up of simple unimposing words.*

- George Elliot

# Scientific Writing

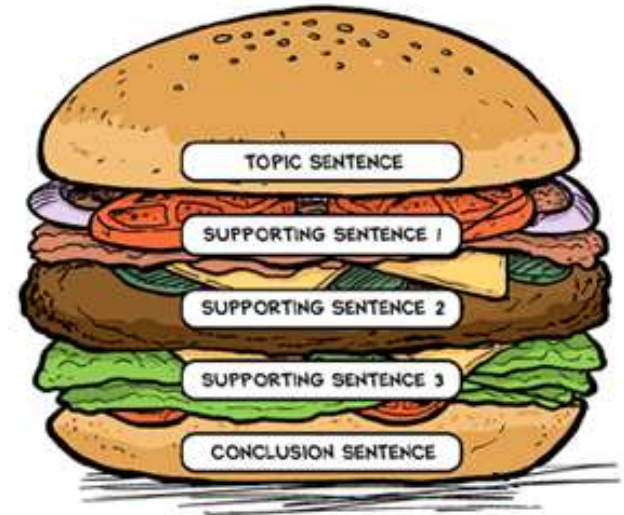
## Paragraph

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- A paragraph is a collection of related sentences dealing with a single topic
- A paragraphs is a unit of thought with one effectively developed idea
- A good paragraph greatly assists your reader in following a piece of writing

# Scientific Writing Paragraph

- Keep one idea to one paragraph
- One idea, then include several pieces of supporting evidence within the single paragraph
- Include several points in a single paragraph as long as they relate to the overall topic of the paragraph



[http://www.readingrockets.org/strategies/paragraph\\_hamburger](http://www.readingrockets.org/strategies/paragraph_hamburger)

# Scientific Writing

## Effective Paragraph

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- A paragraph should contain each of the following: **Unity, Coherence, A Topic Sentence, and Adequate Development**
- **Unity**
  - The entire paragraph should have a single focus
- **Coherence**
  - You can help create coherence in your paragraphs by creating logical bridges and verbal bridges

# Scientific Writing

## Effective Paragraph

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- **Coherence (cont.)**

- Logical bridges
  - Same idea is carried over from sentence to sentence
  - Successive sentences can be constructed in parallel form
- Verbal bridges
  - Repeat key words in several sentences
  - Use synonymous words
  - Use transition words to link ideas

# Scientific Writing

## Effective Paragraph

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- Topic Sentence

- A topic sentence indicates in a general way the main idea of the paragraph
- Regardless of whether you include an explicit topic sentence or not, you should be able to easily summarize the main idea of the paragraph

# Scientific Writing

## Effective Paragraph

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- Adequate Development
  - The topic should be discussed fully and adequately
  - This varies from paragraph to paragraph, depending on the author's purpose
  - Paragraphs that only have two or three sentences might not be fully developed

# Scientific Writing

## Effective Paragraph

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- Methods to achieve Adequate Development
  - Use examples and illustrations
  - Cite data
  - Examine testimony
  - Use a story
  - Define terms in the paragraph
  - Compare and contrast
  - Evaluate causes and reasons
  - Examine effects and consequences
  - Offer a chronology of an event



# Scientific Writing

## Effective Paragraph

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- How do I know when to start a new paragraph?
  - When you begin a new idea or point
  - To contrast information or ideas
  - When your readers need a pause
  - When you are ending your introduction or starting your conclusion

# Scientific Writing

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- Additional Considerations

# Scientific Writing

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- Avoid Anthropomorphic Expressions
  - Avoid giving human attributes to inanimate objects or non-human organisms

No

“The results suggest...”

Yes

“We conclude from these results...”

# Scientific Writing

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- Teleological Expressions
  - End result of a process is its goal
  - Teleology
    - The explanation of phenomena by the purposes they serve rather than by postulated causes

# Scientific Writing

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- Question: “*Why is the water in the tea kettle boiling?*”
  - Answer 1: “The heat from the fire raises the temperature of the water until the molecules move faster and faster so that some escape the surface and become a gas.”
  - Answer 2: “The water is boiling because I want some tea.”
- **Answer 1:** *Efficient cause*...an **explanation** of how the phenomenon took place (primary form of science writing)
- **Answer 2:** *Final cause*...the **reason** the phenomenon took place

# Scientific Writing

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- Simplicity

- Strive for straightforward sentences in your writing
- Clearly written sentences are most readily understood
- Simple sentences usually avoid grammatical errors
- Clear simple writing reflects clear thinking

# Scientific Writing

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- Avoid pomposity
- Write with an active voice
- NEVER write to impress
  - Goal of science writing is effective communication

# Scientific Writing

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## ■ Active -vs- Passive Voice

### ■ Active Voice

- Emphasis is on the subject doing the action
- Uses a single verb
- Shorter, personal, more forceful

### ■ Passive Voice

- Emphasis is on the action being done
- Begins with a thing rather than a person
- Uses a 2-word verb: 'is' or 'was' followed by a past-tense verb
- Often used to convey objectivity in writing



# Scientific Writing

## Active -vs- Passive Voice

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### Example

- The solution was heated for 30 minutes at 85° C.

### Rewrite using Active Voice

- We heated the solution for 30 minutes at 85° C.
- Use personal pronoun (“I”, “We”, “She”, “He”) or title (“The lab instructor”)
  - I prefer titles to pronouns, unless the person referred to is clearly identified

# Scientific Writing

## Active -vs- Passive Voice

---

### Example

- Verification of passwords must be done on a daily basis by security personnel.

### Rewrite

- Security personnel must verify passwords on a daily basis.
  - or
- Security personnel must verify passwords daily.

# Scientific Writing

## Active -vs- Passive Voice

---

### Example

- The editing of the financial reports was done over the weekend by the accountant.

### Rewrite

- The accountant edited the financial reports over the weekend.

# Scientific Writing

## Active -vs- Passive Voice

---

### Example

- The modified experimental method was thought to be superior by my research advisor.

### Rewrite

- My research advisor thought the modified experimental method was superior.

# Scientific Writing

- Avoid Jargon!!



# Scientific Writing Jargon

- jargon (Webster):



1. the technical terminology or characteristic idiom of a special activity or group
  2. obscure and often pretentious language marked by circumlocutions and long words
  3. confused, unintelligible language; strange, outlandish, or barbarous language or dialect
- **Eliminate (2) and (3) from your writing!**
  - (1) hard to eliminate; use requires careful and thorough definitions

# Scientific Writing

- Proofreading
  - ALWAYS review what you have written

I have a spelling checker,  
It came with my PC;  
It plainly marks four my revue  
Mistakes I cannot sea.  
I've run this poem threw it,  
I'm sure your pleased too no,  
Its letter perfect in its weigh,  
My checker tolled me sew.

Janet Minor "Spellbound"

# Scientific Writing

## Proofreading

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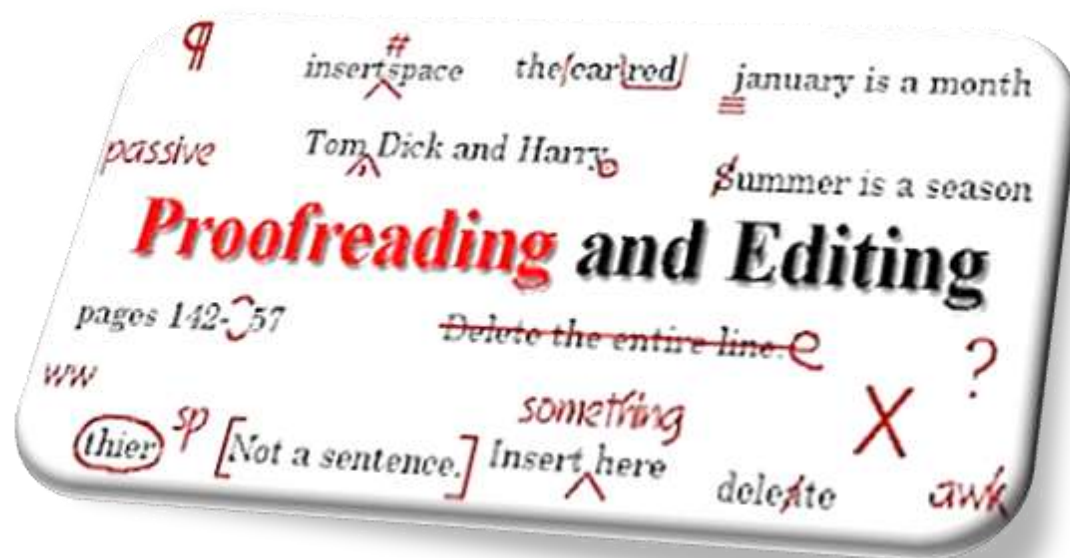
- ALWAYS review what you have written
  - Self-review
    - Do not review immediately after writing
  - Colleague Review
- Check for spelling errors, typos, grammar and syntax errors, incorrect usage, confusing words or sentences, unwanted or incorrect inferences



# Scientific Writing

## Proofreading

- Check entire document for one error type at a time
- Read each sentence thoroughly
  - Read sentences backwards
  - Read out loud
- Circle all punctuation—is it correct?



# Scientific Writing

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- The “Ten Commandments” of Good Writing
  - *according to Robert Day*

# Scientific Writing

## “Ten Commandments” of Good Writing *(Robert Day)*

1. Each pronoun should agree with their antecedent

I  
she  
you  
we  
this  
it

A word, phrase,  
clause, or  
sentence to  
which another  
word refers

# Scientific Writing

## “Ten Commandments” of Good Writing *(Robert Day)*

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- *If a person wants to succeed as a scientist, you have to know how to write effectively.*
  - Pronoun and antecedent do not agree
  
- *If a person wants to succeed as a scientist, she has to know how to write effectively.*
  - Correct

# Scientific Writing

## “Ten Commandments” of Good Writing *(Robert Day)*

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2. Just between you and I, case is important.
  - Different pronouns are used when they are the subject or object of a sentence

# Scientific Writing

## “Ten Commandments” of Good Writing *(Robert Day)*

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- Pronouns as sentence subject
  - I, you, he, she, it, we, they, who
  
- Pronouns as sentence object
  - me, you, him, her, it, us, them, whom

“I like you, but I dislike him.”

NOT

“Me like you, but me dislike she.”

# Scientific Writing

## “Ten Commandments” of Good Writing *(Robert Day)*

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3. A preposition is a poor word to end a sentence with.
  - Prepositions: locators in time and place
  - *The professor can sit **on** the desk (when he's being informal) or **behind** the desk, and then his feet are **under** the desk or **beneath** the desk.*
  - If possible, rework a sentence so that it does not end with a preposition

# Scientific Writing

## “Ten Commandments” of Good Writing *(Robert Day)*

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### 4. Verbs has to agree with their subject.

- In the present tense, a verb must agree in number with its subject.
- Add an “s” to a verb if the subject is singular.
- Remove an “s” from a verb if the subject is plural.
- Bob boils off the ether using a Bunsen burner.
- Bob and Bill boil off the ether using a Bunsen burner.
- Tracy has to go to the market after school.
- Tram and Naomi have to go to the market after school.



# Scientific Writing

## “Ten Commandments” of Good Writing *(Robert Day)*

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5. Do not use double negatives.
  - Don’t use double negatives.
  - Don’t use no double negatives.
  - Don’t nobody use no double negatives.
  - Don’t nobody use no double negatives no how.

# Scientific Writing

## “Ten Commandments” of Good Writing *(Robert Day)*

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### 6. Remember to never split an infinitive.

- A split infinitive occurs when an adverb is placed between “to” and a verb

- She used to **secretly** admire him.

- You have to **really** watch him!

**Incorrect**

- She used to admire him **secretly**.

- You **really** have to watch him!

**Correct**

# Scientific Writing

## “Ten Commandments” of Good Writing *(Robert Day)*

### 7. Avoid clichés like the plague.



# Scientific Writing

## “Ten Commandments” of Good Writing *(Robert Day)*

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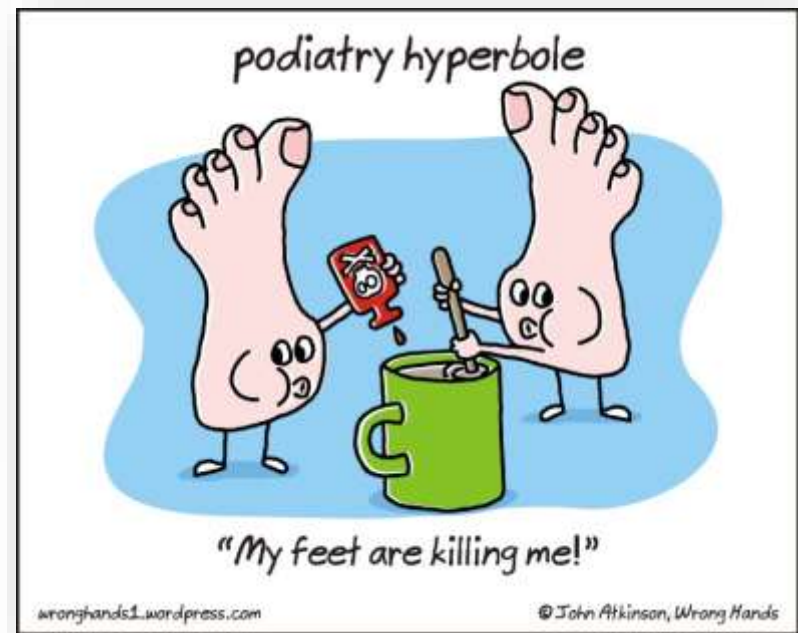
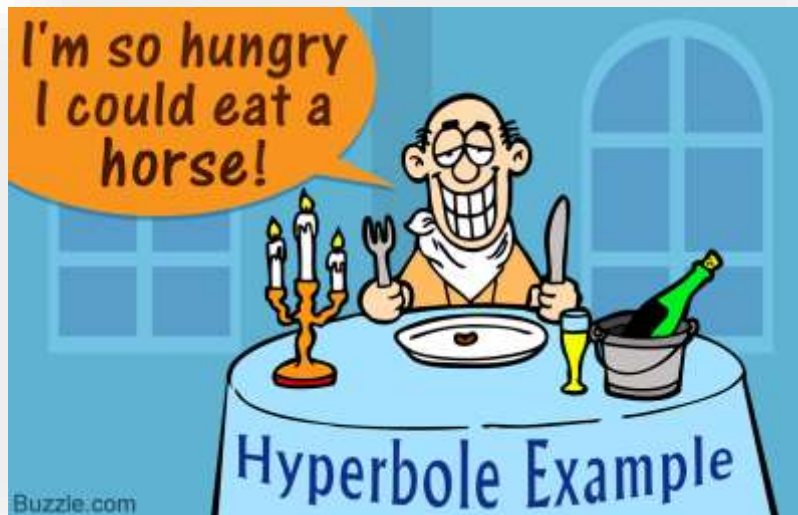
8. Join clauses good, like a conjunction should.

- Clause: a group of related words containing a subject and a verb
- *I like cooking **and** eating, **but** I don't like washing dishes afterward. Sophie is clearly exhausted, **yet** she insists on dancing till dawn.*
- Common conjunctions
  - and, but, because, although, provided that, as long as, ...

# Scientific Writing

## “Ten Commandments” of Good Writing *(Robert Day)*

9. Do not use hyperbole; not one writer in a million can use it effectively.



# Scientific Writing

## “Ten Commandments” of Good Writing *(Robert Day)*

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### 10. About sentence fragments.

- Complete sentences have **three** components:
  1. A subject (the actor in a sentence)
  2. A verb (the predicate or action)
  3. A complete thought (it can stand alone and make sense—it's independent)

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*In fact, you may, on occasion, violate everyone of the rules dreamed up by generations of grammatical sticklers. The obvious purpose of grammatical rules is to facilitate clear communication. When rules of grammar do not serve this purpose, they should be disregarded.*

- Scientific English. Guide for Scientists and Other professionals. Robert a. Day and Nancy Sakaduski

# In-Class Activity

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- Write a Paragraph

- At the top of a separate piece of paper, write “Written By” then your ID number. On the second line, write “Edited By” followed by a blank space.
- I. Write a Paragraph. Using several sentences, describe briefly one of the following topics:
  - a) The molecular events that occur when cold water is heated to boiling
  - b) How cognitive biases can lead to errors in decision-making
  - c) Explain the essential differences between mechanical energy, potential energy, and kinetic energy
  - d) Describe the central Dogma of Molecular Biology
- Use the guidelines discussed to help you craft your paragraph
- Write double-spaced, and leave at least 1 inch margins on the left and right
- The instructor will collect your paper and give it to another student for editing.



- 
- I. Editing the Paragraph. Using a colored pencil or pen, edit the paragraph about one of these four topics. Pay particular attention to the following features:
1. Is the topic sentence clear?
  2. Are the sentences grammatically correct?
  3. Are there any problems with word choice? If so, suggest alternatives.
  4. Do the sentences follow a logical sequence? If not, how might they be better arranged?
  5. Are there unnecessary sentences? If so, underline these.
  6. Do the sentences flow well?
  7. Overall, is the paragraph effective?

