Scientific Writing…

- Why, how?

Horizons

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How to write consistently boring scientific literature

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Although scientists typically insist that their research is very exciting and adventurous when they talk to laymen and prospective students, the allure of this enthusiasm is too often lost in the predictable, stilted structure and language of their scientific publications. I present here, a top-10 list of recommendations for how to write consistently boring scientific publications. I then discuss why we should and how we could make these contributions more accessible and exciting.

"Hell is sitting on a hot stone reading your own scientific publications"

Erik Ursin, fish biologist

Ten recommendations for boring scientific writing

- 1. Avoid focus
- 2. Avoid originality and personality
- 3. Write l o n g contributions
- 4. Remove most implications and every speculation
- 5. Leave out illustrations, particularly good ones
- 6. Omit necessary steps of reasoning
- 7. Use many abbreviations and technical terms
- 8. Suppress humor and flowery language
- 9. Degrade species and biology to statistical elements
- 10. Quote numerous papers for self-evident statements

On a more serious note…

Biol 150-03 Seed Germination Paper Evaluation – 40 points

- This paper is to be written as a group. You should plan to develop the entire paper together and should own every aspect of the work turned in.
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- Authors of manuscript:
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- **Title 2 points**
- 1. inadequate
- 2. adequate
- 3. effective
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- **Study rationale (Introduction) 10 points**
- 1. not clearly evident
- 2. evident, but not well developed
- 3. stated clearly and developed appropriately
- 4. stated and developed elegantly

- **Materials and methods description 10 points**
- 1. inappropriate or inadequate
- 2. adequate
- 3. clear and efficient
- 4. elegant
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- **Data analysis and presentation (Results) 10 points**
- 1. inappropriate or inadequate (e.g. no visual presentation of results)
- 2. adequate (e.g. figs and tables present, but inadequate/illogical use in text)
- 3. clear and efficient (minor errors/omissions in figures/tables/text)
- 4. elegant

- **Data interpretation (Discussion)   8 points**
- 1. inadequate or inappropriate
- 2. explained and justified
- 3. clearly related to original question and associated hypotheses and predictions
- 4. demonstrating intellectual creativity by placing conclusions in larger context and/or proposing *interesting and relevant* directions for further research

- **Grade: /40**

About Papers

- **Review Investigations: papers, stats**

- As in other Biology classes, prepare your papers in the style of concise scientific articles, with the conventional sections:

- a descriptive and interesting **title** and a brief **abstract** (~200 words) summarizing the paper;

- an **Introduction** defining the general problem , the specific question(s) the paper addresses, and the reasons that the specific study is interesting and valuable (i.e., make the reader want to read the paper!), with appropriate reference to the primary literature; objectives, hypotheses and specific predictions should be clearly stated.

- a **Methods** section, naming and describing the study organism (if any), the setting, sample size, and the methods of data collection and statistical analysis used to answer the question(s); can I duplicate your study?

- a **Results** section, *succinctly describing* the data and the outcome of the data analysis (*do not give **raw** data unless there is a **very** compelling reason!*), with figures and tables that communicate information clearly and effectively;

- a **Discussion** section, which describes and interprets the answers to the questions the introduction poses, with appropriate reference to the original objectives/hypotheses and the primary literature; broader implications? Negative results? We should have had a >*n*

- **Acknowledgments** of help; and

- a **Literature Cited** section (see INV for format and citation style – no footnotes)

- Use 1.5 to 2.0 spacing and print on two sides. Do not include separate title pages.

- Please refer to *Investigations* for more detailed advice: http://www.grinnell.edu/academic/biology/BC_manual.pdf

- To write papers, you'll need to use software capable of statistical analysis and graphical presentation. You may use Excel for graphics and Minitab for data analysis.

- Tense?
- Active or passive voice?
  - “we did this,” “we did that”, “and then we…”

Data Analysis

- What causes the mean value of a sampled group to vary?

Data Analysis

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- Measurement error, uncontrolled environmental variation, natural variation within the variable of interest, experimental manipulation of some controlling variable?

Data Analysis

- To determine whether a difference between two means is scientifically meaningful, we need to partition out the variation in our data that is caused by a given variable or experimental manipulation from that caused by measurement error and environmental variation. In other words, we need to analyze our data using statistical hypothesis tests.

- How do we do this?

An experimental hypothesis…

- A hypothesis is an educated guess about what explains a natural phenomenon under investigation, formulated in terms of the particular data you have collected.

- A statistical hypothesis test allows you to discriminate between an *alternative hypothesis, which is your estimation of the effect of a given variable or experimental manipulation on the data you have collected, and a null hypothesis, which is the idea that the variable or manipulation you're studying will have no effect on your data.*

The Outcome: Test Statistics

- As the absolute value of a test statistic increases, so does your confidence that you can reject the null hypothesis. How large the test statistic must be for you to reject the null hypothesis declines with sample size.

$$SE = \frac{S}{\sqrt{n}}$$

- You will never be certain that the alternative hypothesis is true; all you can have is some defined level of confidence that the null hypothesis is false. By convention, when the absolute value of a test statistic is so large that there's less than a 5% chance that the null hypothesis is true, (a so-called alpha or P-value of 0.05 out of 1), scientists reject the null hypothesis and tentatively accept the alternative.

The t-test

The formula for the t-test is as follows:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{S_{\overline{X}_1 - \overline{X}_2}}$$

where

$$\overline{X}_1 \text{ and } \overline{X}_2$$

are the means of each your two groups and

$$S_{\overline{X}_1 - \overline{X}_2}$$

is the standard error of the difference between groups 1 and 2. Thus the t-value is the ratio of the difference between your groups to the precision of your estimate of that difference.

t-test

- The t-value is the ratio of the difference *between your groups to the precision of that estimate***. The latter quantity will be larger when the variability within your groups is larger, and smaller when sample size increases.***

- If the difference between your groups is relatively large compared to the precision of your estimate, then your t-value will be relatively large. A relatively *large t-value suggests that the difference between your groups is caused by a given variable or experimental manipulation, rather than by chance natural variation.*

- By convention, if the P-value is less than 0.05 (a 1 out of 20 chance), one rejects the null hypothesis of no difference in means, and accepts the alternative hypothesis that the two groups differ.

- A relatively *small t-value suggests that the difference between your treatment groups is largely due to chance natural variation and measurement error, rather than to a given variable or manipulation. By convention, we do not reject a null hypothesis when the chance of getting a t-value is greater than 0.05.*

The analysis of variance (ANOVA)

- To analyze these data using an ANOVA, you first need to calculate the *grand mean. The grand mean is* simply a fancy term for the mean of all of your observations, regardless of group. The grand mean can be calculated using the following formula Where *a is the number of groups, n is the number of observations within each group, and Y is a single observation.*

$$\bar{\bar{Y}} = \frac{1}{an}\sum_{a}\sum_{n} Y$$

ANOVA: the F-value

- The test statistic for an ANOVA is called an ***F-value. The F-value for an AVOVA is calculated using the following formula:***

$$F = \frac{\left(SS_{among} / a-1 \right)}{\left(SS_{within} / a(n-1) \right)}$$

Go analyze your data…