

CBGS Manuscript Format for Science Research Projects

A Checklist for both your Prospectus & your Final Paper

With a few exceptions (like using color graphs), the CBGS format below will meet Virginia Junior of Academy of Science standards. By carefully following the format here, you'll minimize the number of changes that you have to make when submitting to VJAS.

Basic Format

- Your Prospectus (junior year) should contain these five sections, in this order:
 - (1) Abstract
 - (2) Introduction & Literature Review
 - (3) Hypotheses (including symbolic null and alternative hypos)
 - (4) Methods and Materials
 - (5) Literature Cited

- Your Final Paper (senior year) will have these sections:
 - (1) Abstract
 - (2) Introduction & Literature Review
 - (3) Hypotheses
 - (4) Methods and Materials
 - (5) Results
 - (6) Discussion & Conclusions
 - (7) Literature Cited
 - (8) Acknowledgments (optional)
 - (9) Appendix (plural: Appendices)

- A good Prospectus will be at least 5 pages long, probably more
- The main text of your Final Paper (Abstract, Intro, Hypos, Methods, Results, Discussion, Lit Cited, and Acknowledgments ...but **NOT** including graphs, tables, & figures) should be **6-10 pages**. The total length including your main graphs, tables, & figures cannot exceed **12 pages** (VJAS maximum).
- Beyond these 12 pages, you may include additional data or extra info (e.g., your raw data, photos, less essential graphs, etc.) in an Appendix (-ces). This is optional. However, your final paper's grand total length cannot exceed **20 pages**.
- Number your pages** at the bottom, starting with the Abstract.
- In addition, include a separate Title Page (but VJAS won't want this!) (this page is NOT numbered and does NOT count toward your 12 page max).
- The Abstract, Intro, Hypos, Methods, Results, Discussion, & Lit Cited sections should run back-to-back, one right after the other (i.e., they don't go on separate pages).
- If you want, you may insert graphs, tables, and other figures directly into the body of your paper, amidst the text (using text boxes ...see below). However, it's probably

easier to just put tables & figures on separate pages, after the Lit Cited section (note: if they'll fit, you may put more than one figure on a single page).

- ❑ Compose your paper in Microsoft Word (required for electronic copies to VJAS).
- ❑ DOUBLE SPACE!!!
- ❑ Use *Size 12 Times New Roman* font. No exceptions; this is a VJAS requirement. Feel free to italicize, underline, or embolden for emphasis.
- ❑ Margins should be 1" to 1.25". For VJAS, there MUST be a 1" margin around every page – top, bottom, left, and right ...including a 1" space around graphs, tables, and other figures. And hey, don't try that cheap 7th grade trick of increasing your margins in order to make your paper look longer than it really is. Bleah.

Tables, Graphs, and other Figures

- ❑ Every table, graph, and other figure MUST have a **caption**. In MS Word, the best way to import a table, graph, map, or picture is to FIRST create a **text box**, and then paste it in. A text box is also your best way to create a caption. For example, suppose you want to copy a table or graph from Excel into your Word document:
 - (A) In your Word document, click on the "Insert" menu and select Text box. (If that stupid "Create Your Drawing Here" thing comes up, then click somewhere OUTSIDE it! This creates a small text box and makes that stupid drawing canvas go away, stupid thing. Now click on the border of the little text box and you can drag it and/or resize it as desired). *Don't forget, VJAS requires a 1" margin between all figures and the edge of the paper. That means on ALL SIDES: left, right, top, and bottom.*
 - (B) Now go into your Excel document and highlight your entire graph or the cells containing your table.
 - (C) Copy.
 - (D) Go back to your Word doc, click inside your text box, and paste.
 - (E) Make another wide text box overtop or underneath, and type in your caption (such as "Figure C: blah-blah-blah" or "Table B: yadda-yadda-yadda")
 - (F) To get rid of the black outline, right-click the border of each text box, choose "Format... Color and Lines," and turn off both the "Fill" and the "Line."
- ❑ **Tables** and **Figures** must be lettered (or numbered). However, for some dumb reason, Tables and Figures are supposed to be lettered (or numbered) independently of each other. That is, your Final Paper will probably have BOTH a "Table A" AND a "Figure A." **"Figures" include graphs, maps, pictures, and anything else visual that ISN'T a "Table."**
- ❑ Figure A should be the FIRST graph, map, or pic that you refer to IN THE TEXT of your paper. Figure B is the 2nd figure referenced in the text. And so on. ***In short, in your text, don't refer to Figure B before Figure A!*** Ditto for Tables.
- ❑ Color graphs are **GOOD** (despite what VJAS says). The use of color in your graphs can make things so much easier for your reader to interpret. Plus you'll definitely want color graphs in your PowerPoint presentation at VCU. So please feel free to submit color graphs in your paper to your CBGS MES teacher. We like 'em! *Unfortunately, though, VJAS doesn't allow color figures, so later you'll have to make*

some changes, using shades of gray, dashed and dotted lines, open and closed data points, etc. (worry about this later).

- ❑ When importing graphs or tables, make sure your Fonts are big enough for the poor ol' eyes of us aging readers. Sometimes you'll have to make changes after importing. After importing into MS Word, you can usually just double-click a graph or table, and it'll call up Excel and let you go right in to make adjustments. If not, you may have to manipulate the graph back in Excel, and then re-import it.
- ❑ Make sure your graphs and their captions create **no guesswork for your reader**. Be sure to include units on axes. Are you graphing the means ...or something else? What do those error bars represent? How'd you calculate those values? Is a legend necessary, and if so, is it crystal clear? It's also nice to state sample size (e.g., "N = 8") and p-values (e.g., "p < 0.05" or "p = 0.16") where appropriate. You can do this by superimposing a text box on your graph (see instructions above). Ditto for Tables and other Figures. Don't let your reader do any guessing!!!

On Style and Such

- ❑ **Rule #1: WRITE FOR YOUR READER!!! Do not expect your reader to be a MIND reader!** You are not writing for yourself, and you are NOT writing for your MES teacher! Rather, you are writing for **someone you don't know** ...a VJAS judge, perhaps. You can assume your reader is educated and scientifically literate, but you cannot assume she's an expert in wetlands ecology, or fisheries biology, or child psychology, or whatever. You do NOT write merely to express your thoughts accurately on paper. No. Instead, you must strive to re-create your own thoughts in someone else's mind. There's a difference. It's not enough merely to put down words that are technically correct, nor is it enough to show that you yourself understand. **Instead, make your reader understand!** Paint a clear picture of your project, how you did it (or plan to do it), and what you discovered (or hope to discover). Talk to your reader. Keep asking yourself: *if I were to read this passage aloud to, say, Uncle Albert, would he really understand it?*
- ❑ Good Advice: **Proofread OUT LOUD.** (If you're embarrassed someone might hear you, then go lock yourself in the car.) Reading aloud puts you in the seat of your audience. If something doesn't sound right coming out of your mouth, well, then it ain't right! Fix it! **NEVER EVER EVER SETTLE** for wording that you know is awkward, weak, confusing, vague, squishy, or less than lucid. Figure out a way to make things crystal clear, even if it means dismantling and rewriting whole sentences and paragraphs.
- ❑ **Dew knot trussed spellchecker two dew yore proofreading four ewe, bee cause it will naught ketch awl yore mistakes.** MS Word spellchecker didn't find a single spelling error in the preceding sentence! It always misses mistakes, and sometimes it'll say you've made a mistake when you haven't. You MUST proofread. Carefully!
- ❑ We expect good grammar and syntax, same as your English teacher. Subjects and verbs must agree. Pronouns must refer to a clear antecedent. Modifiers musn't dangle. And the most common grammatical goof we see year after year, paper after paper? **...the comma splice.** Know what this is, and don't do it. (Or as a comma splicer would put it: "Know what this is, don't do it.")
- ❑ **Write in 3rd Person.** Honestly, we at CBGS have no problem with 1st person ("I" or "we"), especially since it makes it easier to write in a strong, active voice (see below).

Unfortunately, VJAS and many science journals still haven't entered the 21st century, and only allow 3rd person writing. This is an old and dying scientific convention, designed to project a sense of pure objectivity, even though everyone knows perfectly well that the study was conducted by real, living, breathing human beings. So to prevent your having to rewrite your paper later for VJAS, stick with 3rd person from the get-go.

- ❑ Try hard to stay in the **active voice** rather than the passive voice. This makes for much stronger writing. Passive voice is “backwards writing,” and it deadens your prose. Unfortunately, though, since we're stuck with 3rd Person, staying in the active voice can be difficult, especially in your Methods section. But try!

Weak but Legal: “Each frog was put through a 10° temperature increase.”

Strong but Illegal: “We put each frog through a 10° temperature increase.”

Strong and Legal: “Each frog experienced a 10° temperature increase.”

(NOTE: you can also substitute “I” and “we” with “the scientist(s)” or “the researcher(s),” but this gets old, so don't get carried away.)

- ❑ In the main text of your paper, you **MUST** cite your sources by **author** (or agency) and **year** (e.g., “Boogenhauer, 1997” or “DEQ, 2001”). This is usually done parenthetically at the end of a sentence. This is a difference in convention between science papers and English or History papers. See *Goff's Scallop paper for details and examples*.
- ❑ Use **metric** for all measurements and data.
- ❑ On writing numbers:
 - Write a number as a numeral whenever it's 10 or greater (e.g., 18 flowers), or whenever followed by a unit of measurement (e.g., 8 mm or 3 g/L).
 - Spell out single-digit numbers when it's a quantity of objects or organisms (e.g., *five* fish or *two* hypotheses). However, in a list you may use all numerals (e.g., 17 blue crabs, 5 grass shrimp, and 9 gobies).
 - At the start of a sentence, always spell the number out, no matter what.
 - Whenever you write a decimal number, place a zero in front of the decimal point. Incorrect: $p < .05$. Correct: $p < 0.05$.
- ❑ No slang, y'all, and t'ain't allowed to use no contractions, neither. Y'all.
- ❑ The first time you mention a living organism in your paper, give its genus and species name parenthetically. Thereafter you can just use the common name. However, you should repeat this in both the Abstract and the Intro (and the Title).
- ❑ *Italicize* genus and species names. The genus name always gets capitalized, while the species name is all lower case ...*Homo sapiens* (humans), *Callinectes sapidus* (blue crab), *Tursiops truncatus* (bottlenose dolphin), *Speedibus incredibilus* (cartoon roadrunner), etc.
- ❑ What to do about gender bias – namely, the use of “he,” “him,” and “his” as a general pronoun? Hmm. There's a lot of dispute about this, but here's what NOT to do: don't use expressions like “he or she” and “his/her” and (yuck!) “s/he.” Those expressions ruin the fluidity of your prose and cause the reader to stumble. Best

advice: when writing about no one in particular, say “he” and “his” 50% of the time, and “she” and “her” the other 50% of the time. Mix it up!

- ❑ **Don't plagiarize! And for heaven's sake, never ever electronically copy and paste words straight from a website.** That's just slimy (plus it's easy to catch, using a quick Google search). **Similarly, DO NOT copy and paste the citation formats off the internet (e.g., off Google Scholar) ...'cause they ALWAYS get it wrong! You MUST create your OWN citations following our acceptable CBGS/VJAS formats!** (Details below.)
- ❑ In science papers, you should also avoid direct quotations. Use a direct quote only if a writer has expressed some idea in such a distinctive, compelling way that it's worth repeating her exact words. **Ninety-eight percent of the time, it's your job to “translate” the words and work of other scientists for your own reader.** It's a tough to skill to learn, but you can do it. Just imagine yourself at the dinner table explaining another scientist's work to good ol' Uncle Albert...

Abstract

- ❑ In your Prospectus (junior year), this is a single paragraph that briefly summarizes the experiment or field study that you are proposing, with a few words on what results you predict and why they could be meaningful.
- ❑ In your Final Paper (senior year), the Abstract summarizes your research, your key results, AND your big conclusions. It's more than a mere Intro. It's a start-to-finish, front-to-back overview of your entire work. The idea is to allow the reader to decide whether or not to read the whole paper, depending on her own research aims.
- ❑ Write the Abstract last, after completing all the rest of your paper. Do not include table or figure references here, nor literature citations.

Introduction & Literature Review

- ❑ Introduce your topic and frame the question(s) you are tackling. What is the purpose of your study? Discuss theoretical reasoning and background, citing and describing (in your own words, please!) the work of other scientists in the field. Make clear connections between the work of these OTHER scientists and your OWN study (or proposed study). Also include general information about whatever location, habitat, and living species (if any) that you studied (or plan to study). Make connections between your study and the broader scientific, ecological, or environmental framework, emphasizing the potential significance of your research. Include social or historical context, if appropriate. (Note: When importing the Intro from your Prospectus to your Final Paper, please review the comments that your teacher made on your graded Prospectus!)
- ❑ You will need a minimum of **SIX scientifically reputable** sources, including at least **TWO “primary”** sources (these are usually peer-reviewed or “refereed” sources from a science journal). You must actually USE (and cite) these sources in the BODY of the paper. **Your main goal is to meaningfully connect the RESULTS of other scientists' work to your own project.** How do their findings shed light on your own study? (See our “Student Guide to Scientific Literature Search.”)
- ❑ At the end of your Intro, give a nice “nutshell” statement of your research and its purpose. This will make a nice lead-in for your Hypotheses and Methods sections.

Hypotheses

- ❑ State and explain the specific hypothesis(-es) you tested (or plan to test), along with the corresponding null. In most cases, you'll want to represent these symbolically, as the basis for later graphing and statistical testing. Remember, in most studies you are comparing the MEANS between different groups/treatments ...so SAY so!

Materials & Methods

- ❑ In your Prospectus, describe the actual experiment and/or field studies that you plan to conduct. **Explicitly** name your independent and response variables, constants, controls, treatments, and so on. State the population to be studied and your method of taking samples from it (using random numbers, right?!). Also state your sample size (N) ...and remember, this is NOT the grand total # of objects or organisms or locations that you studied; rather, it's the # PER GROUP or PER TREATMENT (e.g., if you have 3 groups of 20 fish, then it's N = 20 ...NOT N = 60). Also describe how you plan to analyze the data, including your statistical test(s). It's important to offer a clear explanation of your plan of attack, but do NOT write this like a recipe!
- ❑ In your Final Paper, you should be able to import your Methods section from your Prospectus, with appropriate changes (such as changing future tense to past tense). You want to paint for the reader a vivid picture of what you actually did, yet you do not want to overwhelm him with details. Again, it's not a recipe. Help him visualize!
- ❑ Be especially clear about your method of taking samples, how you randomized, how you assigned treatments, and how you took measurements. This is often a source of confusion for the reader. **Diagrams & maps are a huge help, even if hand-drawn!**
- ❑ Explain any mathematical manipulations or analyses of the data, incl. statistical tests.

Results (Final Paper ONLY)

- ❑ This section should be brief. Just state the major results you got, but **avoid interpreting** them (that goes in the Discussion section). **Refer the reader to your Graphs and Tables, and let these tell the story!**
- ❑ Nevertheless, DO state a few of your key numbers, like means or percentages. Focus on **differences** and **changes**. Also, state whether or not differences were "statistically significant" ($p < .05$), or maybe even "statistically very significant" ($p < .01$) The best way to state p-values is parenthetically, in one of the following ways:

Statistically signif diffs: $p = 0.034$ OR $p < 0.05$

Statistically "very" signif diffs: $p = 0.0078$ OR $p \ll 0.05$ OR $p < 0.01$

In tables, if a mean or percent or numerical difference is statistically significant, a common tradition is to follow it with an asterisk (e.g., 278.3*). If it's statistically very significant, follow it with a double asterisk (e.g., 278.3**).

See Pages 5 and 17 of Goff's Scallop paper for more help with p-values!!!

Discussion & Conclusions (Final Paper ONLY)

- ❑ **This is the most important part of your paper.** Now's the time for **thoughtful interpretation** of the cold results. Emphasize meaning, suggest importance, make predictions and extensions, and weave things into the BIG PICTURE. This is where your paper comes full circle, connecting smartly back to what you wrote in the Intro.

- ❑ Don't be afraid to speculate (but not too wildly) on what hidden things might be going on behind or within your data. This is a fruitful way to suggest **future studies**, or future **improvements** to your own experiment or study.

A Few Thoughts on what to do with high p-values ...PLEASE READ:

It takes a p-value less than 0.05 to reject your null hypothesis. A p-value greater than 0.05 may mean one of two things: either there is NO difference out there in nature (i.e., the null hypo is really correct), or there actually IS a difference, but your experiment just "failed to detect" it. Nature is "noisy," so detecting real differences typically requires a fairly large sample size. But time and logistical constraints can make it difficult for us at CBGS to achieve big enough N's. So what to do, what to do???

Do This: If you got high p-values but still think you can see an interesting pattern in your graphs and data, then offer a thoughtful interpretation of the results **AS IF** they are statistically significant. Go ahead and talk about the patterns you see. But then at the end, tag on a little disclaimer like, "However, these trends were not statistically significant; perhaps a larger sample size would have revealed a clearer pattern." (Of course, in a paper for a real science journal, this would be a no-no ...but our main goal here is to think and interpret and discuss)

Literature Cited

- ❑ Scientists use a rather different citation format than that used in English and social studies papers (such as MLA). In science citations, it's always author or agency first, then year, then title, and finally publishing info ...in that order. **See Goff's Scallop paper for abundant examples!!!** You may also consult the VJAS Style Manual at www.vacadsci.org/vjasstyle.htm.
- ❑ ***On Internet sources:*** If you accessed a scientific journal online, you do NOT need to include the web address. Just cite it as if you had pulled the journal off a library shelf (same difference). However, for webpage articles and sources, you DO need to include the web address, and you should also write down the DATE that you accessed that webpage. Also, hunt around for the webpage's date of publication (often given as a "date last modified" at the bottom of the webpage or on the website's homepage). In your paper, it's best to cite webpages by author or agency (such as U.S. EPA or VCU Geology Department), NOT by title of the article.
- ❑ Single space each individual citation in the Lit Cited section, but double space *between* citations.
- ❑ This is NOT a bibliography. ***You list ONLY those sources that you actually used and cited in the body of your paper.***

Acknowledgments (optional) (Final Paper ONLY)

- ❑ Acknowledgments thank folks who contributed supplies, assistance, advice, etc. This is optional, and don't go overboard, but it's nice to give credit where due. This goes immediately after the Lit Cited section, but before the Appendices.

Appendix (Final Paper ONLY)

- ❑ Your appendices can include photos of your experiment, tables of raw data, interesting but less essential graphs, and other stuff that is sort of "optional" for the reader to look at (and that was too big to fit within the 12-page VJAS limit).