So, how do you write a research proposal?
“Regardless of what field of science or engineering you ultimately pursue, being able to articulate your ideas cogently is crucial for professional success. To help you build the skills needed to achieve this, we have designed a progressive writing assignment. You will have the opportunity to develop an original research proposal in consultation with the Bi1 staff.”
**Motivation**

- Think deeply about a biological research problem that interests you
- Appreciate the way that many different scientific fields interface with biology
- Begin to develop scientific thinking and writing skills
- Communicate their ideas clearly and effectively
HYPOTHESIS -

- Bi1 Reader contains 5 prewritten hypotheses related to Caltech research (+ relevant professors!)
  - (1) Biomechanics
  - (2) Alternative energy
  - (3) Network design
  - (4) Ecology/microbiome
  - (5) Evolution
- You can, however, choose any biological problem that interests you. . . as long as you can formulate a hypothesis and a reasonable means to test it.
- If you choose your own topic, it must be vetted through your TA.
I. Introduction
   A. What is the question?
   B. What is the significance of the problem?
   C. What is the background – what has been done before?

II. Experimental Plan
   - Specific aims (1-3)
   - Description of the approach including a rationale for use of these methods within this context

III. Predicted outcomes and possible alternative approaches

IV. Potential impact: if successful in achieving your aims, why would it matter?
HYPOTHESES/AIMS

What are we looking for in a hypothesis?

- **What we want:** An interesting and specific idea that is testable and needs further research.
- **What we don’t want:**
  - Rehashing a question that has already been asked
  - Existential angst about whether your proposal will actually work in reality (before experimentation)
  - Vague hand-waviness between multiple questions that just reviews the issues in the field at hand
RESEARCH

- Find good sources
  - Web of Science: http://apps.webofknowledge.com/
  - Google Scholar: http://scholar.google.com/
  - Caltech professors (usually available by request)

- Use simple search terms
  - Example: “tumor angiogenesis” vs. “upregulation of FLT-1 VEGFR in rat glioma model of tumor angiogenesis”
  - Try multiple terms: be prepared for most to fail to find what you’re looking for!

- Surf the abstract, intro, and conclusion of a given paper. If it seems relevant, THEN go through methods and experiments.
Once you find a good paper, you can backsearch and frontsearch!

- **Backsearch**
  - Go to references
  - See what the relevant paper has cited
  - Click through to go read!

- **Frontsearch:**
  - Go to “cited by” (or similar title)
  - See what more recent papers have cited this paper
  - Click through to go read!
RESEARCH

- Always keep track of what sources you’re using!
- Create a citation list for the end of your proposal
  - No minimum or maximum number of sources
  - Whatever is necessary
    - “Dogs have four legs” \(\rightarrow\) no citation
    - “Recent studies have shown that increased CD68+ macrophages result in a shortened progression-free-survival \( (P=0.03) \)” \(\rightarrow\) yes, citation!
  - Cite within the proposal via superscript numbers
    - E.g. “Recent studies show that dark chocolate may not actually prevent cancer.\(^1\) However, no one has paid this any mind.”
    - GIVE FORMAT FOR CITATIONS (Author, A. and B. Author2 (YEAR) Title, Journal, Volume:Pages.)
FORMAT

- 4 pages MAX
- Double-spaced
- 11pt Arial font
- 1-inch borders
- Figures and references NOT included in page requirement
  - Please submit a version of your final proposal without figures (via email) so that we can check this!
  - You probably don’t need more than 1-2 figures for a proposal this short. ONLY what is necessary, please!
FORMAT (SUGGESTED)

- **Page 1**
  - 1 paragraph of intro and setting up the question
  - Listing a few (2-3) major sub-questions that they are asking and how they relate to each other and the overarching question.

- **Pages 2-4**
  - Go into more detail on the background (~1 page)
  - Propose the experiments that you would like to do to test your hypothesis/address the question (~1.5 pages)
  - Discuss what you might learn and how this would add to the knowledge in the field (~1/2 page)
WRITING STYLE

- Avoid
  - Empty phrases
    - Can you read and understand your sentence after omitting the phrase? It’s probably not necessary.
  - Dangling modifiers
    - Be careful with “its,” “their,” etc.
  - Abbreviations/acronyms unless mentioned 3x in paper already
  - Direct quotes – use your own words! No plagiarism.
- No slang/contractions/run-on sentences
- SPELL-CHECK!!!
SCHEDULE

- Week 1: Introduction to assignment (no work due this week)
- Week 2: Define interests (multiple ideas) due April 10
- Week 3: Refine ideas due April 17
- Week 4: Hypotheses/aims (ONE idea) due April 24 -- worth 20% of writing assignment total
- Week 5: Methodology/Approach due May 1
- Week 6: Rough draft due May 8 -- worth 30%
- Week 7: Revision of corrected rough draft (no work due this week)
- Week 8: Final draft due May 22 -- worth 50%
GRADING CRITERIA

Is the hypothesis well conceived?

Are the aims clearly stated and are the methods appropriate to address them?

Is the information logically organized, with smooth transitions between ideas?

- Are the ideas supported by accurate statements, appropriate evidence, adequate citation of relevant research?
- Is the paper polished? (e.g. word choice, sentence structure, grammar, spelling, punctuation, appearance)
- Does it conform to the suggested length/formatting?