Scientific Method
&
Developing Grant Proposals

Dr. Charles Long
VTPP
March 1, 2010
What is a Scientist?

• A scientist is a person who asks questions and tries different ways to answer them.
• A scientist learns from his/her senses.
• A scientist notices details.
• A scientist draws what he/she sees.
• A scientist writes about what happens.
• A scientist makes comparisons by measuring.
• A scientist must count exactly.
• A scientist looks at objects carefully to decide how to sort.
• A scientist designs experiments to test predictions.
• A scientist experiments by trial and error.
• A scientist thinks logically.
• A scientist keeps trying over and over.
• A scientist has fun.

Barbara Lehn
The Scientific Method and Proposal Development
The Scientific Method

• The steps of the scientific method are to:
  – Ask a Question
  – Do Background Research
  – Construct a Hypothesis
  – Test Your Hypothesis by Doing an Experiment
  – Analyze Your Data and Draw a Conclusion
  – Communicate Your Results

http://www.sciencebuddies.org/
Scientific Method Flow

1. Ask Question
2. Do Background Research
3. Construct Hypothesis
4. Test with an Experiment
5. Analyze Results
6. Draw Conclusion

If Hypothesis is True:
- Report Results

If Hypothesis is False or Partially True:
- Think! Try Again
Background Research

• Library
• Internet
• Advisor

• Most likely problems:
  – Information overload.
  – Information wasteland.

• How to read a scientific paper.
Good Hypothesis Building

• Hypothesize using your independent variable (the variable you change during your experiment) and your dependent variable (the variable you observe).

• Changes in the dependent variable depend on changes in the independent variable.

• For example: "If a particular independent variable is changed, then there is also a change in a certain dependent variable."
What Makes a Good Hypothesis?

• Is the hypothesis based on information contained in the background research?
• Does the hypothesis include the independent and dependent variables?
• Have you worded the hypothesis so that it can be tested in the experiment?
• Is the time frame for testing this hypothesis sufficient?
• **With a good hypothesis, you should answer "Yes" to every question**
Experimental Design

• Plan carefully how to test your hypothesis, by altering the independent variable(s) and accurately measuring the dependent variable(s).
  – Don’t forget the control group.

• Develop clear written guidelines for laboratory procedures with enough detail to allow others to duplicate your work.
Experimental Design

• Develop a description and size of all experimental and control groups.
• List everything you must do to perform your experiment.
  – Think about all the steps that you will need to go through to complete your experiment, and how much time will be required for each step.
• Define how you will change your independent variable and how you will measure that change
• Define how you will measure the resulting change in the dependent variable(s)
• The experimental procedure should explain how the control variables will be maintained
• Specify how many times you intend to repeat your experiment, so that you can verify that your results are reproducible.
• Consider the analysis of data, graphical representation and appropriate statistical methods as appropriate.

• Remember: A good experimental design enables you or someone else to duplicate your experiment exactly!
Analysis & Reporting

• Ask for help.
• Consider statistical methods before you begin.
• Draw the data tables and set up worksheets so that data can easily added.
• Start drafting the final poster and manuscript early.
• Build the report as you go.
Developing the Student Proposal
Getting started.

• Ask your mentor for:
  – Review articles.
  – Grant proposals.
  – Presentations.

  – Develop a clear understanding of the “big picture”.

Components of the Proposal

• **Introduction**
• **Specific Aims**
• **Research Strategy**
  – *Significance*
  – *Innovation*
  – *Approach*, including Preliminary Studies
• **References**
Proposal Development

• **Introduction**
  – State the importance of this *area of research.* Describe the problem or critical need being addressed.

• **Specific Aims**
  – State concisely the goals of the proposed research and summarize the expected outcome(s), including the impact on the research field(s) involved.
  – List succinctly the specific objectives of the research proposed, e.g., to test a stated hypothesis, create a novel design, solve a specific problem, challenge an existing paradigm or clinical practice, address a critical barrier to progress in the field, or develop new technology.
Proposal Development

• **Research Strategy**
  – *Significance*
  – Explain the importance of the problem or critical barrier to progress in the field that the proposed project addresses.
  – Explain how the proposed project will improve scientific knowledge, technical capability, and/or clinical practice in one or more broad fields.
  – *Innovation*
  – Explain how the application challenges and seeks to shift current research or clinical practice paradigms.
  – Describe any novel theoretical concepts, approaches or methodologies, instrumentation or intervention(s) to be developed or used, and any advantage over existing methodologies, instrumentation or intervention(s).
  – *Approach*, including Preliminary Studies
  – Describe the overall strategy, methodology, and analyses to be used to accomplish the specific aims of the project.
  – Discuss potential problems, alternative strategies, and benchmarks for success anticipated to achieve the aims.

• **References**
  – The references should be limited to relevant and current literature.
**NAME**
Charles R. Long

**POSITION TITLE**
Assistant Professor

eRA COMMONS USER NAME (credential, e.g., agency login)
crlong

**EDUCATION/TRAINING** *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)*

<table>
<thead>
<tr>
<th>INSTITUTION AND LOCATION</th>
<th>DEGREE (if applicable)</th>
<th>MM/YY</th>
<th>FIELD OF STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Missouri, Columbia</td>
<td>B.S.</td>
<td>1986</td>
<td>Animal Science</td>
</tr>
<tr>
<td>University of Missouri, Columbia</td>
<td>M.S.</td>
<td>1989</td>
<td>Animal Science; Genetics</td>
</tr>
<tr>
<td>University of Massachusetts, Amherst</td>
<td>Ph.D.</td>
<td>1996</td>
<td>Veterinary &amp; Animal Science</td>
</tr>
</tbody>
</table>
Biosketch

A. Personal Statement

B. Positions and Honor
   Positions and Employment
   Other Experience and Professional Memberships
   Honors

C. Selected Peer-reviewed Publications
   Most relevant to the current application
   Additional recent publications of importance to the field (in chronological order)

D. Research Support
   Ongoing Research Support
   Completed Research Support
Ask for help as soon as you need it. Don’t delay.