

# Appendix

Teaching Undergraduate Students How to Identify a Gap in the Literature:  
Design of a Visual Map Assignment to Develop A Grant Proposal Research Question.

By

Anne Kruchten, PhD, and Jenean O'Brien, PhD

In

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## A. Signaling Pathway Map Instructions

In the field of cell biology, we use pathway maps to describe what is happening both inside and outside of a cell. We also use pathway maps in a two-dimensional format to convey a third dimension of time. These maps are critical to our understanding of cell biology, and due to the rapid changes in the field, the maps are rapidly changing as well. In order to be proficient in the field, a scientist must be proficient at both reading and creating these forms of visual communication.

Visual pathway maps are also a good way to summarize large amounts of information and quickly understand a particular research area. We will use this aspect of pathway maps to develop your understanding of a particular field and discern the areas of a field in which information is lacking. Your map should tell the story of your chosen drug's actions even when you aren't present to explain it. In this way, you will develop a pathway map to encompass the background required for your grant proposal.

Creating this map requires a significant amount of critical thinking skills. First, you must develop good search terms to find relevant sources. Next, you must take time to review each source and make a decision about whether it is relevant to this project, as defined by the steps below. Finally, you must synthesize the information in the article into the large field and place it appropriately onto the map you produce. Because of the complexity of the project, I suggest that you work on it in stages and do not wait until the last minute.

To complete this assignment, follow the steps below:

1. Choose a drug that you are interested in studying. The term "drug" is used loosely here. A drug could be a pharmaceutical agent, an environmental toxin, or other chemical. The only requirement is that your drug interacts with a cell and initiates a signaling reaction in the cell.
2. Research your drug in the primary (and secondary) literature. As you read each article, add a visual summary of the article to your pathway map. For example, if you learn from an article that your drug interacts with receptors X, Y and Z, draw those interactions on your map.
3. Every item that you add to your map should be properly referenced using a numbering system that corresponds to CSE style references in a numbered bibliography (this can be separate from your map image.) Endnote is an excellent citation management system that we will discuss in class. It can be downloaded for free at <http://libguides.css.edu/GettingStarted/CitationHelp#s-lg-box-wrapper-349979>.
4. Focus on the direct effects of your drug on signal transduction and the initiation of the signaling cascade. A secondary focus can be on the cellular outcomes of the signaling cascade.
5. When you cannot find information about a step on your map, such as how the pathway moves from point A to point B, label this step with a question mark. Your first draft will likely have multiple question marks.

Your completed signaling pathway map must

- Fill one side of a 24" x 24" piece of paper (printed copies for class may be 8.5" x 11")
- Be produced and submitted in digital form.
- Be submitted to Blackboard as a PDF with the file name LastFirst\_MapDraft or LastFirst\_MapFinal as appropriate
- Follow the conventions of published signaling maps, such as the use of arrows, limited text, labeling, shapes, etc. As you research your drug, pay attention to the maps you see in the literature.
- Use line, color, space, shape, value, texture, etc, as described in our art discussion, to successfully portray the cellular events initiated by your drug
- Include one or more question marks noting areas of research which are missing information.
- Include a central question developed after you finish your research, suggested by the question marks you labeled on your map.
- Describe how your drug interacts with the cell, the target cell type and receptor type, the immediate steps that occur after interaction with the cell, and the major effects the drug has on the cell.
- You may consider adding a key to explain the symbols.
- Your title should indicate the drug and its general function/relevance.

**Some dates to remember:**

- 1/22 Bring a drug idea (or ideas) to class for discussion
- 1/24 Art discussion
- 2/7 First draft of maps due; peer review in class
- 2/14 Beginning of scheduled feedback appointments
- 2/24 Final draft of maps due; peer review in class
- 4/22 Presentation of signaling pathway maps at the Scholarship and Creative Arts week

Late assignments included in the semester long project, including both drafts and final products, will result in grade reductions.

Absence at a peer review day or failure to bring a draft for peer review will result in grade reductions.

## B. Draft Pathway Map Peer Review Form

Name of Reviewer \_\_\_\_\_

- 1) What is the first thing you noticed about the pathway map?
  
- 2) What order did you take through the pathway map? Was it clear what order the designer wanted you to take through the map?
  
- 3) What parts/areas confused you? Why?
  
- 4) What suggestions (constructive criticism) do you have for improvement?  
Specific feedback is very helpful.

### Review Criteria for Signaling Pathway Map – please score accordingly:

Element	10	7	5	3	0
<b>Central question</b>	The focus of the pathway map highlights the central question while effectively framing it in the context of the cell. The unknown elements are highlighted				The central question is undefined
<b>Line, shape, value, texture, and color</b>	Art elements are effectively used to convey the message.				Art elements are not effectively used.
<b>Time</b>	The importance of time relationships are effectively conveyed using arrows, spacing, or some other mechanism				Events appear to occur simultaneously
<b>Space</b>	Space is used appropriately to organize the map in the context of the cell				Cellular contexts are not conveyed appropriately
<b>Citations</b>	Significant and appropriate citations are included in CSE formatting.				Citations are not appropriately included.
<b>Other comments</b>					

## C. Final Pathway Map Peer Review Questions

Name of Reviewer \_\_\_\_\_

1) What do you see when you read this pathway map? Briefly summarize how the pathway works.

2) What parts/areas confused you? Why?

## D. Pathway Map Grading Rubric

Name \_\_\_\_\_

Grades for late assignments included in the semester long project, including both drafts and final products, will be reduced 10% for each 24 hour period they are late.

Absence at a peer review day or failure to bring a draft proposal for peer review will result in a 20% reduction in your grade for that portion of the semester long project.

2/7 First draft of maps due; turned in: \_\_\_\_\_

In-class and ready with draft: \_\_\_\_\_

2/24 Final draft of maps due; turned in: \_\_\_\_\_

In-class and ready with draft: \_\_\_\_\_

### Grading Rubric for Signaling Pathway Map

Element	10	7	5	3	0
<b>Central question</b>	The focus of the pathway map highlights the central question while effectively framing it in the context of the cell. The unknown elements are highlighted				The central question is undefined
<b>Line, shape, value, texture, and color</b>	Art elements are effectively used to convey the message.				Art elements are not effectively used.
<b>Time</b>	The importance of time relationships are effectively conveyed using arrows, spacing, or some other mechanism				Events appear to occur simultaneously
<b>Space</b>	Space is used appropriately to organize the map in the context of the cell				Cellular contexts are not conveyed appropriately
<b>Citations</b>	Significant and appropriate citations are included in CSE formatting.				Citations are not appropriately included.

Final Score: \_\_\_\_\_

Other Comments:

## E. Map to Research Question Worksheet

Using your signal pathway map to frame a grant proposal question

1. Briefly list/describe the major elements of your signaling pathway.
2. What are the major conclusions that are known about how your pathway works?
3. How does this work contribute to our understanding of this topic?
4. What are some remaining questions?
5. Look at your list of questions above and mark each question with one or more of the following labels:  
I = Important question to advance the field  
E = Fairly straightforward question to address experimentally (specific aims)
6. Are any of your questions labeled both I and E? These questions typically make good grant proposal ideas.
7. If no questions are both I and E, consider trying to break some of your I-labeled questions into more easily answerable questions.

## F. Grant Proposal Instructions

Using the information developed from the pathway maps, each student will write a grant proposal, review their peers' proposals, and revise their own proposal. Proposals will be evaluated for scientific content, writing style, incorporation of appropriate methods to address the question, and overall significance. Detailed instructions for writing a grant proposal are found on pages 219-229 of the Short Guide to Writing About Biology by Pachenik (available on Blackboard).

All proposals must follow the following guidelines:

- 12-point serif font with 1 inch margins on all edges and single spaced throughout
- Numbered figure captions for all images, placed below the image (these may be in font as small as 10-point); Table headings above all tables
- Files must be submitted to Blackboard and/or Turnitin as directed below as a Word document with the file name LastFirst\_ProposalDraft or LastFirst\_ProposalFinal as appropriate
- Appropriate formatting (headings, indentations, etc) for ease of readability for the reader
- Incorporation of your signaling pathway map with an appropriate figure caption.
- Development of a single overarching research question and one specific aim to address this question
- Development of two experimental designs (a primary design and an alternative design) to address the specific aim
- Inclusion of all sections as described below

Important dates to remember:

2/24	Complete "Using your signal pathway map to frame a grant proposal question" form in class
3/25	First draft of proposal due via Blackboard; peer reviews in class
3/27	Beginning of scheduled feedback appointments
4/8	Final draft of proposal due via Turnitin and Blackboard
4/20	Grant funding meeting; peer critiques due in class

### Sections of a Grant Proposal

#### Introduction

This section is similar to an abstract in a research paper in that it summarizes the whole proposal. Typically a single page, this page must catch the attention of the grant reviewer and describe:

- Why your question is being asked (why is it important? what led up to this question? 1-2 paragraphs);
- Your single overarching research question/hypothesis and one specific aim to address this question;
- What experimental work is proposed to address the question; and
- how any results will impact the scientific community.

Like an abstract, this section is often best written last. It will likely be revised and edited several times through this process. The answer to question number four on the attached worksheet is often the central focus of an introductory paragraph in this section, followed by the central research questions, or specific aims, determined in questions 5, 6, and 7.

#### Background

This section establishes a framework for your scientific question. The answers to questions 1, 2, and 3 on the attached worksheet create the main body of the background section, which is typically three to four pages including images (your pathway map, figures that were helpful from articles you read). How has this field developed? Where does the field stand now? Often described from a broad level down to a more detailed, narrow level. Although this includes a summary of the literature, rather than being simply a review of all available information, the background section is a persuasive essay that supports the central thesis – your research question/hypothesis and specific aim. It should be clear how your study fits into the current research in the field. Also, how will your study move the field forward? The answer to question number four is often found at the end of the background section as a summary of the persuasive essay. That is, this section ends with a single overarching research question/hypothesis and one specific aim you plan to pursue.

#### Proposed Research

In this section, your job is to describe to the reviewer the types of experiments you will perform to address your specific aim, to investigate your central research question. An equally important job is to convince the reviewer that you have the competency and experience to perform this work. Both of these tasks can be accomplished by adequately describing



experiments. To answer your specific aim described above, you should thoroughly describe one experimental approach that would address this aim. Additionally, you should describe one alternative experimental approach that you would take in the event that the primary approach does not work for technical reasons. The alternative approach can be described in less thorough detail. These sections should be brief, without the detail of a materials and methods section of a research paper. However, significant details should be included, such as the conceptual framework (why each piece), design (major differences between experimental and control groups, treatment types), methods (including how you analyze the results) and interpretation of expected data (describe both: the outcome if your hypothesis is correct AND what the data would look like if it does not support your hypothesis). Confidence is often gained by describing alternative methods that will be used should the primary methods fail. This section is typically three to four pages, including images. Diagrams explaining the overall experimental process and demonstrating theoretical results (for both outcomes) are often helpful.

#### Literature Cited

References should be cited in text. List all literature references using CSE style (see the CSE style guide on the library website for more information <http://libguides.css.edu/biology>). *The references should be limited to relevant and current literature.* While there is not a page limitation, it is important to be concise and to select only those literature references pertinent to the proposed research.

For more information on ethically and appropriately using sources in your work, see the library guide at <http://libguides.css.edu/biology>. As a resource for you to check for both plagiarism and grammatical errors, proposals may be submitted via Turnitin at any point during the writing process. See the Turnitin Student Instructions for more information at <http://resources.css.edu/library/docs/turnitinforstudents.pdf>.

## G. Draft Grant Proposal Peer Review Form

~10 minutes per draft, each student reviews two drafts

You're not reading for total comprehension but for big picture understanding. In other words, can you find the following components and answer the following questions?

Please respond to the following questions. Also feel free to write edits and comments directly on the draft.

- 1) Overall – how do you feel about what it looks like? Is it too long? Too short? Are the right sections present? Can you tell what it's about? Write your response here:

### Introduction Section:

- 2) Underline the sentence in the introduction that actually highlights the important problem.
- 3) Briefly describe what we will learn if we fund this proposal – what is the goal of this project? Write your response here:

### Background Section:

- 4) Underline the topic sentence of each paragraph.
- 5) Write bullet points about the important things we already know about this topic. What information are you walking away with as the reviewer? Write your bullet points here:
- 6) What's unclear to you? Write your response here:

### Research Section:

- 7) Summarize the question. Write your response here:
  
- 8) Summarize the experimental design. Write your response here:

## H. Grant Proposal Grading Rubric

Category	Score	Comments
<b>Introduction</b>		
Does this study address an important problem? -Why this question is being asked; Why is it important? What led up to this question? <b>20 points</b>		
If the aims of the application are achieved, will this advance scientific knowledge? -A single overarching research question and one specific aim to address this question; -What experimental work is proposed to address the question; and -how any results will impact the scientific community. <b>20 points</b>		
<b>Background</b>		
Is it clear how this field has developed and where the field stands now? -broad to narrow -summary of literature <b>20 points</b>		
Is it clear how this study fits into the current research in the field, and how this study will move the field forward? -ends with single overarching research question and one specific aim <b>20 points</b>		
<b>Proposed Research</b>		
Are the conceptual framework (why each piece), design (controls, groups defined), methods, and analyses (expected outcomes for correct and incorrect) adequately developed, well integrated, and appropriate to the aims of the project? <b>20 points</b>		
Does the applicant acknowledge potential problem areas and consider alternative tactics? <b>20 points</b>		
<b>References cited</b>		
Are the ideas used in the proposal appropriately referenced in-text? Is CSE style correctly and uniformly used? Appropriate and relevant? <b>10 points</b>		
<b>Writing Style</b>		
Is the writing grammatically correct and has it been proofread? Stylistically, does the writing flow from one idea to the next? <b>10 points</b>		
<b>Formatting</b>		
-12-point serif font, 1-inch margins, single spaced -Numbered figure captions for all images, placed below the image. Table headings above all tables. -Incorporation of your pathway map with an appropriate figure caption.		

<b>10 points</b>		
<b>Total for Proposal (out of 150 points)</b>		
<b>Category</b>	<b>Score</b>	<b>Comments</b>
<b>Other Components</b>		
<b>Draft (10 points)</b> Turned in on time and brought to class for peer review		
<b>Peer Review (10 points)</b> Present and participated in full peer review.		
<b>Instructor meeting (5 points)</b> Met with instructor, brought copy of draft to meeting.		
<b>Final version (10 points)</b> Turned in on time and incorporated peer and instructor feedback.		
<b>Review for Funding Meeting (10)</b> Completed two thoughtful reviews on time.		
<b>Funding Meeting (5 points)</b> Present and participated in funding meeting.		
<b>Total for Other (out of 50 points)</b>		
<b>Overall Score (out of 200 points)</b>		

# I. Funding Meeting Reviewer Form

Proposal # \_\_\_\_\_

Reviewer's Name \_\_\_\_\_

	Score	Comments
<b>Introduction</b>		
Does this study address an important problem?  <b>7 points</b>		
If the aims of the application are achieved, will this advance scientific knowledge?  <b>7 points</b>		
<b>Background</b>		
Is it clear how this field has developed and where the field stands now?  <b>7 points</b>		
Is it clear how this study fits into the current research in the field, and how this study will move the field forward?  <b>7 points</b>		
<b>Proposed Research</b>		
Are the conceptual framework, design, methods, and analyses adequately developed, well integrated, and appropriate to the aims of the project?  <b>7 points</b>		
Does the applicant acknowledge potential problem areas and consider alternative tactics?  <b>7 points</b>		
<b>References cited</b>		
Are the ideas used in the proposal appropriately referenced? Is CSE style correctly and uniformly used?  <b>4 points</b>		
<b>Writing Style</b>		

Is the writing grammatically correct and has it been proofread? Stylistically, does the writing flow from one idea to the next?  <b>4 points</b>		
<b>Total Points (out of 50):</b>		

## J. Funding Meeting Instructions

In your group, spend approximately 5-10 minutes per proposal.

The two readers of each proposal should lead the discussion.

- 1) The primary reviewer (Reviewer #1) starts the discussion:
  - a) Summarize the proposal's ideas.
  - b) Use the Funding Meeting Reviewer Form you completed before class to highlight the strengths and weaknesses of each proposal.
- 2) The secondary reviewer (Reviewer #2) adds additional comments.
- 3) The rest of the group should ask questions and be sure you understand the overall proposal.
- 4) Decide as a group on an overall score (1 through 5) and record it on your Funding Meeting Ranking Form.  
  
1=Highly recommended for funding  
3=In the middle  
5=Not recommended for funding
- 5) After reviewing all proposals, the group should make a consensus recommendation on the top two proposals (rank them as #1 and #2 on your Funding Meeting Ranking Form).

Example of the Funding Meeting Ranking Form

Proposal #	Reviewer #1 Score	Reviewer #2 Score	Overall Group Score	Rank Top 2
5	43/50	48/50	1	1
6	36/50	42/50	3	
7	32/50	37/50	4	
8	40/50	44/50	1	2

# K. Funding Meeting Ranking Form

(each group only receives their group's chart and views their group's completed chart, this is a master copy)

## Group 1

1 – Highly recommend funding 3- In the middle 5- Not recommended

Proposal #	Review #1 Score	Review #2 Score	Group Score	Rank Top 2
1				
2				
3				
4				

## Group 2

1 – Highly recommend funding 3- In the middle 5- Not recommended

Proposal #	Review #1 Score	Review #2 Score	Group Score	Rank Top 2
5				
6				
7				
8				

## Group 3

1 – Highly recommend funding 3- In the middle 5- Not recommended

Proposal #	Review #1 Score	Review #2 Score	Group Score	Rank Top 2
9				
10				
11				
12				

## Group 4

1 – Highly recommend funding 3- In the middle 5- Not recommended

Proposal #	Review #1 Score	Review #2 Score	Group Score	Rank Top 2
13				
14				
15				
16				

## Group 5

1 – Highly recommend funding 3- In the middle 5- Not recommended

Proposal #	Review #1 Score	Review #2 Score	Group Score	Rank Top 2
17				
18				
19				
20				