

## **Introduction to Writing Scientific Articles for Undergraduate and Graduate Students**

The purpose of this resource is to help undergraduate and graduate students develop the skills to write introduction and discussion sections in scientific articles and to write literature review articles. Before articles are published, they are called manuscripts. This document includes:

**Part 1. How to Write an Introduction to a Scientific Manuscript**

**Part 2. How to Write a Discussion to a Scientific Manuscript**

**Part 3. How to Write a Literature Review Manuscript**

**Part 4. Writing Tips and Resources**

## Part 1. How to Write an Introduction to a Scientific Manuscript

The purpose of this section is to help you develop the skills to write an introduction to a scientific manuscript. This section includes:

- I. Overview of Manuscript Introductions
- II. How to Study an Example Introduction
- III. How to Brainstorm for Your Introduction
- IV. How to Outline Your Introduction

### I. Overview of Manuscript Introductions

In an introduction to a scientific manuscript, an author should communicate **why** they are addressing their specific hypothesis, objective, or research question, and **what** their specific hypothesis, objective, or research question is. To explain why they are doing their project, the author presents background information, which is used to identify a specific **knowledge gap** and to communicate the **importance of filling it**. To explain what their project is, the author explicitly states the **hypothesis, objective, or research question**. In their introductions, authors commonly communicate the “why” and “what” of their projects by using sentences that answer these four questions:

- 1) What is already known about the topic of this paper?
- 2) What is the knowledge gap that this paper intends to fill?
- 3) Why is filling this knowledge gap important?
- 4) What hypothesis, objective, or research question does this paper address?

Each sentence in an introduction can be categorized by the question it answers. By studying the introductions to a few papers and identifying where authors put these four types of sentences, you can develop an intuition for where readers expect to find certain types of information and where there is freedom to not follow a strict, formulaic structure. Three structural norms to watch for include:

- The specific objectives are laid out in the last paragraph of the introduction. This is typical and important. Scientists jump to the last paragraph of the introduction to look for the specific objectives.
- The first paragraph of the introduction is often a microcosm of the entire introduction. The first paragraph may include one or two sentences that answer each of the four questions. At the end of the first paragraph, it helps if there is a reference to the objective of the paper, at least in a broad sense, so the reader knows early-on where the introduction, and the paper, is headed.
- Overall, introductions often begin with a broad statement of the research problem and then narrow to the more specific knowledge gap addressed in the paper. This structure is often depicted as a funnel or upside-down triangle (Benninghoff, 2020).



Broad

Specific

## II. How to Study an Example Introduction

As with any art form or skilled task, a person begins to learn how to do it by studying examples. When learning how to write in a specific genre, this means not only reading pieces of writing from that genre but also analyzing them: breaking them down, thinking about why they are structured the way they are, thinking about what aspects of the structure or style you might want to emulate the next time you sit down to write.

In this section, I use Vasudevan et al. (2017) to model how a person who wants to learn how to write an introduction could study an example. I provide the model in two forms: a pdf with annotations in the margins and Table 1, which condenses the annotations so it's easier to compare paragraphs and see patterns. In looking through the pdf, you may categorize the sentences somewhat differently. That is okay, even good. A sentence can serve multiple purposes, and readers might interpret the primary purpose differently. Analyzing and annotating examples of scientific writing isn't about matching the interpretation of another reader; the goal is to develop the skill of thinking about writing in this way.

As part of completing the exercises in this resource, it is recommended that you annotate the introductions of two papers of your choice, using the annotated introduction in the Vasudevan et al. (2017) pdf as a model. When I choose a scientific paper to study, I typically print it out in hard copy. Then, in the margins, I pencil notes about what each sentence is doing. For each sentence, I ask myself: What work is this sentence doing? What type of question is this sentence answering? How does that question fit into the overall goal of the introduction?

Table 1. How the introduction of Vasudevan et al. (2017) is organized, sentence by sentence.

SENTENCE	CONTENT
Paragraph 1	
1	<b>Introducing process under study</b>
2, 3	<b>What is known about how the process works</b>
4	<b>Knowledge gap</b>
5	<b>What is known within the knowledge gap</b>
6	<b>Hypothesis</b>
7	<b>Importance of work</b>
Paragraph 2	
1–3	<b>Discussion of knowledge gap; narrowing of knowledge gap</b>
Paragraph 3	
1–7	<b>What is known about one part of the hypothesized mechanism</b>
Paragraph 4	
1	<b>What is known about another part of the hypothesized mechanism</b>
2	<b>How two parts of hypothesized mechanism may interact; knowledge gap</b>
Paragraph 5	
1–10	<b>What is known about how the hypothesized mechanism works</b>
Paragraph 6	
1	<b>Claim of the importance of this research</b>
2–4	<b>Support for the claim of importance</b>
5	<b>Hypothesis</b>
6	<b>How hypothesis was addressed</b>

### III. How to Brainstorm for Your Introduction

If you are like most writers, sitting down to write a functional introduction may feel daunting. One reason writing an introduction can feel difficult is because it involves two tasks that seem to need to happen simultaneously: generating ideas and organizing them. It's easier if we tackle these tasks one at a time. This section provides questions to help you generate the ideas you need to write your introduction. Below each question are key phrases that are often found in sentences that answer that question (Benninghoff, 2020).

\* Every aspect of your paper should relate to your hypothesis, objective, or research question. The first question in this list asks you to articulate your specific objective. This is designed to help you stay centered on your topic as you answer the rest of the questions.

#### 1. What are your specific objectives?\*

We predicted/hypothesized that...  
To determine/study/examine/assess/analyze...  
In this study, we examined...  
This report describes...  
We examined whether X is...  
We determined if...  
We analyzed Y...

#### 2. What specific knowledge gap is your paper intending to fill?

...is unknown/unclear  
...has not been determined  
...does not exist  
The questions remains whether...

#### 3. Why is filling this knowledge gap important?

Understanding X will...

#### 4. What is the larger research problem your work will contribute to solving?

X is/affects...

#### 5. What background knowledge will your reader need to understand your research question?

X is/affects...  
X is a component of Y  
X is observed when Y happens...  
X causes Y

#### **IV. How to Outline Your Introduction**

I ordered the brainstorming questions to match how I might think about my research. But this order is different from the order of topics I would expect to see in an introduction. Below, I have reordered the questions to resemble a typical introduction. Cutting and pasting your content into this order could be a useful starting point.

First paragraph with one sentence addressing each question:

4. What is the larger research problem your work will contribute to solving?
5. What background knowledge will your reader need to understand your research question?
2. What specific knowledge gap is your paper intending to fill?
3. Why is filling this knowledge gap important?
1. What are your specific objectives?

Body paragraphs to expand on relevant background information:

4. What is the larger research problem your work will contribute to solving?
5. What background knowledge will your reader need to understand your research question?

Paragraph delineating the knowledge gap:

2&3. What specific knowledge gap is your paper intending to fill? Why is filling this knowledge gap important?

Objectives paragraph:

1. What are your specific objectives?

#### **Questions to guide your outline:**

- What norms and variations did you notice in the two example introductions you studied in Part II?
- How can you put key information in the positions where scientists would expect to find it and order your ideas in a way that makes sense for your topic?

## Part 2. How to Write a Discussion to a Scientific Manuscript

The purpose of this section is to help you develop the skills to write a discussion to a scientific manuscript. This document includes:

- I. Overview of Manuscript Discussions
- II. How to Study an Example Discussion
- III. How to Brainstorm for Your Discussion
- IV. How to Outline Your Discussion

### I. Overview of Manuscript Discussions

The discussion is where the author identifies whether their results supported their hypothesis or not. In the discussion, the author can explain why they got their results and why they arrived at their conclusion; they can compare specific results from their study with results from other studies and present their ideas about what all the information taken together could mean. Eight types of sentences are common in discussions:

- 1) Review of background, knowledge gap, objective, and/or methods
- 2) Statements of key findings: What was the answer to the research question?
- 3) What specific results led to this conclusion?
- 4) How do results relate to other research?
- 5) Speculation about why those results were found in this study
- 6) Speculation about how the greater process works based on evidence
- 7) Why is this research important?
- 8) What research remains to be done?

By studying the discussion sections of a few papers and identifying where authors put these eight types of sentences, you'll develop an intuition for where readers expect to find specific types of information and where there is freedom to not follow a strict, formulaic structure. One norm to watch for is:

- The key finding (i.e., the answer to the research question) should be in a prominent location, such as the first sentence of the discussion. In Vasudevan et al. (2017), the key finding is stated in the topic sentence of paragraph three and signals the beginning of the actual discussion of results.

## II. How to Study an Example Discussion

As with any art form or skilled task, a person begins to learn how to do it by studying examples. When learning how to write in a specific genre, this means not only reading pieces of writing from that genre but also analyzing them: breaking them down, thinking about why they are structured the way they are, thinking about what aspects of the structure or style you might want to emulate the next time you sit down to write.

In this section, I use Vasudevan et al. (2017) to model how a person who wants to learn how to write a discussion could study an example. I provide the model in two forms: a pdf with annotations in the margins and Table 2, which condenses the annotations so it's easier to compare paragraphs and see patterns. In looking through the pdf, you may categorize the sentences somewhat differently. That is okay, even good. A sentence can serve multiple purposes, and readers might interpret the primary purpose differently. Analyzing and annotating examples of scientific writing isn't about matching the interpretation of another reader; the goal is to develop the skill of thinking about writing in this way.

As part of completing the exercises in this resource, it is recommended that you annotate the discussions of two papers of your choice, using the annotated discussion in the Vasudevan et al. (2017) pdf as a model. When I choose a scientific paper to study, I typically print it out in hard copy. Then, in the margins, I pencil notes about what each sentence is doing. For each sentence, I ask myself: What work is this sentence doing? What type of question is this sentence answering? How does that question fit into the overall goal of the discussion?

Table 2. How the discussion of Vasudevan et al. (2017) is organized, sentence by sentence.

SENTENCE	CONTENT
Paragraph 1	
1	<b>Knowledge gap</b>
2	<b>Summary of process under investigation</b>
3	<b>What was hypothesized</b>
4	<b>Basis for hypothesis</b>
Paragraph 2	
1–4	<b>Rationale for study subject</b>
5	<b>Need for this research</b>
6–7	<b>What was already known about process under investigation</b>
8–10	<b>Rationale for methods, connecting methods to the focus of this study</b>
11	<b>Summary of focus of this study; area of future research</b>
Paragraph 3	
1	<b>Key finding: what results showed about hypothesis</b>
2	<b>Similarity to other research; 1st category of evidence that supports hypothesis</b>
3	<b>Difference between this result and other research</b>
4	<b>Suggested reason for difference</b>
5–6	<b>Details about methods and results of this study that relate to difference</b>
7	<b>How methods may have affected results that relate to difference</b>
8	<b>Fact from similar research on other species</b>
9	<b>Specific result from this study and how it may relate to the hypothesis</b>
10	<b>Remaining knowledge gap</b>

SENTENCE	CONTENT
Paragraph 4	
1	<b>2nd category of evidence from this study that supports hypothesis</b>
2	Similarity of this evidence to similar research on other species
3	Fact from similar research on other species
4	<b>Remaining knowledge gap</b>
5	<b>Rationale for method to investigate the basis for the first and second categories of evidence that supported the hypothesis</b>
6	<b>Result of investigation</b>
7	Similarity and difference between this result and other research
8–10	Related findings from other research
11	<b>Possible explanation for how hypothesized process works in this study based on findings from other research</b>
12	<b>Remaining knowledge gap</b>
Paragraph 5	
1	<b>3rd category of evidence from this study and how it supports the hypothesis</b>
2	Fact from other research that supports connection between the evidence from this study and the hypothesis
3	<b>Hypothesized detail about evidence</b>
4–6	<b>4th category of evidence from this study and how it relates to other evidence from this study</b>
7	<b>Possible explanation for how hypothesized process works based on evidence from this study</b>
8	<b>Statement of belief in explanation</b>
9	<b>Follow-up idea to explanation</b>
Paragraph 6	
1	<b>Rationale for investigating follow-up idea, a 5<sup>th</sup> category of evidence</b>
2–4	<b>Result of investigation</b>
5–9	<b>Possible explanation for how hypothesized process works based on other research</b>
10	<b>Related, surprising result from this study</b>
11–13	<b>Possible explanation for surprising result</b>
14	<b>Remaining knowledge gap</b>
Paragraph 7	
1	<b>Definition of a 6th category of evidence that was investigated</b>
2–3	<b>Rationale for investigating it</b>
4	<b>Result of investigation</b>
5	<b>Interpretation of result (did not appear to be a part of the hypothesized process)</b>
6–10	<b>Possible explanation for how hypothesized process works based on other research</b>
Paragraph 8	
1	<b>A 7th category of evidence that was investigated</b>
2–4	<b>Rationale for investigating it</b>
5	<b>Result of investigation</b>
6	<b>Definition of term</b>



SENTENCE	CONTENT
7	<b>Result of investigation, using term</b>
8	<b>Fact from other research</b>
9–10	<b>Results of investigation</b>
11–12	<b>Possible explanation for how hypothesized process works based on evidence from this study and other research</b>
Paragraph 9	
1	<b>An 8th category of evidence that was investigated</b>
2–4	<b>Conflicting results from other research on this topic</b>
5	<b>Result of investigation</b>
6	<b>How result relates to hypothesis</b>
7	<b>Rationale for a 9th category of evidence that was investigated</b>
8–9	<b>Results of investigation</b>
10	<b>How results relate to hypothesis</b>
11	<b>Remaining knowledge gap</b>
12	<b>Possible explanation for how hypothesized process works based on evidence from this study</b>
Paragraph 10	
1	<b>Restatement of objective</b>
2	<b>Restatement of key evidence (Categories 1 and 2) that supported hypothesis</b>
3–4	<b>Restatement of key evidence (Category 3) that supported hypothesis</b>
5–6	<b>Restatement of key evidence (Category 5) that supported hypothesis</b>
7	<b>Restatement of key evidence (Category 8) that supported hypothesis</b>
8	<b>Affirmation that results support hypothesis</b>
9	<b>Importance of this research to industry</b>
10	<b>Direction of future research</b>

### III. How to Brainstorm for Your Discussion

If you are like most writers, sitting down to write a functional discussion may feel daunting. One reason writing a discussion can feel difficult is because it involves two tasks that seem to need to happen simultaneously: generating ideas and organizing them. It's easier if we tackle these tasks one at a time. This section provides questions to help you generate the ideas you need to write your discussion. Below each question are key phrases that are often found in sentences that answer that question (Benninghoff, 2020).

\* Every aspect of your paper should relate to your hypothesis, objective, or research question. The first question in this list asks you to answer your specific research question. This is designed to help you stay centered on your topic as you answer the rest of the questions.

#### **1. What is the answer to your research question?\***

We found/determined/observed that...  
Our findings indicate/demonstrate that...  
Our analysis implies/suggests...  
Our results lead to the conclusion that...  
Our study shows that...  
Based on our observations...  
From these data we hypothesize that...  
In this study, we have shown that...  
In this study, we have found that...  
This paper describes...

#### **2. How does the answer to your research question compare with conclusions from other research?**

...consistent with...  
Similar to...  
...has also been observed by...  
...has also been reported...  
X has been demonstrated...  
However, other studies found that...  
...is controversial...  
...does not agree with...

#### **3. What specific results led to your conclusion?**

In our experiments...  
...can be attributed to...  
We determined X by...  
We found that...  
Our data show that...  
...has been demonstrated by...

#### **4. How do those specific results compare with other research?**

...consistent with...

Similar to...  
...has also been observed by...  
...has also been reported...  
X has been demonstrated...  
However, other studies found that...  
...is controversial...  
...does not agree with...

**5. If your results differ from other work, why do you think they differ?**

We propose/expect/suspect that...

**6. If your results weren't what you expected, why do you think you got the results you did?**

Surprisingly,...  
To our surprise...  
...was not expected.  
We propose/expect/suspect that...

**7. Could any of your results mean more than one thing? What are the different interpretations? Which interpretation do you think is more valid? Why?**

...may be used to...  
...is important for...

**8. What do your results indicate about the larger research problem your work relates to?**

Our findings can/can be used to/will serve to...  
We recommend that X is...  
Y should be used for...  
...is probably...  
Y indicates that X might...  
These findings imply that X may...  
Here, we propose/hypothesize that...  
In summary/conclusion,...  
Finally/Taken together/Overall,...  
We conclude that...

**9. What should be studied next?**

...was not possible...  
...could not be measured...  
...was limited by...  
Further observations are needed...

#### **IV. How to Outline Your Discussion**

I ordered the brainstorming questions to match how I might think about my research. But this order is different from the order of topics I would expect to see in a discussion. Below, I have reordered the questions to resemble a typical discussion. Cutting and pasting your content into this order could be a useful starting point.

Begin your first paragraph with your most important finding:

1. What is the answer to your research question?
2. How does the answer to your research question compare with conclusions from other research?

Body paragraphs to expand on what your results mean:

3. What specific results led to your conclusion?\*
4. How do those specific results compare with other research?
5. If your results differ from other work, why do you think they differ?
6. If your results weren't what you expected, why do you think you got the results you did?
7. Could any of your results mean more than one thing? What are the different interpretations? Which interpretation do you think is more valid? Why?

\*Each body paragraph might discuss one specific result and could include your responses to one or more of the questions 4–7.

Paragraph suggesting areas for future work; this could also be interspersed throughout the body paragraphs as it was in Vasudevan et al. (2017):

9. What should be studied next?

Paragraph reiterating the significance of your main finding, returning to the big problem you mentioned at the beginning of the introduction:

8. What do your results indicate about the larger research problem your work relates to?

#### **Questions to guide your outline:**

- What norms and variations did you notice in the two example discussions you studied in Part II?
- How can you put key information in the positions where scientists would expect to find it and order your ideas in a way that makes sense for your topic?

### Part 3. How to Write a Literature Review

The purpose of this section is to help you develop the skills to write a literature review. This document includes:

- I. Overview of Literature Reviews
- II. How to Study an Example Literature Review
- III. How to Brainstorm for Your Literature Review

#### I. Overview of Literature Reviews

The goal of a literature review is often to summarize what is currently known about a clearly defined topic of research. A literature review could include a history of relevant research, key findings and how they fit together, and recommended areas for future studies. Ten types of content are common in literature reviews:

- 1) What is the topic of this review?
- 2) What other resources does the author recommend?
- 3) Why is this topic important?
- 4) What is the history of research on this topic?
- 5) Fundamental background information
- 6) Information on subtopics
- 7) Summaries of prior information
- 8) Identification or discussion of knowledge gaps
- 9) Hypotheses
- 10) Current research

By studying several literature reviews and identifying where authors put these types of content, you'll develop an intuition for what should be included in a literature review and how it could be organized. Ten tips for writing literature reviews are provided in this paper:

Pautasso, M. (2013). Ten Simple Rules for Writing a Literature Review. *PLoS Computational Biology*, 9(7): 1–4. <https://doi.org/10.1371/journal.pcbi.1003149>.

## II. How to Study an Example Literature Review

As with any art form or skilled task, a person begins to learn how to do it by studying examples. When learning how to write in a specific genre, this means not only reading pieces of writing from that genre but also analyzing them: breaking them down, thinking about why they are structured the way they are, thinking about what aspects of the structure or style you might want to emulate the next time you sit down to write.

In this section, I use Ott (2019) to model how a person who wants to learn how to write a literature review could study an example. I provide the model in two forms: a pdf with annotations in the margins and Table 3, which condenses the annotations so it's easier to compare paragraphs and see patterns. In looking through the pdf, you may categorize the sentences somewhat differently. That is okay, even good. A sentence can serve multiple purposes, and readers might interpret the primary purpose differently. Analyzing and annotating examples of scientific writing isn't about matching the interpretation of another reader; the goal is to develop the skill of thinking about writing in this way.

As part of completing the exercises in this resource, it is recommended that you annotate two literature reviews of your choice, using the Ott (2019) pdf as a model. When I choose a scientific paper to study, I typically print it out in hard copy. Then, in the margins, I pencil notes about what each sentence or section is doing. For each part of the text, I ask myself: What work is this sentence or section doing? What type of question is this part of the paper answering? How does that question fit into the overall goal of the literature review?

Table 3. How one literature review, Ott (2019), is organized.

SENTENCE	CONTENT
<b>Heading 1: Introduction and Historical Perspective</b>	
Paragraph 1	
1	<b>Topic of this review</b>
2-4	<b>Where to find reviews on related topics</b>
Paragraph 2	
1-3	<b>Historical importance of study topic</b>
Paragraph 3	
1-4	<b>Historical definition of study topic</b>
Paragraph 4	
1-8	<b>Early advancements in understanding study topic</b>
Paragraph 5	
1-6	<b>What is known about the biological structure that is central to the study topic</b>
Paragraph 6	
1-5	<b>Early advancements in understanding the biological structure and its role in the study topic</b>
<b>Heading 2: Brief Overview of the Immune System</b>	
Paragraph 7	
1-7	<b>Basics of how the bovine immune system works</b>
Paragraph 8	
1-4	<b>Introducing a key characteristic of the immune system: memory</b>
Paragraph 9	

SENTENCE	CONTENT
1–4	<b>Introducing cell types involved in innate immunity</b>
Paragraph 10	
1–10	<b>What one cell type does</b>
Paragraph 11	
1–3	<b>What another cell type does</b>
Paragraph 12	
1–3	<b>More about what certain cell types do</b>
Paragraph 13	
1–7	<b>More about what certain cell types do</b>
8	<b>Reference to introduction where the early discovery of this was described</b>
Paragraph 14	
1–4	<b>Summary of how the immune system works</b>
<b>Heading 3: Immunological Detection of the Bovine Conceptus</b>	
Subheading 1: Mating-induced Immune Response	
Paragraph 15	
1–3	<b>Immune response starts at mating</b>
4–5	<b>What is known about why immune response starts at mating</b>
6	<b>Knowledge gap</b>
7–9	<b>Support for knowledge gap</b>
10	<b>Reiteration of knowledge gap</b>
Subheading 2: Immunological Recognition of the Conceptus	
Paragraph 16	
1–4	<b>What is known about immune response early in pregnancy</b>
5	<b>Knowledge gap</b>
Paragraph 17	
1–7	<b>How early pregnancy immune responses work</b>
8	<b>Knowledge gap</b>
9	<b>Importance</b>
Subheading 3: Local (Uterine) Immune Responses to the Conceptus	
Paragraph 18	
1–2	<b>What aspects of the knowledge gap have been studied?</b>
3–5	<b>Weaknesses of previous work</b>
6	<b>Importance</b>
Paragraph 19	
1–2	<b>One cell type present during early pregnancy</b>
3–6	<b>What that cell type does normally vs. during pregnancy</b>
7–11	<b>One study about that cell type during pregnancy in cattle</b>
12–14	<b>What is known about that cell type in rodents and humans during pregnancy</b>
15–16	<b>Why that cell type is thought to be important during pregnancy in cattle</b>
Paragraph 20	
1–4	<b>Other cell types present during early pregnancy</b>
5–8	<b>Similarities between the cell type discussed in the previous paragraph and these other cell types</b>

SENTENCE	CONTENT
9–14	<b>What is known about what all of these cell types do during early pregnancy</b>
Paragraph 21 1–10	<b>What is known or likely about the cell types present during early pregnancy</b>
11	<b>A hypothesis</b>
Paragraph 22 1–6	<b>Mechanisms to protect the conceptus from attack by killer cells</b>
Paragraph 23 1–7	<b>Evidence of killer cells in the endometrium during early pregnancy</b>
8	<b>Reminder of what one cell type does</b>
9–12	<b>More about what cell types have been found during early pregnancy</b>
13–14	<b>Hypothesized relationship between timing of cell types and mechanisms for conceptus survival</b>
Paragraph 24 1–13	<b>Mechanisms for immunosuppression stimulated by the conceptus</b>
Paragraph 25 1–11	<b>More about what cell types have been observed when and how they affect immunosuppression</b>
Paragraph 26 1–3	<b>Definition of another cell type</b>
4–9	<b>Presence of that cell type in the endometrium and its role in immunosuppression</b>
Paragraph 27 1–7	<b>Another cell type present during pregnancy: what has been observed...and what is not understood</b>
8–11	<b>Support for how that cell type affects immunosuppression</b>
<b>Subheading 4: Peripheral Immune Responses to the Conceptus</b>	
Paragraph 28 1–3	<b>One type of peripheral response to pregnancy that affects immunosuppression</b>
4–8	<b>How the response affects immunosuppression</b>
Paragraph 29 1–4	<b>Prior false assumption about the immunosuppression process in cattle</b>
5–7	<b>Basis for correcting the false assumption</b>
8–9	<b>Knowledge gap</b>
10–11	<b>Hypothesis for how it might work</b>
12	<b>Knowledge gap</b>
<b>Heading 4: Summary</b>	
Paragraph 30 1–11	<b>One to two sentences about immunosuppression steps at each stage of early pregnancy</b>
12–14	<b>Areas of current research</b>
15	<b>Importance of research in this field</b>



### **III. How to Brainstorm for Your Literature Review**

If you are like most writers, sitting down to write a literature review may feel daunting. This section provides questions to help you get started.

1. What is the topic of your literature review?
2. Who will be interested in a literature review on this topic and what would they want to know?
3. What is your plan for finding and organizing relevant literature? See Rules 2 and 3 of Pautasso (2013).
4. How was knowledge on your topic built over time? Follow the trail of citations from the references in recent papers back to the first papers on your topic.
5. What topics and subtopics are important, according to the literature?
6. What fundamental background information will your reader need to know to understand specific subtopics?
7. How could you logically order the topics and subtopics?
8. What research on the topic is currently being done?

## Part 4. Writing Tips & Resources

The purpose of this section is to provide you with tips and resources that can help you with scientific writing. This sections includes:

- I. Tips for Writing Manuscripts
- II. Strategies to Help You Write

### I. Tips for Writing Manuscripts

- Organize your ideas in an outline before writing your introduction and discussion. Or, alternatively, start writing and then create an outline. Be aware of how you are organizing your ideas. Be strategic about how you organize your ideas.
- Always mention elements in the same order. For example, the order of steps described in the methods should correspond to the order of the results.
- Results should report findings without interpreting what they mean in relation to the research question. However, a little bit of interpretation here or there could be okay to help tie the ideas together. Study examples of results sections to get a feel for this.
- Anytime you have a discussion with your advisor, your labmate, or a colleague at a conference about what your results mean, write down the ideas that come up. Those ideas are exactly what you'll need when you write your discussion.
- Assume that people may only skim your paper. They might read: 1) The title, 2) The title and abstract, or 3) The title, abstract, and conclusion. Make sure that you clearly communicate your key message in each of those locations.

## II. Strategies to Help You Write

Below is a list of common writing problems in bold, followed by potential solutions.

**I need more content.** Read five more papers.

**I have too much information and no focus.** Group what you have to say into more specific categories that will fit in the length of a paragraph (about half a page, double-spaced).

**I don't know how to begin.** Create an outline with subheadings. Start generating bits of material under the subheadings as ideas come to you.

**I am struggling to get words on paper.** Try timed free writes, where you don't stop putting words down in 10-minute blocks.

**I feel overwhelmed with how much I have to write.** Create small daily assignments for yourself, one or two paragraphs, that will give you a feeling of accomplishment for the day.

**I am not spending enough time writing.** Form a group with a fellow grad student or two and meet weekly to review each other's work.

**I am stuck in a section.** Use placeholders (a quote from a paper or a citation) to allow you to move on to work on other sections.

**I don't like deleting work that took time but no longer fits.** Create a dump document to put things you've written that you like but that are no longer needed. Maybe a place for them will turn up later, and you won't have to start from scratch. Save a new version each day you work on your document.

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