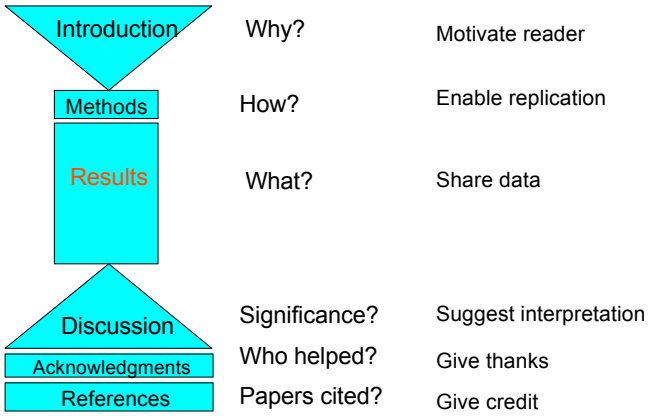
Writing Your Honors Thesis

- Usual scientific paper format. 5 sections
  - Abstract
  - Introduction
  - Materials and Methods
  - Results
  - Discussion
- You are writing the thesis for fellow scientists in your field.

Types of papers:

- Method
- Descriptive
- Hypothesis

All need solid structures
All have one main point which is the one thing you want readers to know.



General guidelines

How long should the thesis be?

- Hard to define a specific length (same as for all scientific publications).
- Longer is not always better.
- Cover the topic, include all relevant data.
- Usually 15-40 double-spaced pages of text.
  - Extra pages for figures and references

General guidelines
Verb tense and active voice

Use past tense in most areas of the paper.

- Introduction. Most experimental work was done in the past.
- Results. Past tense reporting on experiments you DID in the past.
- Present tense is used for ongoing facts. "EcoR1 is a restriction enzyme." "RNA is translated into protein."

Passive voice versus active voice.

- Most science writers will recommend that you use active voice whenever possible which usually means action verbs. However this can be difficult without including yourself in the action.
- Methods section commonly is done with passive voice. "mice were bred. Mice were immunized. Mice were infected."

General guidelines
Where to begin?

Where to begin THE thesis?

Basically two parts--- Data figures, Writing

- Usually best to start with putting your data into figures.
- Start writing whatever section is easiest for you.
- Most people begin with writing methods but others start with Introduction.
- Writing text describing your data can be a starting point.

General guidelines
Deciding what data to use

Which data do you include?

--only data that pertains to your results.

-- only data you generated unless required for story.

Problems with data

--Negative data to demonstrate what did not work.

--Need to distinguish between issues of technique versus outlying values versus inconsistent results.

(do you have data is a different issue)

Summarizing data into figures

1) Figures are a pictorial summary

- Graph → Data in connected series
- Chart → Data in separate series
- Picture → Must be seen (Photos)
- Diagram → Model to show concepts

All have figure Legend

2) Tables → Data in an array

Table format

- Columns and rows
  - Organize a table so that the similar items read down, not across
- Table usually has title above
- Footnotes are BRIEF explanations about data including: Exceptions, Abbreviations, Statistics
  - Do not write out information that belongs in the results!

Ref: V. McMillan

Four parts to figure legends

1. Title
   - One sentence to identify the main point of the figure.
2. Brief experimental details
   - Enough details so that the reader can understand figure.
3. Definitions
   - Symbols or bar patterns that are not explained in figure.
     - Antigen present
     - Control
4. Statistical information
   - Number of samples, p-values, etc.

Common errors in making figures

small amount of data should not be graphed

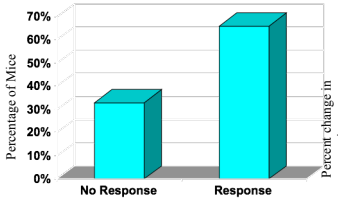


Figure 1. Percentage of mice that responded to amoxicillin treatment. Three mice were treated with 0.5 mg/ml amoxicillin for 7 days.

ANSWER: Include data in text.

Low number of replicates Hard to justify error bars and statistics

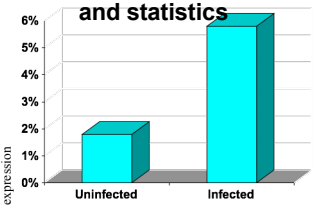


Figure 2. Infected and uninfected cells were tested two times for the change in expression of NF-kB. The average of the two experiments is shown. Infected cells had a greater percent change in expression.

ANSWER: state number of times done. Maybe do not put in fig

How to display the data?

Raw Data from Leishmania paper

Table vs Figure??

Pt #	Case	IFN-g SLA	IFN-g PHA	IL-2 SLA	IL-2 PHA	IL-10 SLA	IL-10 PHA	IgE
		pg/ml	pg/ml	pg/ml	pg/ml	pg/ml	pg/ml	ng/ml
1	Active ACL	1140	>2000	<125	700	50	>2000	600
2	Active ACL	<125	870	<125	120	<125	208	40
7	Active ACL	<125	755	<125	<100	<125	600	190
8	Active ACL	629	<125	<125	600	140	1160	220
12	Active ACL	>2000	>2000	<125	1100	<125	>2000	140
22	Active ACL	<125	>2000	<125	720	<125	930	40
23	Active ACL	<125	250	<125	<100	80	<125	75
24	Active ACL	<125	1045	<125	200	<125	154	140
25	Active ACL	<125	<125	<125	<100	<125	100	320
26	Active ACL	162	697	<125	<100	<125	468	250
27	Active ACL	<125	426	<125	<100	250	210	226
28	Active ACL	<125	<125	<125	<100	250	225	367
29	Active ACL	<125	777	<125	400	460	260	480
30	Active ACL	<125	313	<125	<100	320	770	134
31	Active ACL	<125	1018	<125	300	250	240	57
36	Active ACL	882	720	411	1093	217	>2000	432
37	Active ACL	1568	>2000	600	741	150	482	341
5	Asymptomatic	<125	<125	<125	<100	<125	340	210
6	Asymptomatic	320	196	<125	<100	<125	690	380
9	Asymptomatic	960	>2000	<125	250	<125	720	150
15	Asymptomatic	460	>2000	<125	1500	<125	>2000	100
18	Asymptomatic	210	>2000	<125	700	<125	1450	<15
19	Asymptomatic	<125	>2000	<125	350	<125	>2000	90
20	Asymptomatic	1440	>2000	<125	1000	<125	>2000	140
21	Asymptomatic	500	>2000	<125	1850	<125	>2000	65
34	Asymptomatic	488	>2000	<125	<125	<125	>2000	615
3	Neg ctrl	<125	>2000	<125	<100	<125	538	480
4	Neg ctrl	<125	>2000	<125	<100	<125	300	330
10	Neg ctrl	<125	106	<125	<100	<125	235	140
11	Neg ctrl	<125	>2000	<125	>2000	130	>2000	250
13	Neg Ctrl	980	>2000	<125	550	<125	>2000	40
14	Neg ctrl	<125	>2000	<125	>2000	<125	>2000	90
16	Neg ctrl	<125	>2000	<125	1800	<125	>2000	180
17	Neg ctrl	220	>2000	<125	>2000	<125	>2000	100
32	Neg Ctrl	553	1709	<125	<125	<125	<125	510
33	Neg Ctrl	337	1909	<125	<125	<125	>2000	554
35	Neg ctrl	<125	300	<125	294	<125	>2000	348

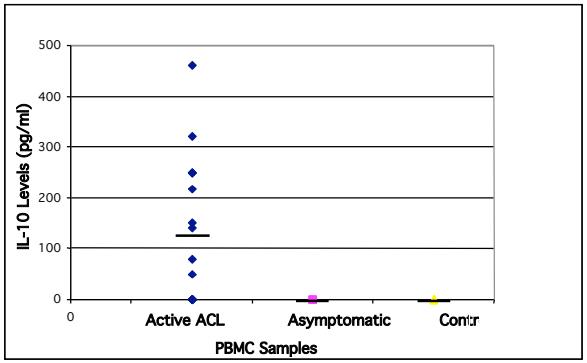


Figure 1. IL-10 produced by PBMCs in response to stimulation with the Leishmania antigen. Peripheral blood mononuclear cells (PBMCs) collected from people with active atypical cutaneous leishmaniasis (ACL) infection, people with asymptomatic ACL, and uninfected people (control) were stimulated with 2 mg of soluble Leishmania antigen (SLA). IL-10 levels were measured by ELISA.

When you begin writing Start with the easiest

(After you have figures ready)

1. Materials and Methods

↓

2. Results

↓

3. Discussion and Introduction

↓

4. Abstract

Biochemistry, Immunology, & Molecular Biology: Content

- Description of samples, strains
- For each experiment:
  - Reaction conditions
  - Reagents
  - Instruments
  - Name and location of suppliers

Reagents

- What was in the reagents?
  - Tris buffer (5 mM NaCl, 5% TRIS, pH 7.6)
  - TE (10 mM Tris-HCl [pH 8.0], 1 mM EDTA)
- Need chemical concentrations in moles or micrograms/milliliters (ug/ml) most of the time.
- Occasionally will only state dilution used.
  - Such as with detergents (0.05% Tween) OR sera (diluted 1:1000 in PBS).

Abbreviations

- Define all reagent abbreviations once
  TE, TBE, SSC, DTT
- Abbreviations for common techniques or buffers are not explained.
  (such as ELISA or PCR)
- But this varies greatly between fields.

Suppliers

In general in publications, you need to

- List the NAME of a reagent and where you bought it.
  Example: Reverse transcriptase (Amersham Corp., Arlington Heights, IL).
- The Name and LOCATION of the supplier of an instrument.
  Example: Cetus 480 thermocycler (Perkin Elmer, Norwalk, CT)

This is probably less critical in an undergraduate honors thesis.

Level of Detail in Methods

- Important to explain what you did so the experiment could be repeated by another scientist.
  - Not the same as a protocol but similar.
- Specifics of how YOU did the flow cytometry, not how to do flow cytometry.

Detail in Methods------ Example

Flow cytometric analysis of spleen cells from infected mice.
After harvest, spleens were disrupted between the frosted ends of two glass slides in complete RPMI medium, which consists of RPMI 1640 (Invitrogen, Carlsbad, CA) supplemented with 10% fetal calf serum (FCS) (Hyclone, Logan, UT), 10 mM Hepes, 200 mM L−glutamine, 10,000 U/ml penicillin and streptomycin, 50 mM 2-mercaptoethanol, 1% non-essential amino acids, and 1% sodium pyruvate. Single-cell suspensions were prepared in flow buffer (PBS/5%FCS/10 mM Hepes/5 mM EDTA/0.05%NaN_3), blocked with anti-mouse CD16 (clone 24G2) hybridoma supernatant, and stained with directly-conjugated monoclonal antibodies (mAbs) against mouse cell surface markers as previously reported (Wu et al 2005).

Materials and methods: Format

Subheadings and 1st sentence of the paragraph

PCR reactions. A reaction mixture was prepared containing 50 mM KCl, 10 mM Tris, etc.

OR

Sample collection. Serum samples were collected from 300 pregnant adolescents (<19 years old) and 306 pregnant adults (>19 years old).

Specific details (rest of the paragraph)

References in Methods

- Can refer to previous paper for methods you developed. But be specific.

  Example: NOT CLEAR

  "cells were lysed as previously described (9)"
  BETTER: "cells were lysed by ultrasonic treatment as previously described (9)"

- If referring to other publication often good to briefly review the protocol.
  Example:
  "..as previously described (9). Briefly, cells were lysed by ultrasonic treatment and then..."

Introduction

For an honors thesis the Introduction is not a review of the field. You need to provide background about the purpose and only relevant references.

The function of Introduction Is to motivate the reader!

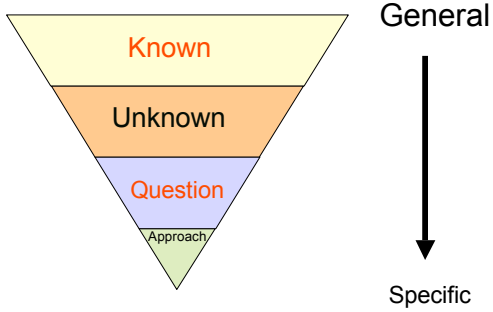
Should answer:

•Why did you do this study?

•What was done previously in this area?

•How are you going to do the study?

Flow of Introduction



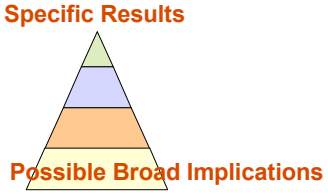
The Discussion is your opportunity to:

- Provide conclusions and relevance of your data
- Discuss issues of technique, sample collection, controls. This is when you explain WHY you think things did not work
- Propose next experiments

Introduction versus Discussion

Introduction was
Broad background→ specific question

Discussion is the opposite
your specific findings → implications



Content of Discussion

1) Conclusions
2) Implications/Significance
3) Limitations
4) Future directions

Clearly distinguish between what you have shown vs. what you imagine

Writing style recommendation
Place emphasis deliberately

- To emphasize important information
  - Put it in the power positions
  - Repeat it
  - Flag it: "The most important finding was that..."
- To de-emphasize less important information
  - Condense it
  - Omit it

Ref: M. Zeiger

Link Ideas:
Use transitions!

Not as clear: "1 is true, 2 is true, 3 is true. The conclusion is…"

Preferred: "1 is true, suggesting this conclusion. *Similarly*, 2 is true, lending additional support to this hypothesis. *Furthermore*, 3 is true. *Thus*, it seems that the conclusion is supported…"

Link Ideas:
Transition words

Transition Words
Therefore, / Thus, /In conclusion
First, Second, Finally
For example
However, / In Contrast, / Instead
In addition, / Similarly, / Furthermore, / Also,
Although / Despite / Nonetheless

Be simple. Be concrete. Be specific.

Word or Phrase	Preferred for papers
Looked at	Examined
Prior to	Before
Due to the fact that	Because
The vast majority of	Most
Utilize	Use
At this point in time	Now
It has long been known that	USE A REFERENCE!!!

Ref: V. McMillan