Good scientific writing

In science the credit goes to the man who convinces the world, not to the man to whom the idea first occurs.

- Sir Francis Darwin

Good scientific writing

“Publish or perish!!!”

Good research is meaningless unless you can write and communicate your findings in a clear and interesting fashion

“Use words with precision and economy to construct sentences that are exact, clear and as simple as the subject permits”

What is Research?

- Research refers to a systematic process of investigation into a problem
- Research means a scientific and systematic search for pertinent information on a specific topic
- It is an art and science.
- The purpose of research is to discover answers to questions through application of scientific procedures

Type of Research Studies

- **Exploratory research** gets familiarity with a new phenomenon or to achieve new insights into it.
- **Descriptive research** includes surveys and fact-finding enquiries. The main characteristic of this method is that the researcher has no control over the variables; he can only report what has happened or what is happening.
- **In analytical research** the researcher has to use facts or information already available, and analyze these to make a critical evaluation of the material.
- **Applied research** aims at finding a solution for an immediate problem facing by a society or an industrial/business organization.

Good scientific writing

- **Types of scientific writing**
  - **Research Proposals/Synopsis**
  - **Projects**
  - **Theses**
  - **Reports**
  - **Publications/papers/Review paper**
  - **Presentations/Talks**
  - **Presentation Posters**

Good scientific writing

- Structure & organization of the text
- Style
- Measurement units
- Tables
- Figures, graphs
- Literature citation

Your supervisor is not here to teach you basic grammar and spelling.

Good scientific writing

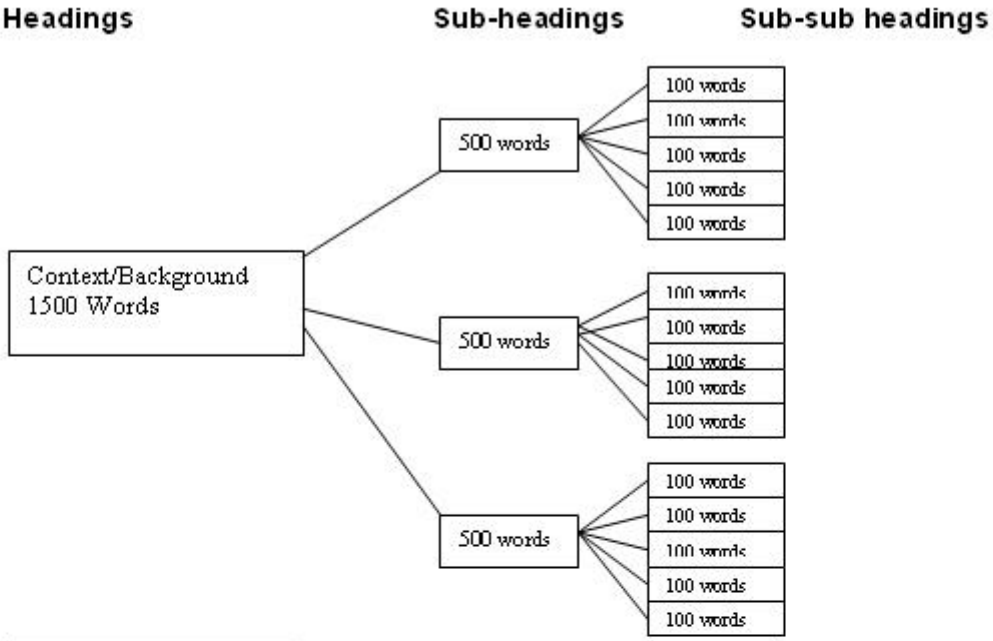
Structure & organization of the text

Major text sections in scientific papers are :

- Title
- Abstract (Summary)
- Introduction
- Materials and Methods
- Results
- Discussion
- Literature Cited/References

Ever! Most people's first drafts are terrible. "Good writing is rewriting" and you should make a serious effort at editing, rewriting, and fine-tuning before you give the manuscript to anyone else to read

Outlining a Thesis



* Apply the above approach to headings or other sections of your paper.

Good scientific writing

Structure & organization of the text

Titles of scientific papers

- Concise title that gives reviewer a general sense of what you are investigating.
- Too long and technical or Too short and broad tilts are not good.

Types of title

- **Indicative titles** indicate the subject matter of a paper but give no indication of any results obtained or conclusions drawn e.g. *The effectiveness of bed nets in controlling mosquitoes at different seasons of the year.*
- **Informative titles** give an indication of results achieved and conclusions drawn as well as the subject matter of the paper e.g. *Bed nets control mosquitoes most effectively when used in the rainy season.*
- **Question-type titles** obviously asks a question. e.g. *When are bed nets most effective when used to control mosquitoes?*

Good scientific writing

Structure & organization of the text

The Scientific Paper: Abstract

An abstract is a shortened version of the paper and should contain all information necessary for the reader to determine:

(1) what the objectives of the study were;

(2) how the study was done;

(3) what results were obtained;

(4) and the significance of the results/conclusions.

Frequently, readers of a scientific journal will only read the abstract, choosing to read at length those papers that are most interesting to them. For this reason, and because abstracts are frequently made available to scientists by various computer abstracting services, this section should be written carefully and succinctly to have the greatest impact in as few words as possible.

Although it appears as the first section in a paper, most scientists write the abstract section last.

Pay attention to tenses.

Good scientific writing

Structure & organization of the text

Introduction gives state of knowledge in the specific field referred to in the paper and explains the incentives and objectives of the work.

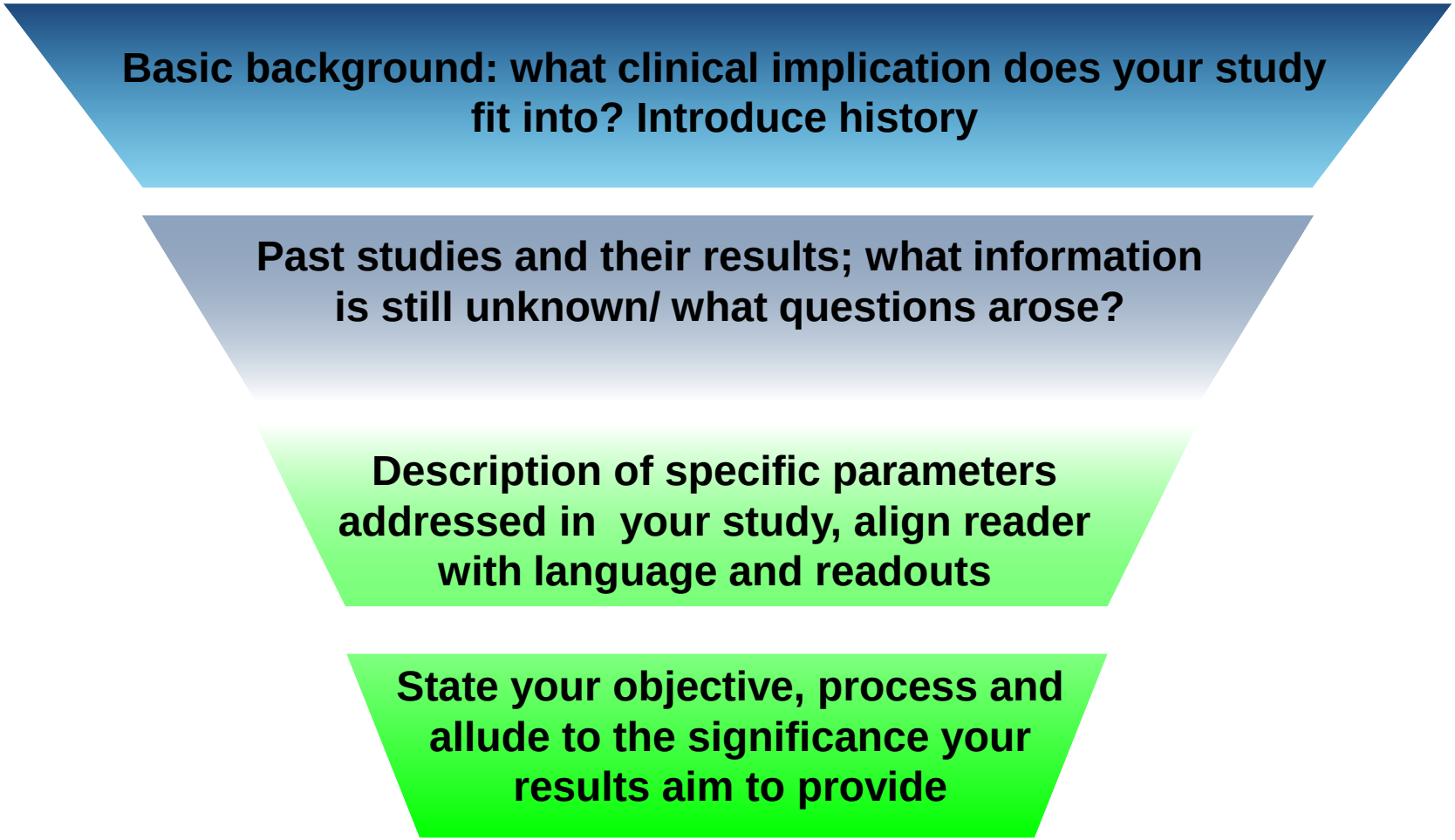
- **What is the subject? What is the problem?**
- **What do we know already?**
- **Why we need this research?**
- **What is the working hypothesis?**
- **What are the objectives of the work?**

Introductions and conclusions are the hardest parts.

Good scientific writing

Structure & organization of the text

Introduction: format



Good scientific writing
Structure & organization of the text

- **Guides reader into the specific material you are about to discuss**
  - ✓ **Where does the clinical implication of your study lay?**
    - **pest-specific?**
    - **Basic biological process?**
    - **Economics?**
  - ✓ **Introduce basic background and concepts: history and references**
    - **characterize the background of the issues you will address in your study**
    - **outline the evolution of the topic of interest by discussing previous study's results and conclusions; use primary references**
    - **i.e. therapy development, models, molecular biology, etc…**
  - ✓ **What studies already exist that are similar to your investigation**
    - **what were their conclusions?**
    - **what are they lacking; what still requires elucidation?**
    - **describe how your study fits into the larger picture of these previous findings**
  - ✓ **The final paragraph should briefly describe what you did, why you did it, and how you did it – all with relevance to the previous studies you have mentioned**
    - **allude to your broader implicated findings: what have you done that makes this an important study that adds value, what gap have you filled?**
  - ✓ **Intro should give reader a working knowledge of history, implications, some specifics, and providing the reason your study adds value**

Good scientific writing

Structure & organization of the text

Materials and Methods fully explain experimental design and methodology

- **Standard methods and materials**
- **Must be reproducible techniques**
- **Organisms used (full botanical/zoological names)**
- **Experimental design**
- **Statistical Analysis**

Good scientific writing

Structure & organization of the text

Results provide precise and brief descriptions of experimental results.

- **Clearly and simply write your findings only**
- **Subheadings may be used**
- **Avoid excessive fragmentation of the text**
- **Must be cleared and to the point**
- **Must be based on your findings**

Good scientific writing

Structure & organization of the text

Discussion

- Discussion must explain results and relate them to previous/current state of knowledge
- Explain discrepancies or stress similarities to other systems/previous reports on same the system
- Should end up with conclusions (“take-home message”)
- Sufficiently supported by your results

Discussion: basics

- **Innovative facet of scientific article, allowing for guided interpretation of results**
  - ✓ **First paragraph summarizes findings in a clear manner**
  - ✓ **Draw conclusions from each major result**
    - **Briefly describe results without repeating previous sections**
    - **Cite literature that your results build upon or contradict**
    - **Explain possible reasons for your findings (appropriately supported by data or references); provide reasons for deviations**
    - **Provide evidence for conclusions combining previous work with current findings**
    - **Suggest future studies to further elucidate or verify your results**
  - ✓ **Be open about your results, describe deviations from hypothesis or expected results, what future experiments would clarify these issues?**
  - ✓ **Broader implications**
    - **Suggest theoretical implications of your results**
    - **Suggest practical application of your results**
    - **Discuss findings in a broader topic – extend to clinical situations if applicable**
  - ✓ **The final paragraph should state what your findings added to the scientific community (why is this study important?) and provide suggestions for future direction**

Good scientific writing

Structure & organization of the text

Literature

- Select most relevant & most recent papers
- Give references in a uniform format

Good scientific writing

Reference and citations

Nature **190**, 364-365 (22 April 1961) | doi:10.1038/190364a0

Insecticide Resistance in Mosquitoes

G. DAVIDSON & C. ELIZABETH JACKSON

1.Ross Institute of Tropical Hygiene, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

MLA Davidson, G., and C. Elizabeth Jackson. "Insecticide resistance in mosquitoes." *Nature* 190. (1961): 364-365.

APA Davidson, G., & Jackson, C. E. (1961). Insecticide resistance in mosquitoes. *Nature*, *190*, 364-365.

Chicago Davidson, G., and C. Elizabeth Jackson. "Insecticide resistance in mosquitoes." *Nature* 190, (1961): 364-365.

Harvard Davidson, G. and Jackson, C.E., 1961. Insecticide resistance in mosquitoes. *Nature*, *190*, pp.364-365.

Good scientific writing

Writing style

- Do not use 1st person singular form

Example: We conducted climate chamber experiments in which we investigated the effect of temperature on spore germination.

Should be: Climate chamber experiments were conducted to investigate the effect of …

- Do not use every-days "jargons"

Example: We had bad luck and found no effect of temperature on spore germination.

Should be: Unfortunately, there was no significant effect of temperature on spore germination detected.

- Use scientific terms correctly and precisely

Example: Plants were sensitive to fungal contamination. Plants were suceptible to fungal infection.

Plants were infected with a spore solution. Plants were inoculated with a spore suspension.

- Be consistent in terming

Example: The spores **were transferred to the selective agar medium. ….Fungal** conidia **developed germ tubes on the** growth medium **within 2 days.**

Good scientific writing

Writing style

Measurement units, symbols and terminology

- Always use unites and symbols recognized under the International System of Units (SI Units)
- Standard abbreviations and terminologies

Good scientific writing

Writing style

Styling the text – Numbers

- **Numerals for measurements, including measurements such as drops, wells, e.g. 96 wells, 5 drops, 10 runs**
- **Commas in numbers of 4 digits or more (except for digits used as designations) e.g. 1,434 kg**
- **Zero in front of decimal points, e.g. 0.26, 0.765**
- **In lists where one item is multidigit, use numerals throughout,**

12.4	**not:**	**12.4**
14.0		**14**
11.2		**11.2**

- **Spell out numbers at the beginning of a sentence (if number is spelled out, unit of measure also should be spelled out), “One day after treatment, onefold, threefold, 10-fold”.**
- **Ranges: use "to" rather than "–" except in tables.**

Good scientific writing

Writing style

Styling the text – Measurements

Further styling rules for units and numerals required in some journals

- **Use the format e.g. t/ha (not t ha-1 or t per ha)**
- **In most cases, values should be given to 2 or 3 significant figures. Usually more digits is spurious accuracy. So, an increase of 18.89% should be written as 19%.**
- **Generally give means and SEDs to one additional significant figure, so if data are 16, 17, 18 etc. the mean and SED should be 17.0 and 2.6**
- **Quote concentrations as amounts not % e.g. 25 mg/g protein, not 2.5% protein.**

Good scientific writing

Writing style

Styling the text – Measurements

- **Do not abbreviate measurements in titles, „Detection of micromol quantities of penicillin in ....“ „A ten milligram sample of .....“**
- **Time: second (s), minute (min), hour (h), day (day), week, month, year.**
- **liter (spell out), but ml, µl, etc.**
- **Use the degree Celsius symbol with temperature (50 °C).**
- **Binomials and trinomials**

  All taxa are italicized. In trinomials, always spell out species, e.g., *X. campestris* pv. *campestris* (not Xcc).

Good scientific writing

Writing style

Styling the text – Measurements

- **Enumeration**

  Use (i), (ii), (iii), (iv).

- **Prefixes and suffixes**

  Generally should be closed up (e.g., postinfection, loopsful, intercrop), even in nonstandard constructions; (see dictionary or style manuals for exceptions)

- **Numbering of tables and figures**

  Must be in the order of mentioning in the text

- **Abbreviations**

  Spell out the term at least once in the abstract and in the running text and place the abbreviation in parentheses at first use; use the abbreviation after that.

- **Footnotes to the text are usually not permitted (in tables yes)**

Good scientific writing

Writing style

Organization of the text – Abbreviations & Citations

(example)

Induced resistance is a plant defense state observed upon infection, conferring a protection against a broad spectrum of pathogens in the area of primary infection and in the distal parts of the plant (23,43). This phenomenon is associated with the accumulation of salicylic acid (SA), required for signal transduction (7), leading to coordinated expression of pathogenesis-related (PR) proteins with antimicrobial activity (49) and lignification (13). Exogenous application of chemicals that mimic natural signaling compounds like SA or its synthetic analogs 2,6-dichloroisonicotinic acid (INA) (36) or acibenzolar-*S*-methyl (ASM) (27) are also effective in inducing resistance.

Another characteristic of plants expressing resistance is the notion of "priming" of defense responses, which is defined as the ability to induce cellular defense responses more rapidly and effectively to subsequent infection (38). This was first demonstrated on parsley cell cultures after application of elicitors derived from cell walls of *Phytophthora sojae*, resulting in phytoalexin accumulation, oxidative burst (19), and defense gene expression, which are greatly enhanced after pretreatment with SA (48), INA (20), or ASM (18). Subsequent studies revealed this phenomenon on whole plants; Latunde-Dada and Lucas (26) showed that ASM mediated systemic priming of phenylalanine

Good scientific writing

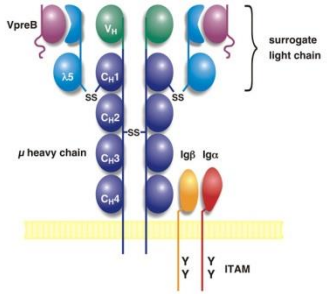
Tables and Figures

Getting started: data

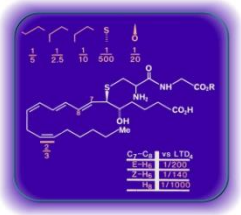
What information do you have and how can you best present it?

Animal model

Molecular biology



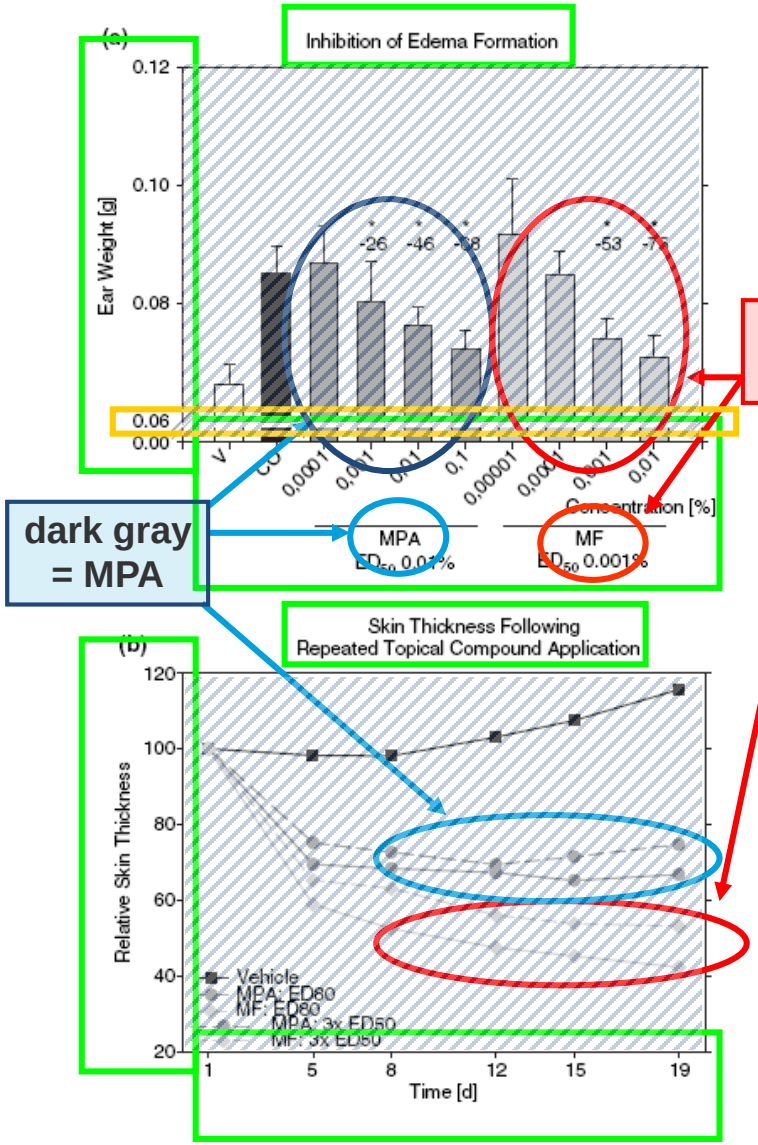
Chemistry



Choose the course of presentation based on the highest added value to the scientific community, which will also yield the optimal journal

Develop an outline & order data to support story

Figures: basics



light gray = MF

dark gray = MPA

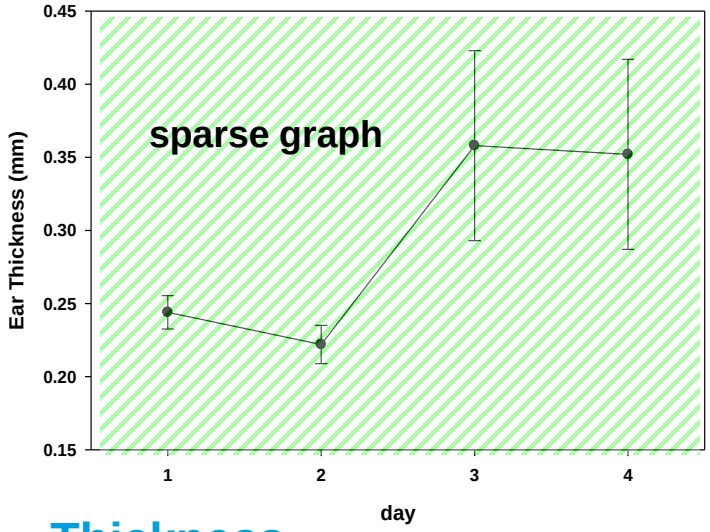
After your abstract, readers will look to figures to gain the most information with the least time investment; therefore your figures should accurately depict and explain your findings in the <u>simplest</u> possible form

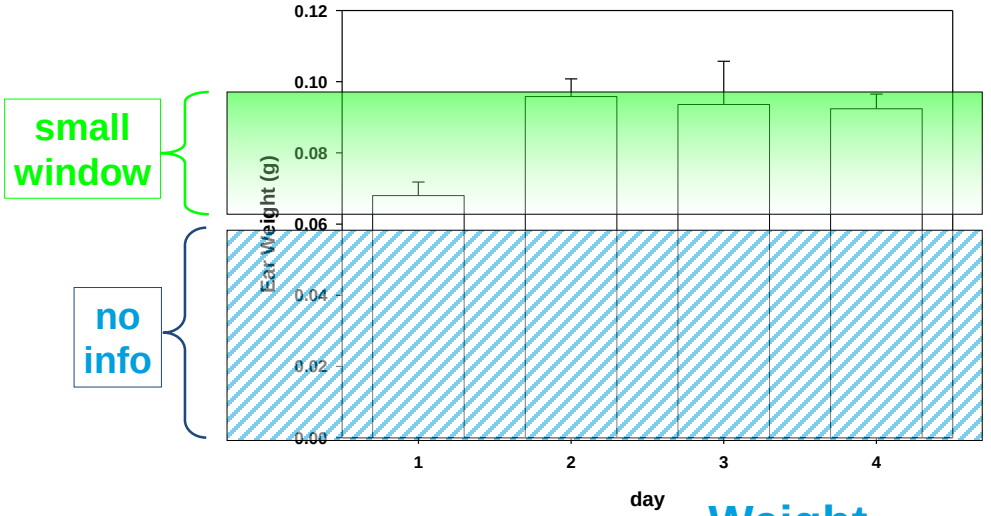
<u>Consider:</u>

- axes/ titles
  - labeling
  - values
- breaks to amplify points of interest
- balanced amount of information
- consistency (colors and symbols)

Mirshahpanah et al. Exp Dermatol 2007

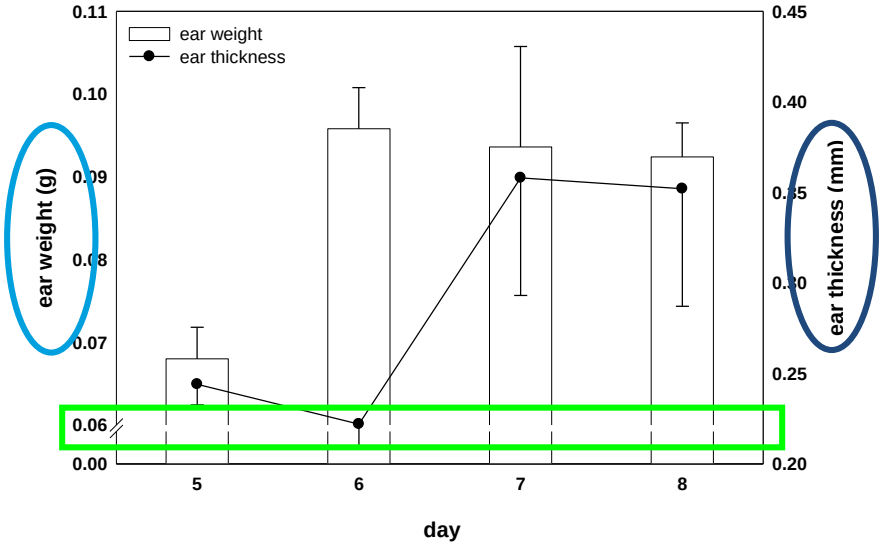
Figures: breaks & dual axes





Thickness → Edema ← **Weight**

Dual axes allows incorporation of two relevant parameters into a single graph, which allows for better comparison



break decreases the amount of space used for irrelevant info and allows for expansion of point of interest

Figures: tables

Maintain consistency, simplicity, and completeness

- **Informative title**
- **clear labeling across headings (along with measurement parameters)**
- **consistent presentation of information: mean ± SD**
- **Legend describes fundamental properties necessary to read table**

Table 2. Progesterone, androgen, and mineralocorticoid receptor-dependent transactivation activity (agonistic and antagonistic) of methylprednisolone aceponate and mometasone furoate

	Progesterone receptor				Androgen receptor				Mineralocorticoid receptor			
	Agonism		Antagonism		Agonism		Antagonism		Agonism		Antagonism	
	EC_{50} (nM)	Efficay (%)	IC_{50} (nM)	Efficay (%)	EC_{50} (nM)	Efficay (%)	IC_{50} (nM)	Efficay (%)	EC_{50} (nM)	Efficay (%)	IC_{50} (nM)	Efficay (%)
Reference	Promegestone (R5020)		Mifepristone (RU 486)		Metribolone		Cyproterone acetate		Aldosterone		ZK 91587[1]	
	0.024 ± 0.005	100	0.039 ± 0.015	100	0.28 ± 0.05	100	21 ± 5.5	100	0.026 ± 0.005	100	7.7 ± 0.8	100
	$n = 5$				$n = 5$				$n = 5$			
MPA	13.0 ± –	68 ± 1.0	125 ± 17.3	28.5 ± 3.3	11.3 ± 1.3	14.5 ± 1.0	>1000	8.7 ± 9.6	6.2[2] ± 1.1	97.8 ± 7.6	>1000	na
	$n = 4$				$n = 4$				$n = 4$			
MF	0.028 ± 0.017	100.7 ± 3.8	>1000	na	0.91 ± 0.2	28.1 ± 8.8	412.5 ± 5.0	47.9 ± 6.7	0.64 ± 0.3	58.0 ± 10.2	3.4 ± 2.8	40.7 ± 10.7
	$n = 6$				$n = 4$				$n = 5$			

EC_{50} values for agonistic and IC_{50} values for antagonistic activity are listed as mean values ± SD. Efficacies are shown as % of maximum effect of the respective reference. EC_{50} or IC_{50} values >1000 nM indicate no activity in the respective transactivation assay.

[1]ZK91587 is 7-α-Methoxycarbonyl-15β,16β-methylene-3-oxo-17α-pregn-4-ene-21,17-carbolactone.

[2]Due to differences in sensitivity of the cell-free binding assays and the cellular transactivation assays, a low potent activity in transactivation was found although no binding was observed.

Mirshahpanah et al. Exp Dermatol 2007

Figures: titles & legends

- First sentence summarizes results of figure
- Followed by a brief "materials and methods" explanation specific for this figure
- Then describes actual results with values and significance where appropriate (*p*-values)
- Ends with statistical evaluation methods and representative value definition

Zollner et al. JCI 2002

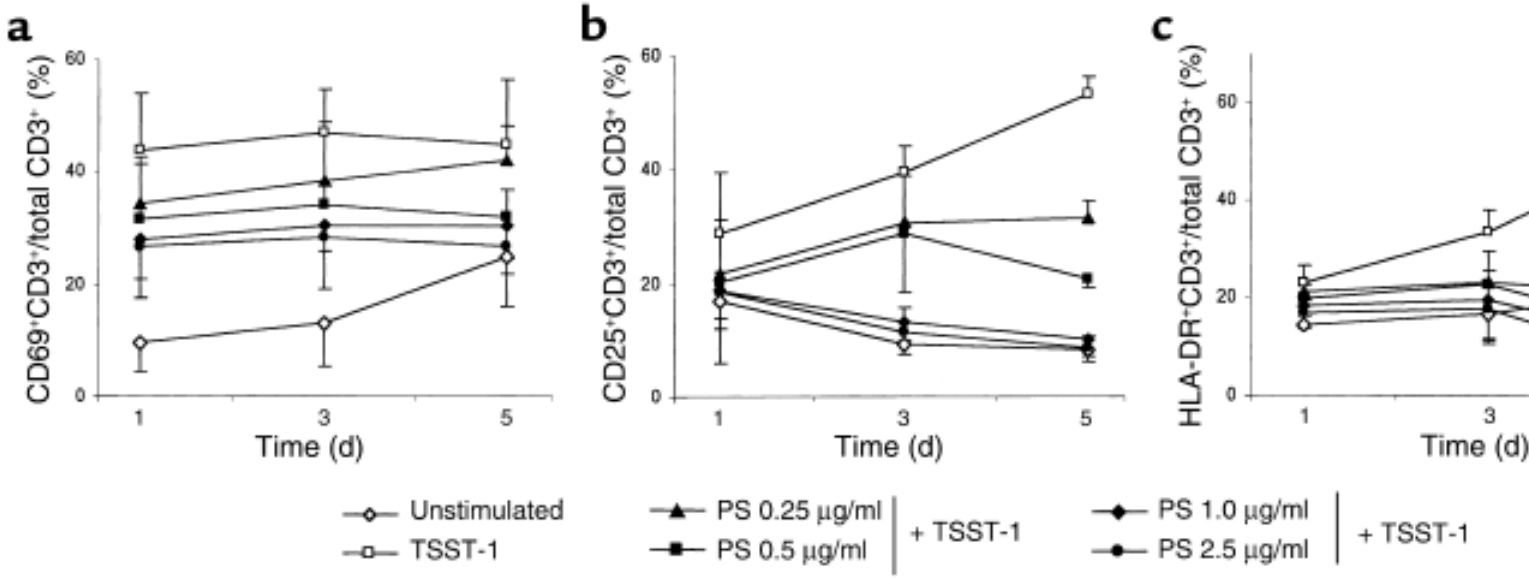


Figure 3

PS-519 inhibits TSST-1–induced expression of T cell activation molecules. PBMCs were stimulated with TSST-1 (100 ng/ml) in the presence or absence of PS-519 (0.25–2.5 µg/ml). $CD69^+$ $CD3^+$ (a), $CD25^+$ $CD3^+$ (b), and HLA-DR^+ $CD3^+$ (c) surface expression was measured at days 1, 3, 5, 7, and 9 (days 7 and 9 not shown) by flow cytometry. Appropriate isotype Ig's served as controls to set gates for positive and negative staining. For CD69 expression, significant reduction was observed on day 1 starting at 1.0 µg/ml ($P < 0.05$), and on days 3 and 5 starting at 0.5 µg/ml PS-519 ($P < 0.001$ and $P < 0.05$, respectively). For CD25 expression, significant reduction was observed on day 3 starting at 1.0 µg/ml ($P < 0.001$), and on day 5 starting at 0.25 µg/ml PS-519 ($P < 0.001$). For HLA-DR expression, significant reduction was observed on day 1 at 2.5 µg/ml ($P < 0.05$), on day 3 starting at 1.0 µg/ml ($P < 0.05$), and on day 5 starting at 0.25 µg/ml PS-519 ($P < 0.001$). Data represent means of five experiments ± SD.

Good scientific writing
Tables and Figures

Tables & Figures

- ❑ Tables … are supertitled
- ❑ Figures … receive captions at the bottom

TABLE 3. Comparison of mycotoxin contents in different kernel fractions of wheat 'Tybalt' inoculated with *Fusarium equiseti*

	Mycotoxin content (µg/kg)[z]			
Kernel fraction	NIV	DAS	MAS	EQUI
Healthy-looking kernels	490	7	560	200
Black point kernels	3,800	39	2,600	710
Ratio	7.6	5.4	4.6	3.6

[z] NIV: nivalenol, DAS: diacetoxyscirpenol, MAS: monoacetoxyscirpenol EQUI: equisetin.

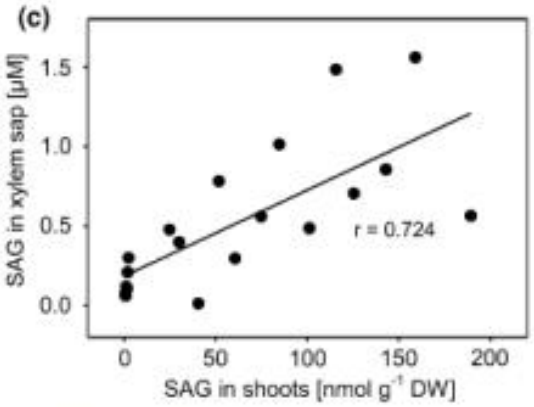


Fig. 2 Comparison of the concentrations of salicylic acid (SA) and SAG in xylem sap and shoot extracts. Xylem sap from *V. longisporum*-infected single plants was analysed 28 days post infection (dpi). Pearson correlation is given (*r*), all correlations are significant at $P \leq 0.01$ (1-tailed *t* test). a SA versus SAG in xylem sap, b SA versus SAG in shoots, c SAG in shoots versus SAG in xylem sap

Good scientific writing

Tables and Figures

Tables

- Cite tables in numeric order in the manuscript.
- Tables should be intelligible without reference to the text or another table.
- Do not repeat data in the text that are given in a table or figure.
- The title should comprehensively summarize the information presented in the table.
- Tables are used to present precise numerical data that show comparisons or interrelationships.
- The minimum number of columns is two. Lists should be incorporated into the text. Nonessential details should be omitted.
- Numbers should be rounded to significant digits.
- Abbreviations are acceptable; explain any nonstandard abbreviations in footnotes.

Good scientific writing

Tables and Figures

Tables: Examples

TABLE 4. Dimensions of *Puccinia allii* basidiospores

Collection no.	Hosts	Length (µm)	Width (µm)	Area (µm²)
North America				
HSZ0163	Garlic	12 ± 1	8 ± 1	76 ± 9
HSZ0508	Garlic	13 ± 1	8 ± 1	88 ± 12
HSZ0343	Garlic	13 ± 1	10 ± 1	103 ± 13
HSZ0341	Chives	14 ± 1	9 ± 1	98 ± 9
HSZ0509	Chives	14 ± 2	7 ± 1	82 ± 9
Mean	…	13.2[a]	8.4	89.4[a]
Middle East				
YA8884	Wild leek	11 ± 1	7 ± 1	62 ± 7
YA8893	Wild leek	10 ± 1	8 ± 1	67 ± 1
Mean	…	10.5[a]	7.5	64.5[a]

[a] Means for North American and Middle Eastern collections are significantly different ($P < 0.05$) using a one-tailed t test.

Good scientific writing

Tables and Figures

Tables: Examples

TABLE 2. Control efficacy of acibenzolar-*S*-methyl (ASM) against *Venturia nashicola*

Treatment	Sporulating leaves (%)	Control (%)	Disease severity	Control (%)
21 dpi[a]				
ASM[b]	48.3 ± 5.02[c]	41.7	33.6 ± 0.65	40.7
DW	82.9 ± 12.8	…	56.7 ± 4.71	…
30 dpi				
ASM	60.3 ± 11.7	29.9	36.2 ± 1.27	47.5
DW	86.0 ± 7.07	…	69.0 ± 5.31	…

[a] Days postinoculation.

[b] Distilled water (DW) or ASM (100 µg ml^{-1}) was applied to Japanese pear leaves two times (7 and 3 days) before inoculation with *V. nashicola*.

[c] Values are means of three replicates ± confidence interval (95%); each of the four ASM means is significantly different from its corresponding DW control.

Good scientific writing

Tables and Figures

Tables: Examples

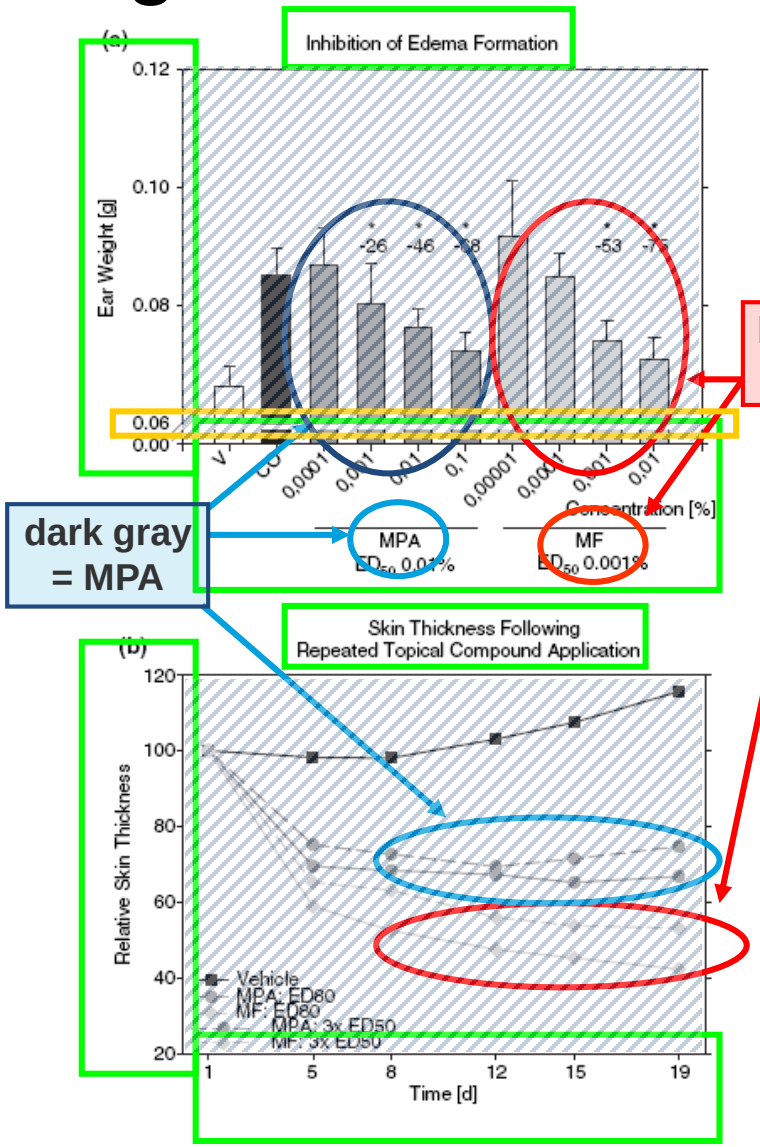
Examples: *How not to shape a table*

Table 3. Antagonistic potential of *T. atroviride* upon *P. aphanidermatum*

Days after inoculation	Hyperparasitism		Antibiosis		Secondary metabolites	
	Pythium	*Trichoderma*	*Pythium*	*Trichoderma*	*Pythium*	*Trichoderma*
1	29.24	18.25	0.00	100	0.00	100
2	34.29	36.00	0.00	100	0.00	100
3	36.74	44.25	2.76	93.65	3.76	87.79
4	-	61.75	6.82	82.08	5.82	82.70
5	-	72.00	11.11	71.66	6.66	83.86
6	-	76.75	14.42	65.81	12.82	72.00
7	-	81.17	18. 49	61.95	17.66	62.96
8	-	81.17	21.26	55.95	18.16	64.07
CD at P=0.05	2.40	13.27	0.78	10.54	0.96	12.25

Good scientific writing

Figures: basics



dark gray = MPA

light gray = MF

After your abstract, readers will look to figures to gain the most information with the least time investment; therefore your figures should accurately depict and explain your findings in the <u>simplest</u> possible form

<u>Consider:</u>

- axes/ titles
  - labeling
  - values
- breaks to amplify points of interest
- balanced amount of information
- consistency (colors and symbols)

Mirshahpanah et al. Exp Dermatol 2007

Good scientific writing

Tables and Figures

Figures

- Avoid 3D if not necessary for the data understanding
- Avoid colours for data points and lines
- time or concentration series data → line graphs; independent data rows → column graphs
- Note time leaps in time series representations
- Provide full and self-explanatory figure captions!!!
- Explain all abbreviations used in a graph in footnote or in the caption text!
- Decide carefully whether and which graph is needed; never double represent data in graphs and/or tables!
- Give statistical analyses whenever possible, i.e. S.E. or SD as error bars; probability level is commonly represented as $P < 0.01$ (LSD)“ or with asterisks indicating the significance level, like *) = $P < 0.05$; **) = $P < 0.01$; ***) = $P < 0.001$
- Provide precise axis legends

Good scientific writing

Tables and Figures

Figures

- Avoid too bold lettering, numbers, and lines for coordinate axes and curves.
- Give tic marks on axes as needed.
- Use solid black or white or hatch or stripe patterns in bar graphs.
- Use solid black and white symbols.

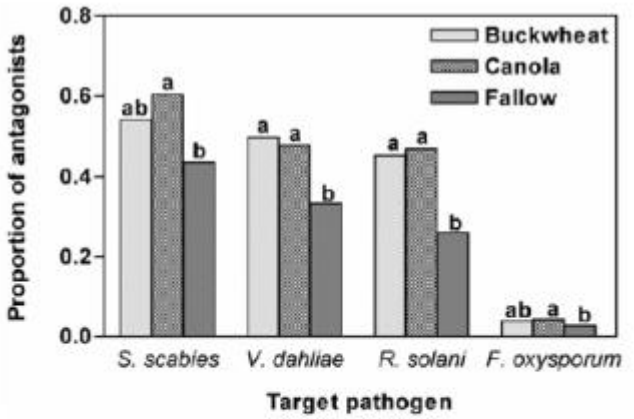


Fig. 4. Effect of green manure on the proportion of streptomycetes antagonistic against *Streptomyces scabies*, *Verticillium dahliae*, *Rhizoctonia solani*, or *Fusarium oxysporum* estimated in April 2002. Data shown are means of 11 (buckwheat) or 12 (canola and fallow) replicates per treatment. For each pathogen, bars with different letters are significantly different ($P < 0.05$, least significant difference).

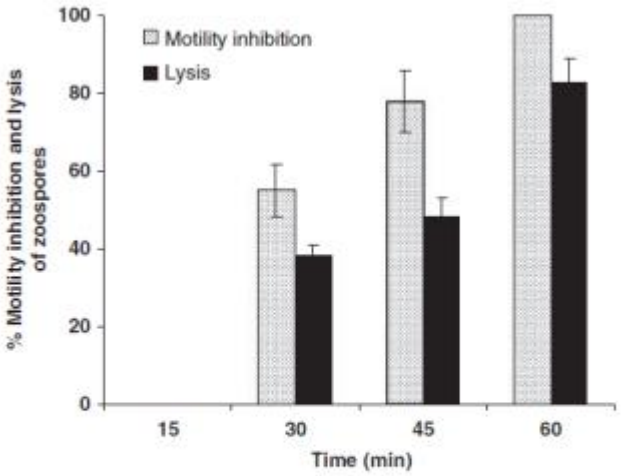


Figure 4 Motility inhibition and lysis activity of khatmiamycin (**1**) at 10 μg ml^{-1} (ca. 30 μM) against zoospores of the grapevine downy mildew pathogen *Plasmopara viticola*.

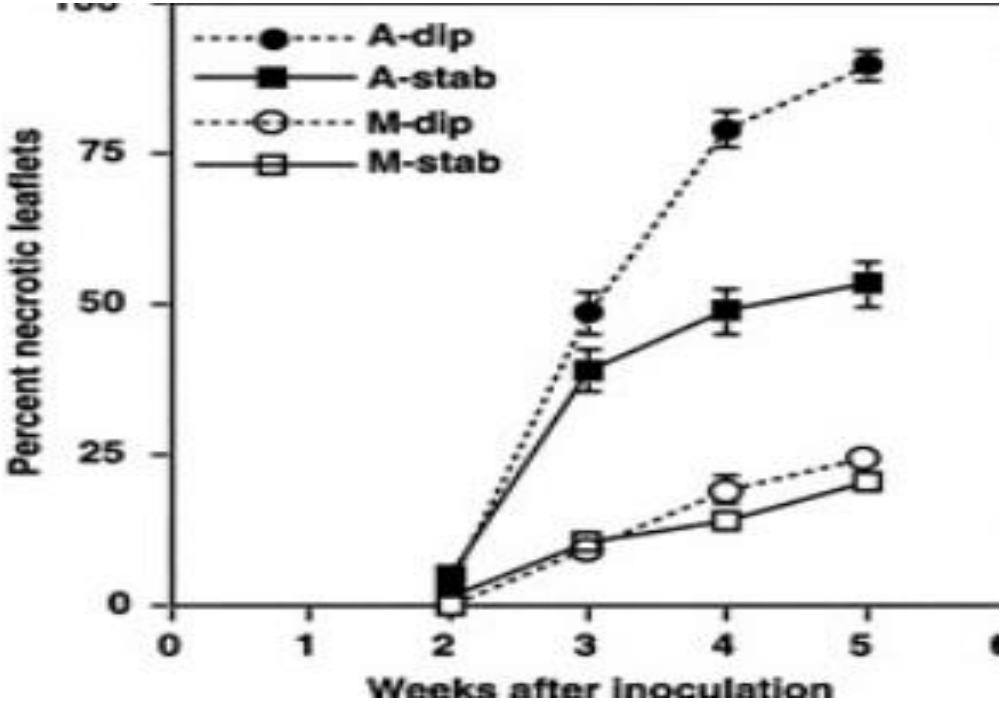
Unsuitable column hatching!

Good scientific writing

Tables and Figures

Figures: Line Charts

In line figures, only standard symbols (boxes, circles, triangles) or other typographic elements should be used. If necessary, please provide a key to any symbols as part of the figure. *Only* standard symbols can be reproduced in captions and may change in conversions.



Good scientific writing

Tables and Figures

Figures: Examples

Graphs – *common sins*

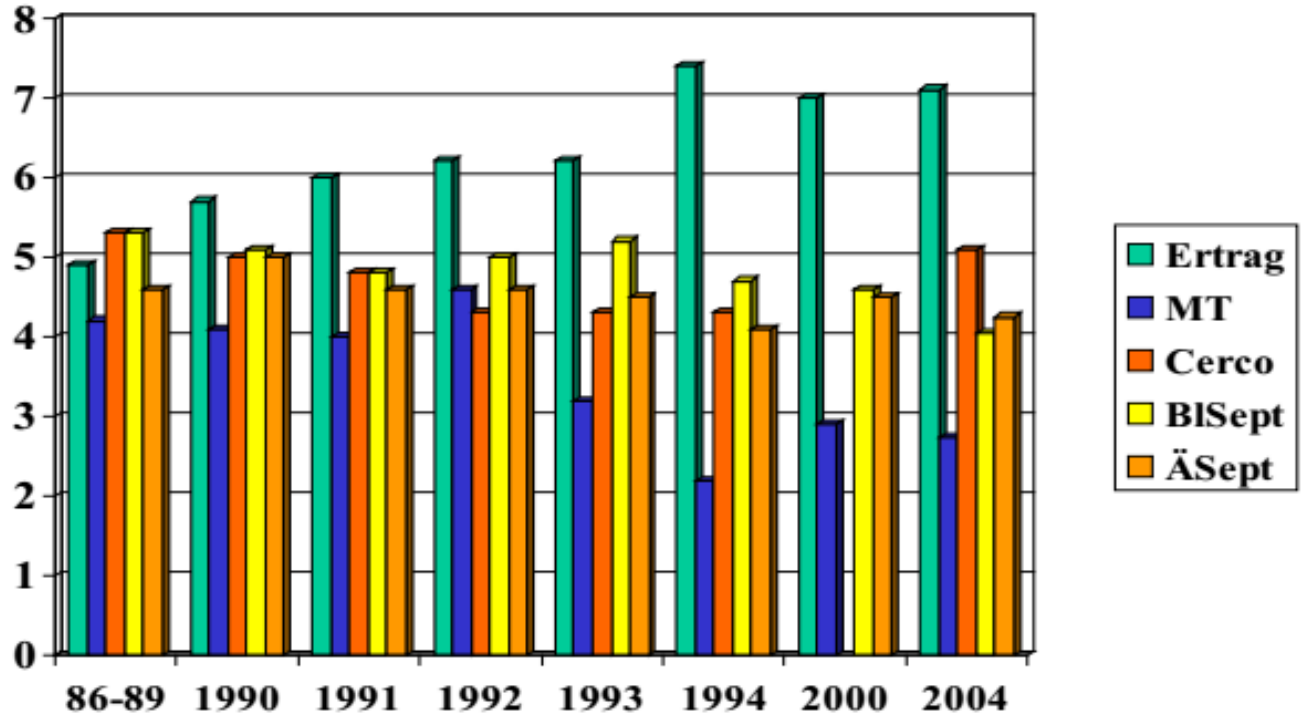


Fig. Disease resistance in German winter wheat cultivars 1990-2004
(yield and susceptibility to disease rated from 1 = low to 9 = high)

Good scientific writing

Tables and Figures

Figures: Examples

Graphs – *how to correctly shape them*

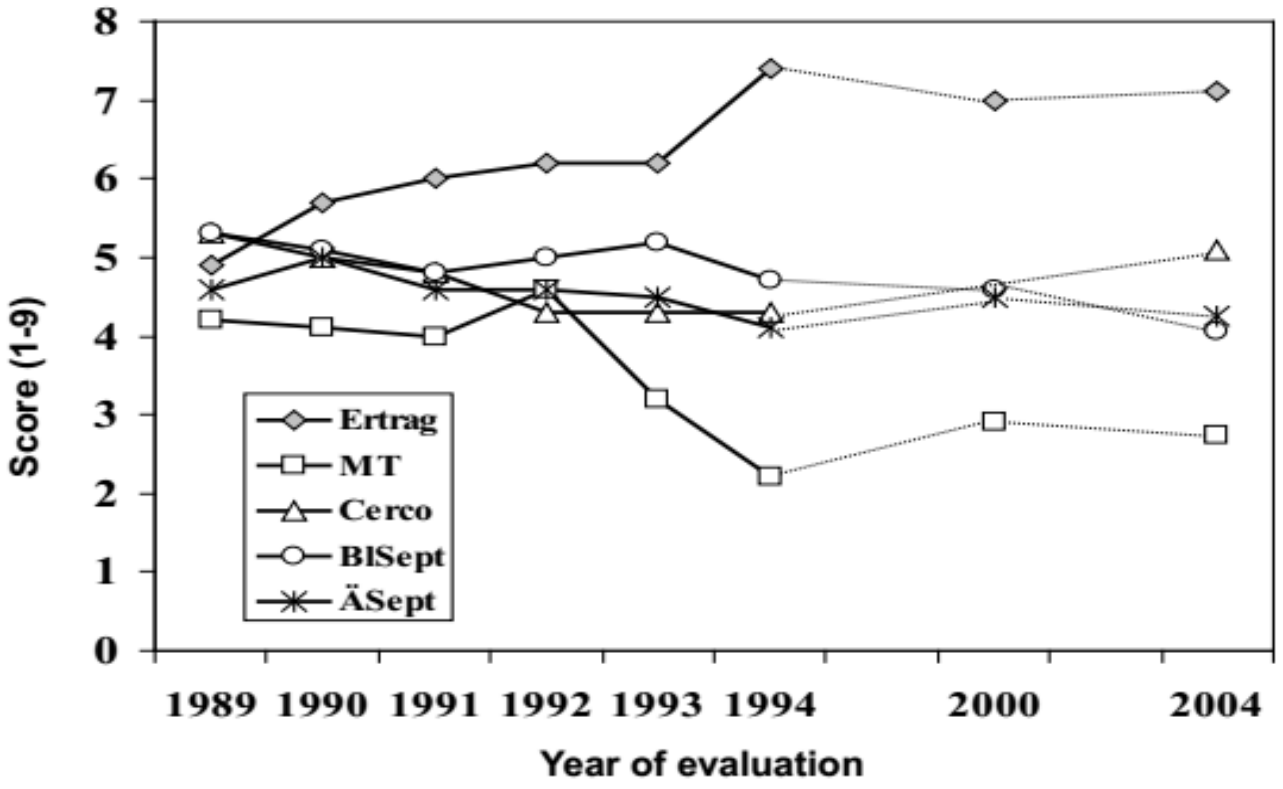


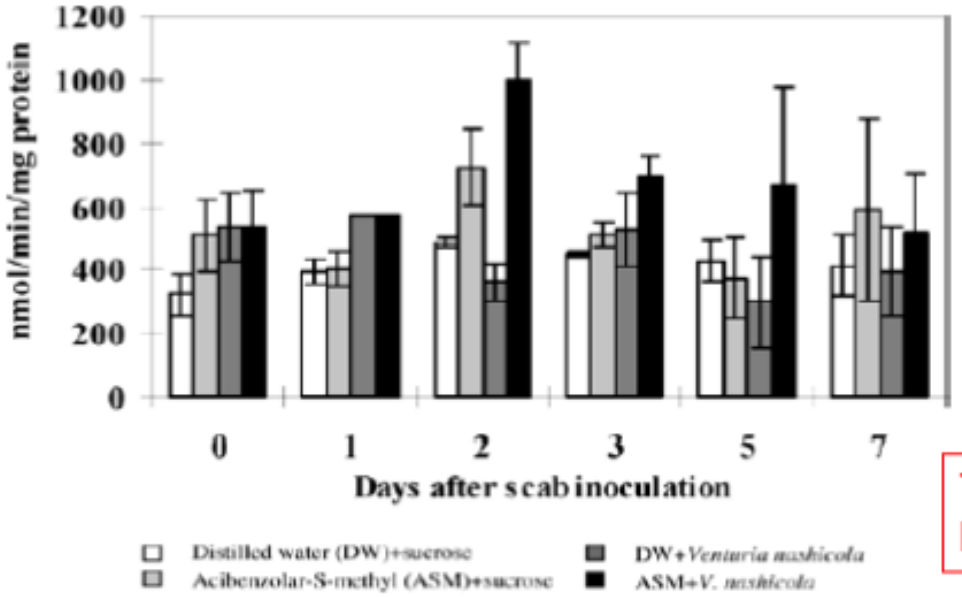
Fig. Level of disease resistance in relation to yield potential in German winter wheat cultivars 1990-2004 (scores ranging from 1 = low to 9 = high are given for yield and susceptibility).

Good scientific writing

Tables and Figures

Figures: Examples

Time series data!!!!



Time series data → line graph!!!

Fig. 2. Time course of changes in **A**, superoxide dismutase activity, **B**, catalase activity, and **C**, ascorbate peroxidase activity in inoculated Japanese pear leaves. Leaves were sprayed two times with acibenzolar-*S*-methyl (ASM) at 7 and 3 days before treatment with sucrose or inoculation with spore suspensions of *Venturia nashicola* prepared in sucrose solution. Values represent the mean of four replicates ± confidence interval (95%).

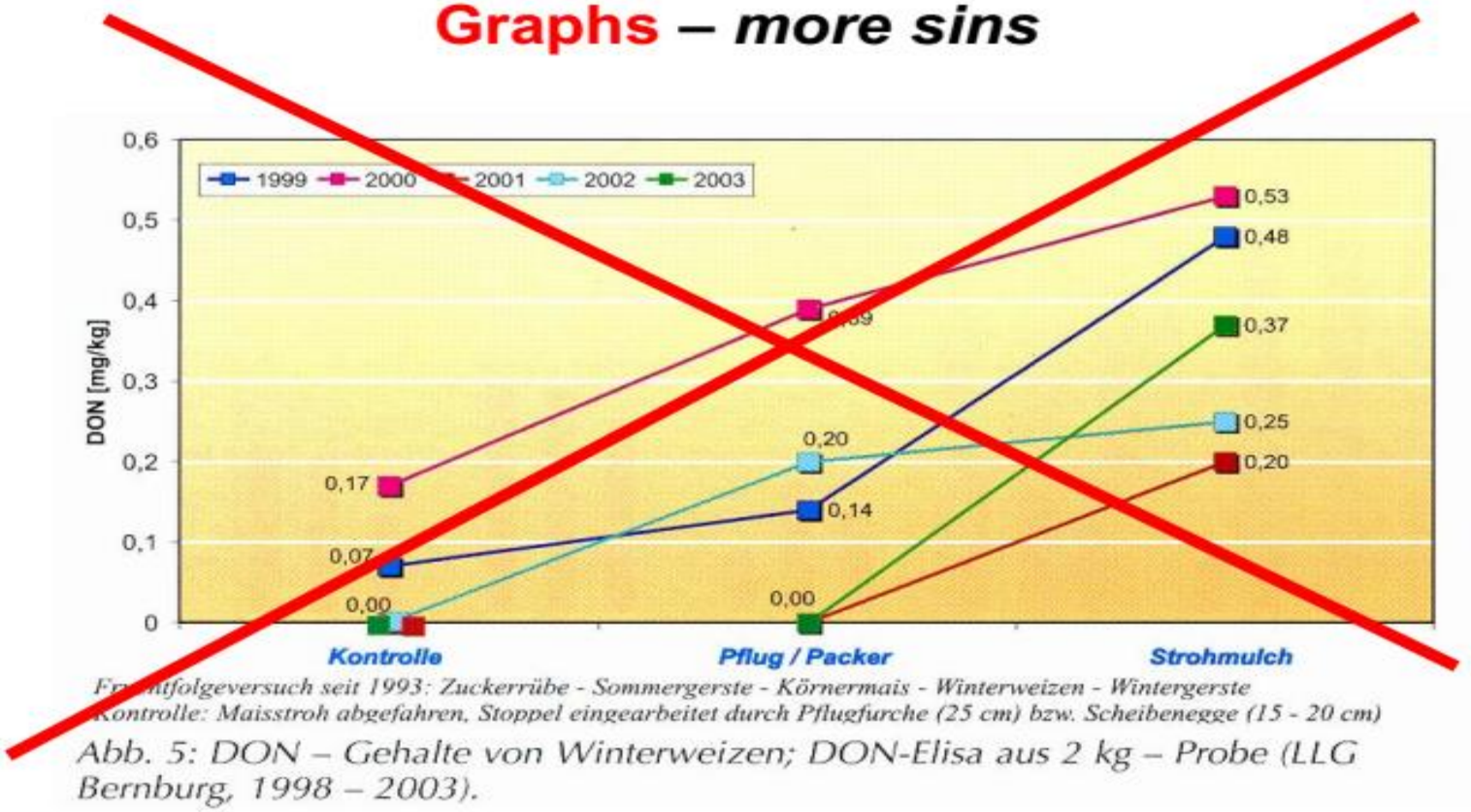
Good scientific writing

Tables and Figures

Figures: Examples

Not time series data!!!!

Never draw lines between categorical data points!!



Fruchtfolgeversuch seit 1993: Zuckerrübe - Sommergerste - Körnermais - Winterweizen - Wintergerste
Kontrolle: Maisstroh abgefahren, Stoppel eingearbeitet durch Pflugfurche (25 cm) bzw. Scheibenegge (15 - 20 cm)

Abb. 5: DON – Gehalte von Winterweizen; DON-Elisa aus 2 kg – Probe (LLG Bernburg, 1998 – 2003).

Good scientific writing

Citations

Literature referencing style: be consistent!!

Judelson, H. S. & Blanco, F. A. The spores of *Phytophthora*: weapons of plant destroyer. *Nat. Rev. Microbiol.* **3,** 47–58 (2005).
Blunt, J. W. *et al.* Marine natural products. *Nat. Prod. Rep.* **26,** 170–244 (2009).
Rahman, H. *et al.* An imidazopyridinone and further metabolites from *Streptomycetes*. *Nat. Prod. Commun.* **4,** 965–970 (2009).

Judelson, H. S., and Blanco, F. A. 2005. The spores of *Phytophthora*: weapons of plant destroyer. Nat. Rev. Microbiol. 3:47-58.
Judelson, H. S., and Roberts, S. 2002. Novel protein kinase induced during sporangial cleavage in the oomycete *Phytophthora infestans*. Eukaryot. Cell 1:687-695.

Young CS, Clarkson JP, Smith JA, Watling M, Phelps K, Whipps JM, 2004. Environmental conditions influencing Sclerotinia sclerotiorum infection and disease development in lettuce. Plant Pathology 53: 387-397.
Zeise K, Seidel D, 1990. Zur Entwicklung und Schadwirkung der Verticillium-Welkekrankheit am Winterraps. Raps 8: 20-22.
Zeise K, Steinbach P, 2004. Schwarze Rapswurzeln und der Vormarsch der Verticillium-Rapswelke. Raps 4: 170-174.

Good scientific writing

Citations

Literature referencing style: Numbered citations

The main causal agent of FHB in Central Europe and the United States is Fusarium graminearum (teleomorph Gibberella zeae), a potent producer of DON and ZEA (8,51). The typical symptoms include partial or complete bleaching of the ear ("white heads") and the occurrence of shriveled and discolored ("scabby") kernels. Nevertheless, at least 17 Fusarium spp. have been isolated from diseased wheat heads (9,52) and, depending on the infecting species, the symptoms and mycotoxins produced can be much more diverse. For example, various Fusarium spp. have also been frequently isolated from black point kernels (16,45). Black point describes a brown to black kernel discoloration of small grain cereals which is observed in nearly all growing regions.

LITERATURE CITED

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2. Bergmann, C. W., Ito, Y., Singer, D., Albersheim, P., Darwill, A. G., Benhamou, N., Nuss, L., Salvi, G., Cervone, F., and De Lorenzo, G. 1994. Polygalacturonase-inhibiting protein accumulates in *Phaseolus vulgaris* L. in response to wounding, elicitors and fungal infection. Plant J. 5:625-634.
3. Bradford, M. M. 1976. A rapid and sensitive method for quantification of microgram quantities of protein utilizing the principle of protein-dye binding. Anal. Biochem. 72:248-254.
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5. Cervone, F., Hahn, M. G., De Lorenzo, G., Darvill, A., and Albersheim, P. 1989. Host pathogen interactions. XXXIII. A plant protection converts a fungal pathogenesis factor into an elicitor of plant defense responses. Plant Physiol. 90:542-548.

Good scientific writing

Citations

Literature referencing style: Author citations

… considered critical for pathogen cycles and the virulence in Peronosporomycete phytopathogens, the underlying molecular mechanisms of zoospore motility as well as the process of zoospore release from sporangia are poorly understood (Judelson and Blanco 2005; Judelson and Roberts 2002; Walker and van West 2007). Transformants obtained by silencing Pigpa1 or Pibzp1 genes in Phytophthora infestans produced zoospores with impaired motility and weak virulence, indicating that both the G□subunit and protein kinases may be involved in the motility of zoospores (Blanco and Judelson 2005; Latijnhouwers et al. 2004). However, the presence of a specific protein kinase and its role in zoosporogenesis and motility of Peronosporomycete zoospores has not been shown. Marine microorganisms are known to produce diverse secondary metabolites with potentials to inhibit specific enzymes or proteins in many signaling pathways (Karaman et al. 2008; SeboltLeopold and English 2006)

LITERATURE CITED

Agrios, G. N. 1997. Plant Pathology. Academic Press, San Diego, CA, U.S.A.

Baldauf, S. L., Roger, A. J., Wenk-Siefert, I., and Doolittle, W. F. 2000. A kingdom-level phylogeny of eukaryotes based on combined protein data. Science 290:972-977.

Blanco, F. A., and Judelson, H. S. 2005. A bZIP transcription factor from *Phytophthora* interacts with a protein kinase and is required for zoospore motility and plant infection. Mol. Microbiol. 56:638-648.

Connolly, M. S., Williams, N., Heckman, C. A., and Morris, P. F. 1999. Soybean isoflavones trigger a calcium influx in *Phytophthora sojae*. Fungal Genet. Biol. 28:6-11.

Dick, M. W. 2001. The Peronosporomycetes. Pages 39-72 in: The Mycota VII, Part A, Systematics and Evolution. D. J. McLaughlin, E. G. McLaughlin, and P. A. Lemke, eds. Springer-Verlag, Berlin.

Good scientific writing

NEVER

Never …

… send a paper to more than one journal at the same time

… submit a paper to a journal without the full knowledge and agreement of all authors

… fake a paper or any of the data or statements therein

… plagiarize any other person‘s work, even if it is a literature search

Research Proposal/Synopsis

- Any research study should have a proper proposal in written form before it is actually carried out
- A research proposal is a written report presenting the plan and underlying rationale of a future study.
- It is like a outline or the building plan before the real study starts
- Writing a research proposal is both science and art
- A good research proposal is based on scientific facts and on the art of clear communication

What is a research proposal?

- …..deals with ideas of researcher about

✓ what kind of research one wants to do?

✓ what objectives and methodology has been set?

✓ how much time and resources are required to complete it?

✓ how the research finding are to be reported?

✓ and so on.

❑ one is an individual's or a research institute's formal offer to produce a product or render service to a client in response to a request from the client

❑ ….a work plan, prospectus, outline, and statement of intent ahead.

❑ In short, he/she is proposing a work frame for completing the research

How to write research proposal?

- A research proposal is intended to convince others that you have a worthwhile research project and that you have the competence and the work-plan to complete it.

- Generally, a research proposal should contain all the key elements involved in the research process and include sufficient information for the readers to evaluate the proposed study.

- Regardless of your research area and the methodology you choose, all research proposals must address the following questions:

✓ What you plan to accomplish?
✓ Why you want to do it and?
✓ How you are going to do it?

Detailed Components/elements of research proposal

- Title
- Introduction
- Statement of the problem
- Rationale/justification/significance of the research
- Scope and limitations of the study
- Review of literature
- Objectives of the research
- Operational definitions of terms used
- Hypothesis
- Methodology Used
- Time schedule/work plan
- Budget/estimated cost built up
- Organization of the report/chapter outline
- Bibliography/References
- Conclusions
- Appendix

Components of a Research Proposal

- Title and Abstract
- Introduction
- Justification/Need of the project
- Objectives
- Background /Review of literature
- Methodology
- Time frame and work schedule
- Budget

Components of a Research Proposal

Title and Abstract

- Title should be concise and descriptive. Often titles are stated in terms of a functional relationship, because such titles clearly indicate the independent and dependent variables. However, if possible, think of an informative but catchy title. An effective title not only pricks the reader's interest, but also predisposes one favourably towards the proposal.
- Abstract is an overview of the main story and gives highlights from each section of the paper.
- Limited length (100-300 words, typically)
- Abstract stands on its own and used, with title, for electronic search engines.
- **Most often, the only part people read**

Components of a Research Proposal

Abstract Gives:

1. Background
2. Question asked
   - "We asked whether," "We hypothesized that,"…etc.
3. Experiment(s) done
   - Material studied (molecule, cell line, tissue, organ) or the animal or human population studied
   - The experimental approach or study design and the independent and dependent variables
4. Results found (will be given in report/manuscript)
   - Key results found
   - Minimal raw data (prefer summaries)
5. The answer to the question asked
6. Implication, speculation, or recommendation

Components of a Research Proposal

Introduction

- The problem proposed to be studied is introduced in this section
- It should help the reader to acquaint with the topic
- Introduction should be short about one or two pages
- The problem should be stated in such a way that it's importance and relevance is realized by any one who reads it.

Components of a Research Proposal

Justification/Need of the project

Clearly define the proposed intervention and justify why this intervention is the best solution to the manage the target problem.

Components of a Research Proposal

Objectives of the study

- This is a very important and pivotal section and everything else in the study is centered around it
- The objective of the proposed study should be stated very clearly
- The objective stated should be specific, achievable and measurable
- Too many objectives to be avoided
- If there is more than one objective the objectives can be presented in the appropriate order of importance

Components of a Research Proposal

Literature Review

- This section reflects extensive review of literature done by the investigator
- In this section what is already known about the topic is written including the lacunae
- Just quoting the literature verbatim will not serve the purpose
- It is important to make it coherent, relevant and easily readable knowledge
- It helps the investigator to gain good knowledge in that field of inquiry
- It also helps the investigator to have insight on different methodologies that could be applied

How to write research proposal?

Literature Review

✓ most professors prefer a separate section, which allows a more thorough review of the literature

The literature review serves several important functions:

✓ Ensures that you are not "reinventing the wheel“

✓ Gives credits to those who have laid the groundwork for your research

✓ Demonstrates your knowledge of the research problem

✓ Demonstrates your understanding of the theoretical and research issues related to your research question

✓ Shows your ability to critically evaluate relevant literature information

✓ Indicates your ability to integrate and synthesize the existing literature

✓ Provides new theoretical insights or develops a new model as the conceptual framework for your research

✓ Convinces your reader that your proposed research will make a significant and substantial contribution to the literature (i.e., resolving an important theoretical issue or filling a major gap in the literature).

How to write research proposal?

Research methodology

The Method section is very important because it tells your Research Committee how you plan to tackle your research problem. It will provide your work plan and describe the activities necessary for the completion of your project

- ✓ The guiding principle for writing the Method section is that it should contain sufficient information for the reader to determine whether methodology is sound and practicable.
- ✓ Are the experiments reproducible?
- ✓ Furthermore, since there are no well-established and widely accepted canons in qualitative analysis, your method section needs to be more elaborate than what is required for traditional quantitative research
- ✓ More importantly, the data collection has a far greater impact on the results.
- ✓ Describe clearly how you will gather data for the study?
- ✓ Indicate the population, sample size and the sampling procedure
- ✓ Explain the statistical methods to be used with rationale

How to write research proposal?

Research methodology

For quantitative studies, the method section typically consists of the following sections:

- ✓ Design -Is it a questionnaire study or a laboratory experiment? What kind of design do you choose?
- ✓ Subjects or participants - Who will take part in your study ? What kind of sampling procedure do you use?
- ✓ Instruments - What kind of measuring instruments or questionnaires do you use? Why do you choose them? Are they valid and reliable?
- ✓ Procedure - How do you plan to carry out your study? What activities are involved? How long does it take?
- ✓ Analysis: what kind of analyses methods will be used to analyze the collected data?

Components of a Research Proposal

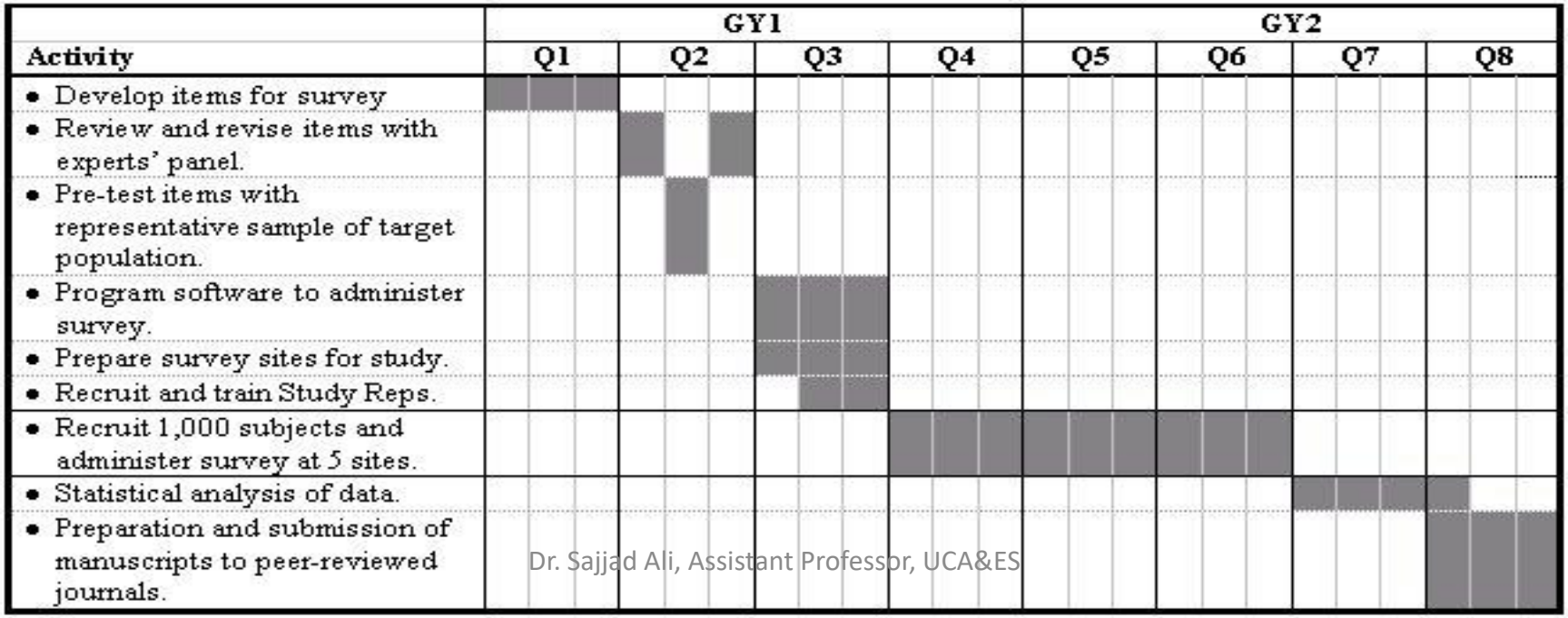
Research methodology includes:

- Study design
- Study sampling specifications
- Sample size
- Instrumentation
- Other specific procedures

Components of a Research Proposal

Time Frame & Work Schedule

- The proposal should include the sequence of tasks to be performed, the anticipated length of time required for its completion and the personnel required.
- It can be presented in tabular or graphic form
- Flow charts and other diagrams are often useful for highlighting the sequencing and interrelationship of different activities in the study.



Components of a Research Proposal

Facilities

The proposal should also include the important facilities required / available for the study namely computers, laboratories, special equipment etc.

Components of a Research Proposal

Budget

- The budget translates project activities into monetary terms
- It is a statement of how much money will be required to accomplish the various tasks.
- Major items
  - Salary for staff
  - Travel
  - Purchase of equipment
  - Printing costs
  - Consultancy charges
  - Institutional overheads

How to write research proposal?

Common Mistakes in Proposal Writing

- ✓ Failure to provide the proper context to frame the research question
- ✓ Failure to delimit the boundary conditions for your research
- ✓ Failure to cite landmark studies
- ✓ Failure to accurately present theoretical & empirical contributions by other researchers
- ✓ Failure to stay focused on the research question
- ✓ Failure to develop a coherent and persuasive argument for the proposed research
- ✓ Too much detail on minor issues, but not enough detail on major issues
- ✓ Too much rambling -- going "all over the map" without a clear sense of direction.
- ✓ Too many citation lapses and incorrect references
- ✓ Too long or too short.

Tips and Tricks

- Read, read and read
- Take notes
- Talk to supervisors, experts, fellows
- Write topics and topics
- Get confused, get afraid
- Generate a number of research questions
- Systematize research questions
- Cut down these in line with your coherent thinking

DOs and DO NOTs

- DO

✓ Prepare a professional looking proposal
✓ Make it interesting
✓ Make it informative and meaningful
✓ Write easy way to read
✓ Use clear headings and sub-headings
✓ Be concise, precise
✓ Check spelling and grammar
✓ Present in accurate and acceptable format
✓ Proofreading before submitting

❑ DO NOTs

✓ Use no words which you do not understand
✓ Use difficult words that are unimpressive to the readers/supervisor/authority.

Forms of Scientific Writings

Research Paper

- A **research paper** is a primary source.
- It reports the methods and results of an original study performed by the authors.
- The kind of study may vary (it could have been an experiment, survey, interview, etc.), but in all cases, **raw data have been collected and analyzed** with **conclusions drawn from the results**.
- Research papers follow a particular format. Look for:
  - A brief **introduction** will often include a review of the existing literature on the topic studied, and explain the rationale of the author's study. This is important because it demonstrates that the authors are aware of existing studies, and are planning to contribute to this existing body of research in a meaningful way (that is, they're not just doing what others have already done).

Forms of Scientific Writings

Research Paper

- A **methods** section, where authors describe how they collected and analyzed data. Statistical analyses are included. This section is quite detailed, as it's important that other researchers be able to verify and/or replicate these methods.
- A **results** section describes the outcomes of the data analysis. Charts and graphs illustrating the results are typically included.
- In the **discussion**, authors will explain their interpretation of their results and theorize on their importance to existing and future research.
- **References** or works cited are always included. These are the articles and books that the authors drew upon to plan their study and to support their discussion.

Forms of Scientific Writings

Review Paper

- A **review article** is a secondary source.
- It is written about other articles, and does not report original research of its own.
- Review articles are very important, as they draw upon the articles that they review to suggest new research directions, to strengthen support for existing theories and/or identify patterns among existing research studies.
- For student researchers, review articles provide a great overview of the existing literature on a topic.
- If you find a literature review that fits your topic, take a look at its references/works cited list for leads on other relevant articles and books!

Forms of Scientific Writings

Thesis/Dissertation writing

- A thesis or dissertation is a document submitted in support of candidature for an academic degree or professional qualification presenting the author's research and findings.
- In some contexts, the word "thesis" is used for part of a bachelor's or master's course, while "dissertation" is normally applied to a doctorate.
- The term graduate thesis is sometimes used to refer to both master's theses and doctoral dissertations.
- The required complexity or quality of research of a thesis or dissertation can vary by country, university, or program, and the required minimum study period may thus vary significantly in duration.

General Tips

- ✓ **Use consistent tenses – don't switch between past, present and future**
- ✓ **Simple is preferred over complex – words/ sentences/ structure**
- ✓ **Use the active voice (except in methods)**
  - ☑ ***We found correlations…*** **(active voice)**
  - ✖ ***Correlations were found…*** **(passive voice)**
- ✓ **Subject-verb agreement (The mice from each *study* were sacrificed.)**
- ✓ **Use affirmative (+) rather than negative (-) constructions**
- ✓ **Numbers beginning a sentence must be spelled (Twenty-five vs. 25)**
- ✓ **Avoid phrases such as:**
  - **four *different* groups**
  - ***absolute* essential**
  - **in *close* proximity**
  - ***very* close to zero**
  - ***much* better**

General Writing: flow

- ***Simple is better*; writing should be easy to read**
- **Flow of paper should follow an hourglass shape**
  - **Introduction starts broadly (top), narrows to specific point(s) addressed (neck)**
  - **Materials, Results & Figures detail exactly what was observed (grains)**
  - **Discussion applies findings in a broader setting (base)**

General Writing: example

Topic Sentence

Body: supporting evidence

Concluding/ transition sentence

A good paragraph generally possesses several key features that contribute to its clarity and effectiveness in presenting information. **The first feature is a topic sentence that provides the reader with a general overview of the topic covered in the ensuing paragraph. The body of the paragraph should provide substantial information with references and evidence supporting the topic sentence. The final sentence serves to wrap up the ideas and prepare the reader for material to follow in the next paragraph, also known as a transition sentence.** **Upon reading the final sentence, the reader should be able to name the topic of the following paragraph.**