Lehrstuhl für Medizinische Biotechnologie

Technische Fakultät

Friedrich-Alexander-Universität Erlangen-Nürnberg

Guidelines for writing a   
*Bachelor’s* or *Master’s Thesis* at   
the Institute of Medical Biotechnology

Master’s Thesis

*In the program Life Science Engineering  
to acquire the academic degree*

*Master of Science (M.Sc.)*

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Zusammenfassung

**Leitfaden zur Erstellung von Bachelor- und Masterarbeiten am Lehrstuhl für Medizinische Biotechnologie**

In diesem Abschnitt sollen die wesentlichen Inhalte der Arbeit in einem Umfang von höchstens 200 Wörtern zusammengefasst werden. In jeweils ein bis zwei Sätzen sollen Motivation, Ziel der Arbeit und die wichtigsten Ergebnisse genannt werden. Diese Inhaltsangabe soll in deutscher *und* in englischer Sprache abgefasst werden.

In der Masterarbeit soll die eigene Arbeit übersichtlich und präzise präsentiert werden und Grundregeln des wissenschaftlichen Publizierens selbstständig umgesetzt werden können. Der vorliegende Leitfaden enthält Informationen zu den Formatierungsvorgaben des Lehrstuhls, zur Gliederung der Arbeit und zum erwarteten Umfang der einzelnen Kapitel sowie Richtlinien zur Präsentation von Messdaten. Gleichzeitig dient der Leitfaden selbst als Formatvorlage für Bachelor- und Masterarbeiten.

Die Umsetzung der Vorgaben ist ein wesentliches Bewertungskriterium für die Bachelor- oder Masterarbeit. Der Leitfaden sollte also sehr sorgfältig durchgearbeitet werden und jeder einzelne Punkt Beachtung finden.

Abstract

**Guidelines for writing a Bachelor’s or Master’s Thesis   
at the Institute of Medical Biotechnology**

The abstract is a short summary of your thesis limited to a length 200 words.

Motivation and aim of your thesis project, as well as the most important results have to be presented briefly. A German and an English version of the abstract are required.

Your Master thesis should be a concise and well-structured presentation of your own work, which shows that you have mastered the fundamentals of scientific works and publication. This guideline contains information about the given layout requirements, the structure of your thesis, expected lengths of each chapter and about the adequate presentation of experimental data. Moreover, the guideline serves as a reference for the layout of Bachelor- or Master thesis.

Matching the given requirements is an essential criterion for the evaluation of the thesis. Therefore, this guideline should be studied thoroughly and all topics should be implemented.

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Abbreviations

|  |  |
| --- | --- |
| CLSM | Confocal Laser Scanning Microscope |
| HEK-293 | Human embryonic kidney cell line 293 |
| NADH | Nicotinamid-Adenin-Dinukleotid |
| PSF | Point-Spread Funktion |
| SHG | Second Harmonic Generation |
| TRITC | Tetramethylrhodamin Isothiocyanat |
|  |  |
|  |  |

# Introduction

In a thesis, the own work should be presented clearly and precis. The student should independently implement the basic rules of scientific publishing. This guideline including all of the following remarks shall serve as a support.

The Introduction intents to lead towards the aim of your work. The extent should be approximately two pages. The Introduction typically starts with the general background and the motivation of the project, followed by a short summary of the latest state of the art in research and previous works regarding the topic. Concluding from these, you should present the concrete aim of your work. Finally, the structure of the following chapters and the most important tasks should be presented to the reader.

# State of the Art

This chapter should be kept rather short. Do not to write a new textbook, but briefly present the main basics that allow an introduction to the field of research. However, it is important to reference all relevant publications.

## Good scientific practice

The department is committed to the fundamentals of good scientific practice, the way they are written down in the recommendation of the Deutsche Forschungsgemeinschaft (DFG, 1998). These fundamentals are obligatory for bachelor or master students that work on a thesis.

In particular, this means that objectivity has the highest priority during measurements. Manipulation of measurement data is not tolerated in any way and will have considerable consequences. It is not allowed to arbitrarily select “good data” and conceal “bad data” without any quantitative criterion and objective reasoning. Neither is it allowed to “adjust” measurement data so that it fits to a desired result. Deviations from an expected outcome do not always imply “bad” results. Proper scientific work is defined by objectively performing measurements, un-biased description of the results and reasonable discussion. By submitting your thesis, you agree that you have “written this thesis without any external help and not using sources other those […] listed in the theses.” Thus, every adopted statement has to be referenced thoroughly.

## The master thesis

In a master thesis, the own work should be presented clearly and precis. The student should independently implement the basic rules of scientific publishing. The same is valid to a lesser extent for a bachelor or project thesis. Any thesis is an important examination, which the supervisor evaluates critically. Furthermore, theses are very helpful to succeeding students during orientation and enable reproducing results as well as understanding scientific findings.

## Standards of the Department

The department has certain format standards for project, bachelor or master theses. The correct compliance of these standards is part of the grading.

### Extent of the thesis

The extent of the thesis is between 50-70 pages for project and bachelor theses and between 60-80 pages for master theses. These specifications refer to the main text from Introduction until Conclusion without Table of Content and References. It is possible to include an Appendix, but it should not be used excessively.

### What do I submit?

The department requires three versions of the thesis in print (double-paged, adhesive-bound book). Furthermore, an electronic version as PDF format and a complementary documentation (see below) are required. These files have to be copied on two CD/DVD inside paper covers, which is stuck in two of the bound books.

#### Required complementary documentation

In addition to the thesis, the student has to submit all analysis file (Excel sheets, Matlab files, etc.) and figures as well as the raw data (if possible). The data and analysis have to be documented so that it is possible to reproduce and understand the results. If the work consists of designing, theoretical considerations or programming, all drawings, CAD files, calculations and code files have to submitted. In the case of programming tasks, the student has to comment the code sufficiently. A separate folder should contain the literature that was used.

#### Presentation

After submitting the thesis, the student is obligated to give a presentation, which is graded in the programs CBI and LSE. The student has to submit the presentation slides on the same CD/DVD.

### Formatting template

The present guideline can serve as template for the thesis using Word or similar software such as OpenOffice. Alternatively, the usage of the software package *LaTeX* is recommended. A template for *LaTeX* is also available at the department.

Generally, the student has to use the following specifications: the running text has to be written in a readable font using a font size of 12pt with a line spacing of 125-130% (1.05 – 1.1 in Word). The page margins are 4.5 cm at the bottom, 3.5 cm on both sides and 2.5 cm at the top.

## First step: structure of the thesis

It is recommended to start with a rough structure of the thesis, by giving titles and sub-titles for all sections. The Table of Content adjusts accordingly. A clear and reasonable structure is essential for a good grade.

### Structural levels

The Table of Content will only show three structural levels. If you require further structural levels, please use headings similar to heading 4.

#### Additional subitem: heading 4

Heading 4 does not appear in the Table of Content. Further sub items below the 4th structural level are not recommended.

### Short and significant titles

Choose titles that summarize the content of the chapter without extending over more than one or maximal two lines.

## Useage of text processing tools

In the following paragraph, some useful remarks regarding efficient usage of Word and other word processing programs are given.

### Frequent backups

When working on longer documents, it is possible to accidently delete parts without notice. It is recommended to frequently create new versions of the document (e.g. version 1.1 until 4.x) and to save them on several different hard drives.

### Use style sheets consistently

Style sheets are the best way to format throughout the entire document, so that changes can easily be performed at later stages. Font sizes etc. should not be changed individually.

### Using cross-references

Cross-references help to structure the text and guide the reader.

E.g.: As shown in paragraph 2.3.2, …

This cross-reference is automatically updated, if new chapters are inserted. It can be inserted via References – Cross-References.

## Referencing

Every content that was not originally created by the author has to be referenced accordingly. This is also valid for figures created by other colleagues of the department e.g. (Figure XY: G. Prölß, Department MBT).

### Usage of academic literature

An important grading criterion for theses is the independent handling of academic literature. In particular, this includes articles about original work or overview articles published in scientific journals (with *peer-review*). Internet sources are acceptable but not sufficient without additional sources. Textbooks should not be used excessively.

### Referencing and Bibliography

The usage of reference management tools is highly recommended. Besides the well-known software packages Endnote and Citavi, the freeware Jabref offers a reliable alternative. The software can export the reference database to the format .xml used by MS Office 2007. In Word this database can be used via References – (Asatryan, Sheppard, & de Sterke, 2004). Other word processing tools such as LaTeX have similar functions.

In the running text, you reference via the button Insert Citation, as show here (Beck & Brodsky, 1998). The entire reference appears in the chapter Bibliography. Only references that were used in the text and not the entire database should appear in this chapter. The style of referencing can be adjusted according to the template.

The standard at the department is the Harvard style or similar formats: (Authors, year) or [Authors, year]. The Bibliography at the end is in alphabetic order. Further references are DIN 1505-2 and DIN ISO 690.

## Scientific writing

Use objective expressions and adjust your style of writing according to how you read it in the academic literature. Mind the correct grammatical phrasing and describe the performed experiments and the obtained results in the passive. Short and precis sentences are more clear than long and complicated ones. When in doubt, it is usually better to have 2-3 short sentences instead of one single sentence that extents over several lines.

Sentences such as „I am using a badass laser“, „the difference was huge“ or „and then I went to the other setup and started a new measurement“ etc. are bad style and show a lack of interest for academic phrasing.

Guiding the reader through your thesis is essential to prevent confusion. Furthermore, it shows to the reader that you understand why you did your tasks in a certain way and in a certain order. Refer to previous chapters (“as shown in 2.5.3”). Make logical connection between different experiments (“since technique A is known to show XY, it was necessary to perform a control experiment B”). Summarize problems you discussed earlier when presenting your results (“the uncertainty of XY in setup A could be eliminated by experiment B, allowing to determine parameter C with a precision of D”).

# Methods

This chapter is essential for the reproducibility of your results. The entire procedure of obtaining the final results presented in your thesis should be well documented here. This includes all of the utilized materials, devices, solutions, samples, protocols as well as the measurement procedure, data analysis tools and statistical methods. It is recommended to present all methodical steps in a logical order (e.g. describe the samples, then lead to the measurement procedure including the details of all devices and protocols. Finally, explain the data analysis steps that were used to obtain results from raw data). Reproducibility is the key for objective validation in science. Make sure you describe you experimental and/or processing procedure in a way, that any scientist anywhere in the world would be able to perform the same experiments. It is recommended to always carry pen and paper during experiments in order to take notes about relevant experimental parameters (e.g. volume ratios of components in a solution, laser power, integration time, ambient temperature etc.).

In the following, some aspects regarding formats, charts, equations and code are presented.

## Formatting

Every (sub-) title should be followed by a short text. You can use this space to shortly sum up the context of the following sections. This might seem repetitive, but it will improve readability.

### Formulae

Unfortunately, the [consecutive](http://dict.leo.org/englisch-deutsch/consecutive) [numbering](http://dict.leo.org/englisch-deutsch/numbering) of formulae in Word is cumbersome. The formula can be inserted to an empty table with two columns, using the right column for numbering via References – Insert Caption – Label: Formula (Exclude label from caption).

|  |  |
| --- | --- |
|  | (3.1) |

You can refer to formula (3.1) using a cross-reference. Consequential, you can deduce formula (3.2).

|  |  |
| --- | --- |
|  | (3.2) |

The cross-references change automatically, when additional formulae are inserted and captioned. Via right-click, it is possible to update a field manually in the case that the changes are not updated. Simple formulae, such as , can appear in the text without numbering.

Other text processing tools, such as LaTeX, might be easier to use for numbering fields and have similar cross-referencing functions.

### Software code

Programming languages should be formatted in a monospace font (e.g. Consolas 11pt). An easy way to insert software code is the use of embedded openDocument text files (Insert > Object > openDocument Text). An exemplary Matlab code is shown below. It can be edited in a separate file by double clicking.



### Tables

Tables have to be captioned and numbered. The caption is above the table. The content should be well-arranged. Therefore, the format can be adjusted according to the content of the table. Caution with the comma placement: the German notation uses dots for thousands digits and comma for decimal numbers; the English notation is opposite to that (10,5 vs. 10.5). Do not forget to assign the proper units.

Table 3.1 An exemplary table without meaningful content. The caption is above the table and should shortly sum up the content. A reader how open your thesis at this page only, should be able to understand the main idea from this table without reading the entire thesis.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Gruppe A | Gruppe B | Gruppe C |
| Eins | 10,5 W | 12,8 W | 4,9 W |
| Zwei | 13,5 A | 2,3 A | 4,6 A |
| Fünf | 115 mm | 128 mm | 98 mm |

Table 3.2 The same table with different handling of the units.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Gruppe A | Gruppe B | Gruppe C |
| Eins (in W) | 10,5 | 12,8 | 4,9 |
| Zwei (in A) | 13,5 | 2,3 | 4,6 |
| Fünf (in mm) | 115 | 128 | 98 |

# Results

This chapter should present the results of experiments, calculations, simulations or designs. Raw data should not be shown, only processed data. The best way to present results is via figures that transport clear and strong messages (see 4.1).

The text should guide the reader through the different figures and results you present (see 2.7). Each result shown in a figure or table should be descriped shortly but precisly in the text. Furthermore, a statistical evaluation of the main results is an essential part of this chapter. The interpretation, analysis and evaluation of the results however, is subject to the next chapter.

## Figures

The figures have to contain axis labeling (with units!), a caption and if possible error bars. The caption should nicely be readable in a font size between 9 Pt and 12 Pt and contain the central information of what is displayed in the figure. From caption and figure alone, it should be possible to understand the main concept of the presented results. Imagine a reader only opens one page of your thesis and looks at a certain figure. Will he be able to grasp the message you want to convey with that figure without reading the text? The axis have to be labeled proberly with the corresponding units (do *not* use square brackets “[ ]”).

Figure 4.1 Rate of the exponential decay of the intra cellular Ca2+ concentration in three different groups. Group C\* is significantly separable from group A and B with p < 0.01.

Bar plots, such as Figure 4.1 (Cross-reference to the figure caption), should contain error bars (mean and standard deviation). The caption should include an indication of the statistical significance of the results as well as the number of repetitions of the experiment.

Figure 4.2 shows a dose response curve in semi-logarithmic representation. The trend can be fitted to a model function (red). *Never* connect single data points with straight lines or splines. Show individual data points with their respective error bars and plot a fitted curve in another color. The fit function and the result obtained from the fit should be stated in the figure caption.

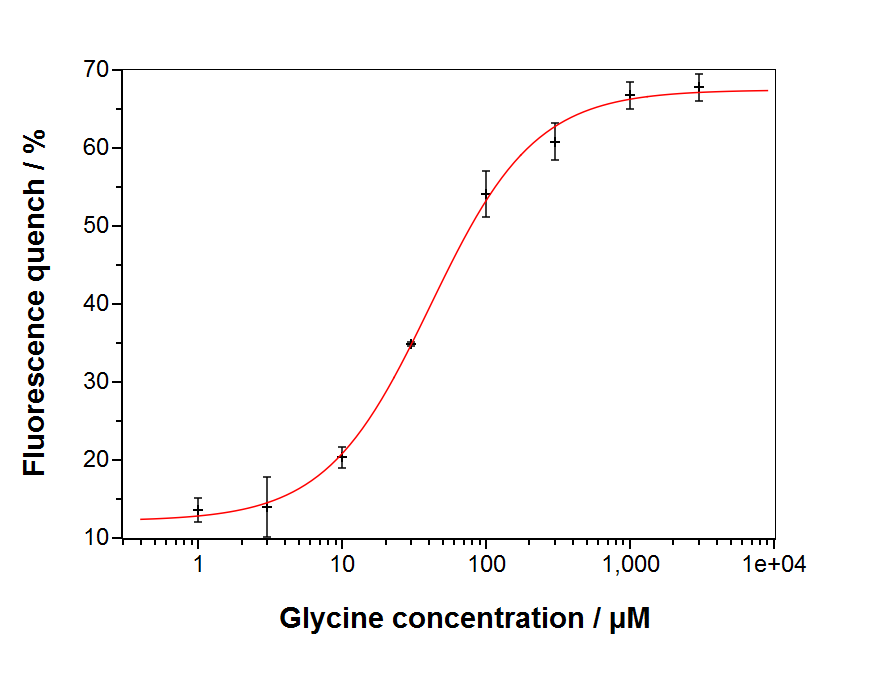


Figure 4.2 Dose-response curve of glycine on the alpha1-GlyR measured in terms of a fluorescence quench. A Hill-function fit yields: EC50 = 41.0 ± 3.3 µM.

## Statistical analysis

The central results of the work require statistical analysis. Differences between different groups are always subject to statistical fluctuations. Therefore, the statistical significance has to be evaluated. Usually, an analysis of variance (ANOVA) is used.

# Discussion

This chapter is the most important part regarding your own intellectual output. Invest a sufficient amount of time writing it. It is very important that you show a deep understanding of the matter.

A good discussion connects the aim and motivation of your work (see Introduction), theoretical background and the progress of other groups presented in State of the Art, the guideline through your methods and materials from chapter 3 and the value-free description of the obtained results. The results should be picked up and discussed deeply. Bring your results into context, regarding the general research question and regarding the literature. How significant are your results? What conclusions can you deduce from your results (and as important as that: what conclusions cannot be deduced from your results alone)? How was the signal-to-noise ratio of your setup? Are there statistical constrains?

Judge your work within the frame of the presented research question. Do not be afraid to discuss “failed” experiments, if your results did not show an expected behavior. Discuss and explain the reasons for these deviations. Critically question other studies as well as your own work. Where are limitations of your approach? Where does your approach have advantages over other state-of-the-art approaches? Search the literature for hypotheses that can explain your results in a reasonable way. Propose your own hypothesis, if needed.

Finally, discuss how you would proceed with the work. How could you improve your approach in the future? How can your approach help answering the general research question? What are the next steps to continue the research in this field?

The discussion should be the very last chapter that you write. Obviously, you can only compare your methods and results to others, after you obtained *all* results and read *all* of the relevant literature.

The discussion should take up 15-20% of your thesis.

# Conclusion

The chapter „Conclusion“ should give a short summary and interpretation of your results. This summary should be condensed to the most important statements and transfer the take home message.

What is important to you? What do you want other people to take away from your thesis? Where do you still see problems that need to be solved in the future and what possibilities do you see as outlook?

In contrast to the Abstract, which is very short, and to the Introduction, which states the aim and motivation of the work, the Conclusion is mainly focused on a summary that is oriented more to result and discussion.

# References

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# Appendix

Space for additional documentation, which was to extensive for the main part. This can include software code, numerical modeling, sequencing, plasmids, primer, calibrations etc.

Curriculum vitae

|  |  |
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|  |  |
|  |  |

Erklärung

Ich versichere, dass ich diese Arbeit selbständig verfasst und keine anderen als die angegeben Quellen und Hilfsmittel verwendet habe. Die Arbeit hat in dieser oder ähnlicher Form noch keiner anderen Prüfungsbehörde vorgelegen.

Declaration

I confirm that I have written this thesis without any external help and

not using sources other than those I have listed in the thesis. I confrm also

that this thesis or a similar version of it has not been submitted to any

other examination board and has not been previously accepted as part of a

exam for a qualifcation.

Erlangen, den xx.xx.xxxx

(sign here)

Max Mustermann

Acknoledgement