Instructions for writing a Master´s thesis in Molecular Biology

General guidelines

In the Master's thesis, you will document and present your Master´s project in a stringent and scientifically correct way, and in a style that is similar to a manuscript submitted for publication in a scientific journal. The aim is to present the work in a clear and comprehensive way that is easy to read and understand for a reader who is at the level of a fellow student at the end of your Master´s programme.

The thesis should be written by yourself, and not contain parts copied from other sources. It will be tested for plagiarism via the URKUND system upon submission for examination. It should be easy to follow, formally correct, and have been carefully proof-read.

The thesis should be organised in the following sections and in the following order, as further outlined below: Title page, Abstract (on separate page), Introduction, Materials and Methods, Results, Discussion, Acknowledgements, References (list of cited references). Pages should be numbered.

Figures and Tables should be embedded, together with figure legends and table headings, in the text, roughly where it is relevant and where it is suitable with respect to overall layout and printing. It would also be allowed to collect the Figures and Tables on separate pages at the end of the thesis.

The text should be written in an easily legible font, like Times New Roman or Arial, font size 12, and Symbol for non-Latin characters. Headings and subheadings should be clearly distinguished using font size and style. Provide line spacing and sufficient margin to allow readers (like examiner and opponent) to make markings and notes. Paragraphs are marked either by indentation of first line, or by adding an extra space (blank line) before the paragraph (but not both options at the same time). The first paragraph after a heading/sub-heading does not need indentation.

Title page

The Title page should show title, author (yourself), and what kind of project this is (e.g. Master´s project in Molecular Biology, 45 credits, course code, Department of Biology, Lund University). It should also show name(s) of supervisor(s), their affiliation, and where and when the work was done.

You should not paste any logotype of the University on this page.

Abstract

The abstract should be on a separate page. It should have a maximum of 300 words.

The background to the work is outlined clearly and concisely in a few sentences. The specific question or aim of the project should be explicitly spelled out. The main part of the Abstract should be dedicated to describe/summarize what you did and what the main results were. The Abstract should end with comments on the overall conclusion, overall significance, and/or possibly an outlook towards further work that is needed.

Introduction

The Introduction should describe the background to the project and end with a clear description of the aim of the work.

The text should be supported by relevant references (see below).

Start by putting the work in broad context. Then, while you describe the research field and give appropriate references, you should gradually narrow down your description towards the specific topic and question that you have investigated.

The Introduction may also give the background to and explain strategies and specific methods used in the project.

It should be clear from the Introduction that you have a deep understanding of the research area, the background, the specific question that is addressed in the project, and the chosen methodology.

The Introduction should end with explicit statements of the aim of the work, the question that is addressed, and any specific hypotheses that are tested.

The text should be clear, concise, easy to follow, and not unnecessarily long.

Materials and Methods

The general rule is that materials and method should be described in such detail so that a knowledgeable reader could repeat what you have done. Relevant references should be given for both methods and materials. Give explicit descriptions of where any relevant materials that you have used come from. Give references in cases when materials have been described before (e.g. genetic material like plasmids, or living cells or organisms like cell lines, bacterial strains, plants, or animals). Use Tables to list relevant materials when applicable.

The Materials and Methods sections should be organised by subheadings. The subsections do not have to follow the chronology of the project or the organisation of the results sections. The Materials and Methods section is intended to be used in a more encyclopaedic way and should be organised after methods or approaches (i.e. you go into the Materials and Methods section to look up specific methods or technical details, but you are not expected to read it from start to end like a logically coherent story).

For methods that have been described previously, you may refer to descriptions elsewhere, but you should give enough information so that the reader still understands what you have done without being forced to go the detailed description in the reference. Any deviation for the published method has to be specified.

Any statistical analyses should be clearly described, including for example the methods and types of tests applied, experimental designs, sample sizes, and calculations.

If applicable, you should under a separate subheading “Ethical considerations” specify whether any aspects of the work required for example approval of an Ethical committee, permission to carry out experiments involving animals, material of human origin, or informed consent from patients.

Results

The results sections should be clearly organised and make it easy for the reader to follow the logic of the project and the thesis. Use subheadings, if applicable, to provide structure to the presentation.

As a useful rule of thumb, each subsection in the Results should clarify the following:

- Why was something done? Start each subsection by making it clear what the purpose was of the specific experiment, measurement, or procedure that is described in the subsection.
- What was done? Use a few words to clarify for example what type of measurement or experiment was done. The exact technical details should be in Materials and Methods section, but a sentence or two are often needed to inform the reader about what was done before the results are described.
- What was observed? Describe in words the relevant and most important aspects of the results, and refer to Figures or Tables where the results are shown.
- What does it mean? A brief summarising or interpreting statement about what the specific results mean or indicate is extremely helpful for the reader. This is often necessary to understand the logic of the project and the next step in the investigation. However, elaborate interpretation and discussion should of course be in the Discussion.

Describe both the results and any statistical analyses.

In a Master´s thesis project, time is limited and it is not uncommon that certain experiments or measurements are incomplete or not fully replicated at the end of the project. It is still allowed to present such preliminary, incomplete, or negative results in the thesis, but is has to be clearly stated and documented what the limitations of the results are. Incomplete or inconclusive data would not be included in a scientific publication, but can be part of a Master´s thesis, provided that they are properly documented.

Note that the Results section can be structured in somewhat different ways depending on what type of project you have done. Discuss with your supervisor how to best present the results of your project.

Discussion

This is where the results are fully interpreted and discussed.

Avoid extensive re-iterations of the result descriptions. Instead, the key aspects of the results should be interpreted and discussed in relation to the original aim or hypothesis of the project, and in relation to what is known and has been described previously in the literature. Thus, it is crucial that your discussion contains references to the literature.

Remember to take the statistical analyses into account in the interpretation and discussion.

If there were technical problems or other relevant issues that could have affected the work, this can be discussed here. What could have been done to solve problems, or what other methods or approaches could have been used?

The suitability or limitations of the chosen methods can be discussed. Could alternative methods have been used? In that case, which and why?

What further investigations would now be needed, based on your results and conclusions?

Try to put the addressed scientific question and possibly the obtained results in broader scientific and societal contexts (can be in Introduction, Discussion, or both).

References

Handling of references should follow a variant of the Vancouver style that is called APA 7th. A guide for usage of this reference style is provided by the Biology Library: https://libguides.lub.lu.se/apa_short

All references have to be cited in the text, for example like this (Watson & Crick, 1953), or like this (Yu et al., 2000). It may also look like this when you cite two references at the same time

(Hofmeister & Brun, 2000; Hopwood, 2007). Further examples are given in the guide from the library that is linked above.

All cited references have to be listed at the end, under the heading References. The reference list has to follow exactly the guidelines for the APA 7th style. See link above for more information.

Here follows an example of what a reference list according to the APA 7th style would look like for the four references cited in the text above. Note that one reference is a book, one is a chapter in an edited book, and two are regular papers in scientific journals with different numbers of authors.

References

Hofmeister, A., & Brun, Y. V. (2000). Polarity and cell fate in bacteria. In D. G. Drubin (Ed.), *Cell polarity* (pp. 1-20). Oxford University Press.

Hopwood, D. A. (2007). *Streptomyces in Nature and Medicine. The Antibiotic Makers*. Oxford University Press.

Watson, J. D., & Crick, F. H. (1953, Apr 25). Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid. *Nature, 171*(4356), 737-738. https://doi.org/10.1038/171737a0

Yu, D., Ellis, H. M., Lee, E.-C., Jenkins, N. A., Copeland, N. G., & Court, D. L. (2000). An efficient recombination system for chromosome engineering in *Escherichia coli*. *Proceedings of the National Academy of Science, USA, 97*, 5978-5983.

Note that DOI numbers may be included for papers that have been assigned DOI numbers (see one example above). DOI numbers are useful as identifiers and also provide a link for rapid access to the papers.

Figures and Tables

All figures and tables that are used have to be referred to in the text at least once, for example like this (Fig. 2).

The figures are numbered in the order that they are mentioned in the text.

The Tables are numbered separately, and are also numbered in the order that they appear in the text. See Table 2 for an example.

Figures should be clear and easy to understand. All axes should be correctly labelled. Symbols and text in the figure have to be large enough to be clearly visible in print. Microscopy images should contain scale bars. It is a good idea to point out relevant details by arrows or other symbols (that are of course explained in the legend). All annotations in the figure should be explained in the figure legend (see below). Any data in the form of images should be handled carefully and correctly to avoid corruption, skewing, or misrepresentation of the results.

Each figure should have a figure legend that clearly and concisely describes what is shown in the figure (see Fig. 2 for example). The first line of the legend should work as a "heading" to what is shown in the figure. In the next lines, enough technical information should be given so that reader without significant problems can understand what the figure shows, without having to consult the Materials and Methods. Be careful to explain all symbols or designations used in the figure. Each subpanel should be specifically described. Remember to specify scale bars and other important details.

Note: The figure legend should not interpret the data or give the conclusion! It should explain what is shown in the figure.

Tables should have a Table header above the table that explains what the table contains (like a "heading"). Further clarifications, specifications, or technical explanations should be given in footnotes below the table.

If any figures would contain illustrations made by others, you must clearly state the source of the illustration.

Acknowledgements

This is the place where any relevant information about for example contributions from other persons (like collaborators, supervisors, or other group members) to the presented work can be specified. For a fair evaluation of the Master´s thesis, it important that such contributions are acknowledged. Likewise, if any work done outside the scope of the Master´s project has been used as substantial basis for the presented research, this should be acknowledged. Persons who have provided advice, valuable discussions, or feedback on the manuscript, can be thanked here.

Popularised summary

A popularised summary should be included in or attached to the thesis. See separate instructions for this, found here: https://www.biology.lu.se/sites/biology.lu.se/files/instrpopsummaster.docx

Examples of Figure and Table

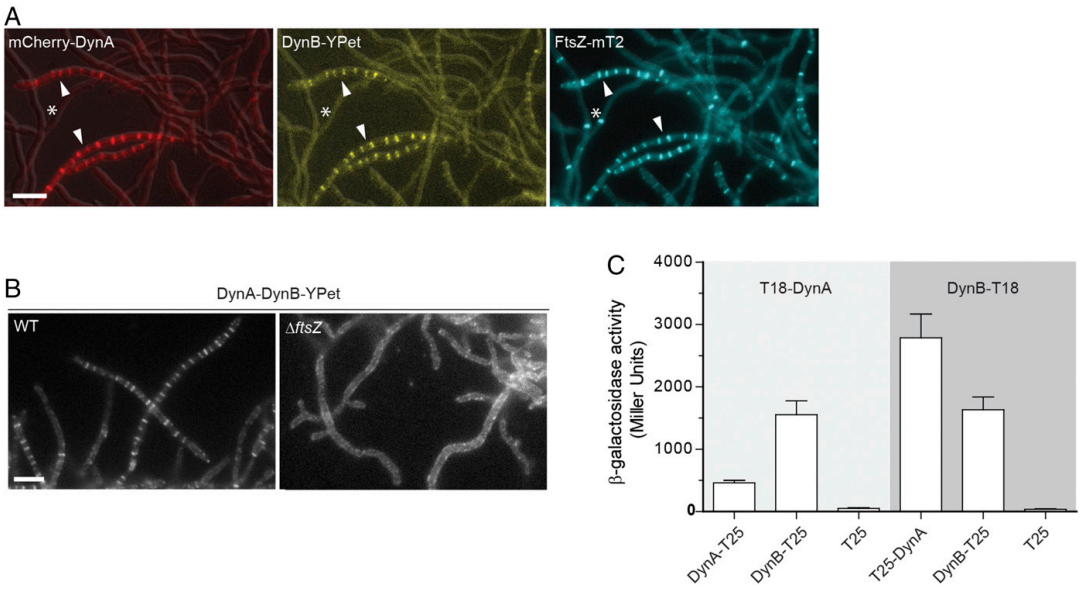

Fig. 2. DynA–DynB complexes colocalize with FtsZ at nascent division sites. (*A*) Subcellular colocalization of fluorescent fusions to DynA (mCherry-DynA) and DynB (DynB-YPet) with FtsZ-mTurquoise2 (FtsZ-mT2). The asterisk denotes vegetative cross-walls and arrowheads point to sporulation septa. Microscopy images of the triply labeled strain (SS206) are representative of at least two independent experiments. (Scale bar: 5 μm.) (*B*) Localization of DynB-YPet in the WT (SS142) and in the *ftsZ* null mutant (Δ*ftsZ*, SS238). The *dynAB-ypet* construct was ectopically expressed from a constitutive promoter (P_{ermE*}). (Scale bar: 5 μm.) (*C*) β-galactosidase activities demonstrating an interaction between DynA and DynB in *E. coli* BTH101. Positive interaction is detected when DynA and DynB protein fusions to the "T18" and "T25" domains of adenylate cyclase reunite the enzyme, resulting in the synthesis of LacZ. Strains expressing only the T25 domain were used as a negative control. Results are the average of three independent experiments. Error bars represent the SEM.

TABLE 2. Differential expression of *hupA-egfp* and *hupS-egfp* in vegetative hyphae and spores

Strain	Gene fusion	Avg fluorescence intensity (arbitrary unit)[a]		Ratio[b]
		Vegetative hyphae	Spores	
K306	*hupA-egfp*	466 ± 168	275 ± 74.1	0.590
K307	*hupS-egfp*	83.5 ± 40.4	948 ± 317	11.4

[a] Average intensity value per pixel after subtraction of background values from surrounding medium. Measurements were done of 100 randomly selected areas of 0.5 μm^2 per strain in images of the type shown in Fig. 2.
[b] Ratio of average fluorescence signal in spores to average signal in vegetative hyphae.

Fig. 2 from Schlimpert *et al.* (2017) *Proc. Natl. Acad. Sci., USA 114*(30), E6176-E6183.
Table 2 from Salerno *et al.* (2009) *J. Bacteriol. 191*(2), 6489-6500.