

Nanobiology Individual Research Projects

Bachelor and Master

Planning, doing research and then communicating about it in written form is at the core of doing science. In the Nanobiology programmes this is embedded in many courses, but doing individual projects requires a bit more guidance.

Every project for credit needs planning, approval, and then a final report. This document includes guidelines, step-by-step guides, requirements and rubrics for all research project courses and their reports.

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Research Project Planning

All projects benefit from proper planning. This section should help you learn to do it better, and remind you of things you might forget.

These guidelines apply to BEPs, MEPs, Company Internships, Academic Research Projects, Independent Research Projects, Honours Projects.

Creating a structured project plan will greatly increase the chances of success in your research project. Planning ahead and discussing your plan with your supervisor will help you set realistic goals, ensure that you have enough time to carry out the tasks required to reach those goals, avoid common pitfalls, and get the most out of your time in a research group. Making a realistic and feasible plan will moreover be a key skill you will need in any job. The preparation phase is therefore an essential step towards a successful project.

We strongly recommend that you NOT rush the planning phase because of the attraction of getting started in the lab. Planning your project well, thinking through pitfalls, alternate hypotheses, necessary skills, writing a plan will help your project be much more successful. Also spend the time with your supervisor to make sure you have a clear mutual understanding of expectations, benchmarks, and communication channels. This can be done additionally with your daily supervisor, but main conversations should be with your responsible supervisor. It is important that benchmarks are about work accomplished not getting results.

Discuss Expectations

Discuss with your supervisor(s) what they expect from you and what you expect from them, both in terms of project results, feedback, work environment and your performance. It is important to communicate about the balance between bench work and any other activities (writing, data analysis, computer modelling, literature, etc). Expectations regarding experimental results should clearly be communicated.

Topics to include:

- Communication methods (phone, email, whatsapp)
- Travel plans (for both of you)—update this regularly
- Lab presence—hours expected in the lab, when are you both in the lab, when do you work from home—update as needed
- Timelines, deadlines and feedback
- Data storage
- Work environment—will you have a desk?
- Anything else that will affect your working together
- Level of supervision, frequency of meetings
- Problem reporting—where and how do you report when there are problems.

Plan of approach and a corresponding timeline

To make your research project a success, it is wise to start with making a plan of approach and a corresponding timeline to define your expectations for the project. The plan is preferably a compact document, say at most 2-4 pages A4, though

will be longer for larger projects This plan should be written by you - the student - but agreed upon with your supervisor(s).

Do not postpone the formulation of this plan.

You should have agreed to your plan with your supervisor within two weeks of starting your project (it is even better when it is finalized before the project starts).

The plan should contain at least the following items:

- Working title
- Your goals with the project, what you hope to learn
- Skills you hope to learn
- Activities you plan to do as part of working on your End Project
- Clear plans for regular meeting to discuss progress and results with your supervisor(s).
- Description of any other activities or plans you have while you're doing your End Project
- Timeline (for example a table or a Gantt chart), including experiments/simulations/etc., data analysis, feedback moments, report writing, final presentation and (if applicable) defence.

In this timeline also include other parts of the curriculum to be done (lectures, exams,...), and also other activities that will take time (jobs, vacations, ...). Do not forget to schedule time for writing your final thesis / report, this should be included as part of the time for the project.

During your project

Have regular discussions to get feedback

You should have regular meetings with your supervisor. For those, you need an agreement with your supervisor about how and how often they're planned, which topics you will discuss, and what your supervisor wants in terms of prepared material.

Discuss your expectations if something is not working the way you thought it would. Bring things up with your supervisor—make sure they know what's going on.

Start writing early

Write your report as you go. Get help with your writing from supervisor, the TU Delft writing center, or friends. Peer feedback can be very helpful in achieving an excellent final project report.

If you are doing a BEP or MEP there are writing courses from TBM on writing those in English.

Make sure you allow plenty of time for revision of your report. You can ask for feedback on small parts as you go. You don't have to finish the whole thing before getting any feedback (and shouldn't wait until then).

Report problems

If you encounter a problem, inform your supervisor. If you are uncomfortable about doing that for any reason, please contact the NB Academic Counsellor Stuieadviseur-NB@tudelft.nl or the programme coordinator info-msc-nb@tudelft.nl or info-bsc-nb@tudelft.nl. We can help you, but only if we know there's a problem. You can also report anything involving social safety to a confidential advisor.

NB3000 Bachelor End Project

These are 20 EC and should be part time for about 20 weeks. Students are usually taking electives at the same time so work around 25-30 hours per week in the lab. Time spent on the project includes writing and editing time.

Other resources

[Study guide](#)

[Thesis office Brightspace](#)

- Greenlist
- BEP Application Form
- BEP Assessment rubric

Step-by-step guide Bachelor Nanobiology

Be sure you start organising your BEP early, preferably around three months before.

Orientation

What are the entry requirements to start a BEP?

When, where and on what subject do you want to do your Bachelor's thesis project?

Read the information of the course NB3000 in the study guide Course browser searcher (tudelft.nl)

Have a look at BEP on Nanobiology BSc Brightspace page for more information.

Use the BEP database from Hooke to see potential Supervisors. BEP/MEP database – S.V.N.B. Hooke

<https://svnbhooke.nl/index.php/bep-mep-project-database/>

Preparations

Application form

Complete the 'application form' with your GreenList supervisor. You can find the GreenList under

Content > Bachelor End Project (BEP) > NB. Send the form for approval to info-BSc-NB@tudelft.nl.

After approval, you will receive the application form back with the Thesis Office in cc. You will receive a confirmation e-mail from the Thesis Office when the application form has been processed.

Do not start your project before you have received this confirmation email.

If you are doing your BEP at Erasmus MC, follow the instructions on the Nanobiology BSc Brightspace page.

Assessment committee

The committee consists of at least two examiners. One of your assessors must be a teacher in the Nanobiology programme, both must be on the Nanobiology GreenList. Which supervisors teach in the Nanobiology programme are indicated on the GreenList.

You must identify the teaching member of your assessment committee at the time of approval. If your responsible supervisor is a teacher then you can identify the second assessor later.

It is the responsibility of your supervisor to finalize your committee.

Grading Scheme

Your BEP will be reviewed according to the criteria mentioned on the 'BEP Grading Scheme'. You can find it under Content > Forms.

During your BEP

Academic counsellor

If your BEP is not going according to plan, contact your academic counsellor as soon as possible. You can send an e-mail to studieadviseur-NB@tudelft.nl or schedule an appointment. Look for more information at Academic Counsellors (tudelft.nl).

Writing help

We strongly recommend that you write as you go. If you're struggling with the writing of your BEP, the TU Delft writing center provides resources. Thesis boost days, one-on-one writing coach and more.

TU Delft Writing Centre

Completion

Defence

If you need to change your second examiner, you must email their name and email address it to the Thesis Office ThesisOffice-TNW@tudelft.nl at least two weeks before the defence.

You must send your report to your assessment committee two weeks (14 days) before your defense.

Arrange a date and a room for your presentation with your supervisor and assessment committee.

Your supervisor can arrange or help you arrange a room.

Archive/Repository

You are required to submit your final report to us for archiving. This should be done by including the thesis office in the CC when you email your final report to your assessment committee. The report is kept confidential in a secured environment and used for quality control and accreditation purposes.

Students may upload their report to the TU Delft Repository but it is not required in Applied Sciences.

You can do it yourself (in consultation with your supervisor) if you want. See Home | TU Delft Repository

Final Grade

The responsible supervisor sends the assessment form to the Thesis Office. The responsible supervisor can find the link to the assessment form under Content > Forms. A blank assessment form is never provided to a student.

Once the Thesis Office has received the application form, report and assessment form, your BEP is complete and the grade can be processed in Osiris. The grade will be registered with the date of your defence. You will receive a confirmation when your grade has been processed.

Survey

The confirmation of your grade also includes a link to a survey about (the process of) your BEP, please fill this out.

Additional information.

If the BEP is your last subject of your Bachelor Programme, please have a look at Graduation (tudelft.nl).

BEP Report Requirements

A *typical* thesis is about 20-50 pages long. Use the guidelines at the end of this document on writing scientific reports. Below are expected lengths of the various sections for a BEP thesis.

- Introduction 3-10 pages,
- Materials and Methods 5-15 pages
- Results 5-20 pages
- Discussion/conclusions 5-10 pages.
- Reference list: includes all relevant articles and other sources consulted. Use a standard referencing format.

A section on recommended next steps and suggestions for overcoming problems that were encountered can be included, either as a separate section or included in the discussion section.

Supplemental sections or Appendices are not required but can be included for: details of methods not included elsewhere, sequence information, data sets not easily presented as figures, reagent components, DNA construct maps, short descriptions of computer programs / scripts you developed (include links to where the scripts can be found online, but do not include the full code) and other required details that are not presented in the main text. You can also have supplemental videos that can be accessed online; a description of the video and a link (and ideally a screenshot) should then be included in your thesis.

NB3030 Independent Research Project

Students can do small research projects and get credit for it with prior approval. These projects are meant to be small projects and allow us to give credit for extra research projects.

For this course you will need to submit two documents via Brightspace.

- **Project proposal**—which will be evaluated within Brightspace and if it receives approval you'll be able to submit your next document
- **Project Report**—when you have completed it. Once it is evaluated you'll receive your grade and credits.

During your project you should keep a lab journal and work log of hours spent. This should be included as an appendix to your report.

Before starting your project, you should meet with your potential supervisor to plan the project. See the Project Planning Guides for things which you should consider and discuss.

Project Proposal

Your proposal must include the following elements and be two to three pages in length:

- Proposal title
- Supervisor of your project (Greenlist supervisor)
- Daily supervisor (optional)
- Location
- Start date
- End date
- How many ECs you hope to earn by doing the project (max 6 for an elective, max 15 as part of a free minor)
- How many hours you expect to spend working on it
- Body of the project:
 - Brief description of the project including relevance to Nanobiology
 - Activities you'll do during your project including planning for timing
 - Your learning goals
 - Supervision plan with your responsible supervisor (frequency of meetings, format)
- Your proposal should also include a statement from your supervisor saying they agree to supervise you to complete this proposal and have discussed expectations. (Could be an attached email)

Project Report

The project report should be a document that describes what you did during your project. So a 5 EC project report will probably be shorter than a 15 EC project report but there isn't a direct correlation. Use the Guidelines for Writing Scientific at the end of this document.

Writing your report is part of the time you spend on the project. Take your time with this and make sure it's well constructed and thoroughly edited. You can and should get feedback from your supervisor and update accordingly before submitting it to the Programme director for final assessment.

You are not required to do a presentation unless you and your supervisor agreed upon that.

If you have questions, please email info-bsc-nb@tudelft.nl

Report Requirements

A *typical* report is about 10-30 pages long depending on how large the project is. Rule of thumb—2 pages per EC. It includes:

- Introduction: includes background on the question, why it's important
- Materials and Methods
- Results
- Discussion/conclusions
- Reference list: includes at least 5 articles or sources consulted. Again varies by size or type of project. Use a standard referencing format

A section on recommended next steps and suggestions for overcoming problems that were encountered should be included, either as a separate section or included in the discussion section. Also describe what skills you learned.

Required Appendices

- Project log of time spent and work done is required.
- Original proposal document
- Statement from your supervisor (could be email) that they agree with the contents of the report and it reflects the work you did and they are satisfied with it.

Optional Appendices can include: details of methods not included elsewhere, sequence information, data sets not easily presented as figures, reagent components, DNA construct maps, short descriptions of computer programs / scripts you developed (include links to where the scripts can be found online, but do not include the full code) and other required details that are not presented in the main text. You can also have supplemental videos that can be accessed online; a description of the video and a link (and ideally a screenshot) should then be included in your thesis.

NB2903 and NB2905 Bachelor Honours Project report

We have two course codes for honours projects: NB2903HPB is a 7 ec report and HP2905HPB is a 5 ec report. Default is 7 ec honours project and 5 ec interfaculty course, but the variant 5 ec project and 7 ec interfaculty is also allowed.

Students schedule this honours project in their 2nd or 3rd year, and it can typically take 3-6 months.

To complete an Honours project, students must be admitted to the Nanobiology BSc honours program

Other resources:

[Study guide](#)

[Thesis office Brightspace](#)

- Greenlist

Honours project Brightspace

- info letter to supervisors
- honours project form
- honours project rubric

BEP/MEP [database](#) from Hooke to see potential Supervisors. BEP/MEP database – S.V.N.B. Hooke
<https://svnbhooke.nl/index.php/bep-mep-project-database/>

Planning

Decide on the type of project: research proposal (default), business plan or literature review.

- Research proposal: <https://www.nwo.nl/calls/nwo-talentprogramma-veni-enw-2025>
- Business plan: <https://business.gov.nl/starting-your-business/first-steps/business-plan-an-overview/>
- Research review: <https://febs.onlinelibrary.wiley.com/doi/10.1111/febs.16565>

Contact and find a greenlist supervisor who wants to supervise your honours project. Feel free to share the info letter to professors.

Make a project plan with your supervisor and (optional) daily supervisor (use Project Planning). This daily supervisor can be one of their group members, like a postdoc or PhD.

Complete the application form with your GreenList supervisor. Submit the form via the Honours Programme Brightspace

During your project

Work independently, but also make sure to regularly check in with your supervisor(s) as discussed in your planning.

Properly document, and start writing in an early stage

Assessment

Submit your report via BrightSpace (NB Honours)

Your grade will be calculated as 2/3 by your greenlist supervisor, and 1/3 by the honours director.

They will use the honours report rubric to assess the report.

The final grade plus feedback will be published in Brightspace.

Report requirements

A typical report is 10-15 pages long

Appendices are not required, but can be included.

Typical formats for reports are determined by the type of project you are doing. You do not need to follow their exact format. The important thing is the report be clear and concise.

- Research proposal: <https://www.nwo.nl/calls/nwo-talentprogramma-veni-enw-2025>
- Business plan: <https://business.gov.nl/starting-your-business/first-steps/business-plan-an-overview/>
- Research review: <https://febs.onlinelibrary.wiley.com/doi/10.1111/febs.16565>

NB5060 and NB5065 Individual Broadening Research Projects

The report requirements are the same for both NB5060 Company Internship and NB5065 Academic Research Project.

Other resources

[Study guide NB5060](#) and [Study guide NB5065](#)

[Internship Brightspace](#)

- Greenlist
- Application Forms
- Student Internship manual (version A)

Report requirements

A *typical* report is about 15-50 pages

- Introduction: includes the research question and background on the question, why it's important
- Materials and Methods
- Results
- Discussion/conclusions
- Reference list: includes all articles and other sources consulted. Varies by size or type of project. Use a standard referencing format

A section on recommended next steps and suggestions for overcoming problems that were encountered can be included, either as a separate section or included in the discussion section. You should also describe new skills learned, or new ways of using the skills you have.

Optional appendices can include: details of methods not included elsewhere, sequence information, data sets not easily presented as figures, reagent components, DNA construct maps, short descriptions of computer programs / scripts you developed (include links to where the scripts can be found online, but do not include the full code) and other required details that are not presented in the main text. You can also have supplemental videos that can be accessed online; a description of the video and a link (and ideally a screenshot) should then be included in your thesis.

If working for a company, discuss with your supervisors if there are things which should not be included in your report.

Master End Project

The Masters End Project has two prerequisite courses which must be completed before starting a MEP. In the first year, students complete a Project Development Course series (NB4510 and NB4520) which includes input from supervisors on proposal writing and literature review. These commonly form the basis of the Master End Project, but students are allowed to change supervisors and projects after the Proposal Development Course.

NB5903 MEP-PREP is self-paced and done as part of starting the MEP and entering kick off phase. The responsible supervisor should be fully involved.

Students must write a detailed planning document before they can be approved to officially start (Kick-Off). This is administered as a 3 EC course called NB5903 MEP-PREP fully within MyCase. The guidelines includes what should be included and how it should be assessed. We encourage student and supervisor spend some time on it to ensure quality and thoroughness. In general the planning should be detailed, with a thorough supervision plan and the project deliverables for the phases clearly defined.

Other resources

[Study guide NB5903](#) and [Study guide NB5942](#)

[Thesis office Brightspace](#)

- Greenlist
- MyCase QuickGuide
- MEP Assessment rubric
- External Projects step-by-step (if you want to do a project with someone not on the greenlist)

[My Case - Dashboard](#) <https://mycase.tudelft.nl/> is used to collect, review and approve documents related to your MEP. This replaces the previous application form. Within MyCase reviews are required for each phase: Kickoff, Midterm, Greenlight and Finalization.

NB5903 MEP-PREP Guidelines

Purpose and goals of the course

A structured approach will greatly increase the chances of success in any scientific research project. The first step of such an approach is to write a proposal. The proposal is a 'birds-eye, big-picture' level document including background, hypothesis, general methods and plan. You have written such a proposal in the Project Development Course.

The next step is to create a structured project plan to increase the chances of success in your research project. Planning ahead and discussing your plan with your supervisor will help you set realistic goals, ensure that you have enough time to carry out the tasks required to reach those goals, avoid common pitfalls, and get the most out of your time in a research group. Making a realistic and feasible plan will moreover be a key skill you will need in any job. The preparation phase is therefore an essential step towards a successful MEP.

We strongly recommend that you NOT rush the planning phase because of the attraction of getting started in the lab. Planning your project well, thinking through pitfalls, alternate hypotheses, necessary skills, writing plan will help your project be much more successful. Also spend the time to make sure you have a clear mutual understanding of expectations, benchmarks, and communication channels. Important that benchmarks are about work accomplished not getting results.

If you will be doing your MEP based on the proposal that you wrote in Project Development Course, we expect that you'll use large parts of that proposal in creating your project plan for background, and that's ok and not fraud. However, we expect your previously developed proposal to be critically revised, updated and improved. The project plan also requires much more detail in planning description. If you're doing your MEP on a new project, of course including parts of your old proposal will probably be less relevant. Do not include things in your planning document that aren't relevant.

Learning objectives

At the end of the MEP-PREP course, the student will be able to:

- Formulate a research question on a scientific topic in the field of Nanobiology.
- Formulate hypotheses about possible answers to the research question.
- Make a detailed critical planning for a large research project including precise (experimental / simulation) design and necessary resources
- Be able to discuss expectations with supervisors and create shared expectations.
- Write a data management plan.
- Identify meaningful and achievable benchmarks in a research process.
- Identify relevant milestone documents to ensure research is on track
- Reflect on a proposed project to identify potential risks and possible ways to address those risks.
- Identify skill weaknesses and knowledge gaps to complete the project and make a plan to address them.
- Be ready to start their MEP.

Writing your project plan and preparing for your MEP

During this course you will:

- Develop and write a well-defined project plan including benchmarks for your MEP (this can be based on the proposal you wrote in the project development course, but also be on a different topic if you're changing)
- Make sure that you and your responsible supervisor are in agreement about how, what and when the work will be done,
- Complete the required application process to start your MEP (MyCase),
- Complete any other prerequisite trainings and paperwork.

You will use the skills you developed in the project development course to write the project plan for your MEP. To do so, you will need to do the following:

- Review new literature and research group progress, include this summary in the background of your project.
- Refine/(re)formulate your research question and hypotheses.
- Revise your experimental / simulation / modeling approach.
- Update your experimental / simulation / modeling design including data gathering, storage and analysis.
- Make a detailed schedule and discuss it with your supervisor(s). Be realistic and include enough detail for it to be helpful.
- Get training on the relevant skills. If you are going to work in a lab, get the required general safety training as well as specific training on the instrument(s) you will use. If you are going to work with software, make sure that you know how to use it. If you are going to work with pre-existing simulation code, make sure you understand what it does and that you can compile and run it.
- If you need more extensive training, make sure it is available and you include it in your plan.
- Identify and complete any necessary approvals outside of MyCase (Erasmus forms, external projects)

You should refer to your plan and update it throughout the progress of your project. It is your working document. In your MEP report, you should include explanations of when, why and how your project deviated from your original plan. You can re-use pieces of the plan in the MEP report itself. Your entire planning document should also be included as an appendix in your MEP thesis.

If you are planning an external project, getting approval from the Board of Examiners must also be done during this time (see last bullet point). See External Projects on the Thesis Brightspace page.

Requirements for the project plan

In the project plan for your MEP, you specify your research question, how you are going to answer that question, and which activities you plan to do when. The plan should contain a short motivation and setting of the research question, a clear and feasible plan of approach, a plan for data management, and a timeline. The timeline should include plannable meetings (including midterm and 'green light' meeting), time for writing, and sufficient flexibility to deal with both expected and unforeseen difficulties.

The plan must contain the following parts:

- (Working) title, relevant data (your name & student number, research group, supervisor(s), date of submission of the plan).
- Introduction: the setting of your research project (sufficient to understand the research question and what is already known about it, but only at 'need to know' level).
- The research question and associated subquestions you will address.

- Your hypotheses about the answers to your research question.
- Which data you will gather and how you will collect, document, analyse, and store this data (data management plan).
- Which training you have already completed in preparation for the MEP, and which training you still need and when you will get it.
- Possible risks, and how you will mitigate / deal with them.
- Plan for supervision: who will supervise you, how often will you meet, which other regular group activities will you participate in, are there any specific arrangements.
- How much time you will spend per week on your project. When you and your supervisor will be unavailable to work on it.
- Planning of your project on a week-by-week basis, with indications of when you will have your midterm and green light meeting, when you will submit your final report, and a tentative date (week) for your final presentation and defense. The planning should include scheduled time for writing your thesis, getting feedback on your draft thesis and time to process the feedback.

Note that this plan can (and should if applicable) include weeks where you do not work on the project (e.g. the Christmas break); the number of planned hours should correspond to the number of ECTS you get for the MEP.

Assessment:

Your supervisor will assess your project plan on a pass/fail basis; if you get a 'fail', you will get feedback and an opportunity to submit an improved plan. Your plan needs to be submitted in MyCase and approved by your supervisor, and administratively processed *before* you can start your MEP work.

Supervisors will assess whether the plan contains all required elements (described above) and whether the descriptions and plans are reasonable, achievable and relevant within the scope of a MEP. They will also confirm whether any additional approvals have been completed.

After the Supervisor has reviewed it and completed their part of MyCase, the program administration will review it to determine whether you meet the requirements to move from preparatory to working phase of your project (credits earned, etc).

NB5942 MEP Report

Report Requirements

A *typical* thesis is about 30-70 pages long and includes:

- Introduction 10-15 pages, includes the research question and subquestions, background on the question, why it's important, and scope of the problem (what's already known, what other research does it connect to).
- Materials and Methods 5-15 pages, should be complete (more than usually published); parts may be in appendices.
- Results 10-30 pages
- Discussion/conclusions 10-20 pages.
- Reference list: includes all relevant articles and other sources consulted. Use a standard referencing format.

A section on recommended next steps and suggestions for overcoming problems that were encountered can be included, either as a separate section or included in the discussion section.

A reflective section on how planning changed during the course of the project, especially explaining any major changes should be included.

Supplemental sections or appendices are required (See below)

Appendices (required):

- Project Planning document from the Kickoff phase
- Optional: details of methods not included elsewhere, sequence information, data sets not easily presented as figures, reagent components, DNA construct maps, validation experiments, short descriptions of computer programs / scripts you developed (include links to where the scripts can be found online, but do not include the full code) and other required details that are not presented in the main text. You can also have supplemental videos that can be accessed online; a description of the video and a link (and ideally a screenshot) should then be included in your thesis.

Resources

There are many resources available to help you.

Studieadviseur-NB@tudelft.nl Can help with personal circumstances, delays, struggles, graduation, please reach out to schedule an appointment

Programme coordinator: info-msc-nb@tudelft.nl or info-bsc-nb@tudelft.nl Can help with structures, process and advice

Thesis office [Brightspace](#) and email ThesisOffice-TNW@TUDelft.NL : for any process related questions about BEPs and MEPS.

Internship office [Brightspace](#) and email InternshipOffice-TNW@tudelft.nl for any process related questions for Company Internships and Academic research projects.

Confidential Advisor: if you have problems relating to social safety or research integrity you can reach out to a TU Delft confidential advisor [Confidential advisors](#) or SVN B Hooke confidential advisor [Confidants – S.V.N.B. Hooke](#)

[Counselling](#) services are available. Which can help with mental health, but also more practical things.

[Personal Development](#) provides a variety of personal development courses that can help with procrastination, time management and study success.

[TU Delft Writing Centre](#) provides writing coaching and courses on writing and getting unstuck:

And don't forget to talk to your supervisor and/or daily supervisor.

Writing scientific reports

“To present a scientific subject in an attractive and stimulating manner is an artistic task, similar to that of a novelist or even a dramatic writer.” Max Born

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Writing conventions	24
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Nomenclature and style	25
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Additional literature:.....	25
Contributors	25

Goal of writing a report

You are working on or have completed a scientific research project. You have learned something new and might have obtained results which no one has gotten before. Those results might lead to new research questions or a product used in daily life. But how are others going to learn about your findings and new insights?

Scientific research does not only consist of conducting experiments, but also of writing reports about those experiments. The written report allows the researcher to communicate a message about the results they’ve achieved. It also should show the data to the scientific community and builds a path to contribute to the scientific knowledge base. Being able to produce well-written reports, therefore, is crucial to making a good impression when you apply for a job at a university or company.

Writing is a skill that contains a very personal component, it reports the findings and interpretation of an individual or group. Nevertheless, although writing style and preferences are person-dependent, there is a distinct structure and logical order in scientific literature, which you can and should learn. Here, we provide you with information on the structure of scientific reports, which apply to basic lab reports and ground-breaking scientific articles alike. Furthermore, we offer you guidance in scientific writing with the intent to help you improve this important skill. At the end of this course, we expect you to be able to produce a well-structured and well-written scientific report. We are looking forward to reading these reports. Have fun writing!

Structure of a scientific report

The goal of a scientific report is to concisely document the work in sufficient detail so that your reader can follow your reasoning and validate the conclusions you drew. Therefore, a scientific report follows a distinct structure and organization comprising six mandatory components in the following order: title and abstract, introduction, methods, results, discussion, and conclusion.

Before you start writing, you should think about what the main message of your report is. This will help you determine what to include and develop a narrative structure.

Title Page

Reports submitted for academic courses including BEPs and MEPs must have a title page. It should include

- Title: should be short, clear and informative
- Author name and student number
- Course name and code
- Project starting and end date, defence date if relevant
- Location of the project (University, faculty, department, section)
- Name of daily supervisor, supervisor(s) and reviewers
- Confidentiality of the report if applicable

When readers pick up your report, the title is the first thing they read. As such, the title has a purpose of sparking the readers' interest.

The title of a scientific report should state the central message of the work clearly and should be as specific as possible, while still describing the full range of the work in a minimal amount of words (on average ~ 11 words).

Abstract

An abstract is a concise, self-contained summary of the report that allows the reader to get your main message in context. A good abstract starts with one or two sentences on the motivation for the work done, states the addressed research question, contains a (very!) concise description of the used method, states the main results and the implications of the work. It is the first thing of substance the reader encounters and it should also spark their interest; people often decide on whether they are going to read a paper based on the abstract. The abstract should be fully understandable by peers without prior knowledge about the research. Typically, an abstract is restricted to 150-200 words (depending on journal type) and does not contain any references. Hence, words must be chosen very carefully.

The title and abstract should be the last pieces that the writer revises to guarantee that they accurately represent the content of the work.

Introduction

In the introduction, the author(s) informs the reader what the report is about and why the studied subject is important. Typically, a top-down approach is used in which the reader is provided with broad background information on the research field and its scientific significance. The background is followed by a specific research question or challenge point that is addressed in the report. Finally, the introduction concisely summarizes the findings of the reported study. Taken together, we can summarize the three parts of the introduction as topic, problem, solution (for engineering); or topic, observation/discovery, explanation (for science).

The introduction should always include a clear, explicit definition of the scientific aim(s) of your project, that can be easily found (e.g. through different formatting). If you are working on different subprojects/research lines, define their targets separately but make clear how they are connected.

As such, common questions that are set out to be answered in the introduction are:

- What is the field of work and what has already been done?
- What is the research question of this report and why is this important?
- What are the experimental principles and methods used to answer this question?
- What can be learned from the results?

Please be as concise as possible in the introduction! Common pitfalls in introduction writing include providing unnecessary background information, overstating the importance of the work or failing to make the research question clear.

Method (Theory, Materials and Methods)

This section describes how the results were obtained and generated and is used more broadly than a description of the experimental method. It usually contains two subsections: theory and materials & methods. The theory section describes the theory needed to understand and interpret the experiments or the development of a theory described in the report, including necessary equations and explanations of symbols. If you introduce equations, integrate them in the body text (an equation is not a stand-alone part of your report). The materials and methods used in the experiment are described in an independent section and allow the reader to reproduce the results and judge the validity of the conclusions. As such, the experimental methods might include the description of a specific experimental set-up or design (preferably with an informative sketch), and/or the description of a modeling tool. Further, the method section should include a justification of the experimental methods used, including a description of the accuracy of the measurement.

Try to make the method section as informative as you can for the reader, this usually requires a logical structure of this section and not a chronological organization.

Common questions that should be answered in the method section, are:

- What experimental method has been used?
- How are the experiments evaluated and is that statistically valid?
- Why has this method been chosen to answer the research question?

Please be as thorough and detailed as possible in the method section, without expounding beyond the research topic. Common pitfalls in the method section are the inclusion of results, of unnecessary details or a chronological listing of the experimental approach. The method's section should always be written in the past tense.

If in your project you developed or optimized an experimental protocol, wrote a computer program or developed analytical tools these can be summarized in methods and results, and the full versions included in appendices.

Results and discussion

"It's never shameful to be wrong in science, A lot of the best science was done by people being wrong and proving first if they were wrong and then why they were wrong. What is completely toxic to science is to be fraudulent." Karl Herrup¹

The results and discussion section contains a presentation of the obtained data, commonly quantified and presented in tables and/or graphs. Tables present the data directly and are preferred when the exact numerical values of the data are needed. Graphs are a visual representation of data sets and a powerful tool to convey complex data clearly and effectively. They use the magnificent power of the human brain to recognize visual and spatial patterns. Because of the importance of graphs and their broad application, multiple books have been written about creating them. Here, are the guidelines we think are most important:

- Choose the data set that represents the message you want to convey. Be careful, the data should represent your findings fully, including anomalies. It is unethical to "cherry-pick" a data set to make it fit a hypothesis or explanation, and it could get you in big trouble.
- Data points should not be removed from a data set!
- Represent data as clearly as possible, including a description, a number, a unit and an uncertainty estimate. Error bars and scale bars should be implemented and defined. Axes should be clearly labeled and include units.
- Pick a graph style that supports your message. Graphs should be as simple and informative as possible.
- Make your graphs as clear and concise as possible, it should be interpretable on its own. A quick glance should allow the reader to discriminate every data point and fit, even when your report is printed in black and white. You cannot fix bad graphs with good data!
- Use the accompanying caption to clarify every element of the graph. The title of the graph is represented in the caption alone.
- All figures and tables should be discussed in the text. If you don't talk about it in your text, remove it. Avoid sentences such as: "The results of the growth experiments are shown in Figure 21" or "Figure 21 shows...". Instead, use sentences such as "Up to concentrations of 1.5 mM, L-alanine supplementation led to increased specific growth rates relative to a control culture without added L-alanine (Figure 21).

A well-written text with poor graphs will not be evaluated as a high-quality report, so graphs are really worth substantial effort!

The discussion explains the data and argues how the data answers the posed research question(s). The combination of results and discussion facilitates an explanation on what the reader should see in the graphs, whether and why the data were expected, and what the shortcomings of the data are.

As such, the following questions are to be answered in the result and discussion section:

- *Are the graphs accurately representing the data set? And is uncertainty properly assessed?*
- *How do those data answer the research question?*
- *How widely applicable are these results? What are the boundary conditions?*

¹As quoted in Bendix, Aria and Denise Chow "Allegations of fabricated research undermine key Alzheimer's Theory" NBC news, July 26, 2022, <https://www.nbcnews.com/science/science-news/alzheimers-theory-undermined-accusations-fabricated-research-rcna39843ted-research>

Some common pitfalls you should avoid for the results and discussion section are the lack of organizational structure, i.e. presenting results without discussion, posing a discussion unrelated to the obtained results, ignoring data that does not fit the hypothesis or presenting the data in chronological rather than logical order.

Conclusion

The conclusion concisely provides the key message(s) the authors want to convey. The conclusion should allow readers that did not read the full report to understand the answers to all the research questions set out in the introduction and the implications of those findings. The essence is to provide the most general claims that can be supported by the evidence and offer a future perspective on the scientific work.

Questions to be answered in this section are:

- *What can be learned from the work done?*
- *What impact does this work have on the research field?*
- *What further research directions does this work suggest?*
- *What could be the next research step?*

Some common pitfalls in the conclusion include the introduction of new evidence or arguments, a repetition of background information provided before or failing to address all research questions.

We advise you to write your scientific report according to the provided structure above. Nevertheless, you will see that in scientific literature sometimes additional components are added to or segregated from the standard organization when the nature of that work demanded a differentiation. But, for now, structuring your paper according to the most commonly used standard organization will facilitate your writing job and the readability of your report.

Writing style and language conventions

Scientific reports are intended to describe a complex subject as clearly as possible to knowledgeable peers. To match the content of the report to the readers' knowledge or the scope of a journal is a task many writers struggle with, students and professionals alike. For your research report, we expect you to write a report that can be easily read by one of your fellow students. To write a good report, you need to pay attention to good writing structure. A good writing structure can be defined as the formulation of clear and accurate sentences, writing a clearly defined message per paragraph and providing an overall organized structure to your body text.

Beyond the basic structure, you have a writing style. Writing style is rather person-dependent, and what it exactly comprises sometimes sparks arguments among scientists. The best way to explore what you define as good writing style, is by reading well-written scientific papers and paying attention to what you like about the particular writing style and approach used in those papers. Developing your style will be a lifelong process. Go ahead and explore some of your favorite papers, what do you like about the writing and what not?

Writing in scientific style

Overall, the most valued concepts to scientific writing are accuracy, precision, clarity, concision and grace of the writing. Here, accuracy means that claims made in the report are justified by the provided information and, hence, verifiable. Precision means that the meaning of the statements is clear, i.e., there is no confusion possible about the intended meaning of the author. Clarity requires that the written text is easily understood and avoids the usage of unnecessary complicated jargon. Concise writing can be understood as omitting needless words. Grace comprises writing with

elegance and fluency without the loss of accurate, precise, clear and concise wording. Are these concepts you found and appreciated in your favorite papers as well?

Writing conventions

Lastly, there are many conventions that you are supposed to follow but are rarely written out in scientific literature. Here, we aim to provide you with some of those writing conventions:

- Each paragraph focusses on one topic. Basic structure can very useful and comprises: an introduction of the topic with one sentence, followed by supporting sentences and finalize with a concluding sentence.
- Write in your own voice and use simple and professional wording to increase the readability and clarity of your report. Everything you write should support the main message and highlight its context.
- Be consistent in wording and style, when a term is introduced then use it throughout the report. Also, when you refer to a certain section or graph, be exact and unambiguous (Figure 1 shows..., Section 2 introduced..., as can be seen in Figure 3). Furthermore, use the same paragraph style (e.g. starting a paragraph with an indentation) throughout the whole report. This is especially important for headings, have a clear structure to the format.
- Citations are required for any statement that is not derived logically from the current body text and should only comprise published literature, i.e. original papers and textbooks, not the manual of the research practicum.
- Use English tenses appropriately. The most widely used tenses in scientific writing are:
 1. Simple past (The experiment used): describe events that happened in the past and have finished. This tense is mostly used to describe the results.
 2. Simple present (Equation 1 describes...): covers general statements and is frequently used in the introduction.
 3. Simple future (These findings will allow us to...): implies future directions and happenings, mostly used in the conclusion section.
 4. Present perfect (Newton's work has fundamentally changed...): describes things that happened in the past but still have consequences in the present.
- Abbreviations and acronyms are used to reduce tedious repetitions but should only be used for terms that are frequently used (say, more than 5 times). Always spell out the abbreviation or acronym the first time it is used, both in the text body and in figure captions. Try to avoid using abbreviations in figures, tables, captions and the title.
- Mathematical variables have to be introduced the first time used and must be unique. Never use the same notation for different variables. All physical quantities need to include their units, in standard SI units.
- "This" and "These" must always be followed by a noun, so that its reference is explicit.
 - *Not*: This led us to conclude...
 - *But*: This observation led us to conclude...

Edit

Every report needs to be edited, multiple times. What you see in scientific journals is usually a product of frequent rewriting and revision to make the text as clear and concise as possible. You should include in your contributions section who has helped with editing. (This text has gone through multiple revision rounds and multiple peers have looked at it). As such, when you write: draft a paragraph using the words that come to you naturally, then revise and rewrite, and revise again with paying attention to your writing style (can you improve your accuracy, precision, clarity and concision of words). Reread your text the next day, ask a critical friend to read to read it and revise again. And when a friend asks, offer good feedback. Look back at your first draft, do you see your improvement? Is your current version as clear as you could do?

The single biggest mistake that writers make is not allowing enough time to edit. Though balance that with remembering your document will never be perfect and at some point you have to stop and a month later when you look at it again you'll see the glaringly obvious typo you missed.

Format

You can write a clearly structured report with accurate figures and edit the text for language style but if it's badly laid out and unreadable because of font or size choices, or inconsistency of formatting it will make your reader cranky. Spend some time thinking about your format. Pick a readable font in a normal size. Decide how many levels of headings you will need and use them consistently. LaTeX makes this easy, Word does this if you use the tools (Styles), and GoogleDocs does this terribly. Whichever tool you use, spend a little time learning to use its formatting tools.

Nomenclature and style

- Use a correct notation for microbial species (*Saccharomyces cerevisiae*, *S. cerevisiae*, always use italics for genus and species names, space between abbreviation genus and full species name).
- Use proper species specific notation for gene and protein names. It is impossible to list all variations here so look this up to know which combination of 3 letters, caps or not, italics or not is correct for the organism referred to.
- When referring to microbial strains, give their numbers, but always accompany this by a short description of the relevant genotype or phenotype. Just mentioning strain numbers makes reports extremely difficult to read.
- Likewise, cell lines can be referred to by their common acronyms, but always accompany this by a short description of the source and relevant phenotype/genotype (ex: HeLa, human ovarian cancer).
- For numbers larger than 1000 or smaller than 0.001, use the power of 10 (10^3 or 10^{-3}).

Final words

Adoption of the guidelines provided in this document will help you improve the quality of your scientific reports and streamline the writing and reviewing process, tremendously. Good writing is hard work, but with practice you'll become better at it! It is a skill that can be used in all fields wherever your future path leads you.

Science is very rarely a solo adventure, you should always include a short description of contributors and their roles. This list should include anyone providing editing feedback.

Additional literature:

- Mack, C.A. How to write a good scientific paper. 2018 (ISBN: 9781510619135), freely available under: <https://spie.org/samples/9781510619142.pdf>
- Whitesides, G.M. Whitesides' Group: Writing a paper. 2004 *Adv. Mater.* **16** 1375-7

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