Writing your research proposal

Gail Preston and Esther Becker

The main aim of the research proposal is to help you in developing an exciting and feasible research project and in acquiring the skills needed to carry it out!

Research Proposals

- **With your DPhil/PhD supervisor(s)**, you will produce a research proposal describing the work you intend to do, to be submitted within 6 working weeks of commencing your DPhil project.
- The proposal will be reviewed by your viva committee and will inform their questions at the viva.
- The viva committee is appointed by the DTP – but you will be asked to nominate assessors.
- You will be responsible to organise the date, time and venue for the viva (usually within 2 – 4 weeks of submitting the proposal).
- You will receive verbal and written feedback on the proposal, and you may be asked to submit a revised version.
- This process is intended to help you to define your research goals clearly at the outset of your project, helping to ensure that you are able to make good progress.

What is a research proposal?

- Application for funding or approval for a programme of research
- Needs to demonstrate that the proposed research is:
  - Valuable
  - Novel
  - Feasible
  - Well-planned
  - Ethical
  - Good value for money

Building a scientific argument:

Idea | Expectations | Actual observations

https://undsci.berkeley.edu/article/coreofscience_01

Engaging with the scientific literature

- Read reviews/perspectives to get an overview of the field
- Read primary research papers and ask:
  - What questions or unconfirmed hypotheses does this work raise?
  - What would be the next experiment to do?
  - Do I agree with the authors' interpretation of their results?
  - Are there weaknesses or limitations in their methods/analyses?
  - How could any limitations be addressed?

Open your mind

1. Try to pose problems in an open way
2. Look at the information available and think “what else could it mean”
3. If you currently agree with the authors’ interpretation
   – think about what criticisms other people could have
   – what alternative explanations might need to be excluded/disproved

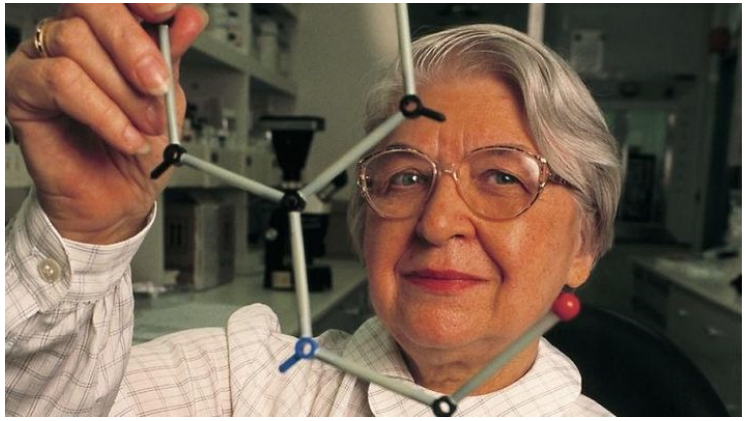
Approaches to innovation

Research proposals are assessed not just for increasing scientific knowledge but also for their degree of originality and innovation.

- Innovation with questions and hypotheses
- Innovation with methods
- Innovation with concepts and theories
- Interdisciplinary interactions

Think outside the disciplinary box

- Innovation often happens at the intersection between disciplines
- Learn about methods that are being used in other fields –
  read widely and talk to people who are studying other modules/subjects



"All sorts of things can happen when you're open to new ideas and playing around with things." — Stephanie Kwolek, chemist who invented Kevlar and winner of the Lavoisier Medal for technical achievements

Go shallow - but then go deep…

- Read deeply in your chosen research area
- Is your hypothesis/question/approach genuinely novel?
- Travel back in time – it's easy to overlook important early work
- Some early studies raise questions that couldn't be addressed with available technologies – can they be studied now?
- Note the methods that are used to ask different questions – what are their strengths and limitations?

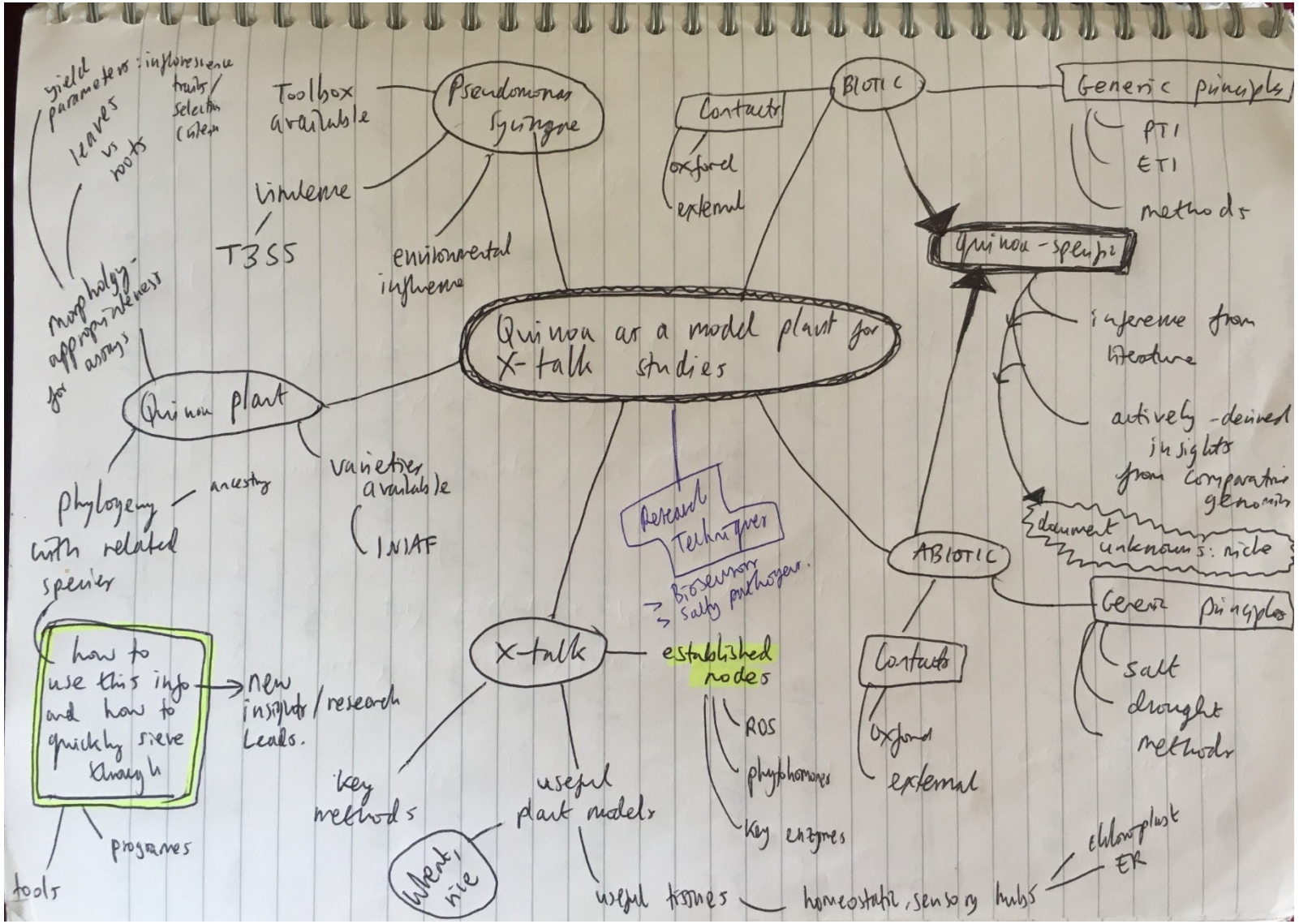
Keep good notes

- Notebook (paper or electronic)

Organise your ideas

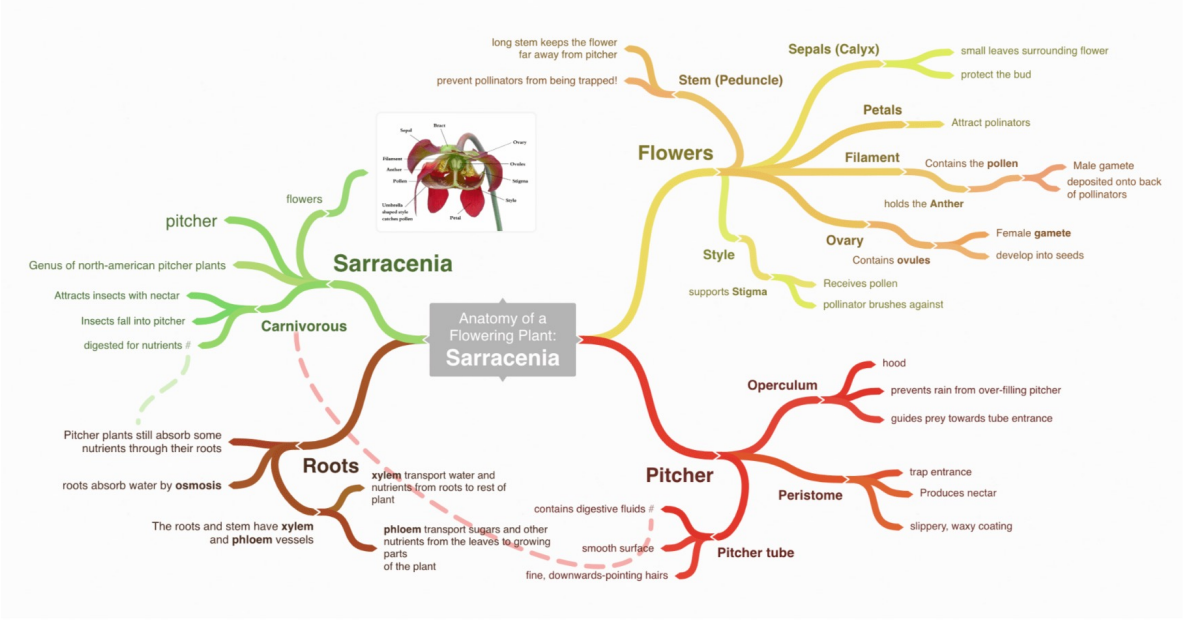
- Post-it notes (paper or electronic)

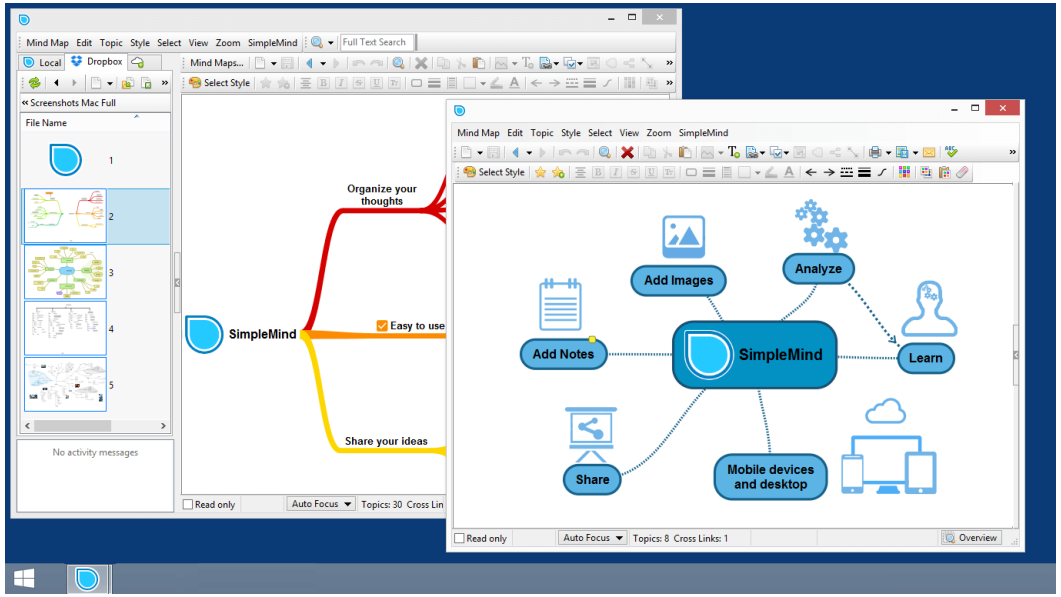
Mind-mapping

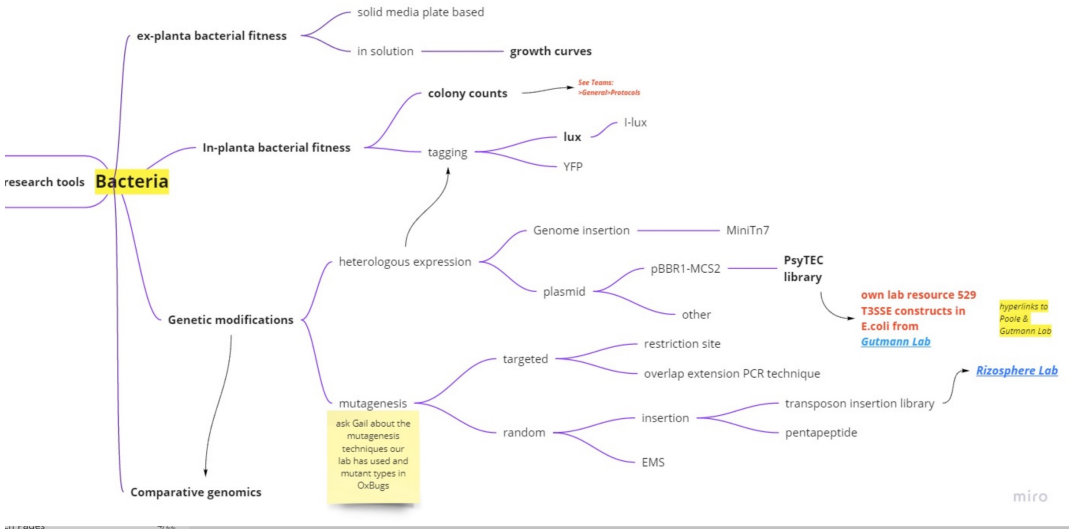


Floren Scrafton

Mind-mapping with software







https://www.literatureandlatte.com/scapple/overview

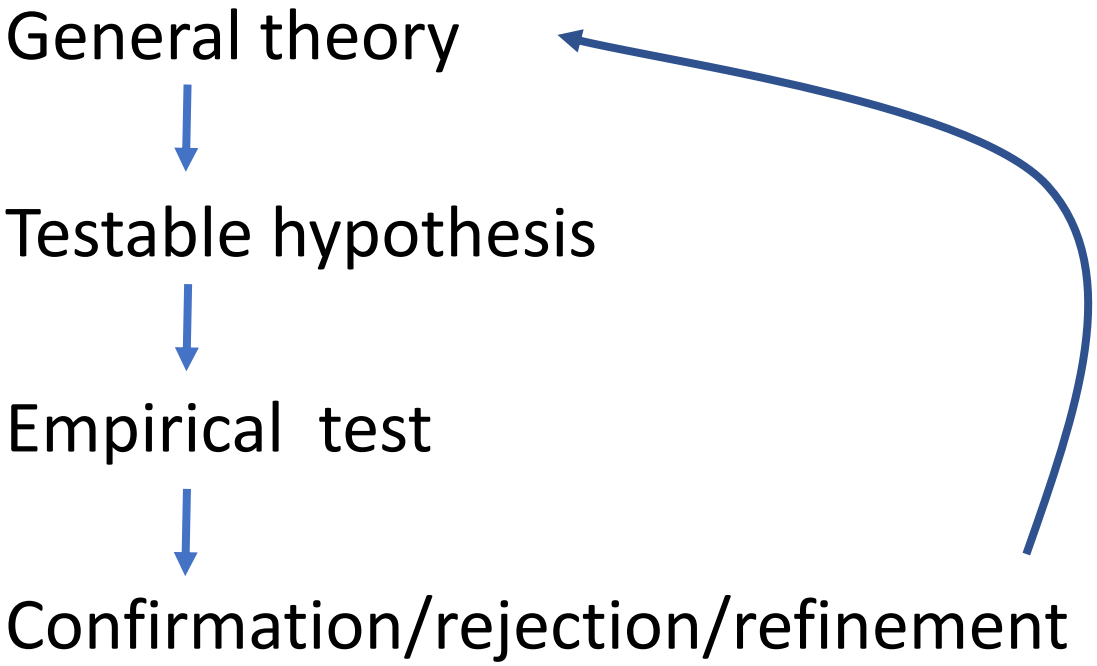
https://productivityland.com/best-mind-mapping-software/

Formulating a research project…

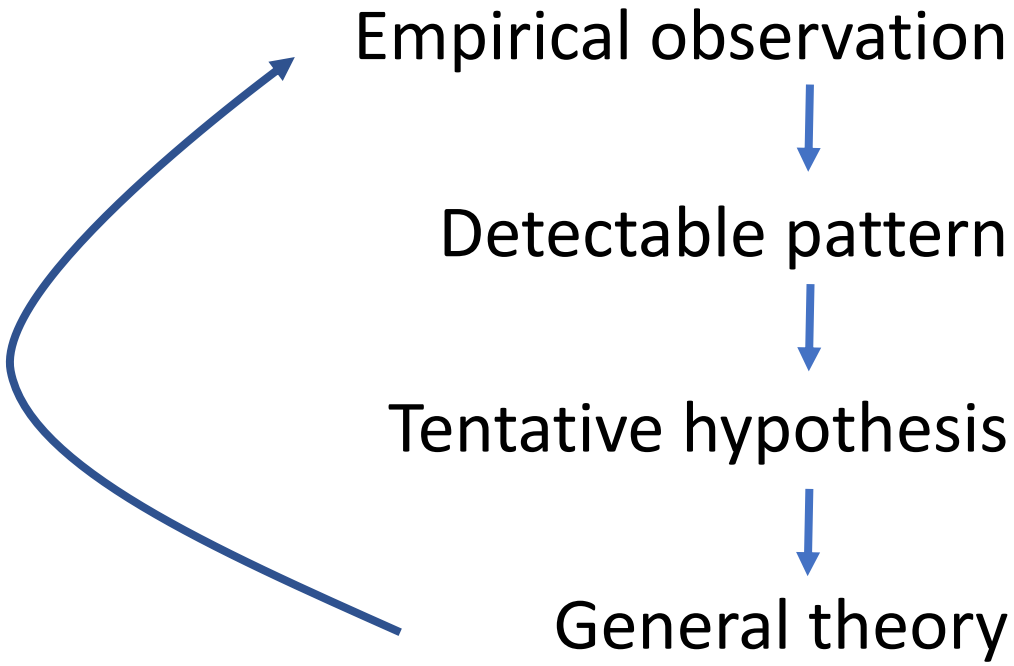
- Hypothesis-driven vs. data-driven
- Descriptive vs. discovery vs. hypothesis

Deductive vs. Inductive Reasoning

Theory-driven research (deductive)



Data-driven research (inductive)



Descriptive

How does temperature affect gene expression in plants?

List of genes that are differentially expressed at two temperatures

Discovery

Why are plants more susceptible to disease at higher temperatures?

Identify genes that are differentially expressed at two temperatures in healthy and immune-challenged plants

Combine with knowledge of genes that function in immunity

Explore further with mutant/GM plants and specific assays

Hypothesis

Alternative histones act as thermosensors that regulate expression of the immune system

Compare gene expression at different temperatures in wild-type and alternative histone mutant plants

Combine with knowledge of genes that function in immunity

Explore further with mutant/GM plants and histone binding assays, biochemical analyses etc.

Approaches to advancing scientific knowledge

- Hypothesis-driven vs. data-driven
- Descriptive vs. discovery vs. hypothesis

- Hypothesis driven projects have a testable hypothesis or hypotheses
- Defining a hypothesis can influence experimental design/interpretation
- Discovery projects can yield important new insights – but are often criticised for being correlative, expensive or lacking focus
- Researchers taking a data-driven approach need to have a concrete plan for following up from the discovery stage
- Some projects successfully combine discovery and hypothesis driven approaches

Defining the scope

Successful projects are SMART

- Specific
- Measurable
- Achievable
- Relevant
- Time-bound

Setting **SMART** goals

S – Specific: I know what I want to accomplish, and why. I know how I will achieve this goal.

M – Measurable: I will know when a goal has been accomplished.

A – Attainable: Achievable in terms of knowledge, skills, abilities and resources – including your time and wellbeing.

R – Relevant: Each piece of work undertaken will advance progress towards an overall goal.

T – Time-bound: Grounded within a specific timeframe.

Research expenses

- Make sure your proposed project is affordable given the resources available to you.
- Research costs: £5k per annum, plus an additional £920 (£230 per year) for travel/fieldwork.
- The full amount will be transferred to host departments at the start of the DPhil project. Additional travel funds can be applied for by submitting claims directly to the DTP.
- Research money can be spent on attending conferences/workshops, lab consumables, software licenses, office supplies, computer processing time, equipment.
- Students and supervisors will receive a copy of the DTP Equipment Guidelines at the start of the DPhil project.
- Students can buy one **desktop** computer (up to £850) in year 2 or 3 only if a computer is not routinely provided by the host department.
- A specific case for support must be made for purchasing a laptop or a higher specification computer using the DTP computer form.
- All computers and equipment purchased belong to the University not to you and **must be returned** to your supervisor when you complete your studies.
- If in any doubt, please ask us before spending money.

Research Proposals - Format

- Up to 8 pages in total including cover page

- Page 1: Cover page - this should contain:
  - Your name, supervisor(s) name(s)*, department, date
  - A one paragraph summary (abstract) for a non-specialist audience (this will be sent to the BBSRC as a description of your project *and* made freely available online)
  - A brief summary of any BBSRC priority areas the proposed research addresses

- Pages 2-6 (5 pages*): Research proposal (*excluding references)
- Page 7: Data management plan
- Page 8: Timeline
- Ethics Statement

* every student must have at least two supervisors from DTP organisations

UKRI-BBSRC Priorities

- Animal health
- Bioenergy: generating new replacement fuels for a greener, sustainable future
- Combatting antimicrobial resistance
- Data-driven biology
- Food, nutrition and health
- Healthy ageing across the life course
- Integrative microbiome research
- New strategic approaches to industrial biotechnology
- Reducing waste in the food chain
- Replacement, refinement and reduction (3Rs) in research using animals
- Sustainably enhancing agricultural production
- Synthetic biology
- Systems approaches to the biosciences
- Technology development for the biosciences
- Welfare of managed animals

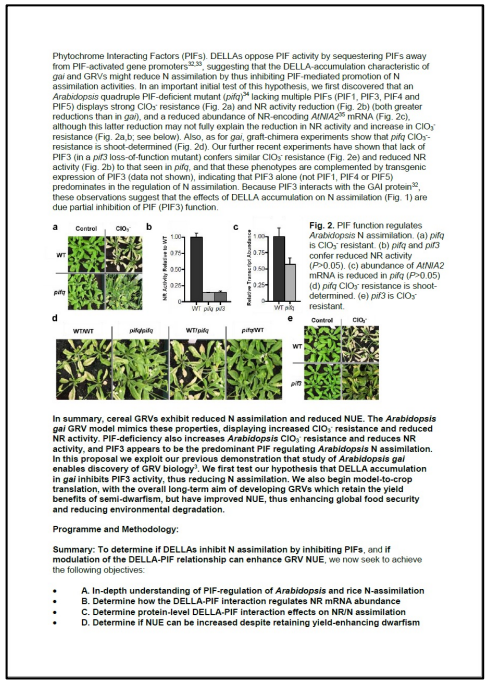
Cross Council Priorities and Programmes

- Energy
- Brain Science and Mental Health
- e-Science
- Environment and Land Use
- Global Food Security
- Global Uncertainties
- Lifelong Health and Wellbeing
- Living with Environmental Change
- Nanoscience

➢ See also UKRI-BBSRC website on "Our research portfolio and priorities"

Research proposal formatting – make it easy to read!

- **All text** (other than text in figures) should be a standard font (e.g. Arial or Calibri) at 11 pt or bigger
- Use italics sparingly – primarily for species names
- Page margins should be at least 2 cm – preferably 2.5 cm
- Paragraphs should be short and focused
- Include headings to identify sections and sub-sections
- Use bullet points where appropriate to help emphasise key information such as a list of objectives
- Use acronyms and abbreviations only for widely understood or frequently used terms



Phytochrome Interacting Factors (PIFs). DELLAs oppose PIF activity by sequestering PIFs away from PIF-activated gene promoters[32,33], suggesting that the DELLA-accumulation characteristic of *gai* and GRVs might reduce N assimilation by thus inhibiting PIF-mediated promotion of N assimilation activities. In an important initial test of this hypothesis, we first discovered that an *Arabidopsis* quadruple PIF-deficient mutant (*pifq*)[34] lacking multiple PIFs (PIF1, PIF3, PIF4 and PIF5) displays strong ClO_3^- resistance (Fig. 2a) and NR activity reduction (Fig. 2b) (both greater reductions than in *gai*), and a reduced abundance of NR-encoding *AtNIA2*[35] mRNA (Fig. 2c), although this latter reduction may not fully explain the reduction in NR activity and increase in ClO_3^- resistance (Fig. 2a,b; see below). Also, as for *gai*, graft-chimera experiments show that *pifq* ClO_3^--resistance is shoot-determined (Fig. 2d). Our further recent experiments have shown that lack of PIF3 (in a *pif3* loss-of-function mutant) confers similar ClO_3^- resistance (Fig. 2e) and reduced NR activity (Fig. 2b) to that seen in *pifq*, and that these phenotypes are complemented by transgenic expression of PIF3 (data not shown), indicating that PIF3 alone (not PIF1, PIF4 or PIF5) predominates in the regulation of N assimilation. Because PIF3 interacts with the GAI protein[32], these observations suggest that the effects of DELLA accumulation on N assimilation (Fig. 1) are due partial inhibition of PIF (PIF3) function.

Fig. 2. PIF function regulates *Arabidopsis* N assimilation. (a) *pifq* is ClO_3^- resistant. (b) *pifq* and *pif3* confer reduced NR activity ($P>0.05$). (c) abundance of *AtNIA2* mRNA is reduced in *pifq* ($P>0.05$) (d) *pifq* ClO_3^- resistance is shoot-determined. (e) *pif3* is ClO_3^- resistant.

In summary, cereal GRVs exhibit reduced N assimilation and reduced NUE. The *Arabidopsis gai* GRV model mimics these properties, displaying increased ClO_3^- resistance and reduced NR activity. PIF-deficiency also increases *Arabidopsis* ClO_3^- resistance and reduces NR activity, and PIF3 appears to be the predominant PIF regulating *Arabidopsis* N assimilation. In this proposal we exploit our previous demonstration that study of *Arabidopsis gai* enables discovery of GRV biology[7]. We first test our hypothesis that DELLA accumulation in *gai* inhibits PIF3 activity, thus reducing N assimilation. We also begin model-to-crop translation, with the overall long-term aim of developing GRVs which retain the yield benefits of semi-dwarfism, but have improved NUE, thus enhancing global food security and reducing environmental degradation.

Programme and Methodology:

Summary: To determine if DELLAs inhibit N assimilation by inhibiting PIFs, and if modulation of the DELLA-PIF relationship can enhance GRV NUE, we now seek to achieve the following objectives:

- **A. In-depth understanding of PIF-regulation of *Arabidopsis* and rice N-assimilation**
- **B. Determine how the DELLA-PIF interaction regulates NR mRNA abundance**
- **C. Determine protein-level DELLA-PIF interaction effects on NR/N assimilation**
- **D. Determine if NUE can be increased despite retaining yield-enhancing dwarfism**

Case for support (5 pages)

- Background: 2-3 pages
  - Description of the research problem
  - Argument as to why that problem is important
  - Review of relevant literature

- Project Description: 2-3 pages
  - Statement of the main aim(s) of the project
  - Description of the proposed research methodology,
  - Expected results/outputs and contingency plans/alternatives (where relevant)
  - Conclusion

A recommendation

- Before you write anything else, write a short introductory paragraph for your case for support that explains *what you want to do* and *why it is important.*

- Print out this paragraph and pin it near your desk. Keep referring to it as your project evolves and make sure what you write and what you do aligns with it and supports it.

Literature review (Background information)

- Places the proposed project in the context of existing work
- Explains its broader significance and/or potential impact
- Lays the groundwork for your project rationale or research question
- Can include preliminary or previous data where relevant
- May include an introduction to specific methods

Aims and Rationale

- States the overarching goal of your project in relation to existing knowledge (*your background literature review*)
- Your goal needs to be clearly framed as a question, hypothesis or aim
- Explain why addressing this question, testing this hypothesis or achieving this aim would be of value or have impact
- Leads into specific objectives

Research methodology/Experimental plan

- Clearly defined objectives/hypotheses
- Experimental/methodological plan of work to address each objective/hypothesis
- State what the expected outcome(s) of each experiment could be and how it will advance understanding of your question/hypothesis
- Identify any potential weaknesses or confounding factors
- Where appropriate, identify contingency plans

- Remember that each objective should be SMART

Experimental objectives/methodology

- Describe your experiments/modelling/data analysis approaches carefully
- Consider and discuss (where relevant):
  - Controls (positive and negative)
  - Sources of variability
  - Replication
  - Reproducibility
  - Feasibility (time needed to collect and process a sample or set of samples)
  - Metadata you will need to curate for each sample/simulation
  - Time points (information vs. value for money)
  - Time needed for data analysis (often underestimated)
  - How you will prioritise your work
  - Risk/ethics

Conclusions

- State how how your work will lead to a conclusion and/or the solution to the problem being addressed.

- Evidence should be given in a descending order of importance, beginning with the most important evidence.

Figures and Tables

Do include figures and/or tables to make key points.

Figures and tables should be:

1. Numbered
2. Mentioned in the main text
3. Have titles
4. Have legends
5. If relevant – be attributed to a published source.

References/Citations (additional to 5 page case for support)

- List citations for previous studies and methods/protocols
- Numerical or alphabetical order (the number or author/year should also be noted in the text of the case for support)
- Citations for journal articles *must* include:
  - Authors (include at least the first five authors for papers with more than five authors)
  - Year of publication
  - Journal
  - Volume
  - Page numbers

References/Citations continued

- Citations for books and book chapters *must* include:
  - Authors (include the first five for books/chapters with more than five authors)
  - Year of publication
  - Publisher
  - Editor(s) (if applicable)
  - Page numbers

- Citations for software/databases should reference the relevant publication where one exists. If there is no publication, provide the complete URL.

- If you need to cite unpublished work, credit the person/people who did the work (e.g. Smith and Jones, personal communication)

Timeline (Gannt Chart)

- Planned timeline (~3 years): 1 page
- Should be in the form of a **Gannt chart** that includes objectives and milestones

Gannt chart (1 page)

	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Objective 1:												
Task A												
Task B												
Objective 2:												
Task C												
Task D												
Objective 3:												
Task E												
Task F												
Task G												
- G1												
- G2												
- G3												
Milestones												
Milestone 1												
Milestone 2												
Milestone 3												
Milestone 4												
Milestone 5												

Make sure the numbered objectives and milestones on your submitted Gannt chart correspond exactly to those in your proposal

Developing your Gannt chart

- Plan your experiments/modelling etc. in as much detail as you can
- Become familiar with the protocols/approaches used and how long they take
- Think about the time needed to grow plants or rear animals
- It can be useful to speak to graduate/postdoctoral mentors as well as academic supervisors to get a realistic idea of:
  - What experiments and data analyses involve
  - How long they take
  - Where bottlenecks/challenges are likely to be
- It is acceptable to include dependencies or contingency plans in your timeline

Timeline (Gannt Chart)

Also include:

- Any training required (based on your Training Needs Analysis form and agreed with your supervisor. Note that you are required to attend the DTP training courses provided in years 2-4 and the annual symposium)
- Scheduling for the internship (12 weeks full time or 60 days part time)
- Time to write your thesis (typically around 3 months)

DTP Training – Compulsory elements

- 2nd year:
  - MT: Preparing for learning and teaching at Oxford (plus teaching experience)
  - HT: Presenting posters at scientific meetings
  - HT: Writing and publishing a research paper
  - HT: Annual lecture
  - TT: Impact Streams - Outreach or Business Skills/Enterprise skills (or additional teaching training and experience in year 3)
  - TT: Annual Symposium

- 3rd year:
  - TT: Interview techniques
  - TT: Planning to write a DPhil
  - TT: Careers overview and CV preparation
  - TT: Annual Symposium/3rd and 4th year presentations

- 4th year:
  - Finishing your DPhil
  - HT: Annual lecture
  - TT: Annual Symposium/3rd and 4th year presentations

Summary (200 words, cover page)

Usually written *after* the case for support:

Should concisely:

- Provide context – why is this project important?
- Define the aim(s) and objectives – what do you propose to do?
- Define the outputs – what will your project achieve?
- State the potential impact – what impact is this likely to have?

Data Management Plan

In preparing the data management plan you need to consider that scientific data needs to be retained **for at least 10 years**. You may wish to include details of:

- *Data areas and data types* - the volume, type and content of data and resources that will be generated e.g. measurements, models, records, specimens and images
- *Standards and metadata* - the standards and methodologies that will be adopted for data collection and management, and why these have been selected
- *Relationship to other data available in public repositories*
- *Secondary use* - further intended and/or foreseeable research uses for the completed dataset(s)
- *Methods for data sharing* - planned mechanisms for making these data available, e.g. through deposition in existing public databases or on request, including access mechanisms
- *Proprietary data* - any restrictions on data sharing due to the need to protect proprietary or patentable data
- *Timeframes* - timescales for public release of data
- *Format of the final dataset*

Ethics statement

- You will be asked to submit an ethics statement with your project similar to those required by UK funding bodies.
- This will require you to provide information on:
  - Human participation
  - Animal research and animal welfare
  - Genetic and biological risk
  - Approvals needed

- This document is additional to the overall page limit.

- It is required that you and your supervisor will seek and obtain approval from appropriate internal and external bodies before commencing any relevant work identified in this document.

Project Viva

- Attendees: You, two subject area experts
- The focus of the viva will be your future DPhil/PhD plans
- Your DTP viva committee will have:
  - your research proposal, data management plan and ethics statement
- The viva will begin with a presentation and last approximately 40-60 minutes
- Presentation: 10 minutes
  - Up to 5 minutes describing the work undertaken to date
  - The remainder describing the work you intend to do in your DPhil/PhD project
  - Where appropriate all 10 minutes can focus on your proposed project
- Questions from the panel concerning
  - the work you have undertaken
  - the research you propose to undertake for your DPhil/PhD
  - general questions pertaining to your first year within the DTP

Assessors are asked to discuss and evaluate:

- Project aims
- Awareness of the wider context of the project
- Familiarity with relevant literature
- Technical feasibility of the proposed project
- Timeline for the proposed project
- Supervision arrangements for the project
- Any additional training required to undertake the proposed project (if relevant)
- Quality of the written proposal
- Quality of the oral presentation

Where work to date is presented in the proposal or presentation assessors may also comment on

- Experimental design
- Analysis of data
- Discussion and interpretation of observations

What is being assessed?

1. Research question/hypothesis/aims

- Will the proposed activity further knowledge and understanding within its field and possibly across different fields?
- Does the project explore and/or suggest innovative and original ideas?
- How well is the idea conceived and organized?
- Are your objectives SMART (specific and relevant)

2. Understanding of the scientific literature

- Does the proposal show a sound understanding of relevant background literature and data?
- Does the selected methodology reflect currently used and emerging techniques?

3. Understanding of methodology/experimental design

- Is the methodology used appropriate?
- Are the methodological details (e.g. experimental design, methodology, data collection details, approach to data analysis) thorough and clear?
- Is the work plan well thought out?
- Can the proposed activity be completed within the specified time frame and with the specified resources?

4. Data management and curation

- Is there a well-thought out plan for management and curation of data and biological resources?

5. Ethics and safety (where appropriate)

- Has due consideration been given to any ethical or safety implications of the work proposed?
- Does the application show awareness of the regulatory context in which research is undertaken?

6. Communication skills

Ability to communicate scientific ideas effectively in written form:

- Coherent, purposeful, structured writing
- Argument and critical analysis
- Narrative flow
- Referencing
- Grammar, punctuation and spelling

Assessors are also asked to comment on:

- Is the proposed project in BBSRC remit?
- Does the project abstract/summary provide a satisfactory description of the project?
- Is the abstract/summary suitable for submission to the BBSRC and to be made publically available?

Assessors can recommend that a proposal be resubmitted and/or re-vivaed

Potential reasons for this may include:

- A poorly written or structured proposal
- Concerns about scientific or technical feasibility
- Concerns about cost implications
- Concerns about a student's understanding of the project
- Concerns about supervision arrangements
- Concerns about the timeline (e.g. too ambitious, too vague)
- Project not in UKRI-BBSRC remit

Review and update your proposal regularly

- Make a detailed plan of work for a block of time (e.g. 12 weeks)
- Overall project review every 3-4 months
- Formal review every 12 months (transfer, confirmation)
  - Progress against timeline
  - Availability of resources
  - New opportunities
  - Intentional change/refinement of focus (where appropriate)

Major changes in direction

- The project proposal and viva process enable us to review and approve your project in accordance with BBSRC remit

- Once your project is approved we share the title and abstract with BBSRC

- Under UKRI terms and conditions once a project is approved you should only make **major** changes to your overall aim(s)/research questions:
  - under exceptional circumstances
  - with explicit approval from the DTP

- We cannot approve any change to project aims and research questions that would take the project out of BBSRC remit

Career Planning

Career development plan

- Developed by you in conversation with your supervisor or an appropriate mentor

Choose your Impact Stream(s)

- Public engagement, policy and outreach

  Funding of up to £250/student available to support outreach activities

- Enterprise and business skills
- Teaching

EEDI Internships

- Optional
- Opportunity to undertake up to 3 months of paid work to support EEDI in the DTC

Accelerating Impact Awards

- Optional
- Support for activities that will increase the impact of your research, but which may not contribute directly to your doctoral thesis (e.g. translation, communication)

Outreach

- Optional for iCASE students
- Funding (up to £250/student) to support outreach activities

Publications

- Let us know of your upcoming publications!

- All of your scientific publications must acknowledge BBSRC as a source of funding using the following statement:

Students funded partly or wholly by the BBSRC DTP*:

- This work was supported by funding from the Biotechnology and Biological Sciences Research Council (BBSRC) [grant number BB/T008784/1].

Industrial CASE (iCASE) students and partner studentships supported by individual studentships

- This work was supported by funding from the Biotechnology and Biological Sciences Research Council (BBSRC) [grant number – BB/T008784/1] and [your DTP partner organisation or industry partner].

** If you are receiving support from other/additional sources you should also acknowledge these, but please do note that you were also supported by the Oxford Interdisciplinary Bioscience Doctoral Training Partnership if you are not directly in receipt of BBSRC funding.*