Practical basics of scientific work (B130P16)

Guaranteed by: 130 - Department of Plant Experimental Biology
Winter term: 0/2 C (hours/week)
Credits: 2
Teachers: Jan Petrášek and Katarina Kurtović
WWW: http://lhr.ueb.cas.cz/petrasek/B130P16.htm

Requirements for obtaining credits:

1) Active participation in lectures
2) Completion of tests on searching, processing and presentation of bibliographic, scientometric and sequence data
3) Preparation of the scientific manuscript

Syllabus

1 Basics of research work

3.10. 1.1 The character of scientific work in the experimental biology

10.10. 1.2 Observation and experiment as the two main activities of scientists

17.10. 1.3 Scientific institutions, organizations, conferences, and social networks
Scientific contributions at the seminars and conferences, rules for effective abstract writing

24.10. 1.4 Ethical rules of scientific work including bad habits in scientific writing
1.5 Financing of the scientific research
1.6 Writing scientific projects and grant proposals

Syllabus

2 Handling with experimental data

31.10. 2.1Organization of work, type of data
2.2 Data explorers, correct data handling and saving
2.3 Spreadsheets, statistical software, graph editors
7.11. 2.4 Processing of structural and sequence data
2.5 Image analysis, graphical software, presentation software

Syllabus

3 Scientific literature

14.11. 3.1 Types of scientific reports and their purpose
3.2 Internet sources of information

21.11. 3.3 How to search for bibliographic records and full text articles - good and bad habits
3.3.1 Bibliographic databases accessible at our faculty
3.3.2 Full text databases accessible at our faculty
3.3.3 Creating your own database of references

28.11. 3.4 Scientometry - a tool for the evaluation of quality and scientific relevance of scientific work
3.5 Peer review of scientific texts - step by step guide through the process

Syllabus

4 Artificial intelligence in experimental biology

5.12. 4.1 AI in the handling and processing of experimental data

4.2 AI in scientific writing

5 Online information databases in experimental biology

12.11. 5.1 Databases of sequences

5.2 Specialized sequence databases

6 Scientific writing

19.12 6.1 Writing bachelor, master and dissertation thesis

6.2 Writing scientific report/paper - good and bad habits, how to publish in a very good journal

1. Basics of research work

1.1. The character of scientific work in the experimental biology

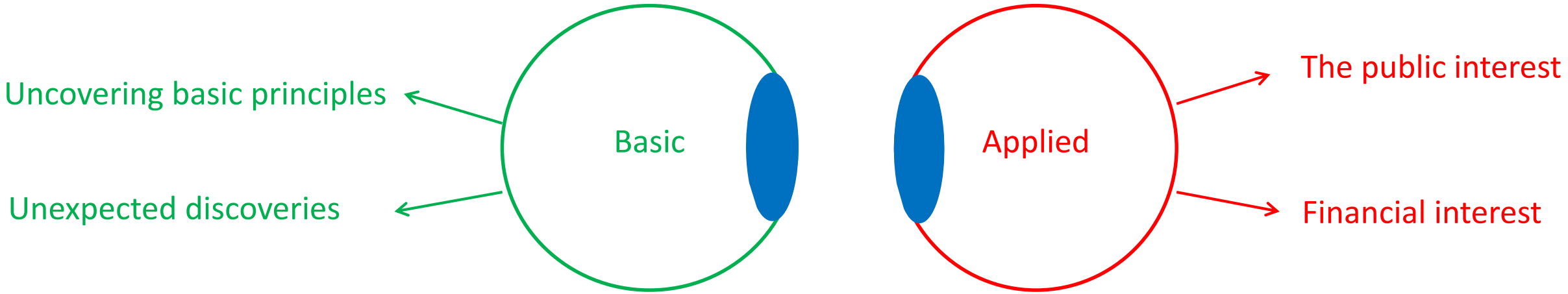
The goal of science is the searching for the „truth“, in biology we explore the principles of regulatory mechanisms in living organisms

Research - systematic activity using scientific methods

Research → Fundamental - revealing the essence of a certain phenomenon

Research → Applied - there is always some economic or public interest behind

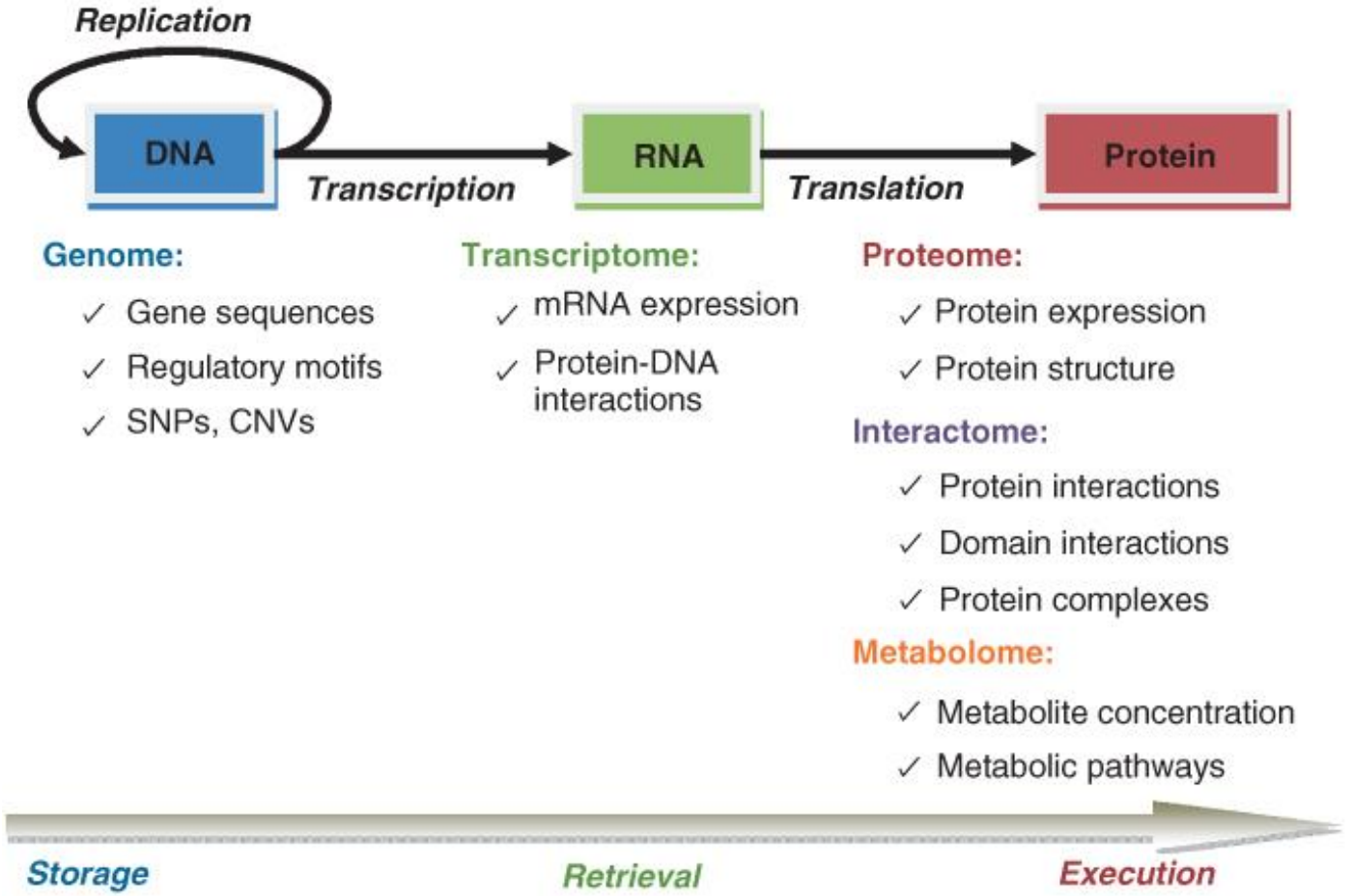
The combination of both fundamental and applied research is ideal



1. Basics of research work

1.1. The character of scientific work in the experimental biology

Experimental biology is now in the age of the accumulation and of large amounts of data - correct scientific evaluation of large data sets is the key to the scientific progress



M Koyutürk *WIREs Syst Biol Med* 2010. DOI: 10.1002/wsbm.61

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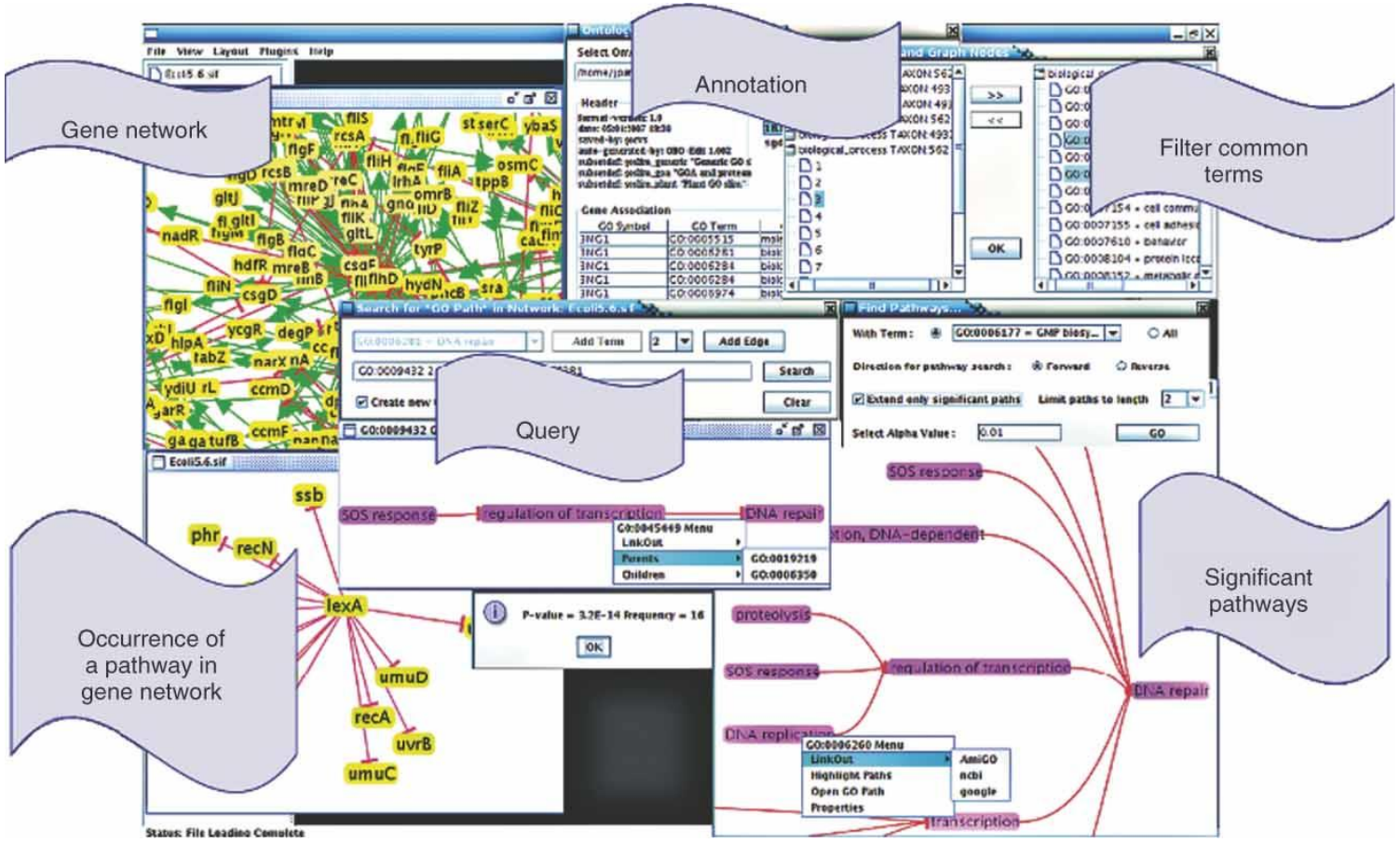

M Koyutürk *WIREs Syst Biol Med* 2010. DOI: 10.1002/wsbm.61 Copyright © 2009 John Wiley & Sons, Inc.

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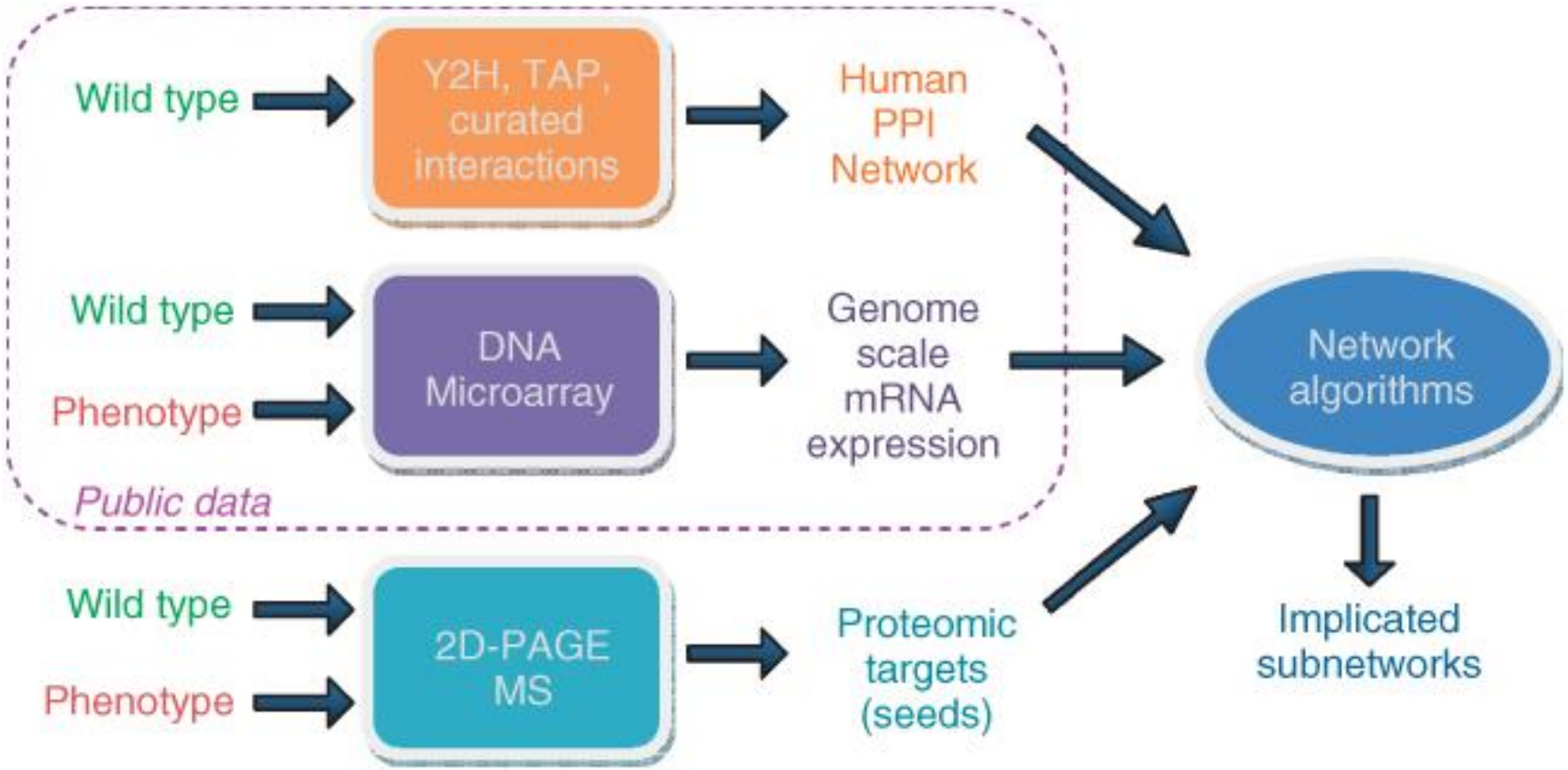
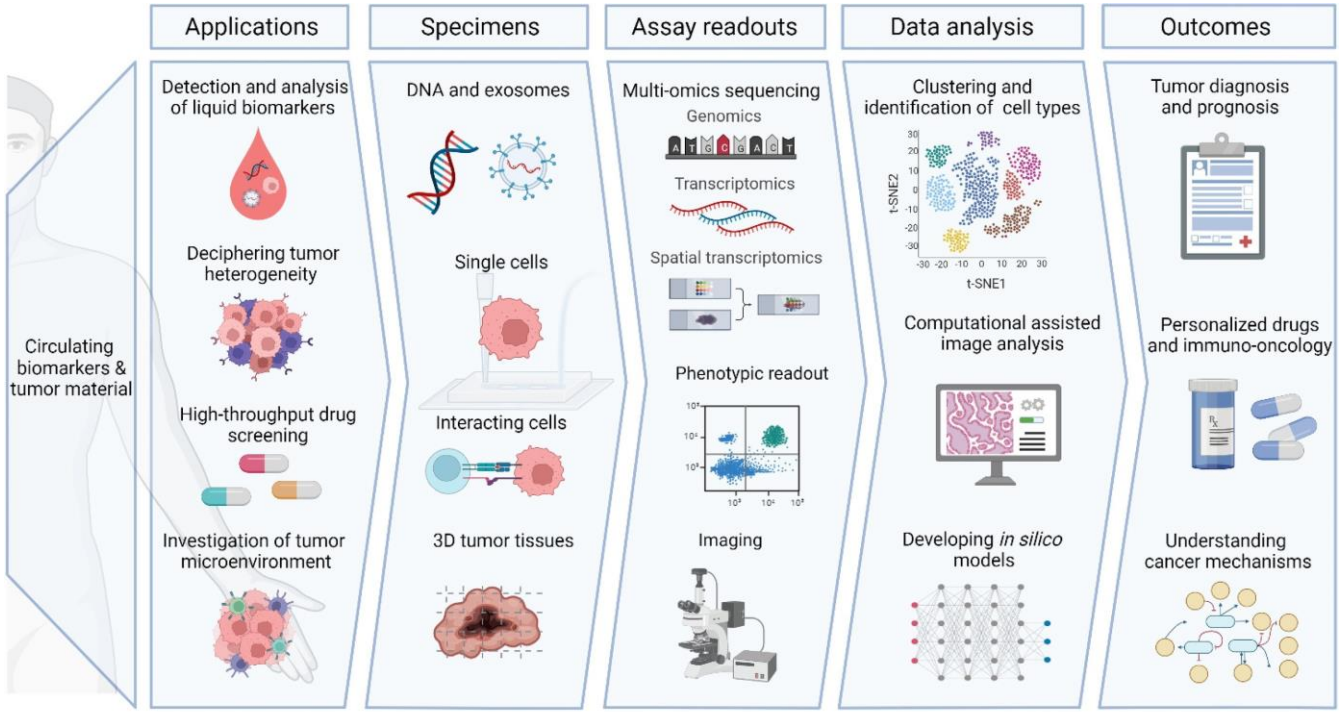


M Koyutürk *WIREs Syst Biol Med* 2010. DOI: 10.1002/wsbm.61 Copyright © 2009 John Wiley & Sons, Inc.

1. Basics of research work

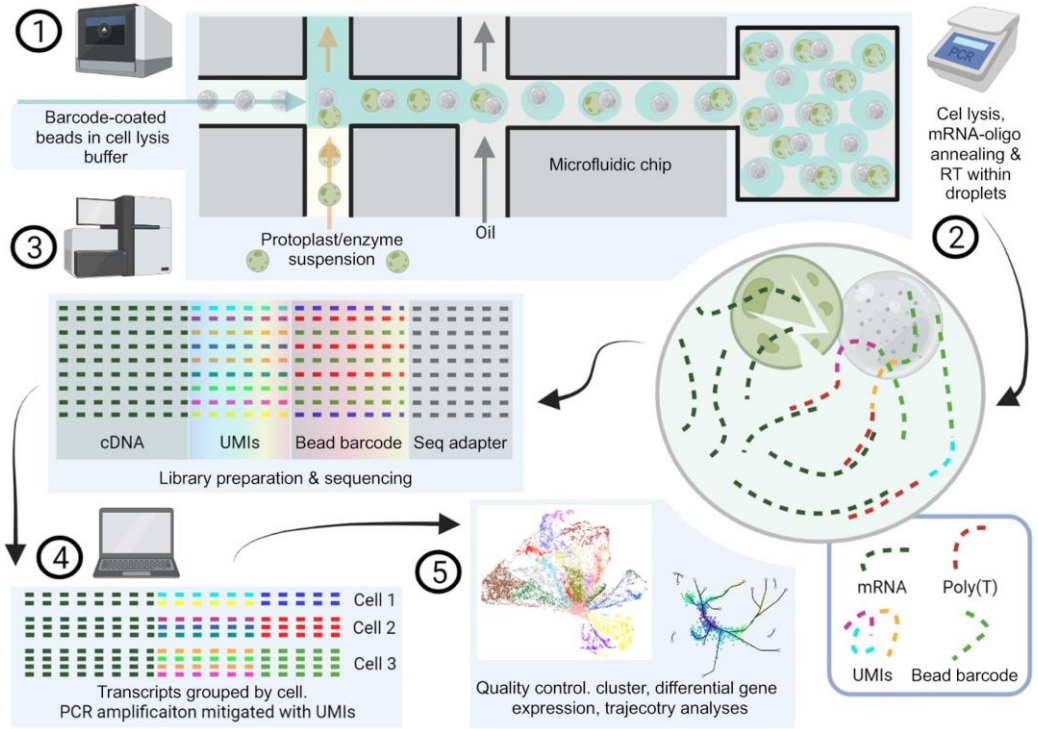
1.1. The character of scientific work in the experimental biology

How to handle high throughput data? And what can they tell us?



Trends in Cell Biology 2022 32947-961DOI: (10.1016/j.tcb.2022.04.008)

Trends in Cell Biology



Trends in Plant Science 2022 27104-105DOI: (10.1016/j.tplants.2021.09.003)

Trends in Plant Science

1. Basics of research work

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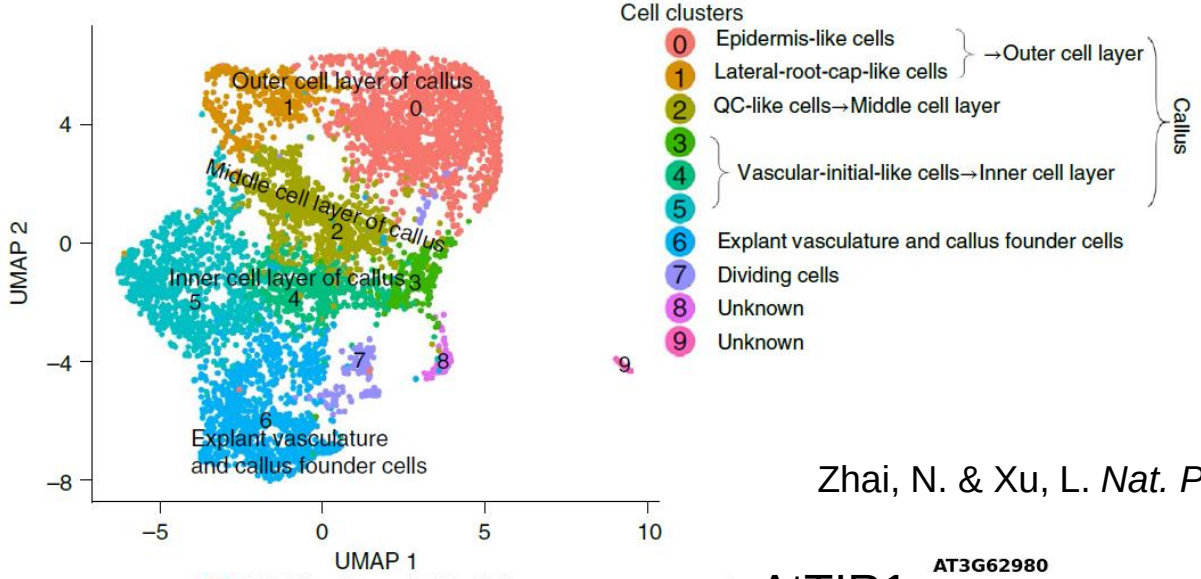
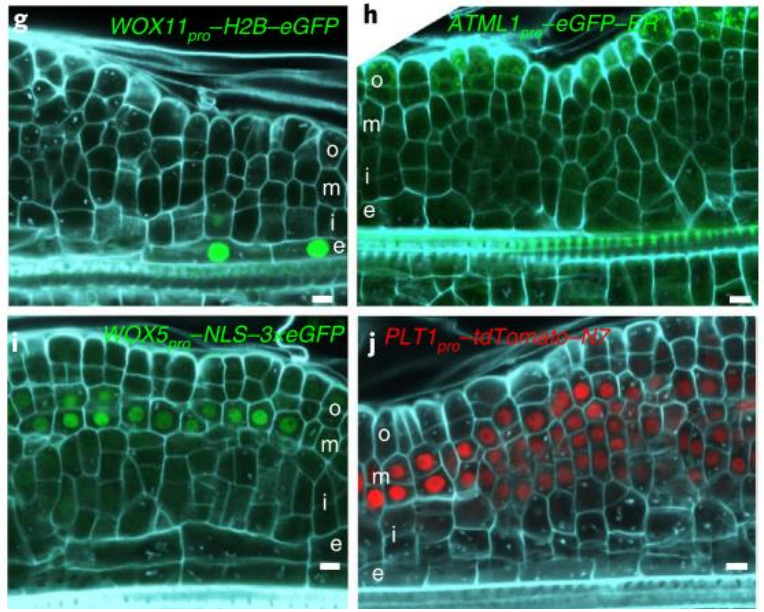
How to handle high throughput data? And what can they tell us?



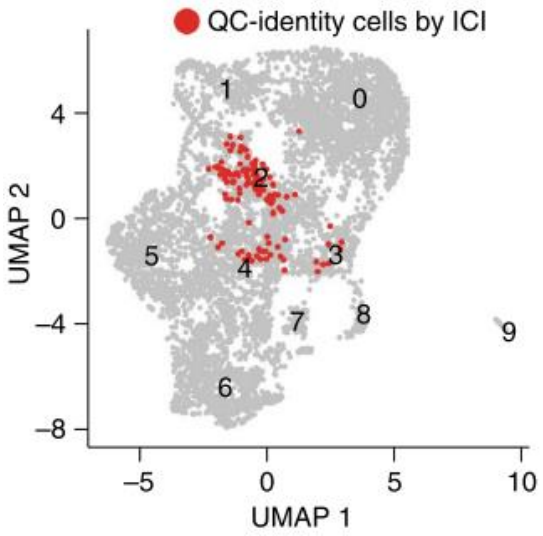
Cell clusters

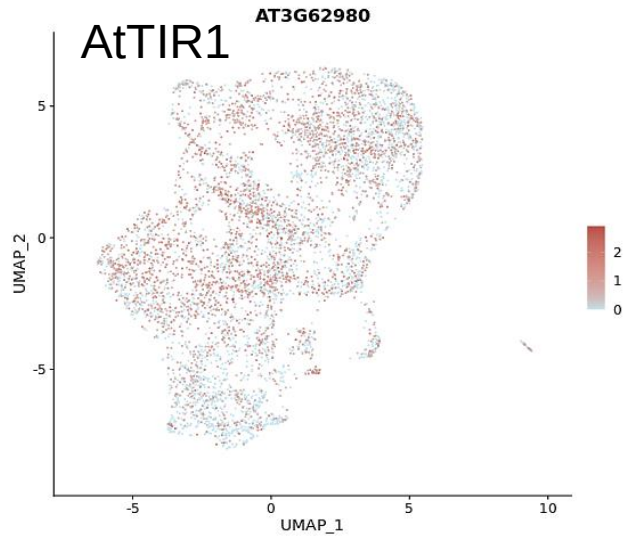
- 0 Epidermis-like cells
- 1 Lateral-root-cap-like cells → Outer cell layer
- 2 QC-like cells → Middle cell layer
- 3
- 4 Vascular-initial-like cells → Inner cell layer
- 5
- 6 Explant vasculature and callus founder cells
- 7 Dividing cells
- 8 Unknown
- 9 Unknown

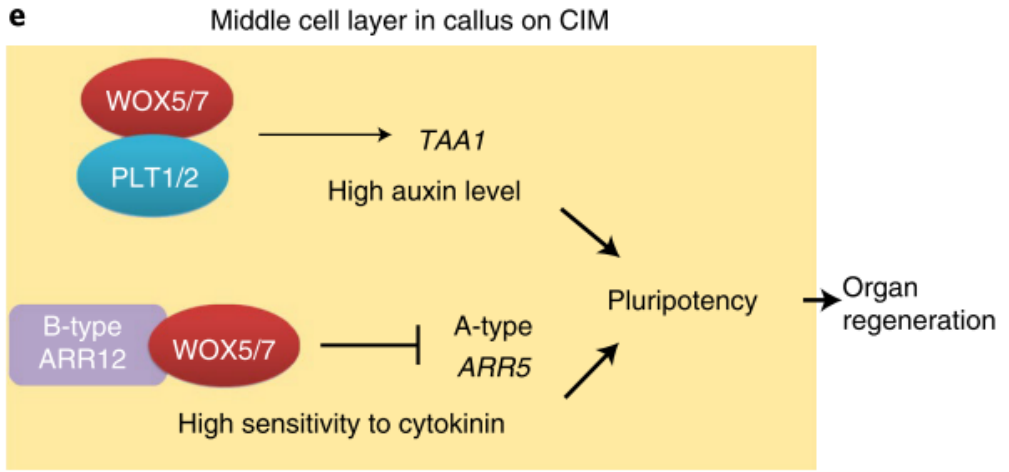
Callus



Zhai, N. & Xu, L. *Nat. Plants* **7**, 1453–1460 (2021)







1. Basics of research work

1.1. The character of scientific work in the experimental biology

Biology as an exact science? This is really a challenge…

http://commons.wikimedia.org/wiki/File:InvestigadoresUR.JPG

http://library.miami.edu/uml/chc/tag/behind-the-scenes-at-chc/

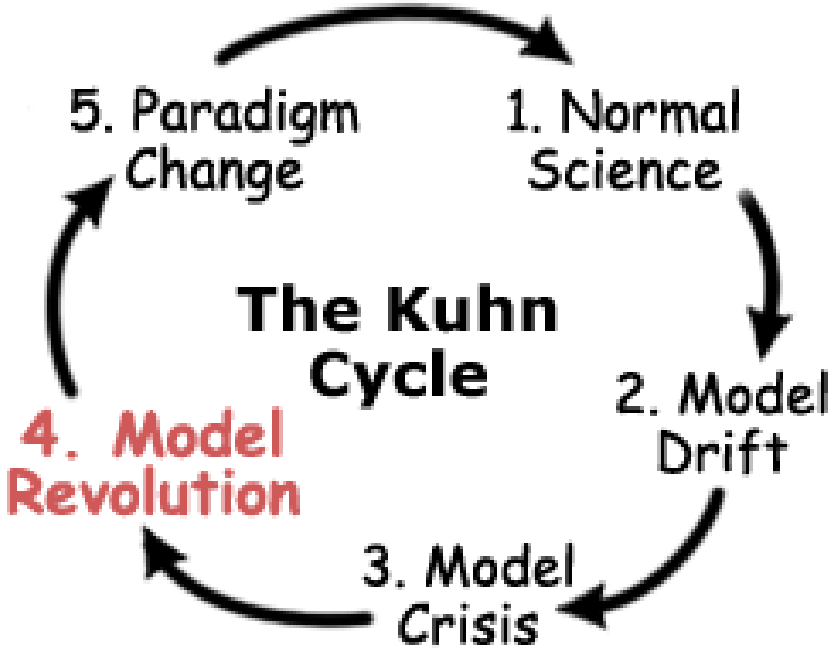
1. Basics of research work

1.1. The character of scientific work in the experimental biology

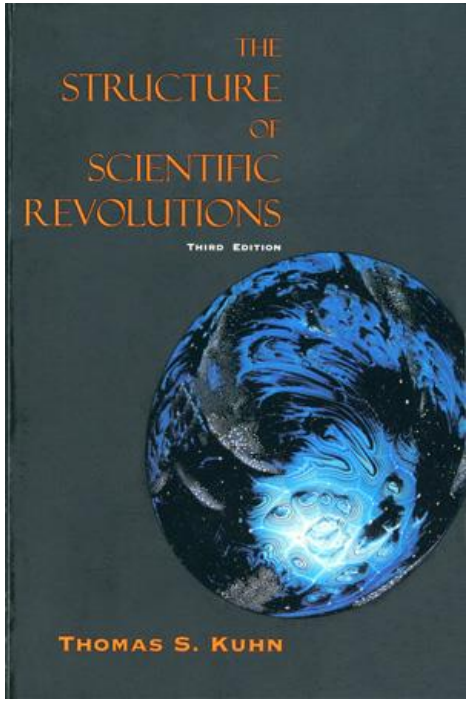
What do we actually do when we do science?

Scientific work → **Testing hypotheses** - verification or falsification

Verifying models - in the biology, the model is the result of experimental activity and reductionist approach to the object studied



http://www.thwink.org/sustain/glossary/ModelRevolution.htm



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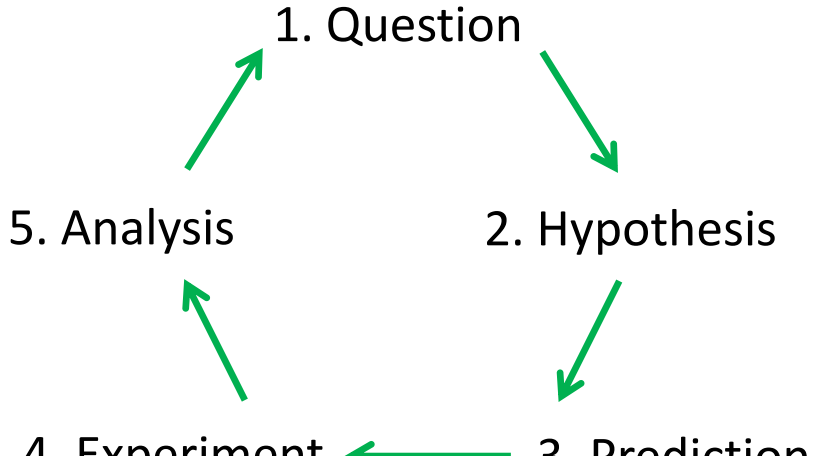
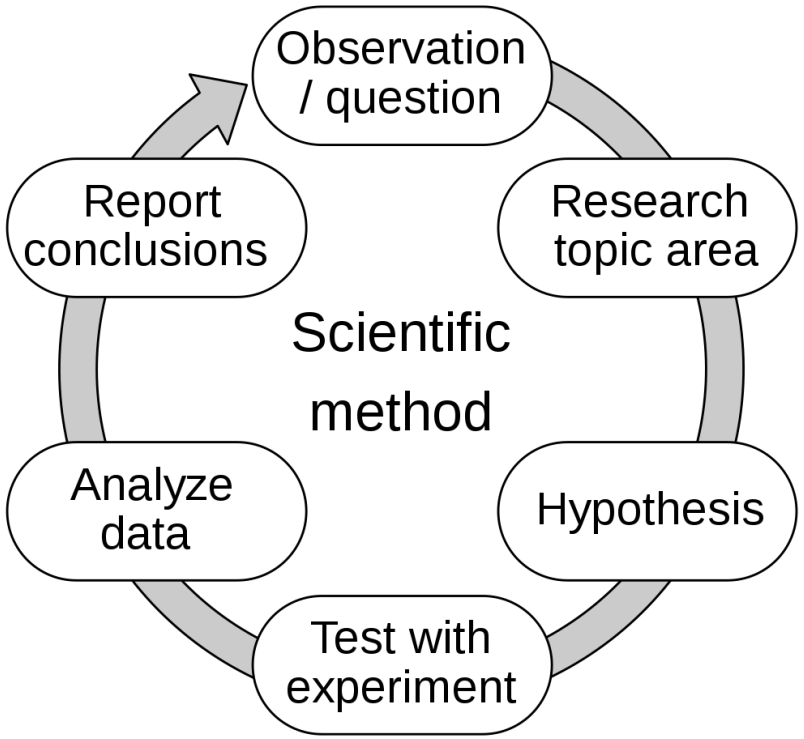


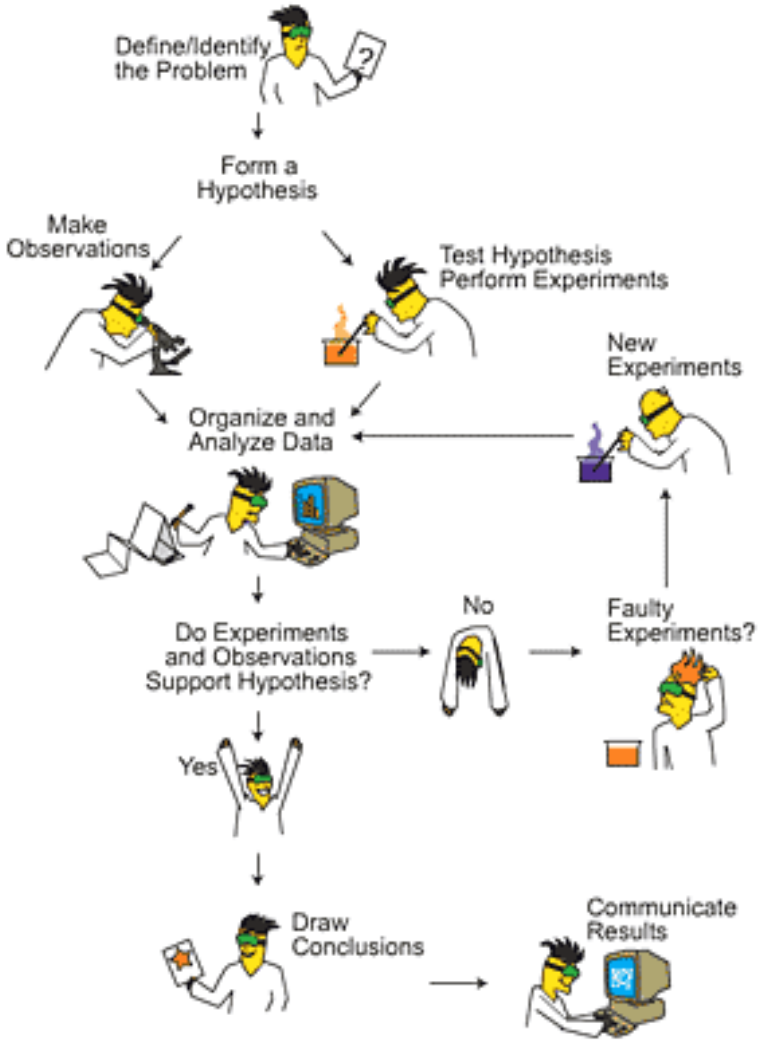
1. Basics of research work

1.1. The character of scientific work in the experimental biology

Scientific method



https://upload.wikimedia.org/wikipedia/commons/8/82/The_Scientific_Method.svg



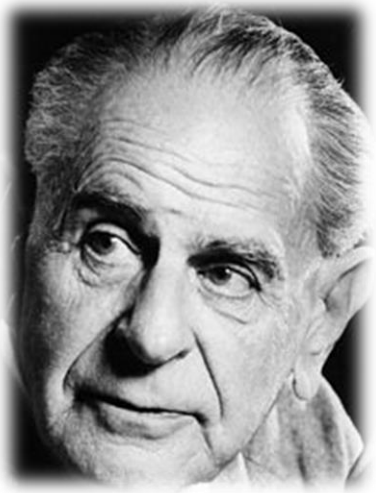
1. Basics of research work

1.1. The character of scientific work in the experimental biology

Asking new questions - the key for the successful scientific research

Scientific discovery is rather a continuous approach to the final „knowledge“

Karl Raimund Popper - philosopher of Austrian origin, his critical rationalism gives a true picture of the continual approaching to the truth, which is achieved through the elimination of various mistakes and errors



- correct scientific statements must be possible to falsify, this is achieved through systematic experimental activity with subsequent interpretation

- Popper’s razor - the theory that is refutable could be replaced by another theory that resulted from the systematic research activity

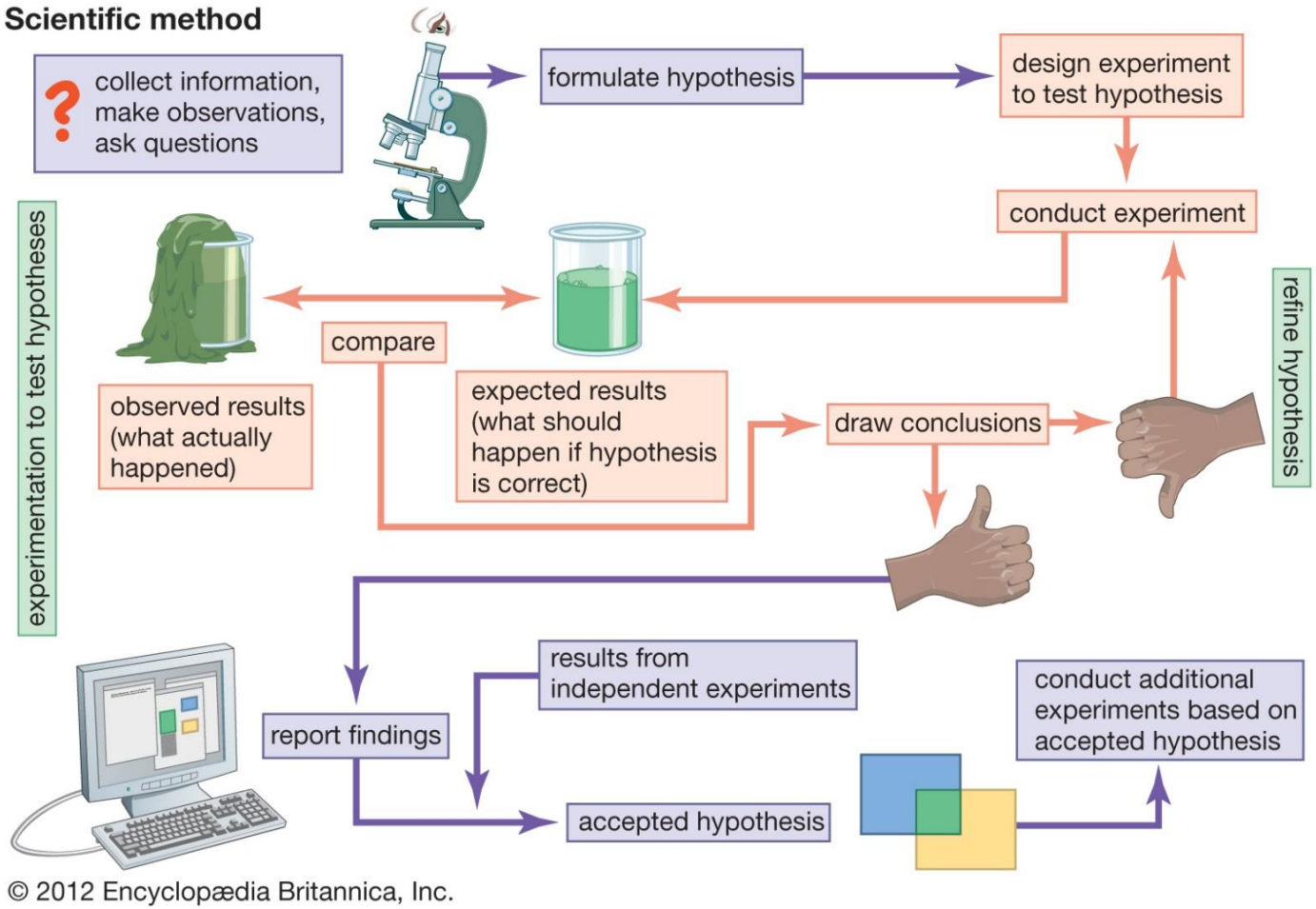
1. Basics of research work

1.1. The character of scientific work in the experimental biology

How to distinguish between scientific and non-scientific activities in biology and other disciplines?

Scientific activities:

- **systematic gathering of data -** experiment and observation
- **formulation of hypotheses** - these **must be falsifiable and testable**, e.g. by comparing results with those of other scientists
- in general, **we cannot verify theories, we can only falsify them**



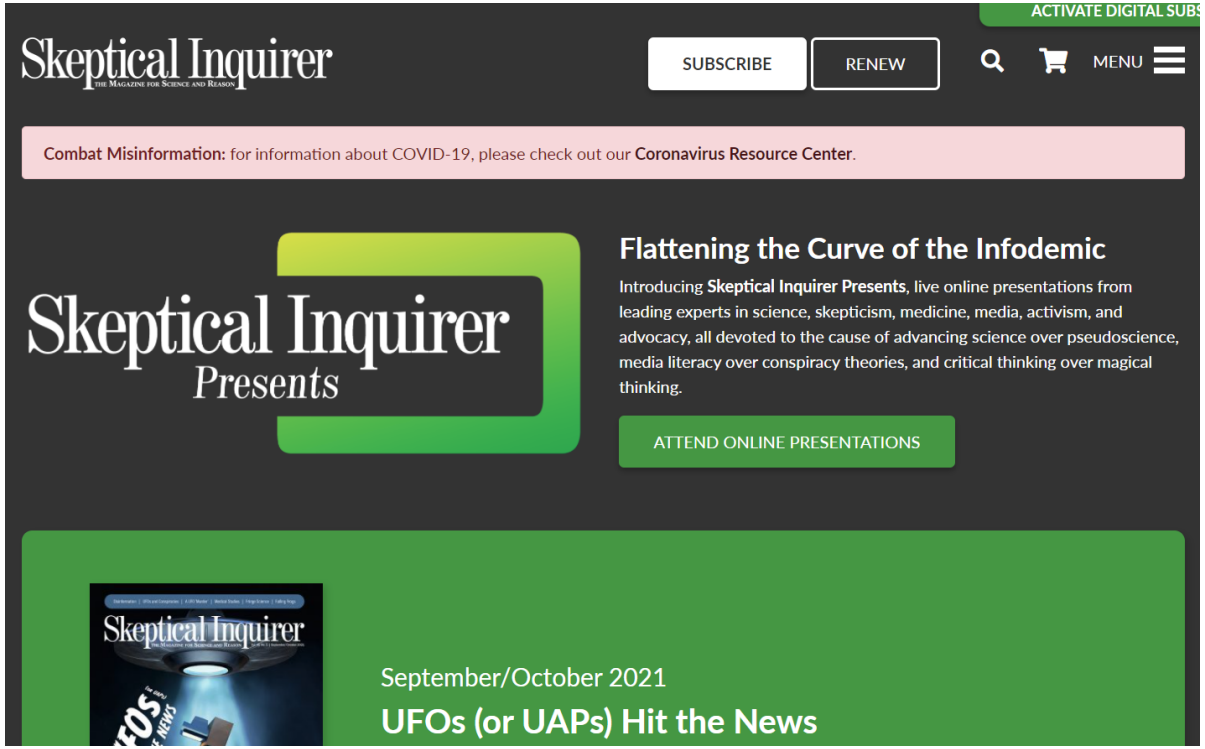
1. Basics of research work

1.1. The character of scientific work in the experimental biology

How to distinguish between scientific and non-scientific activities in biology and other disciplines?

CSI - Committee for Skeptical Inquiry

The society of scientists and philosophers promoting methods and ideas of new skepticism (in a sense of critical rationalism) towards paranormal and other fringe-science claims.



SISYFOS – Czech sceptical club

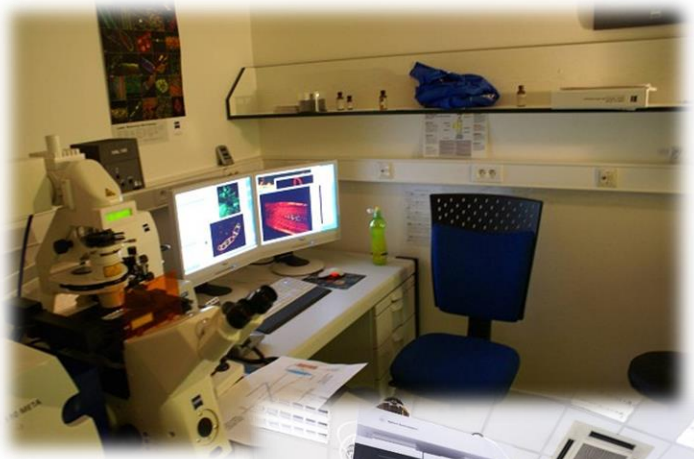
Czech branch of the international sceptical club, known for every year awarding of unscientific activities that are presented publicly

1. Basics of research work

1.1. The character of scientific work in the experimental biology

Categorization of activities of modern experimental biologists:

1) Laboratory expert

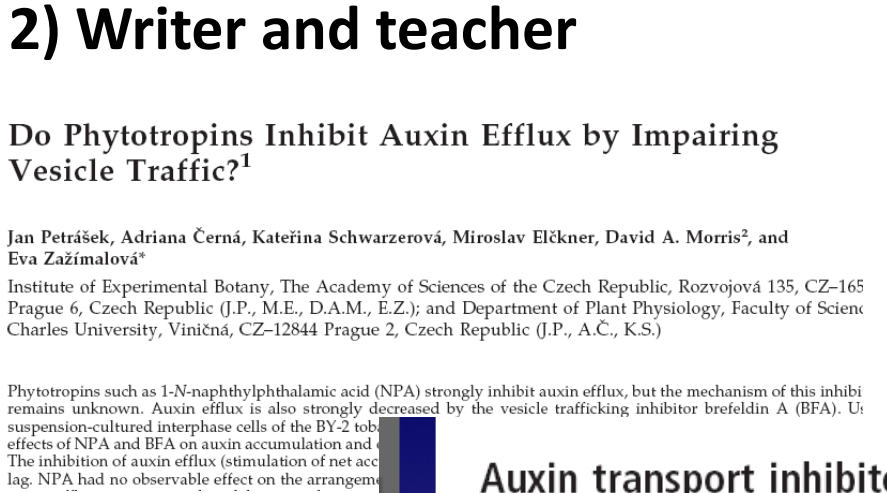


1. Basics of research work

1.1. The character of scientific work in the experimental biology

Categorization of activities of modern experimental biologists:

2) Writer and teacher

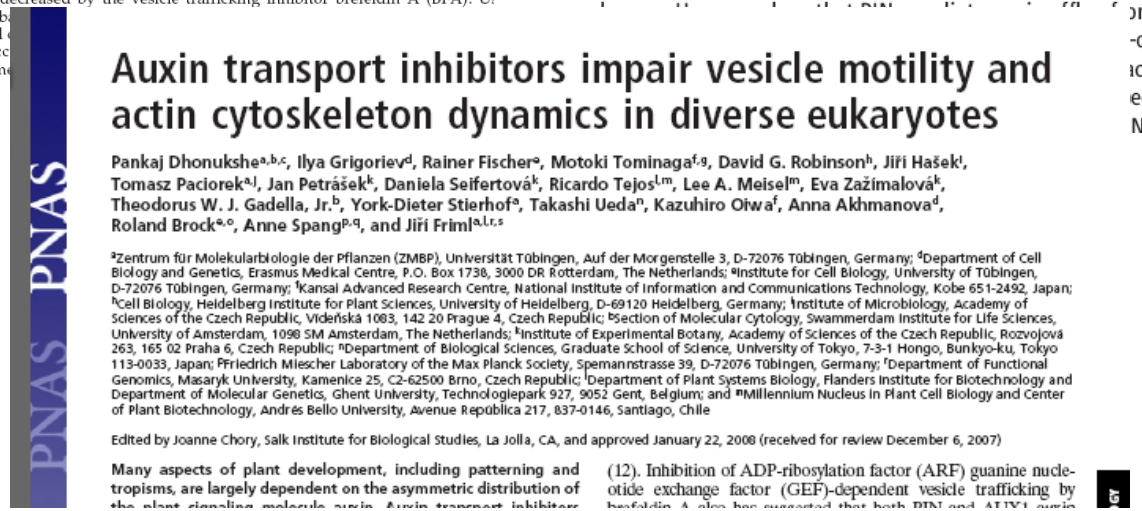


Do Phytotropins Inhibit Auxin Efflux by Impairing Vesicle Traffic?[1]

Jan Petrášek, Adriana Černá, Kateřina Schwarzerová, Miroslav Elčkner, David A. Morris[2], and Eva Zažímalová*

Institute of Experimental Botany, The Academy of Sciences of the Czech Republic, Rozvojová 135, CZ–165 Prague 6, Czech Republic (J.P., M.E., D.A.M., E.Z.); and Department of Plant Physiology, Faculty of Scienc Charles University, Viničná, CZ–12844 Prague 2, Czech Republic (J.P., A.Č., K.S.)

Phytotropins such as 1-*N*-naphthylphthalamic acid (NPA) strongly inhibit auxin efflux, but the mechanism of this inhibi remains unknown. Auxin efflux is also strongly decreased by the vesicle trafficking inhibitor brefeldin A (BFA). U suspension-cultured interphase cells of the BY-2 tob effects of NPA and BFA on auxin accumulation and The inhibition of auxin efflux (stimulation of net acc lag. NPA had no observable effect on the arrangem



PIN Proteins Perform a Rate-Limiting Function in Cellular Auxin Efflux

Jan Petrášek,[1,2] Jozef Mravec,[3] Rodolphe Bouchard,[4] Joshua J. Blakeslee,[5] Melinda Abas,[6] Daniela Seifertová,[1,2,3] Justyna Wiśniewska,[3,7] Zerihun Tadele,[8] Martin Kubeš,[1,2] Milada Čovanová,[1,2] Pankaj Dhonukshe,[3] Petr Skůpa,[1,2] Eva Benková,[3] Lucie Perry,[1] Pavel Křeček,[1,2] Ok Ran Lee,[5] Gerald R. Fink,[9] Markus Geisler,[4] Angus S. Murphy,[5] Christian Luschnig,[6] Eva Zažímalová,[1]* Jiří Friml[3,10]

Intercellular flow of the phytohormone auxin underpins multiple devel
Plant-specific pin-formed (PIN) proteins and several phosphoglycoprot
crucial factors in auxin transport–related development, yet the molecu
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PNAS

Auxin transport inhibitors impair vesicle motility and actin cytoskeleton dynamics in diverse eukaryotes

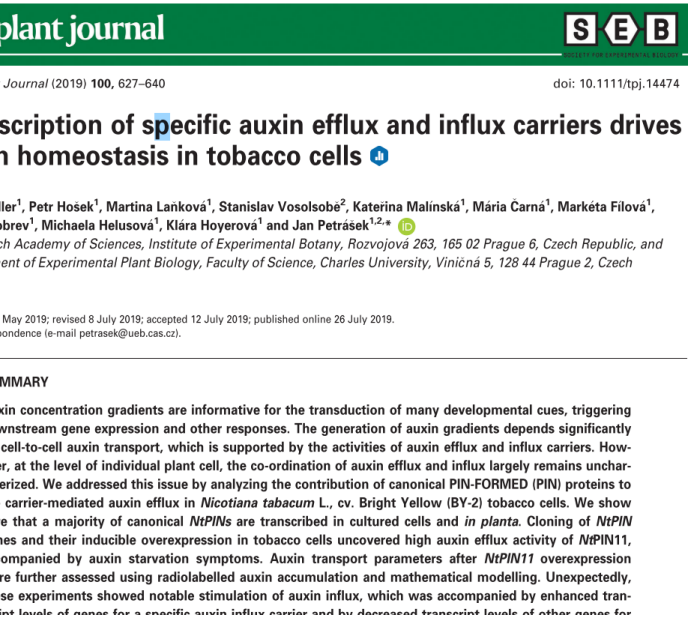
Pankaj Dhonukshe[a,b,c], Ilya Grigoriev[d], Rainer Fischer[e], Motoki Tominaga[f,g], David G. Robinson[h], Jiří Hašek[i], Tomasz Paciorek[a,j], Jan Petrášek[k], Daniela Seifertová[k], Ricardo Tejos[l,m], Lee A. Meisel[m], Eva Zažímalová[k], Theodorus W. J. Gadella, Jr.[b], York-Dieter Stierhof[a], Takashi Ueda[n], Kazuhiro Oiwa[f], Anna Akhmanova[d], Roland Brock[e,o], Anne Spang[p,q], and Jiří Friml[a,l,r,s]

[a]Zentrum für Molekularbiologie der Pflanzen (ZMBP), Universität Tübingen, Auf der Morgenstelle 3, D-72076 Tübingen, Germany; [d]Department of Cell Biology and Genetics, Erasmus Medical Centre, P.O. Box 1738, 3000 DR Rotterdam, The Netherlands; [e]Institute for Cell Biology, University of Tübingen, D-72076 Tübingen, Germany; [f]Kansai Advanced Research Centre, National Institute of Information and Communications Technology, Kobe 651-2492, Japan; [h]Cell Biology, Heidelberg Institute for Plant Sciences, University of Heidelberg, D-69120 Heidelberg, Germany; [i]Institute of Microbiology, Academy of Sciences of the Czech Republic, Videňská 1083, 142 20 Prague 4, Czech Republic; [k]Section of Molecular Cytology, Swammerdam Institute for Life Sciences, University of Amsterdam, 1098 SM Amsterdam, The Netherlands; [l]Institute of Experimental Botany, Academy of Sciences of the Czech Republic, Rozvojová 263, 165 02 Praha 6, Czech Republic; [n]Department of Biological Sciences, Graduate School of Science, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan; [p]Friedrich Miescher Laboratory of the Max Planck Society, Spemannstrasse 39, D-72076 Tübingen, Germany; [r]Department of Functional Genomics, Masaryk University, Kamenice 25, C2-62500 Brno, Czech Republic; [j]Department of Plant Systems Biology, Flanders Institute for Biotechnology and Department of Molecular Genetics, Ghent University, Technologiepark 927, 9052 Gent, Belgium; and [m]Millennium Nucleus in Plant Cell Biology and Center of Plant Biotechnology, Andrés Bello University, Avenue República 217, 837-0146, Santiago, Chile

Edited by Joanne Chory, Salk Institute for Biological Studies, La Jolla, CA, and approved January 22, 2008 (received for review December 6, 2007)

Many aspects of plant development, including patterning and tropisms, are largely dependent on the asymmetric distribution of

(12). Inhibition of ADP-ribosylation factor (ARF) guanine nucleotide exchange factor (GEF)-dependent vesicle trafficking by



the plant journal

SEB

The Plant Journal (2019) **100**, 627–640 doi: 10.1111/tpj.14474

Transcription of specific auxin efflux and influx carriers drives auxin homeostasis in tobacco cells

Karel Müller[1], Petr Hošek[1], Martina Laňková[1], Stanislav Vosolsobě[2], Kateřina Malínská[1], Mária Čarná[1], Markéta Filová[1], Petre I Dobrev[1], Michaela Helusová[1], Klára Hoyerová[1] and Jan Petrášek[1,2,*]

[1]*The Czech Academy of Sciences, Institute of Experimental Botany, Rozvojová 263, 165 02 Prague 6, Czech Republic, and* [2]*Department of Experimental Plant Biology, Faculty of Science, Charles University, Viničná 5, 128 44 Prague 2, Czech Republic*

Received 30 May 2019; revised 8 July 2019; accepted 12 July 2019; published online 26 July 2019.
*For correspondence (e-mail petrasek@ueb.cas.cz).

SUMMARY

Auxin concentration gradients are informative for the transduction of many developmental cues, triggering downstream gene expression and other responses. The generation of auxin gradients depends significantly on cell-to-cell auxin transport, which is supported by the activities of auxin efflux and influx carriers. However, at the level of individual plant cell, the co-ordination of auxin efflux and influx largely remains uncharacterized. We addressed this issue by analyzing the contribution of canonical PIN-FORMED (PIN) proteins to the carrier-mediated auxin efflux in *Nicotiana tabacum* L., cv. Bright Yellow (BY-2) tobacco cells. We show here that a majority of canonical *NtPINs* are transcribed in cultured cells and *in planta*. Cloning of *NtPIN* genes and their inducible overexpression in tobacco cells uncovered high auxin efflux activity of *Nt*PIN11, accompanied by auxin starvation symptoms. Auxin transport parameters after *NtPIN11* overexpression were further assessed using radiolabelled auxin accumulation and mathematical modelling. Unexpectedly, these experiments showed notable stimulation of auxin influx, which was accompanied by enhanced tran-

1. Basics of research work

1.1. The character of scientific work in the experimental biology

Categorization of activities of modern experimental biologists:

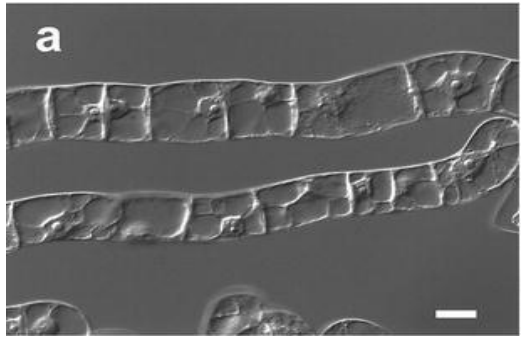
3) Manager and popularizer

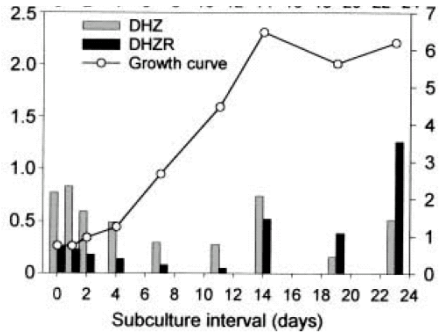
1. Basics of research work

1.2. Observation and experiment - two main activities

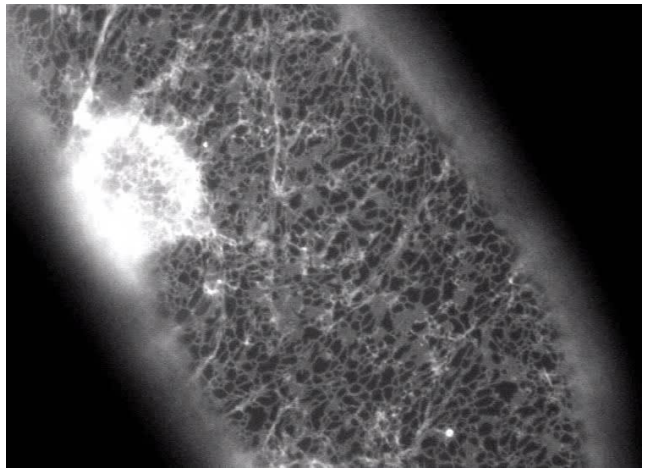
Scientific work

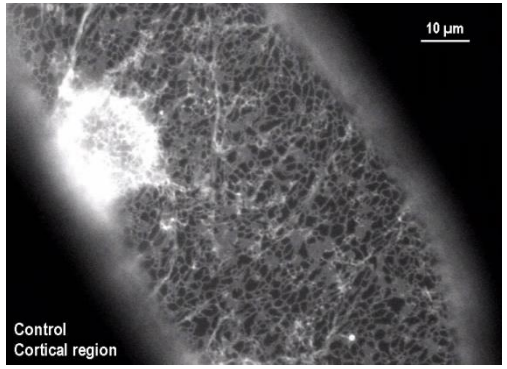
Observation - explorative or analytical (analysis)

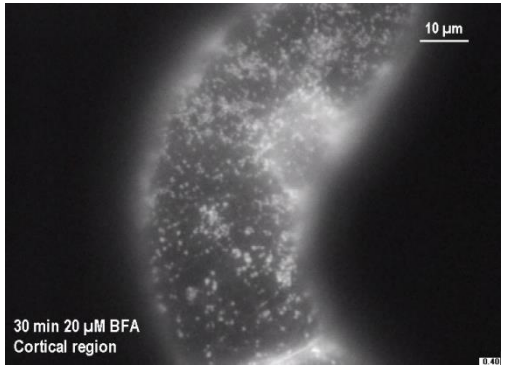




Experiment - following the effect of well-defined factors







The approach of experiment and observation are mixed and can not be separated from each other

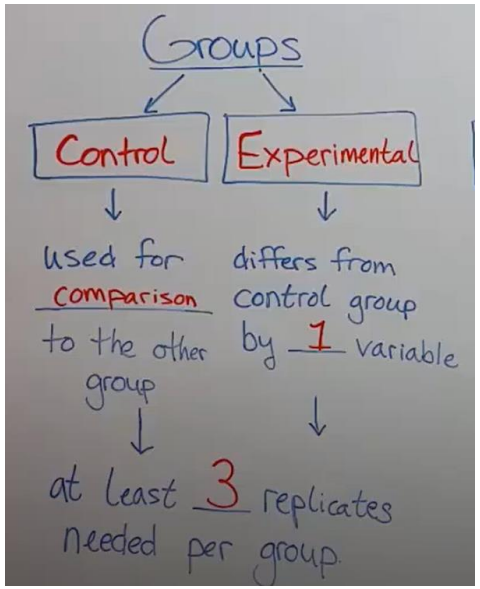
1. Basics of research work

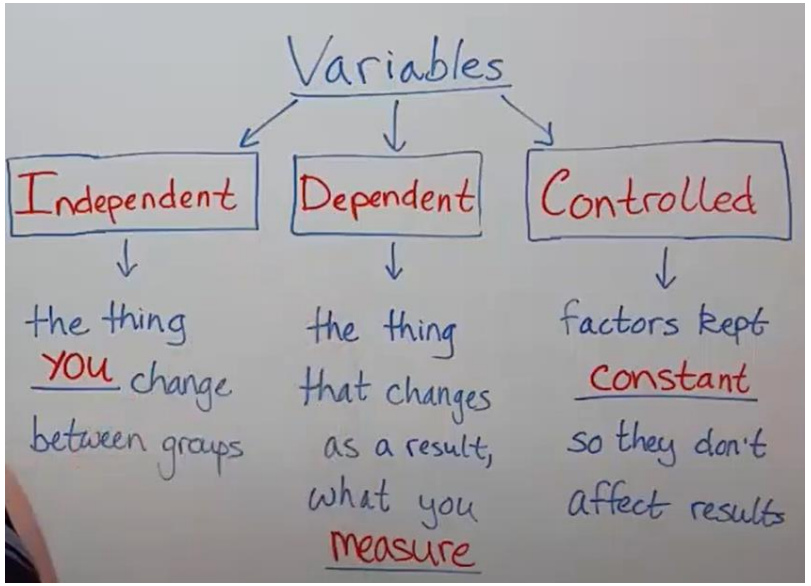
1.2. Observation and experiment - the two main activities of experimental biologists

How to perform experiments?

Experimental design, data acquisition, processing and interpretation

Experimental design: - Experimental Design: Variables, Groups, and Controls - youtube





- Biology Controlled Experiments - youtube

1. Basics of research work

1.2. Observation and experiment - the two main activities of experimental biologists

How to perform experiments?

Experimental design, data acquisition, processing and interpretation

Negative and positive controls

Controls need to be involved to test methods, chemicals, organisms, etc.

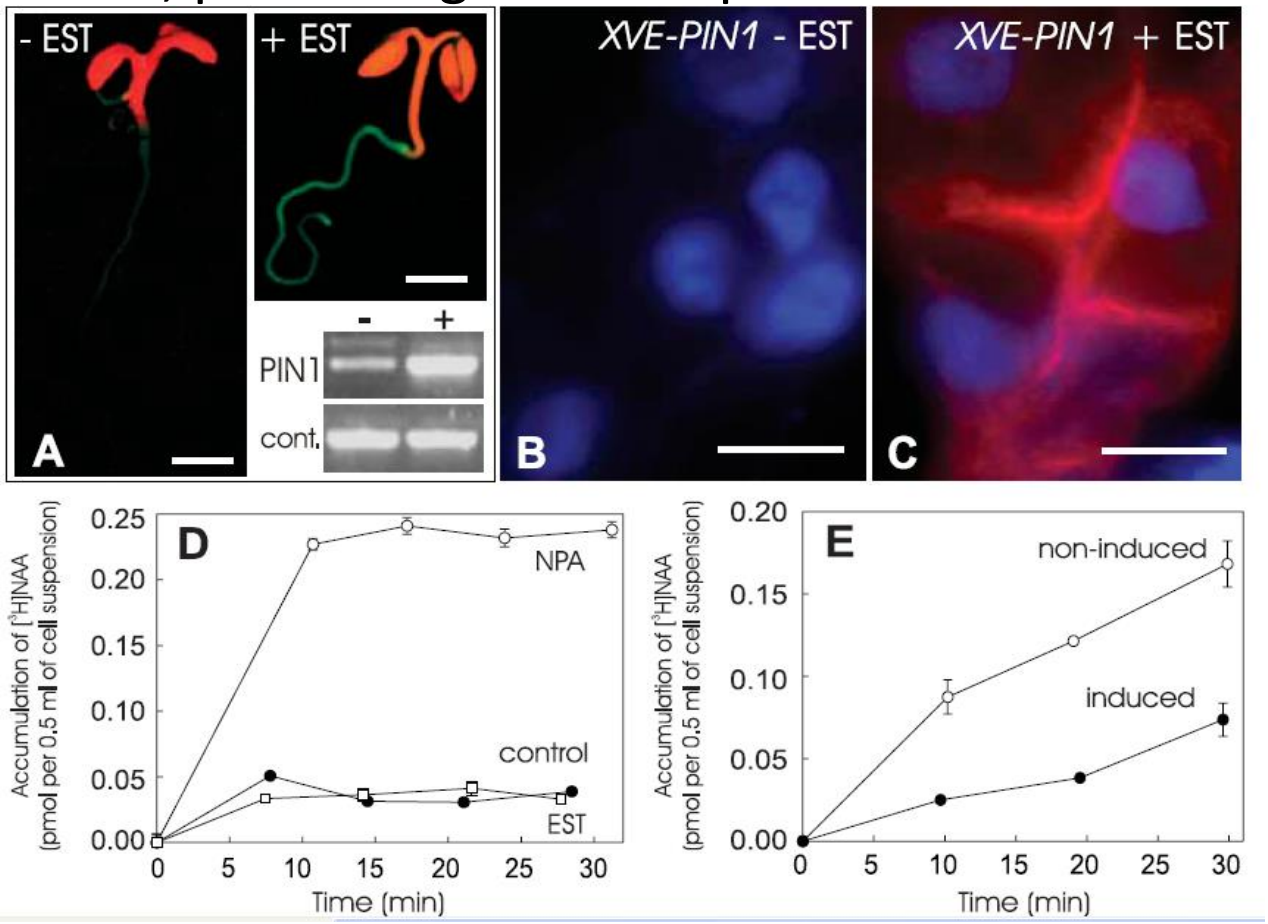
A negative control is a kind of control that is not expected to produce results.

Experimental Design Negative Controls

A positive control is a kind of control that produce known results.

Experimental Design Positive Controls

Positive Control vs Negative Control



1. Basics of research work

1.2. Observation and experiment - the two main activities of experimental biologists

How to perform experiments?
Experimental design, data acquisition, processing and interpretation

Data processing and interpretation:

- both original form of data (numbers, images) and processed data in a form of electronic protocol must be stored

- collecting processed data together with preliminary conclusions in a form of the presentation is very useful

- statistical analysis - it depends on the experimental design, sometimes it is not needed. It is better to consult its use with a specialist.

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Experimental design:

- is the experiment really necessary?
- stating the null hypothesis - it is rejected based on the results of the experiment
- considering time and financial costs
- choosing appropriate methods including their understanding
- considering the way of presentation of results

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How to perform experiments?

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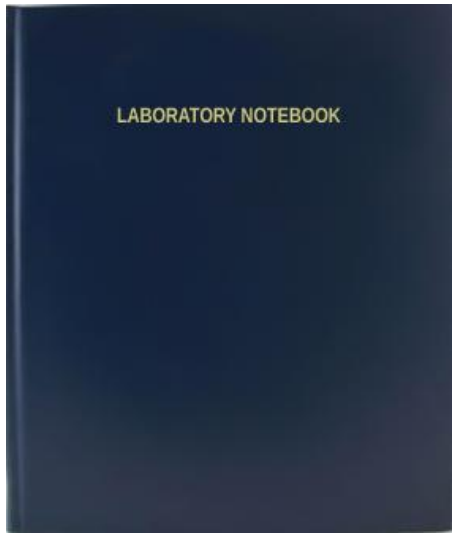
Data acquisition in the laboratory:

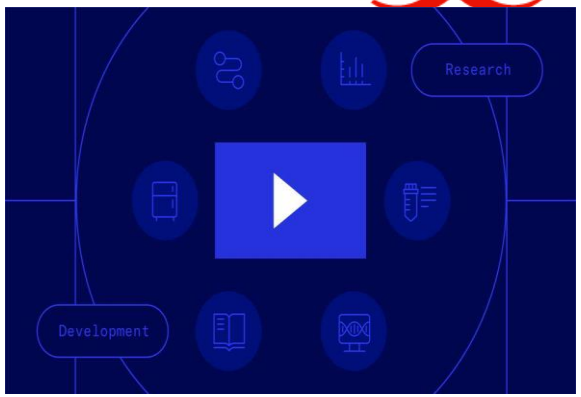


- rules for health and safety policy careful handling with chemicals, radioactive material and genetically modified material, protective coats and glowes are often obligatory

- hand-written laboratory notebook

- electronic version of the experimental protocol

- cloud-based laboratory notebook - Benchling



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Reasons to keep a laboratory notebook

1.To provide yourself with a complete record of why experiments were initiated and how they were performed. You'll forget if you don't. Seriously: even in your youth your brain cells are senescing.
2.To give yourself a central, physical place to record your data, to note statistical outcomes, and to paste graphs that show results. Researchers who keep these items in separate places are unlikely to be productive scientists.
3.To encourage sound thinking. Keeping a notebook gives you a forum to talk to yourself — to ask questions, to record important thoughts about the experimental design, and to speculate on how your results might eventually be interpreted.
4.To provide information to a person who is interested in continuing your research project, even if you deem that possibility hilariously unlikely. And if you're doing important research and die an early, gruesome death, your colleagues might want to pick it up.
5.To get rich. Not everyone sets out with the goal of patenting a process or contraption, but you might stumble onto something actually important, and in such an event you must have a notebook that supports your claims.

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What to use as a laboratory notebook

1.Purchase a notebook that possesses a stitched binding. Spiral-bound notebooks are undesirable because it is too tempting to rip out pages in moments of frustration or when you make silly mistake. And glue-bound notebooks are generally bad because glue doesn't last over time (it ages and becomes brittle, plus cockroaches will eat glue). Ring binders and stacks of loose paper are unacceptable.

2.Some laboratory notebooks have a "carbon copy" function that allows a duplicated sheet to be created and then removed to a second, safer location. I think these notebooks encourage bad notebook procedures and should be avoided. A *proper* notebook has a lot of glued-in information (printed graphs, datasheet templates, photographs, product labels, etc.) that simply will not show up on the sheet below, so the "carbon copy" notebooks are only good for archiving *written* entries. If you really want a backup of your notebook, make a daily date with a Xerox machine. For the truly motivated and/or paranoid, take a photograph of your completed pages each day with your smartphone and store the files in the cloud. Or get a camera equipped with Wifi that sends pics to a designated cloud folder automatically. [If you run a laboratory crawling with undergraduates, you might consider faking a notebook theft just to jar the students into considering these eventualities … it would be a good learning moment, plus good fun to see them all panic.]

3.Notebooks come in a variety of dimensions. Those larger than a standard page are convenient because you can easily paste in printer output without using scissors. On the other hand, smaller notebooks are much easier to lug around in field conditions, and look cute. There's a lot to be said for cute.

4. More expensive notebooks have much nicer paper, so if you like a smooth, non-fibrous surface to write on, spend the extra money. Nothing beats smooth, expensive paper to boost creativity and productivity (but that's just me, and I have a paper and pen fetish).

5. Spend the extra money for a notebook that has pre-numbered pages. You probably can figure out how to number them yourself but it's boring and life is short.

6. If your parents or mentor are springing for the notebook, you might opt for the really, really expensive variety that **lays completely flat when open. It's a small thing, but it grows on you.**

7. If you want to keep a **digital notebook**, take a look at these reviews at The Chronicle, Nature, and Postdocexperience.

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What to put on the outside of your notebook

1.Put your full name and year of use on the front of notebook. And make it the actual year, not ’19. In 100 years that’s going to be so out of date.

2.I also suggest adding your last name and date span (e.g., 2013/06 - 2013/12) on the spine so that you can find your research when it’s on a shelf with lots of other notebooks that look exactly alike (e.g., photograph). For writing on the spine I recommend light-colored paint pens.

3.Put your mailing address, phone number, and e-mail on the inside cover. This information is useful when you foolishly leave your notebook somewhere. Tape a $5 bill to the inside front cover with a note saying, “I’ll give you another if you find this notebook.” If your research is priceless, it’s money well spent. It’s especially good to have wording like this if you do field research with your notebook.

4.Bling. If the notebook is yours, take some pride in what you do and get crafty with the exterior. Good science is an inherently creative process, so I suspect most researchers have blinging talents even if repressed by years of scorn from colleagues.

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General guidelines for maintaining a notebook

1.Use a pen, never a pencil. As for what kind of pen, use a ball point, gel pen, or Rapidograph — all types of which have ink that can stand up to water and most solvents. If you know what you're doing, a fountain pen with archival, waterproof ink (e.g., Bulletproof Black ink from Noodler's) works well, too.
2.Avoid using Sharpies (or equivalent). These markers were very good at resisting water spills but can be removed by many solvents. More importantly, permanent markers tend to bleed through to the underlying page, which makes for rather sloppy, illegible laboratory notebooks.
3.Devote pages 1 and 2 to a Table of Contents (which you will fill in as time passes). Have 2 columns, one for the experiment name and one for the page number where an experiment starts, etc. If you come back to your notebook after 20 years, you will be able to quickly find the appropriate section of your notebook. This Table of Contents is also crucial for others who might want to use the notebook to reconstruct your activities.
4.Never remove a page. This directive is to prevent unscrupulous researchers from "losing" data that might not have been favorable to their research objectives. If you rip out some pages you *thought* were unnecessary, others might reasonably view the gaps as suspicious.
5.If you make a mistake, draw a *thin* line through the word or number rather than obliterating the entry with a blob of ink. You might decide, upon reflection, that your original entry was actually the correct one, and you will be glad that you can still read it.
6.For the same reason, never use correction fluids (e.g., White Out) or strips of white laboratory tape.
7.Write legibly. Your notebook does not have to be a work of art but it should be easily readable by *another* person of average intelligence.
8.Provide the full date whenever you make an entry. Use the international standard format if possible: YYYY/MM/DD (e.g., 2019/01/11). Note: only the month gets a leading zero when just a single digit.
9.There's a fad in some fields to "recopy" notes into a different notebook at the end of the day. I think doing that is insane. Sure, you might have fresh insight when you're recopying data and such, but you'll invariably introduce copying errors (yes, even you). If you really think recopying is going to help your science, I suggest you record your "field" notes on one side of the notebook and then recopy and add insights onto the facing page. However, if you do fieldwork were it is likely that you'll *lose* your notebook or it will be stolen by bands of thugs with machetes, recopying into a secondary notebook might make good sense (so don't travel with both copies, just in case). Again, if you have a smartphone or wifi-enabled camera, just take daily photos of your pages and send them to the cloud.

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