

Practical basics of scientific work (B130P16)

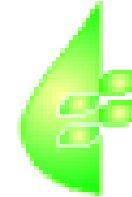
Guaranteed by: 130 - Department of Plant Experimental Biology

Winter term: 0/2 C (hours/week)

Credits: 2

Teacher: Petrášek, J., Dep. Plant Exp Biol and IEB ASCR

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

- 5.10. 1.1 The character of scientific work in the experimental biology
- 12.10. 1.2 Observation and experiment as the two main activities of scientists
- 19.10. 1.3 Scientific institutions, organizations, conferences, and social networks
Scientific contributions at the seminars and conferences, rules for effective abstract writing
- 26.10. 1.4 Ethical rules of scientific work including bad habits in scientific writing
- 1.5 Financing of the scientific research

Syllabus

2 Handling with experimental data

- 2.11. 2.1 Organization of work, type of data
- 2.2 Data explorers, correct data handling and saving
- 2.3 Spreadsheets, statistical software, graph editors
- 9.11. 2.4 Processing of structural and sequence data
- 2.5 Image analysis, graphical software, presentation software

Syllabus

3 Scientific literature

- 16.11. 3.1 Types of scientific reports and their purpose
- 3.2 Internet sources of information
- 23.11. 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
- 30.11. 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

4 Artificial intelligence in experimental biology

7.11. 4.1 AI in the handling and processing of experimental data

4.2 AI in scientific writing

5 Online information databases in experimental biology

14.11. 5.1 Databases of sequences

5.2 Specialized sequence databases

6 Scientific writing

21.12 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

6.3 Writing scientific projects and grant proposals

1. Basics of research work

1.1. The character of scientific work in the experimental biology

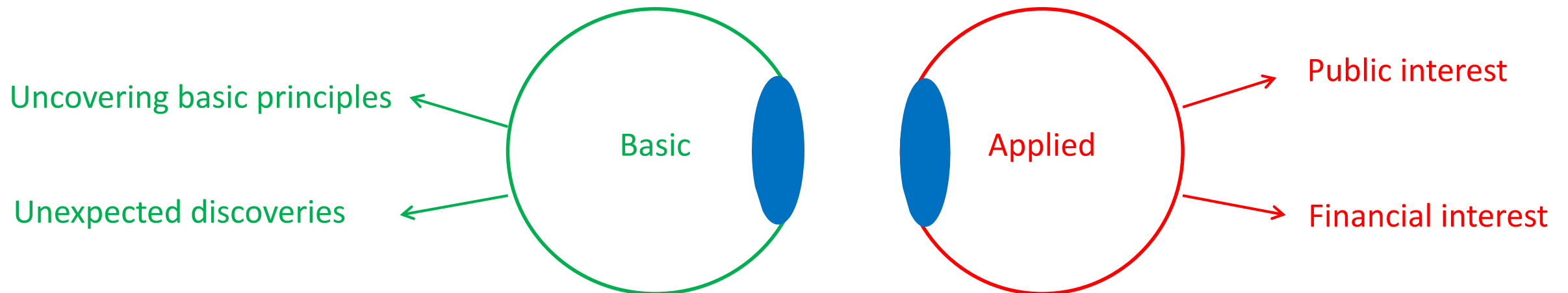
The goal of science is the searching for the „truth“, in biology we explore the principles of regulatory mechanisms in living organisms

Research - systematic activity using scientific methods

Research → Fundamental - revealing the essence of a certain phenomenon

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

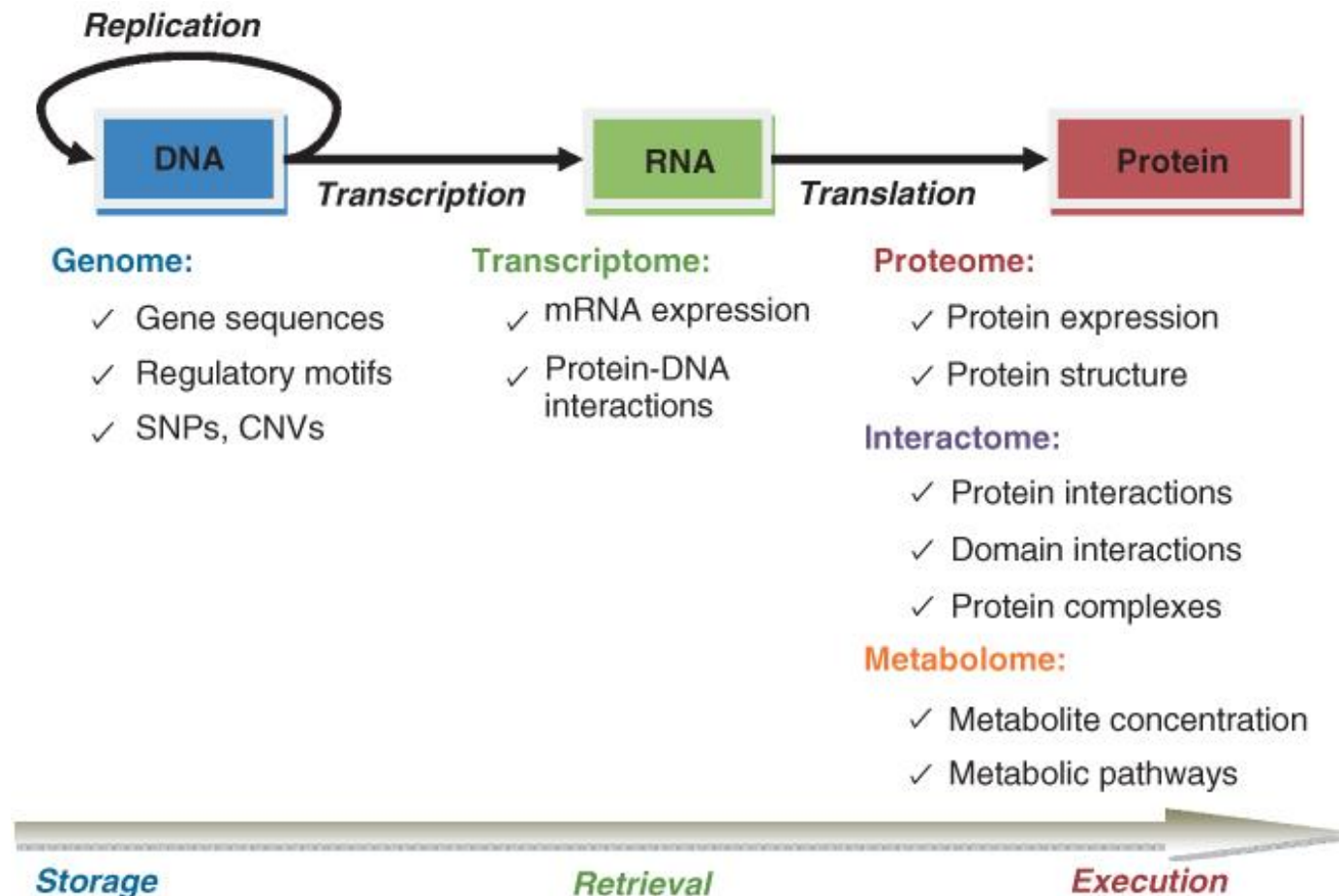
The combination of both fundamental and applied research is ideal



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 amount of data - correct scientific evaluation of large data sets is the key for the scientific progress

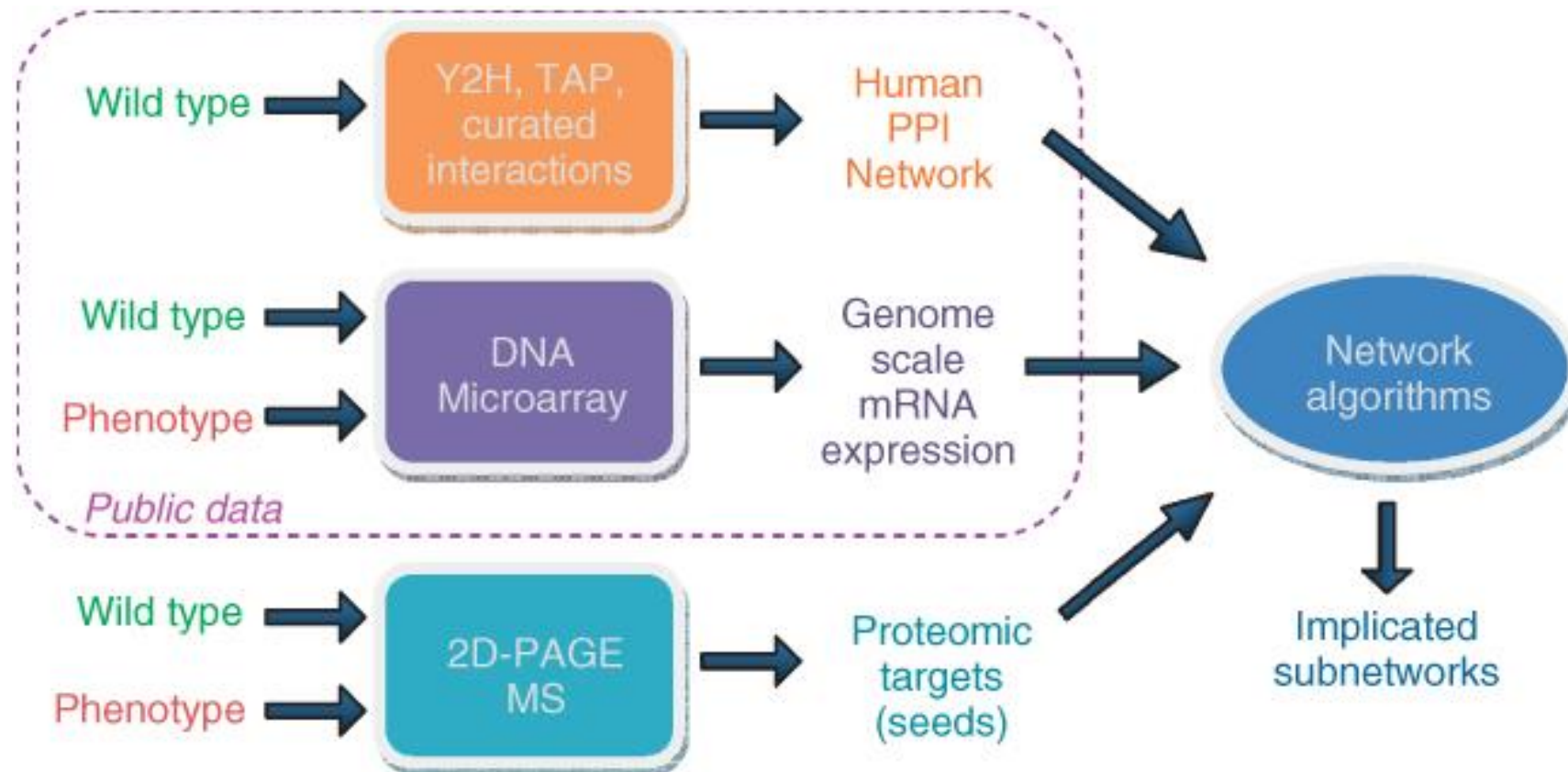


M Koyutürk *WIREs Syst Biol Med* 2010. DOI: 10.1002/wsbm.61
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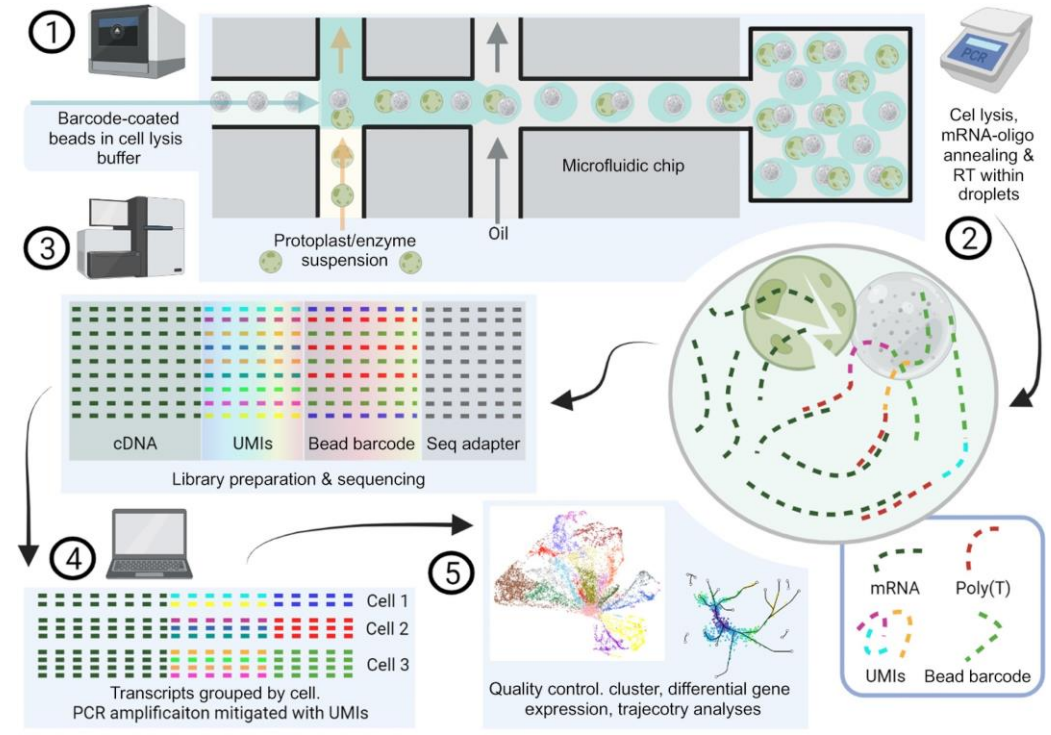
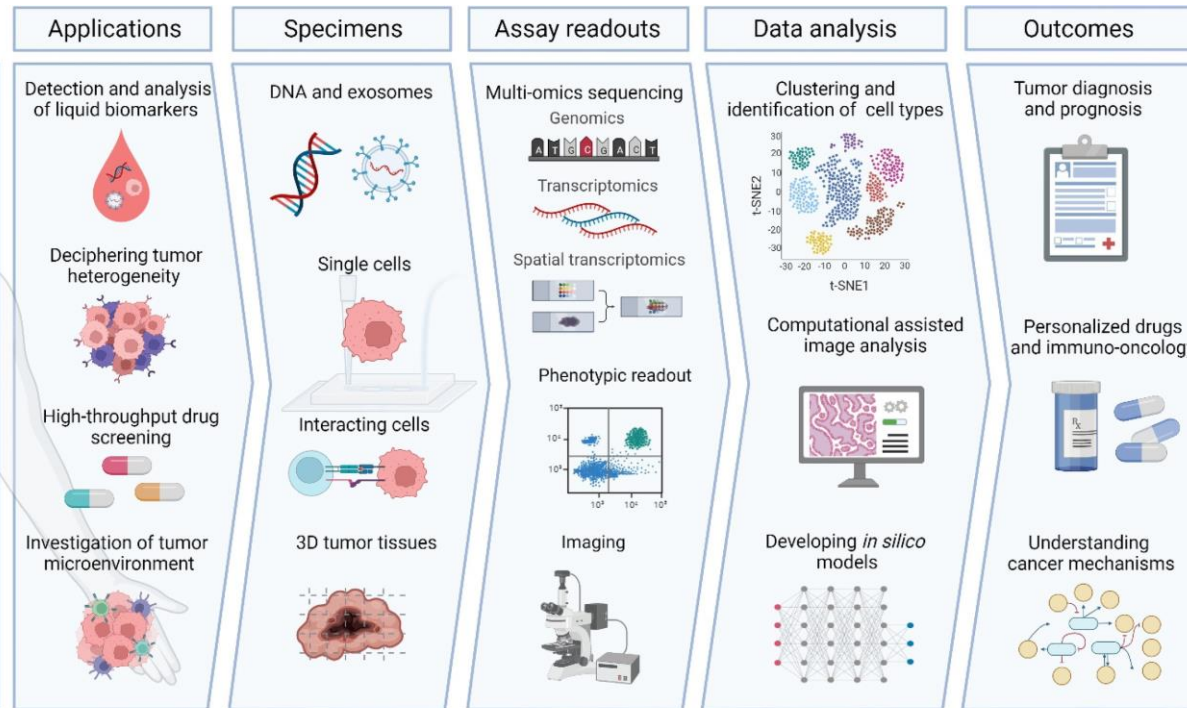


M Koyutürk *WIREs Syst Biol Med* 2010. DOI: 10.1002/wsbm.61 Copyright © 2009 John Wiley & Sons, Inc.

1. Basics of research work

1.1. The character of scientific work in the experimental biology

What to do with high throughput data?



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

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/>

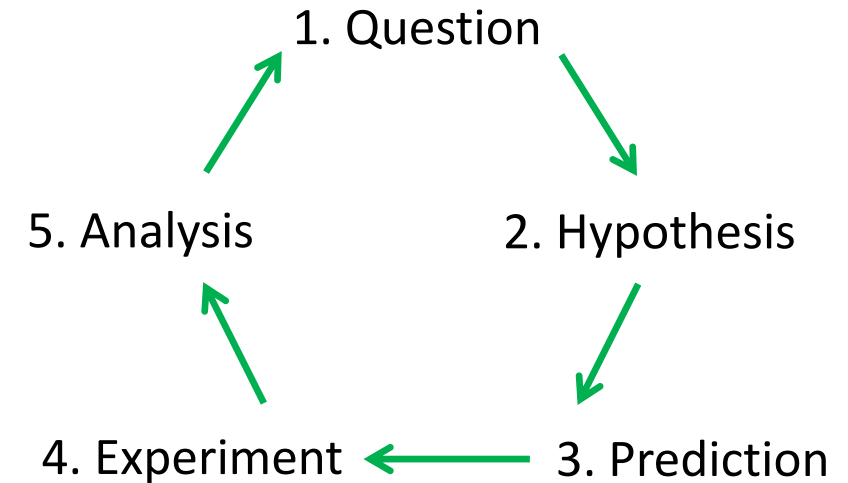
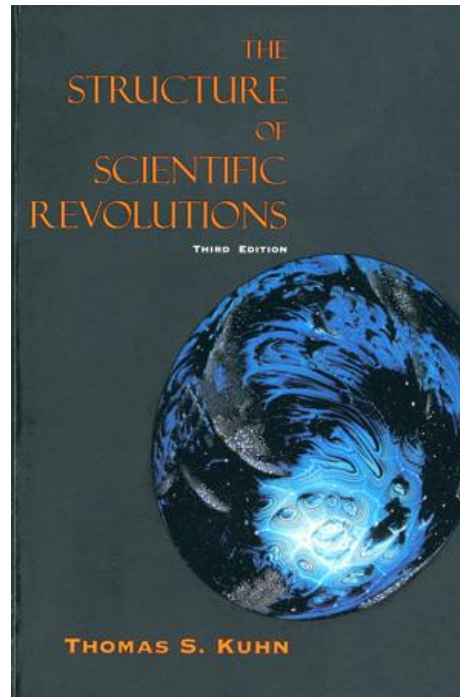
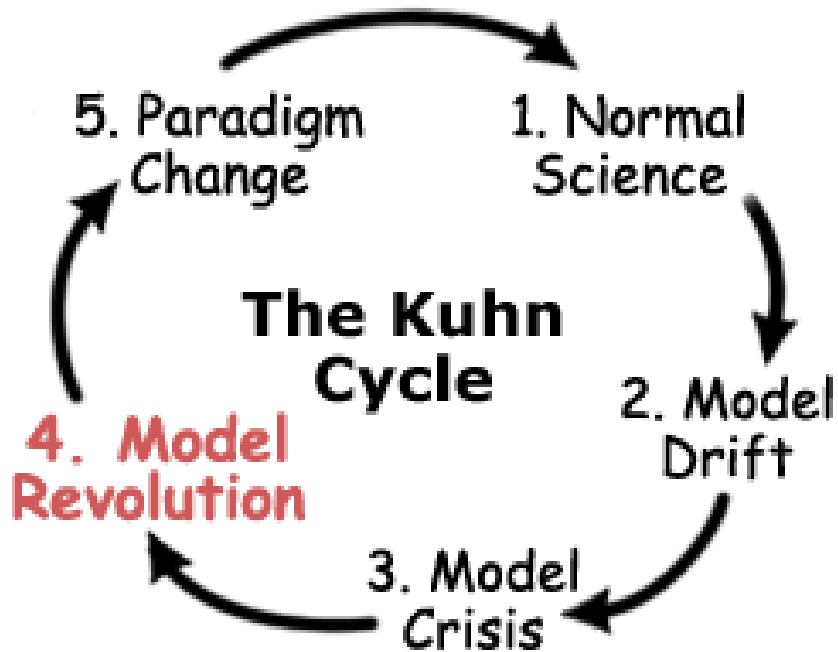
1. Basics of research work

1.1. The character of scientific work in the experimental biology

What do we actually do when we do science?

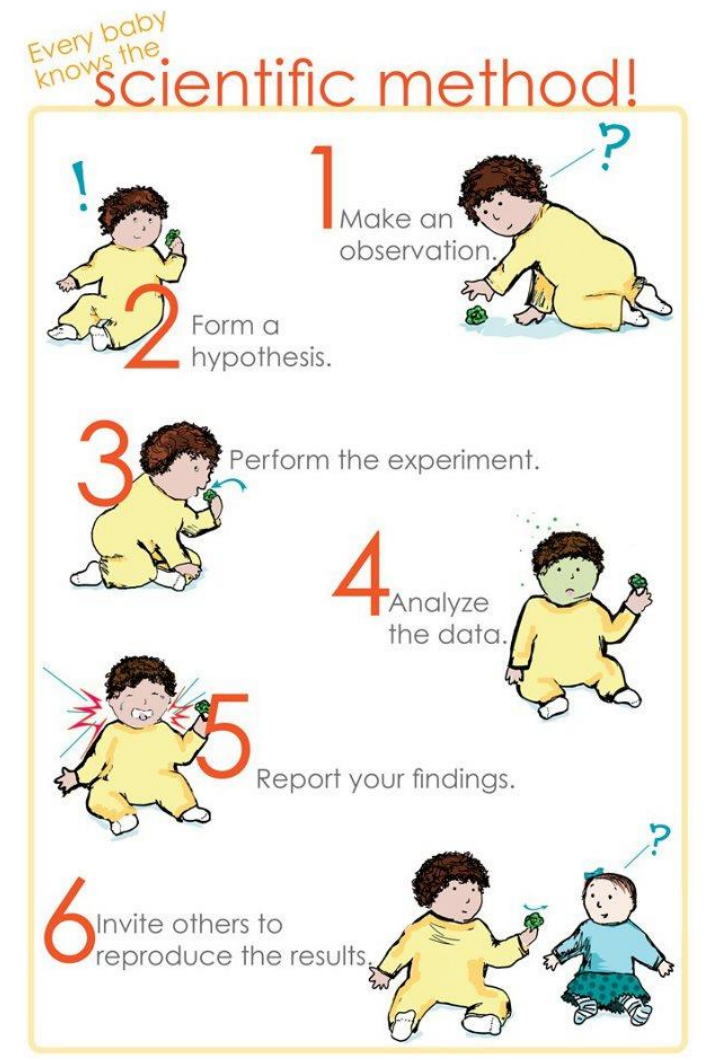
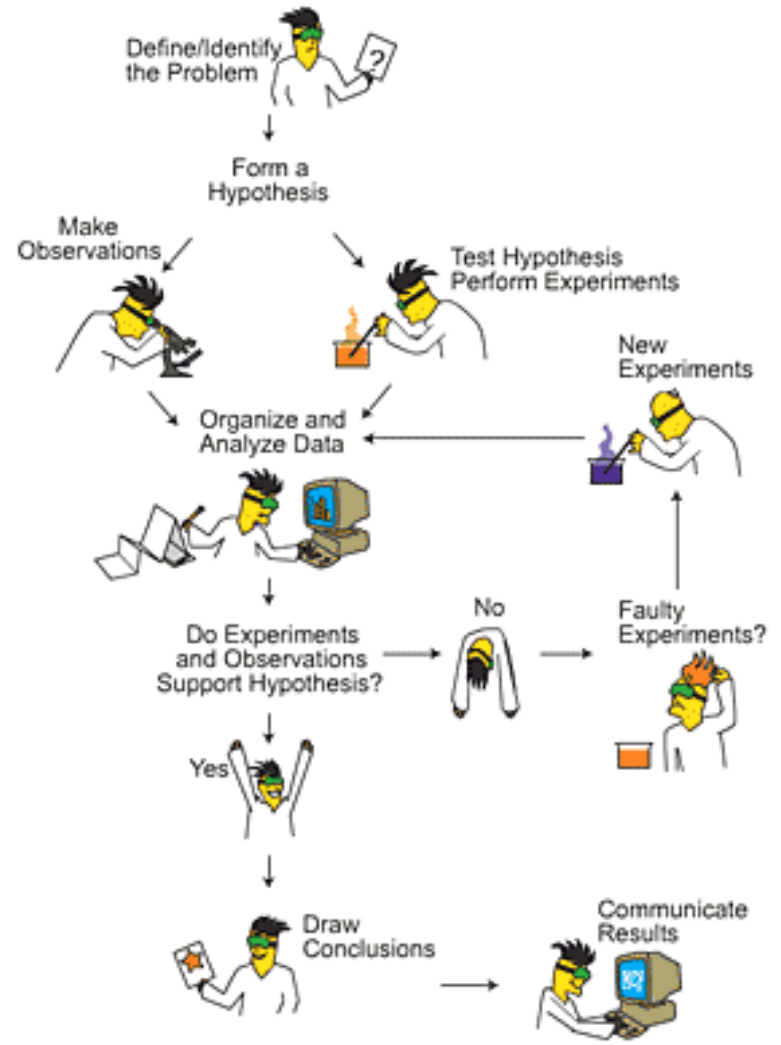
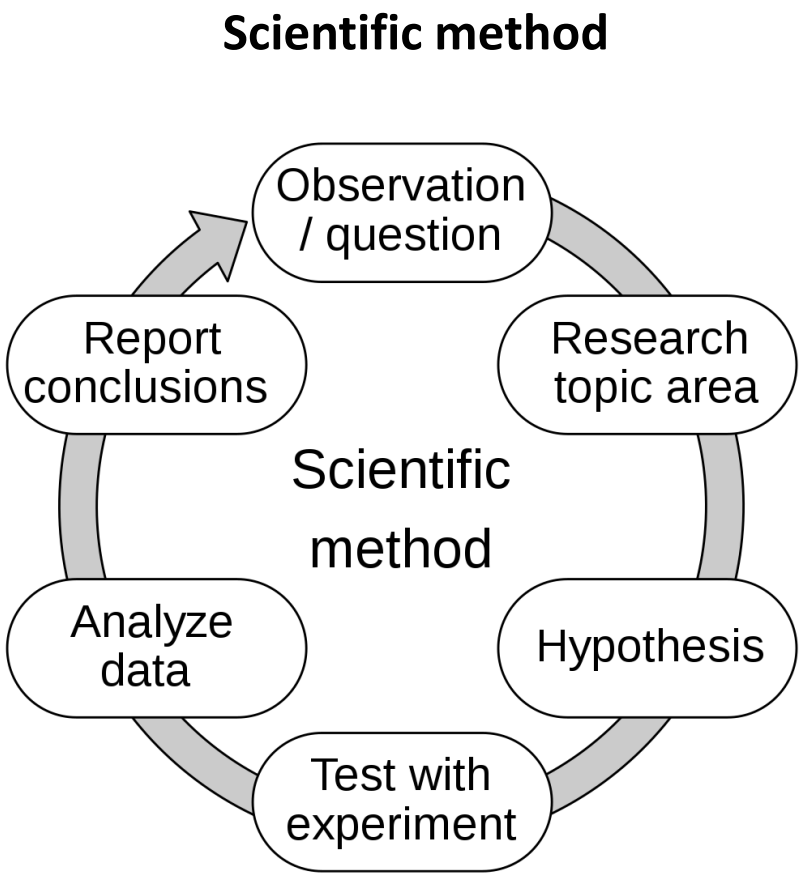
Scientific work → Testing hypotheses - verification or falsification

Verification of models - in the biology, the model represents the result of experimental activities and reductionism approach to the object studied



1. Basics of research work

1.1. The character of scientific work in the experimental biology



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



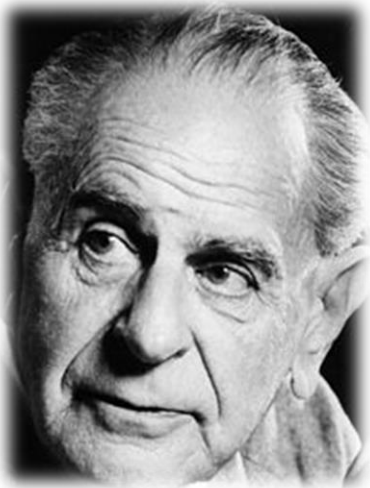
1. Basics of research work

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 continual 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

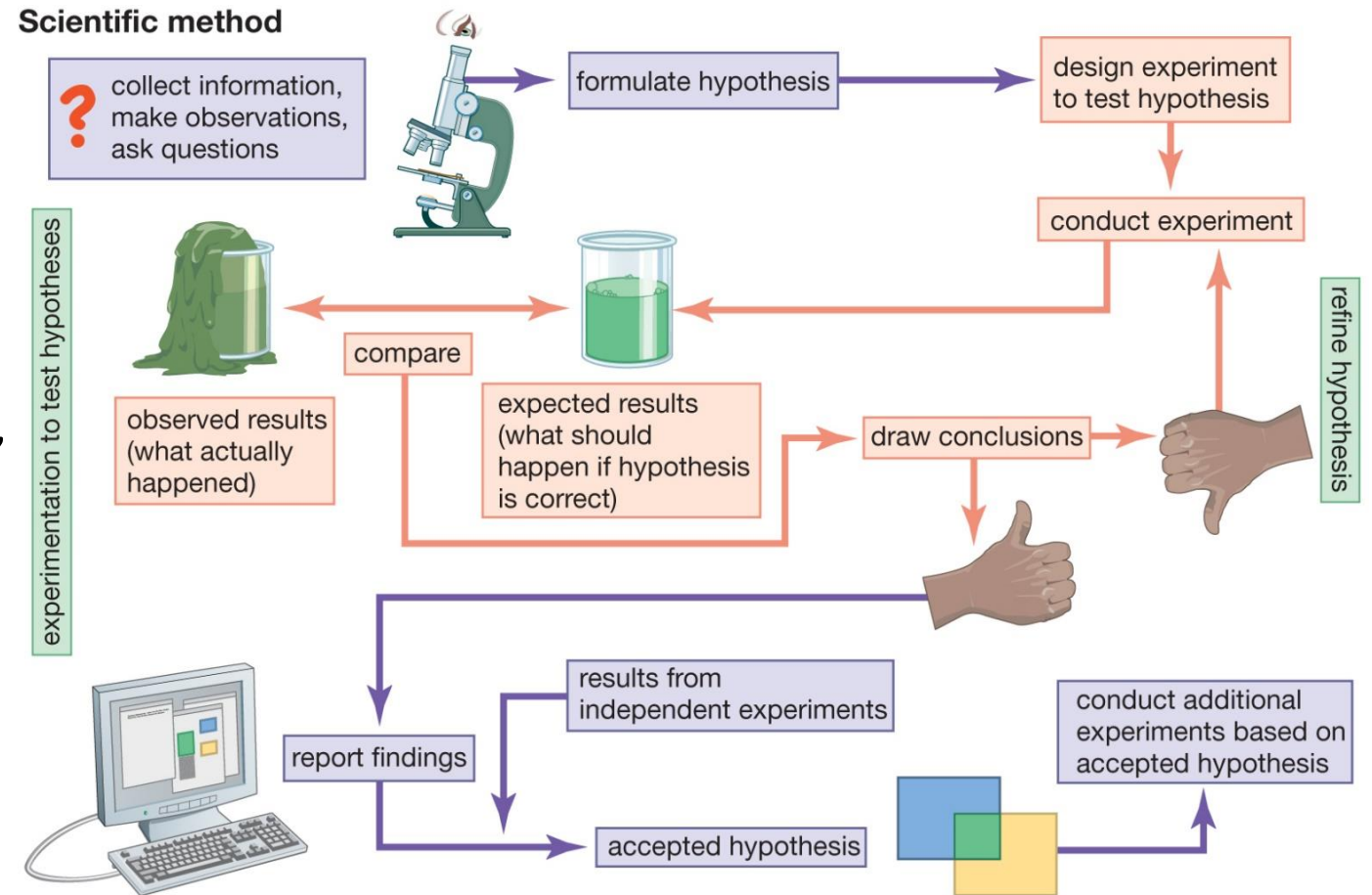
1. Basics of research work

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 able to be falsified and tested**, e.g. by comparing results with results of other scientists
- in general **we cannot verify, we can only falsify theories**



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1. Basics of research work

1.1. The character of scientific work in the experimental biology

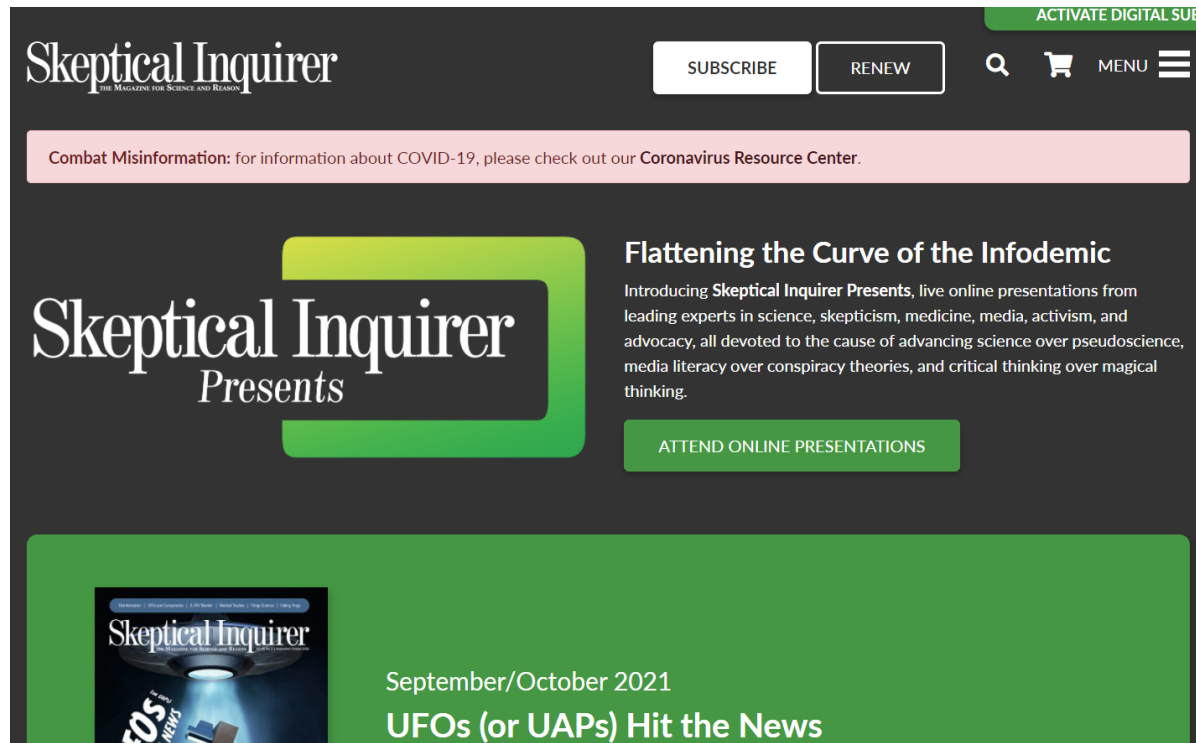
How to distinguish between scientific and non-scientific activities in biology and other disciplines?

CSI - Committee for Skeptical Inquiry

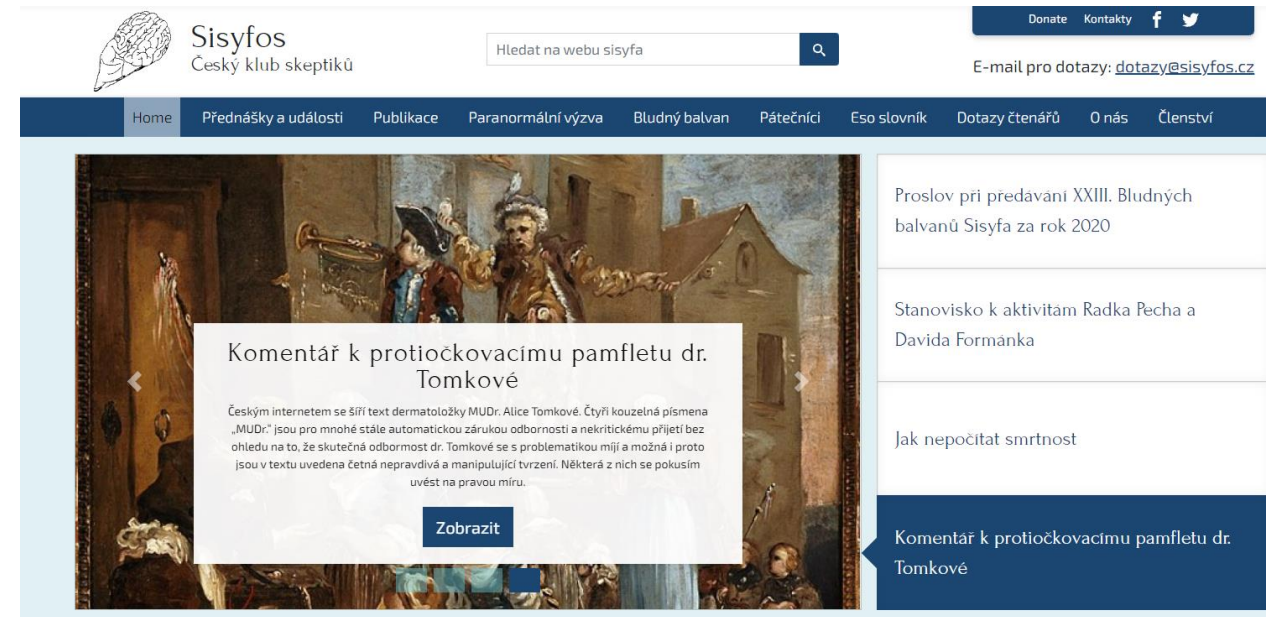
The society of scientists and philosophers promoting methods and ideas of new skepticism (in a sense of critical rationalism) towards paranormal and other fringe-science claims.

SISYFOS – Czech sceptical club

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



The screenshot shows the homepage of the Skeptical Inquirer magazine. At the top, there is a navigation bar with 'SUBSCRIBE' and 'RENEW' buttons, a search icon, a shopping cart icon, and a 'MENU' button. Below this is a pink banner with the text 'Combat Misinformation: for information about COVID-19, please check out our Coronavirus Resource Center.' The main content area features a large green graphic with the text 'Skeptical Inquirer Presents' and a sub-headline 'Flattening the Curve of the Infodemic'. Below this is a green button that says 'ATTEND ONLINE PRESENTATIONS'. At the bottom, there is a green banner with the text 'September/October 2021 UFOs (or UAPs) Hit the News' and a small image of the magazine cover.



The screenshot shows the homepage of the Sisyfos website. At the top, there is a navigation bar with 'Home', 'Přednášky a události', 'Publikace', 'Paranormální výzva', 'Bludný balvan', 'Pátečníci', 'Eso slovník', 'Dotazy čtenářů', 'O nás', and 'Čtenství'. Below this is a search bar with the text 'Hledat na webu sisyfa' and a search icon. To the right of the search bar are links for 'Donate', 'Kontakty', and social media icons for Facebook and Twitter. Below the navigation bar is a large image of a painting depicting a scene with several figures. Overlaid on the image is a white box with the text 'Komentář k protiočkovacímu pamfletu dr. Tomkové'. Below the text is a blue button that says 'Zobrazit'. To the right of the image is a sidebar with several text blocks: 'Proslov při předávání XXIII. Bludných balvanů Sisyfa za rok 2020', 'Stanovisko k aktivitám Radka Pecha a Davida Formánka', 'Jak nepočítat smrtnost', and 'Komentář k protiočkovacímu pamfletu dr. Tomkové'.

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 Elčknér, David A. Morris², 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 Science 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 inhibition remains unknown. Auxin efflux is also strongly decreased by the vesicle trafficking inhibitor brefeldin A (BFA). Using suspension-cultured interphase cells of the BY-2 tobacco cell line, we investigated the effects of NPA and BFA on auxin accumulation and efflux. The inhibition of auxin efflux (stimulation of net accumulation) by NPA was accompanied by a decrease in the auxin efflux rate. The inhibition of auxin efflux by BFA was accompanied by a decrease in the auxin efflux rate. NPA had no observable effect on the arrangement of PIN1 proteins on the plasma membrane.

PNAS 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 Hašekⁱ, Tomasz Paciorek^{k,l}, 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 Stierhofⁿ, Takashi Ueda^o, Kazuhiro Oiwa^f, Anna Akhmanova^d, Roland Brock^{a,o}, Anne Spang^{p,q}, and Jiří Friml^{a,l,t,s}

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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 the plant signaling molecule auxin. Auxin transport inhibitors

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

Jan Petrášek^{1,2}, Jozef Mravec³, Rodolphe Bouchard⁴, Joshua J. Blakeslee⁵, Melinda Abas⁶, Daniela Seifertová^{1,2,3}, Justyna Wiśniewska^{3,7}, Zerihun Tadele⁸, Martin Kubeš^{1,2}, Milada Čovanová^{1,2}, Pankaj Dhonukshe³, Petr Skůpa^{1,2}, Eva Benková³, Lucie Perry¹, Pavel Křeček^{1,2}, Ok Ran Lee⁵, Gerald R. Fink⁹, Markus Geisler⁴, Angus S. Murphy⁵, Christian Luschnig⁶, Eva Zažímalová^{1*}, Jiří Friml^{3,10}

Intercellular flow of the phytohormone auxin underpins multiple developmental processes. Plant-specific pin-formed (PIN) proteins and several phosphoglycoproteins are crucial factors in auxin transport-related development, yet the molecular mechanisms of their function remain unclear. We show that PIN proteins perform a rate-limiting function in auxin efflux in Arabidopsis thaliana and Nicotiana glauca. PIN1 and PIN2 are essential for auxin efflux in Arabidopsis thaliana, whereas PIN1 is essential for auxin efflux in Nicotiana glauca. PIN1 and PIN2 are essential for auxin efflux in Arabidopsis thaliana, whereas PIN1 is essential for auxin efflux in Nicotiana glauca.

the plant journal

S E B

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

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

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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 *NtPIN1* genes and their inducible overexpression in tobacco cells uncovered high auxin efflux activity of *NtPIN1*, accompanied by auxin starvation symptoms. Auxin transport parameters after *NtPIN1* 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 transcript levels of genes for a specific auxin influx carrier and by decreased transcript levels of other genes for



1. Basics of research work

1.1. The character of scientific work in the experimental biology

Categorization of activities of modern experimental biologists:

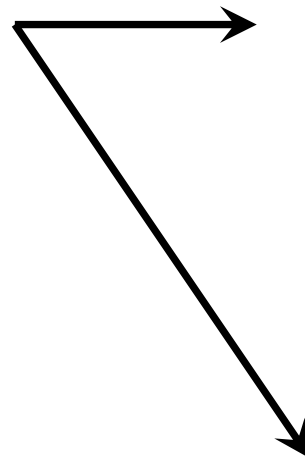
3) Manager and popularizer



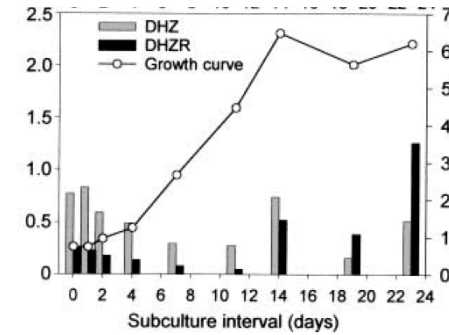
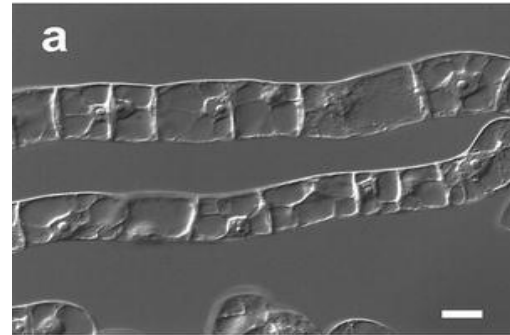
1. Basics of research work

1.2. Observation and experiment - two main activities

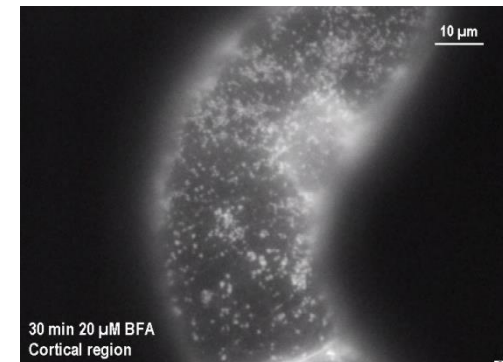
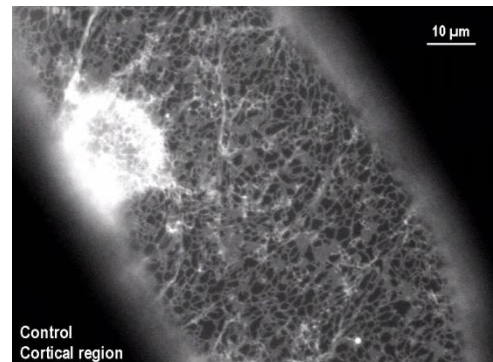
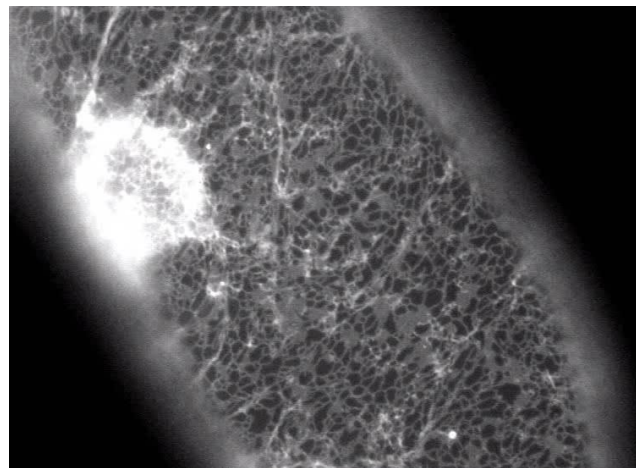
Scientific work



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 – two main activities

How to perform experiments?

Experimental design, data acquisition, processing and interpretation

Experimental design:

- [Biology: Controlled Experiments - YouTube](#)

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

1. Basics of research work

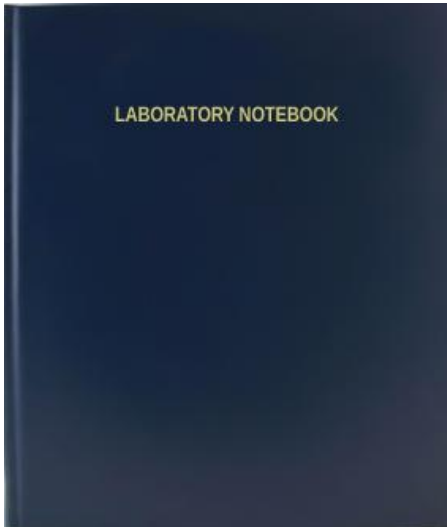
1.2. Observation and experiment – two main activities

How to perform experiments?

Experimental design, data acquisition, processing and interpretation

Data acquisition in the laboratory:

- rules for health and safety policy careful handling with chemicals, radioactive material and genetically modified material, protective coats and gloves are often obligatory
- hand-written laboratory notebook
- electronical version of the experimental protocol



1. Basics of research work

1.2. Observation and experiment – two main activities

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.

Colin Purrington, <https://colinpurrington.com/tips/lab-notebooks/>

1. Basics of research work

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](#).

Colin Purrington, <https://colinpurrington.com/tips/lab-notebooks/>

1. Basics of research work

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.

Colin Purrington, <https://colinpurrington.com/tips/lab-notebooks/>

1. Basics of research work

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 where 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.

Colin Purrington, <https://colinpurrington.com/tips/lab-notebooks/>

1. Basics of research work

1.2. Observation and experiment – two main activities

How to perform experiments?

Experimental design, data acquisition, processing and interpretation

Negative and positive controls

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

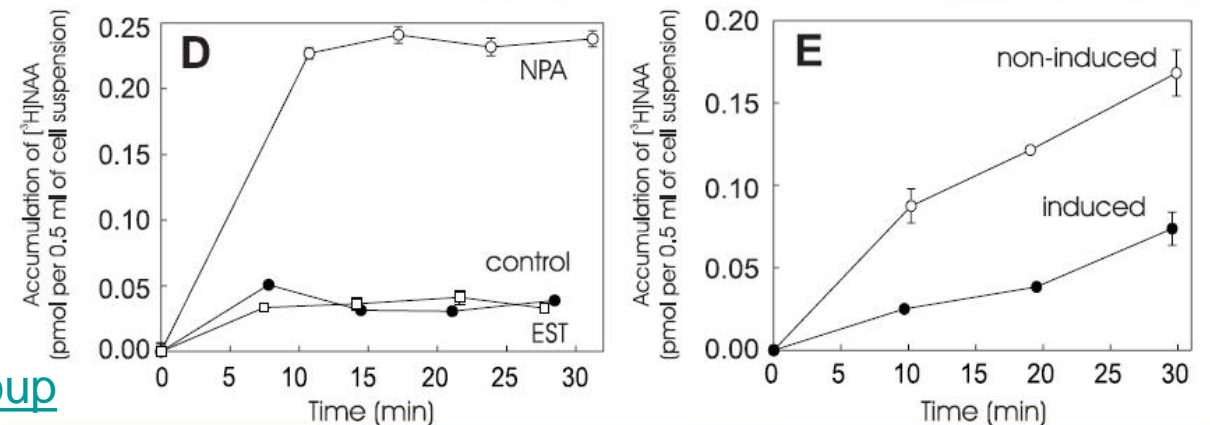
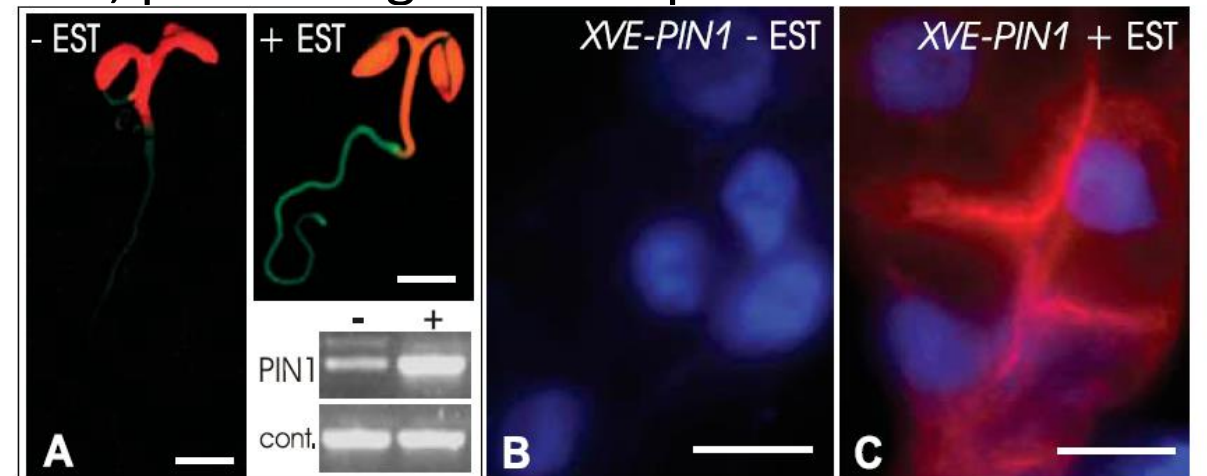
[Experimental Design Negative Controls](#)

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

[Experimental Design Positive Controls](#)

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

[Positive Control vs Negative Control, Experimental Group](#)



1. Basics of research work

1.2. Observation and experiment – two main activities

How to perform experiments?

Experimental design, data acquisition, processing and interpretation

The evaluation and interpretation of the experiment:

- 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 presentation is very useful
- statistical evaluation - depending on the experimental design, when needed it must be consulted with experts