University of Basel

BIOZENTRUM
The Center for Molecular Life Sciences

Electronic Lab Notebook Wiki

Using a wiki system to record experimental work in the life sciences

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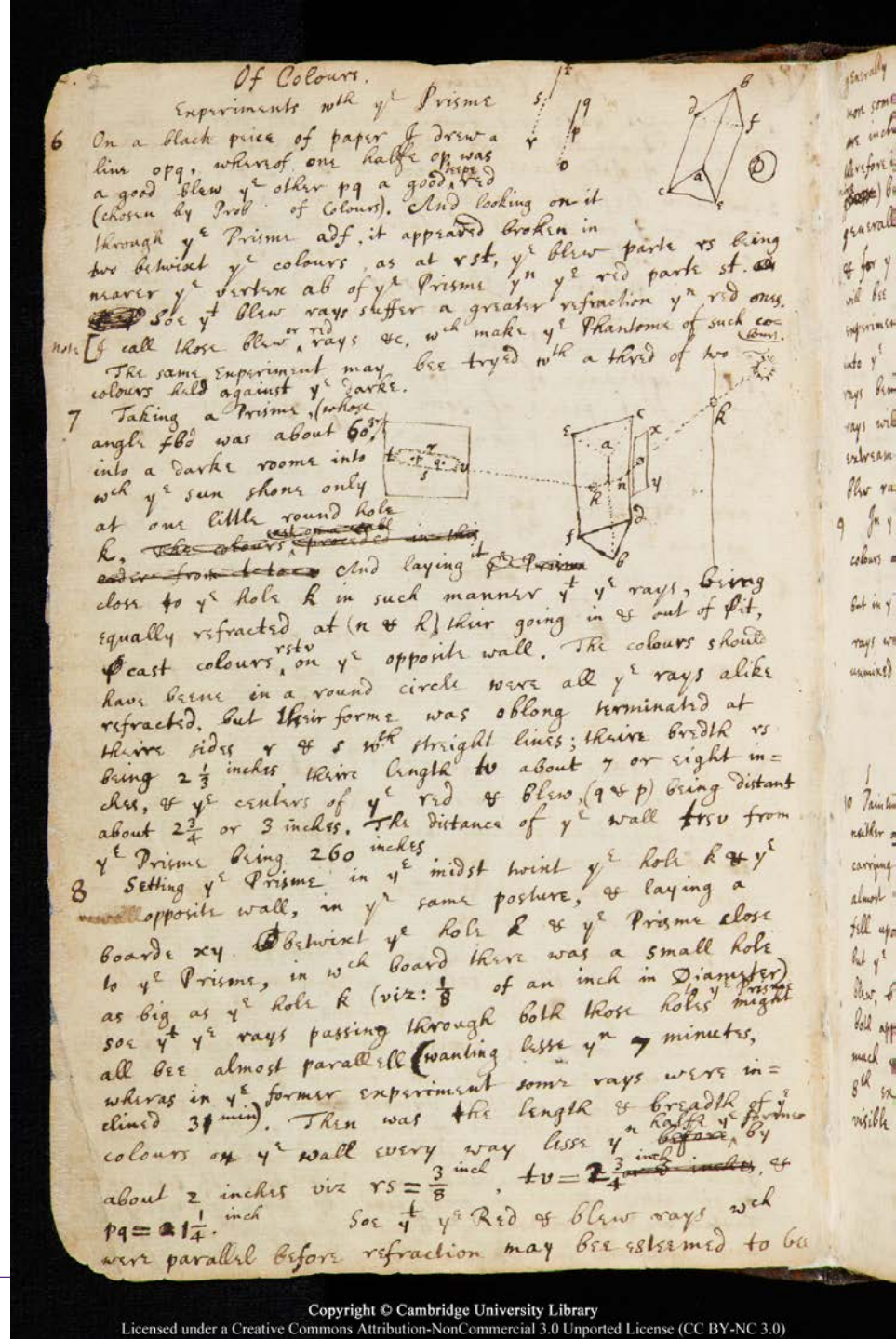
Documenting Experiments

Using an electronic laboratory notebook

Documenting your research is part and parcel of the scientific method

Document your work, your observations both expected and unexpected, and your data.

- Laboratory Notebooks
- Drawings, paintings
- Numeric data in tables, books

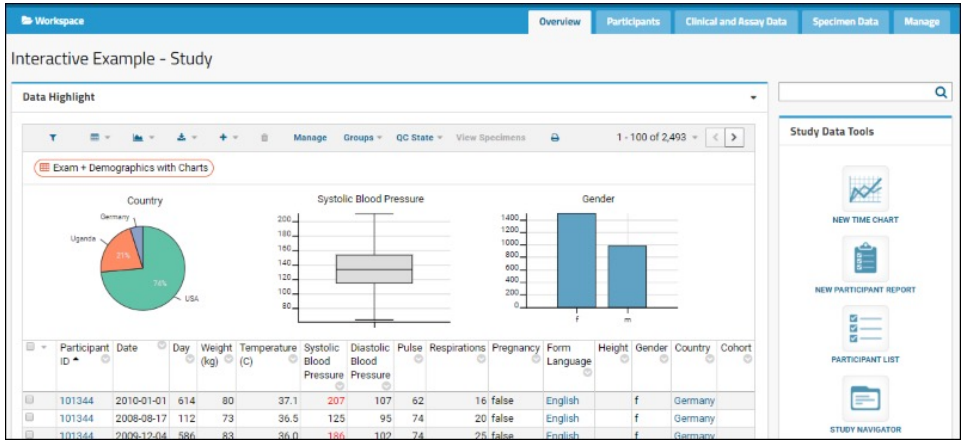


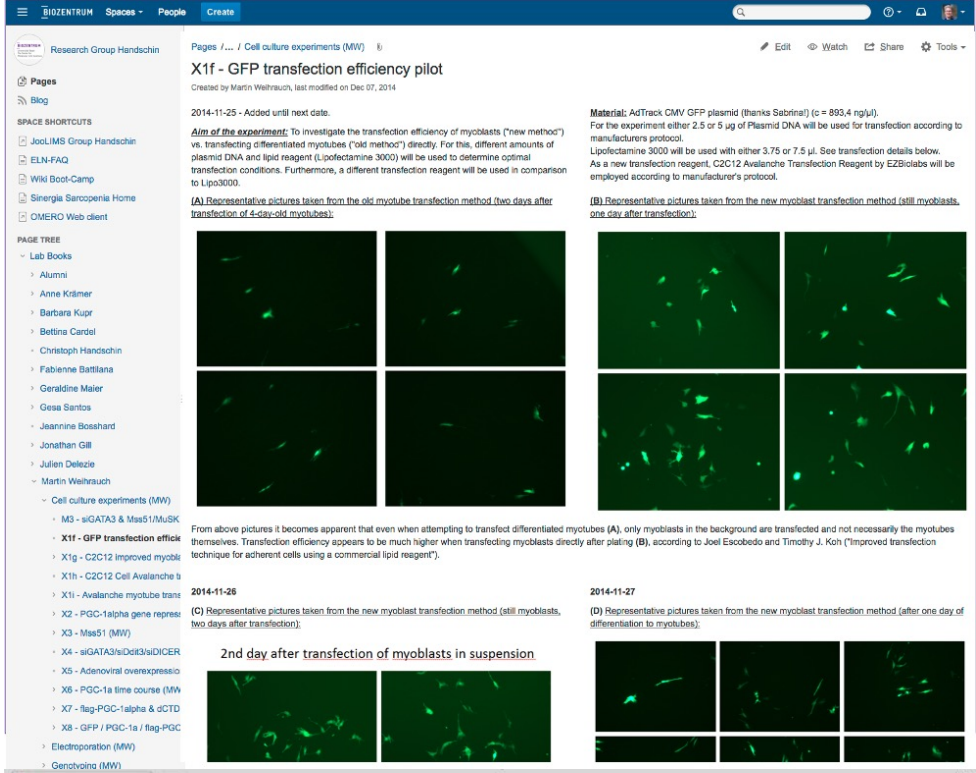
https://commons.wikimedia.org/w/index.php?curid=822362
https://commons.wikimedia.org/w/index.php?curid=136451

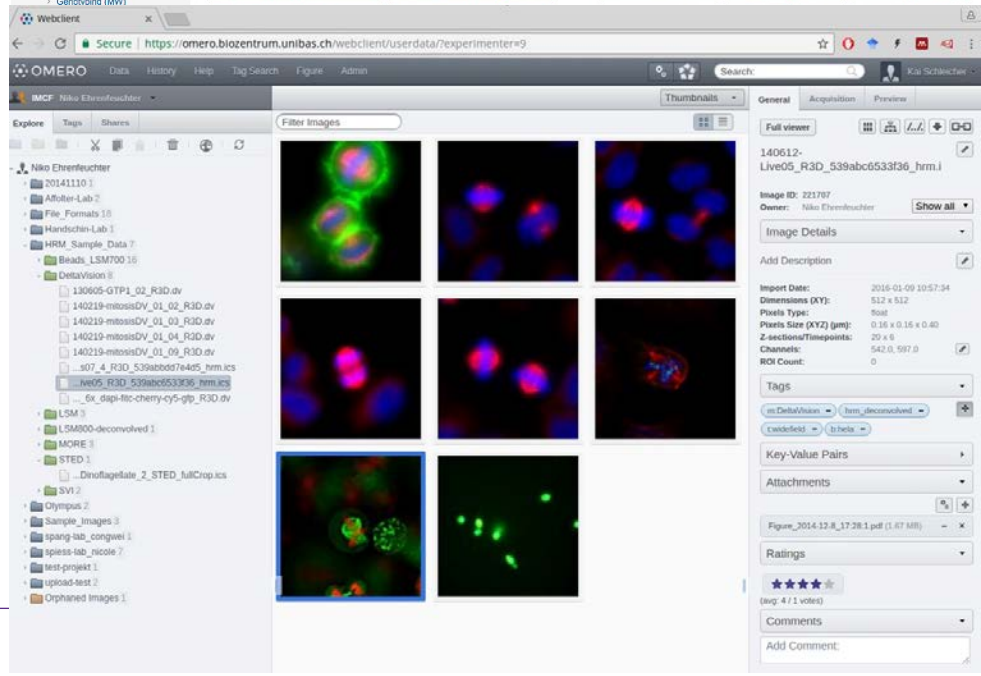
Documenting your research is even more important today

Document your work, your observations both expected and unexpected, and your data.

- **Electronic** Laboratory Notebooks
- **Digital images**
- Numeric data in **files, databases**







The goal:

Reproducible Documentation

Formal requirements for scientific record keeping

Useful records should be:

- Legible (if handwritten)
- Well organized – labeled, indexed, catalogued, etc.
- Accurate & complete – include (1) original data and important study details (meta-data) and (2) successful & unsuccessful studies and activities
- Describe and date ***all*** alterations and changes to records
- Records should allow repetition of procedures and studies by yourself & others
- Are accessible to others (physically and/or electronically) both short and long term
- Are stored and backed-up properly and regularly for the short & long term (archiving)
- Are research diaries of the researcher's work & thoughts

Janet Clark, Ph.D. Director, Office of Fellowship Training NIMH DIRP

Scientific Record Keeping Best Practices

Useful & good research records should include these details:

- **What** you did – experimental protocol
- **When** you did it - date
- **Why** you did it – objective
- **How** you did it – methods
- **Who** you are (the person creating the record)
- **What project**(s) this work was part of
- Who conceived of the study (if not yourself)
- Special materials & instruments utilized
- Source of materials & instruments
- Discussion of data – results – expected and unexpected
- Data handling and analyses
- Data interpretation by yourself (and others if pertinent)
- Next steps based on reported results

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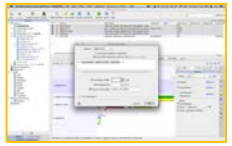
Tool Landscape

Where to store your data: Data management systems


ELNwiki


BEAST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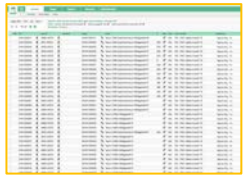
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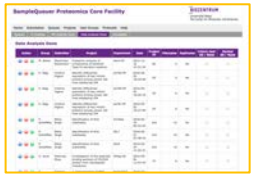
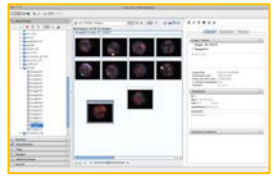

SampleQueuer


LabKey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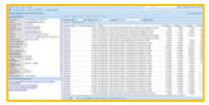
openBIS

ELN
Electronic Lab Notebooks

- **Information about experiments**
- *Who* did *what when* and *why*?
- What was the *outcome*?
- Protocols
- Descriptions
- Gel pictures, …

LIMS
Laboratory Information Management System

- **Track samples and materials**
- Track provenance
- Traceability of processes
- Procedures and workflows
- Automation is relevant
- Strains
- Vectors, …

SDMS
Scientific Data Management System

- **Store and annotate large datasets**
- Provide programmatic access
- Make datasets searchable
- Analysis and visualization may be built-in
- Microscopy images
- Sequencing data, …

What is an Electronic Lab Notebook (ELN)?

An ELN in molecular biology is:

- A replacement for the paper lab notebook, where you write up experiments.
- Provides a verifiable record that and how an experiment was conducted.
- Allows easy access to current and past experimental data

An ELN is not:

- A central repository for all biological data generated
- The tool responsible for uploading data into a result database
- A tool to manage lab activities or stocks (i.e. it is not a LIMS)
- A text mining tool

(Adapted from Eva-Lotta Westberg, Astra-Zeneca)

Benefits and Downsides of ELN (and LIMS) use

Benefits:

- Fulfil requirements for research documentation electronically
  - Scientific integrity/reproducible research requirements
  - Legal issues: Fraud investigations
  - IP requirements
- **Makes information searchable and interconnected**
- **Integration point for people and for data over time and space**
  - New people starting in the lab, picking up experiments
  - Several people in the lab working together
  - Can even be an exchange hub

Downsides:

- Software is often costly
  - geared towards pharma industry
  - (X00$/user/year)
- Often rigid constraints on data entry
  - Users don't like it and don't use it
- Adapting commercial ELNs is costly
- Full IT integration of a lab towards LIMS is costly:
  - tablets, scanners, barcode readers, lab automation, …
  - Lots of equipment updates needed
  - Disrupts work organization in the lab
  - Possibly suited for core facility-type activities

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Bottom line:

- An ELN solution must support the current way of working to be adopted at all.
- Its additional capabilities can then lead to new ways of working together.

Choosing an ELN for your research: Considerations

Usage / Business Model

- Each researcher on their own? Per-group? Per institute/department? Fully open?
- Academic/Open Source vs. Commercial
- Costs: Licenses, Implementation/Customization/Introduction Effort, Operation & Maintenance
- Commercial world:
  (Pharma) Industry requirements major driver of features and costs

Operation

- Server run on-premise versus cloud-based offerings
  - Legal concerns: data protection laws
  - Keeping core Intellectual Property local
  - Due diligence and approval regarding cloud usage necessary
- Commitment to keep system running for 10+ years

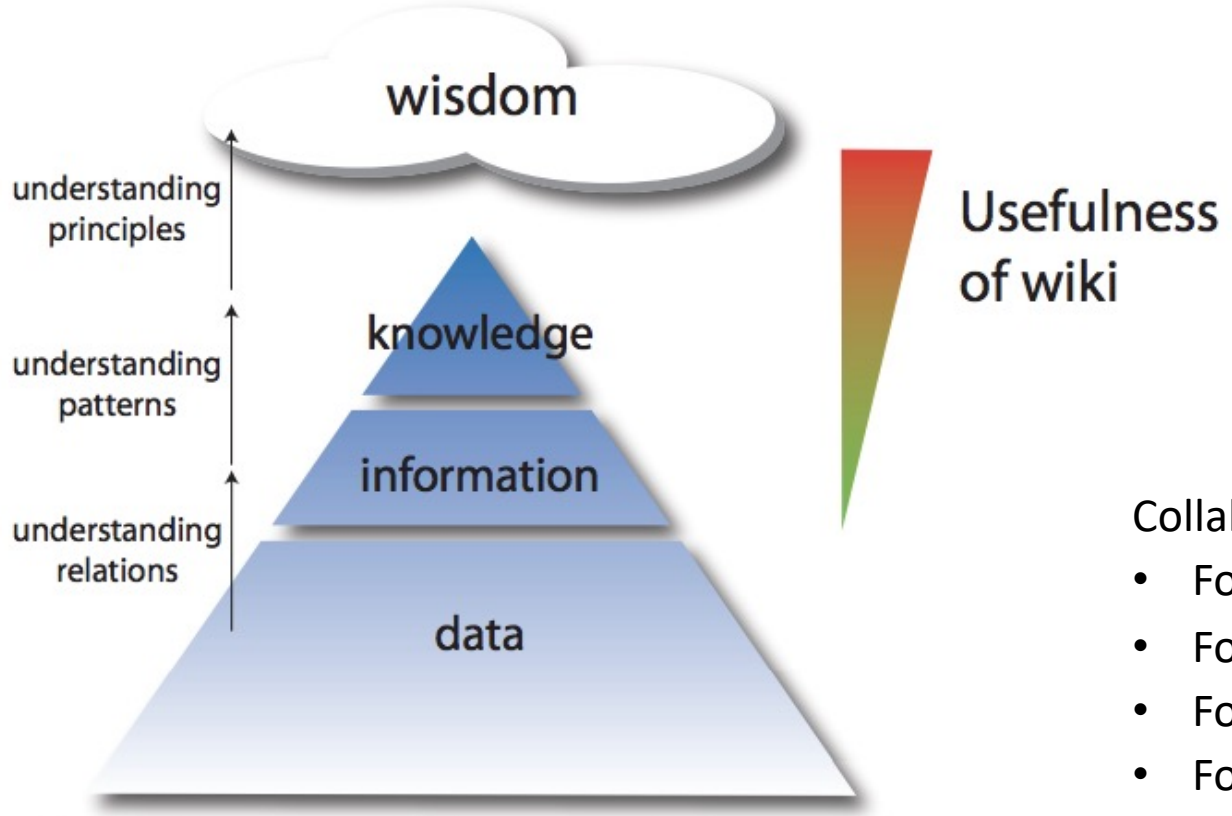
More information

- Choosing an ELN: https://www.nature.com/articles/d41586-018-05895-3
- Collection of ELNs and LIMS: https://www.limswiki.org/ or https://eln-finder.ulb.tu-darmstadt.de/

ELN Wiki Features

Using a Wiki is a simple step into digital record-keeping

Wikis are a knowledge-gathering tool



After: Ackoff, R. L., "From Data to Wisdom", Journal of Applied Systems Analysis, Volume 16, 1989 p 3-9.

Collaborative platform for documentation

- For working groups
- For cross-functional projects
- For process documentation (HR, IT)
- For **research documentation**

Wikis in Enterprises and University

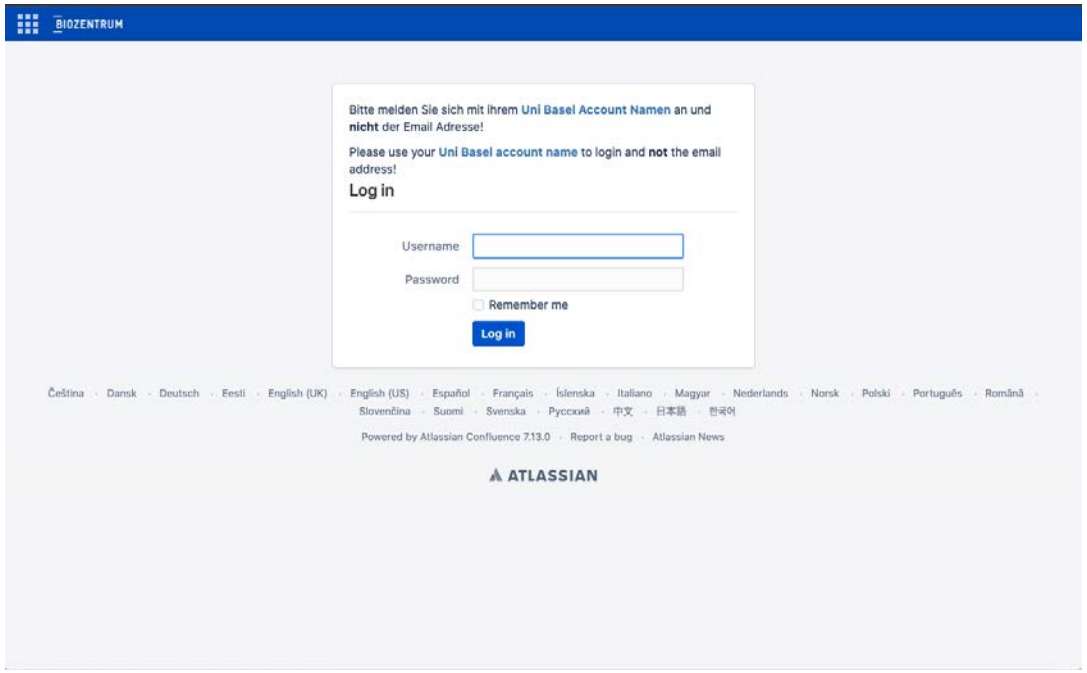
Essential advantages

- Simple editing, fast and intuitive handling
- Focus on collaborative documentation
- Focus on content rather than presentation
- Extensive capabilities to interlink, connect via keywords, search
- Version history and author tracking

Enterprise requirements

- Security and access control (unlike Wikipedia)
- Aggregated user access control (groups and roles)
- Granular access control
- Safe operation and support
- Possibility to extend functionality when needed

ELN Wiki: Browser-based access to research data



Advantage of a wiki:
Very flexible and adaptable
Downside of a wiki:
Very flexible and adaptable

Accessible from everywhere

Requires Unibas login

Flexible and simple to use

- “Paper-on-glass”
- Simple, concurrent editing
- Possibility for templates

Private research group/project space

- Open space: Everyone within group has access
- Version history ensures traceability and audit trail
- Common areas: allow information exchange

ELN Wiki at Biozentrum++

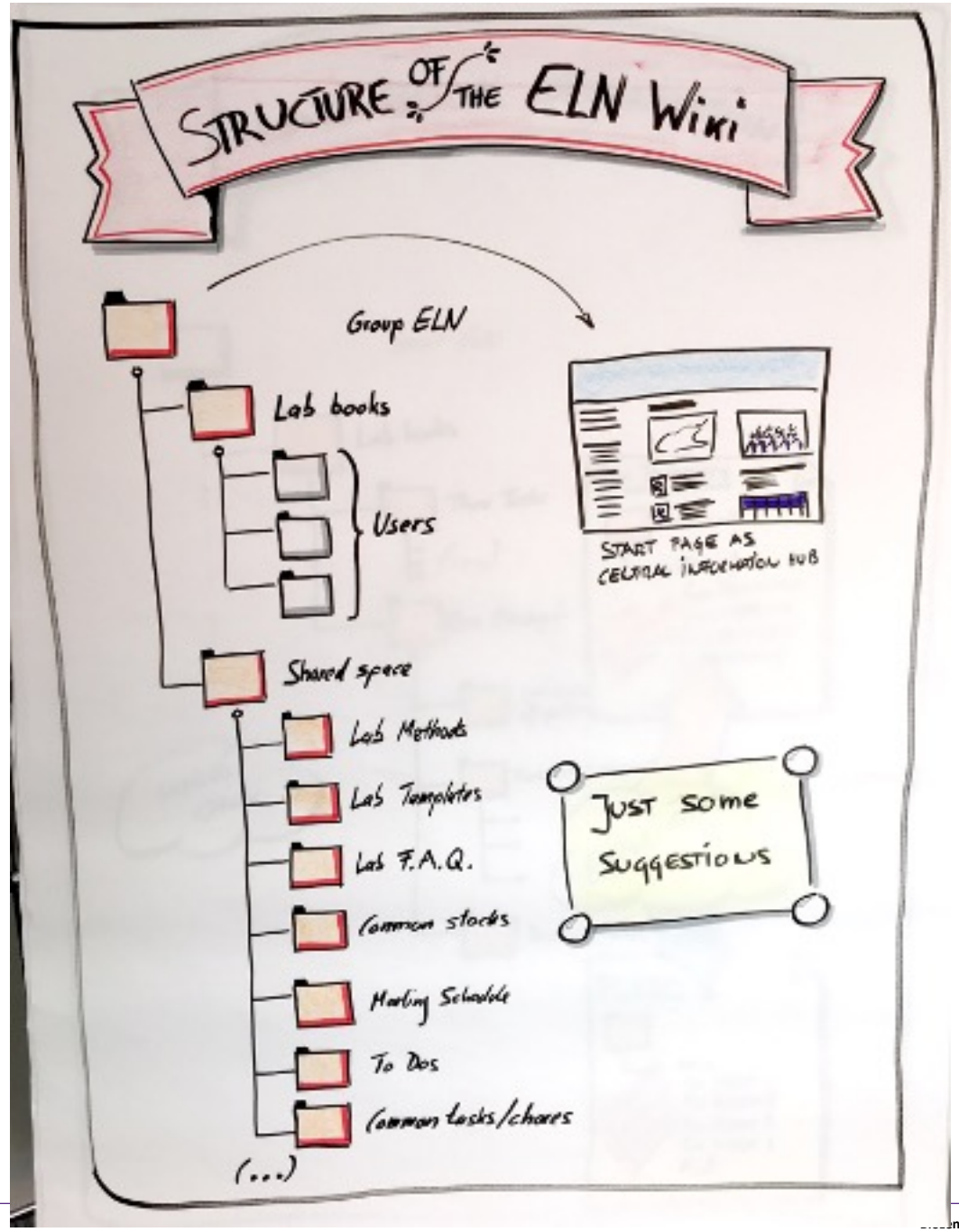
Using Confluence as a Wiki-based ELN

- Started 2013 with a single lab (Jenal group) as prototype.
- Today: 36 ELN Wiki spaces for groups and core facilities:
  - **22 active**, 7 documentation/collaboration spaces,
    1 retired, 6 no longer used.
  - Expanded to: **DBM** (35), **Swiss TPH** (8), **Physics** (2) research groups

- Commercial software: Atlassian Confluence
- Hosted on-premise by IT Services, not cloud-based.

- Data security:
  - Full edit history (regular users can't delete)
  - All data stored locally and backed up (disaster recovery)
  - **Not suitable for patient information/sensitive information**

ELN Wiki Space Design

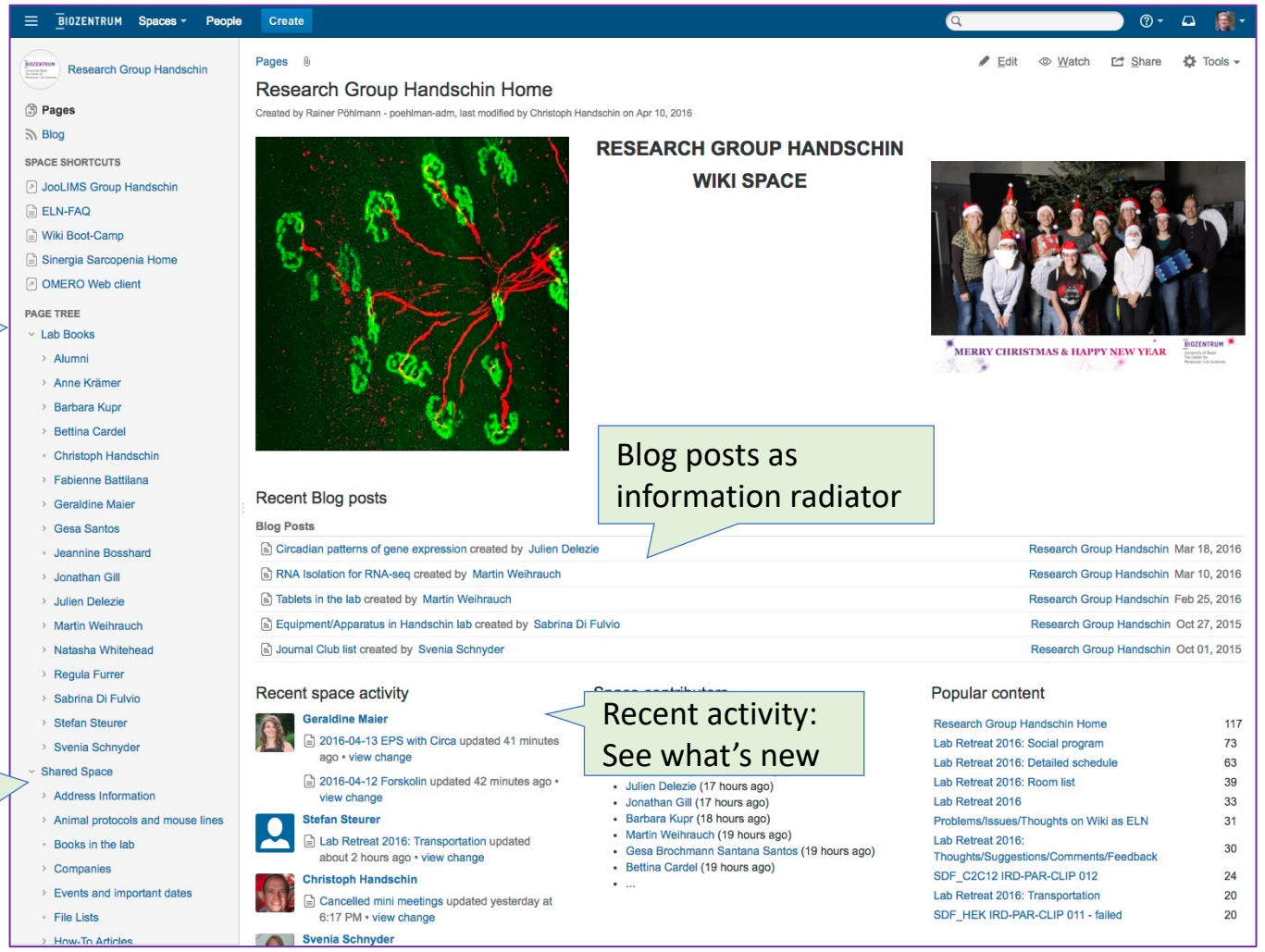


Example ELNwiki start page

Links to relevant pages or other resources

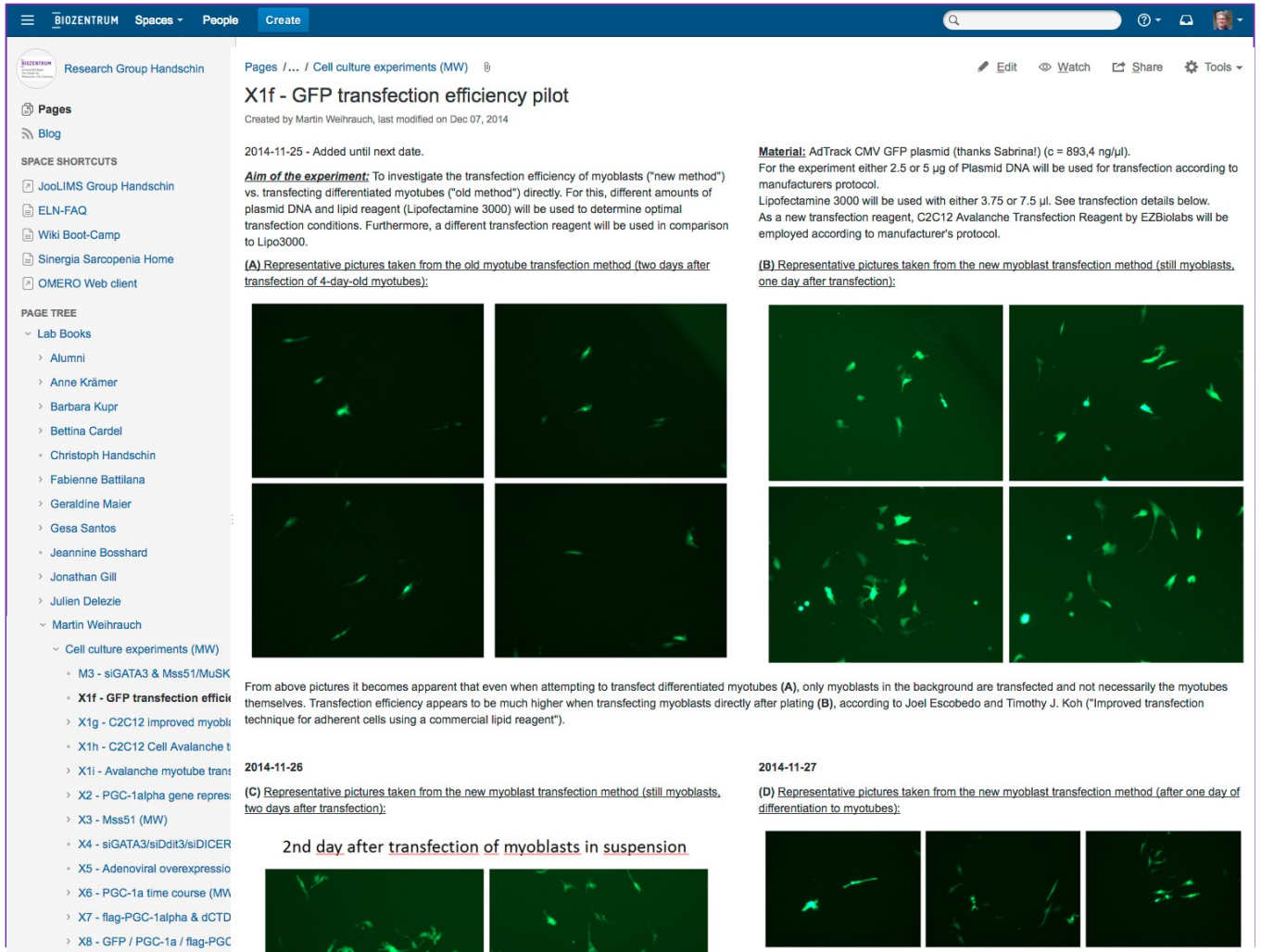
Group member lab books:

Common area:
- Protocols, SOPs
- Oligos, mouse lines
- Lab organisation

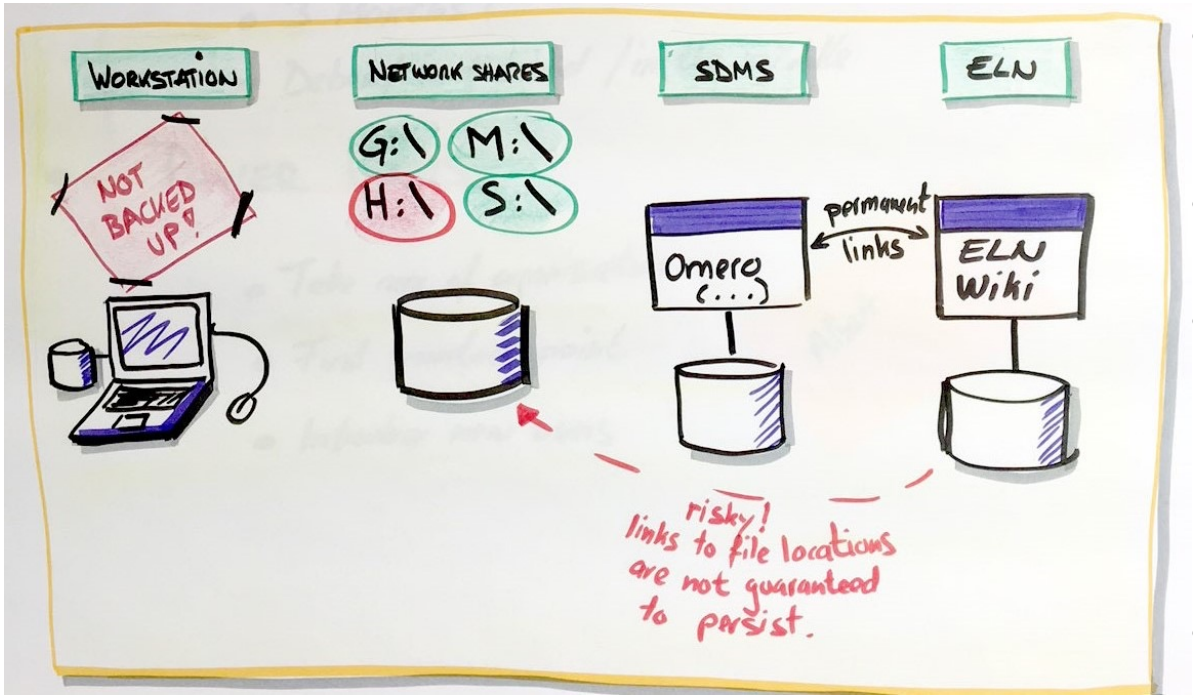


Example ELNwiki experiment page

Opening one member's lab book



Linking experiment description and results



- Illustrative images (Screenshots, gel pictures, set-up of experimental apparatuses):
  Upload / display in-line
- Protocols, vendor instructions, papers:
  Upload / display in-line
- Samples, materials:
  - Permanent link to a LIMS system (e.g. Labcollector, PyRAT, Labkey)

Raw Data:

- Store in SDMS
- Store on a centrally managed, shared drive (and provide location information)
- Store in gitlab (for source code)

ELN Wiki experience at Biozentrum++

“Power features”

- Data is organized by experiment, not constrained by linear page sequence
- Organize content by labels
- **TODO-lists:** TODO in minutes or for experiments
- **Space homepage can become internal information hub**
- Blog posts: Record and transmit information in the lab
- **Optional page- and space-watching (email notifications on updates)**

“Pro features”

- Collect lists of similar items (computers, plasmids, protocols) by using the {page properties} and {page properties report} macros
- Excerpts
- (…)

Summary

Useful, lightweight tool for life sciences & beyond(?)

Clear statement of intent from PI is crucial for good adoption

Key features

- User-friendly, simple
- Central availability of information
- Search, access from everywhere

“Working with ELNwiki: Not faster, but better”