

# Electronic Lab Notebook Wiki

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

Dr. Michael Podvinec  
Biozentrum Research IT



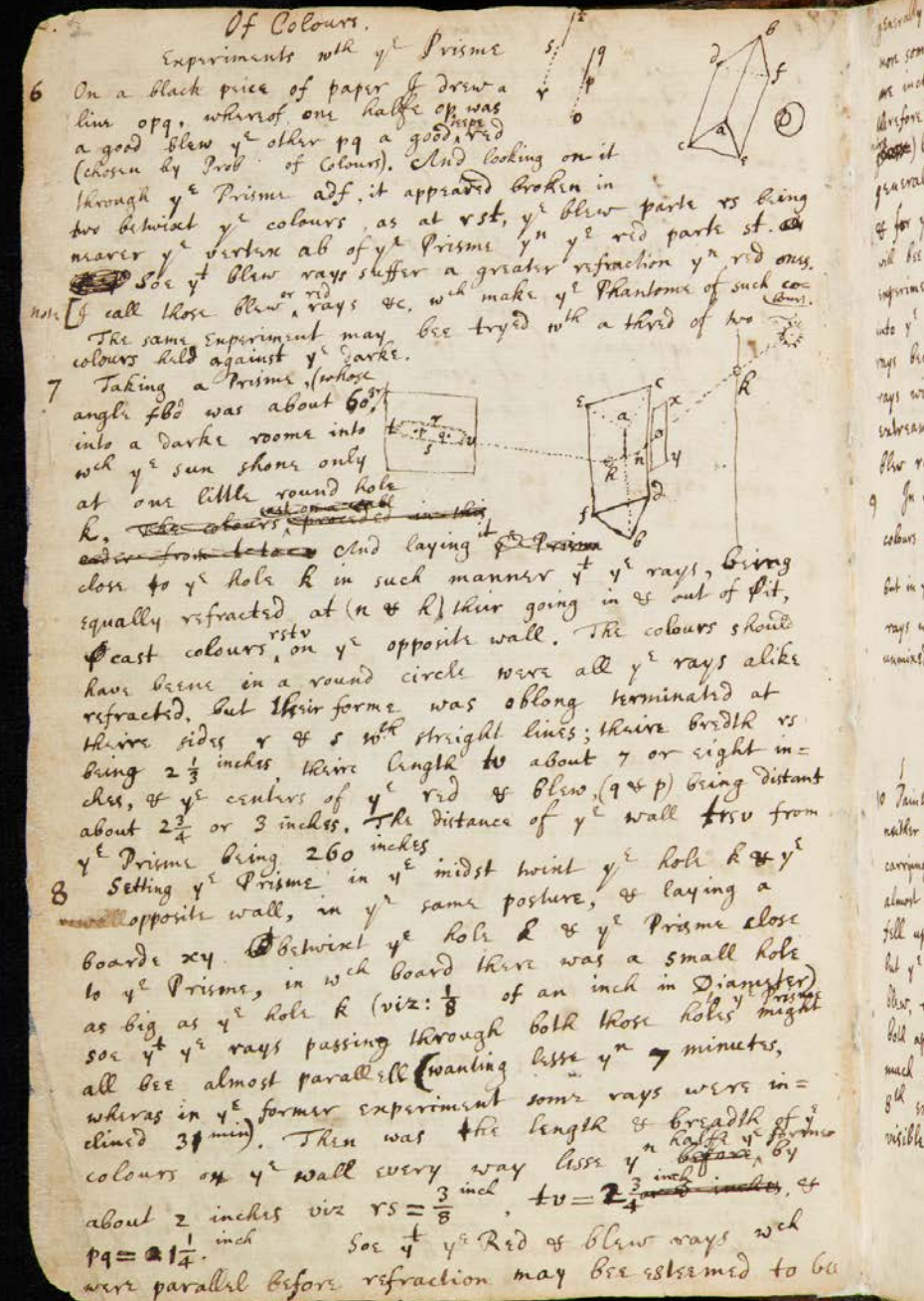
# Documenting Experiments

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

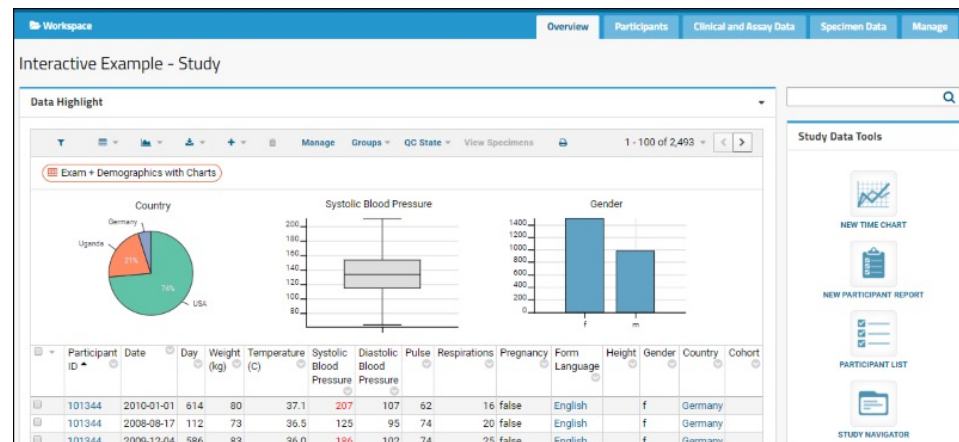




# Documenting your research is even more important today

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

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



Research Group Handschlin

## X1f - GFP transfection efficiency pilot

Created by Martin Wehrauch, last modified on Dec 07, 2014

2014-11-25 - Added until next date.

**Aim of the experiment:** To investigate the transfection efficiency of myoblasts ("new method") vs. transfecting differentiated myotubes ("old method") directly. For this, different amounts of plasmid DNA and lipid reagent (Lipofectamine 3000) will be used to determine optimal transfection conditions. Furthermore, a different transfection reagent will be used in comparison to Lipofectamine 3000.

**(A) Representative pictures taken from the old myotube transfection method two days after transfection of 4-day-old myotubes:**

**(B) Representative pictures taken from the new myoblast transfection method (still myoblasts, one day after transfection):**

From above pictures it becomes apparent that even when attempting to transfect differentiated myotubes (A), only myoblasts in the background are transfected and not necessarily the myotubes themselves. Transfection efficiency appears to be much higher when transfecting myoblasts directly after plating (B), according to Joel Escobedo and Timothy J. Koh ("Improved transfection technique for adherent cells using a commercial lipid reagent").

2014-11-25

**(C) Representative pictures taken from the new myoblast transfection method (still myoblasts, two days after transfection):**

**2nd day after transfection of myoblasts in suspension**

2014-11-27

**(D) Representative pictures taken from the new myoblast transfection method (after one day of differentiation to myotubes):**

**Material:** AdTrack CMV GFP plasmid (thinks Sabrina!) (c = 893.4 ng/μl). For the experiment either 2.5 or 5 μg of Plasmid DNA will be used for transfection according to manufacturer's protocol. Lipofectamine 3000 will be used with either 3.75 or 7.5 μl. See transfection details below. As a new transfection reagent, C2C12 Avalanche Transfection Reagent by EZBiolabs will be employed according to manufacturer's protocol.

Webclient

Secure | https://omero.biozentrum.unibas.ch/webclient/userdata/experimenter=9

OMERO Data History Help Tag Search Figure Admin

Explore Tags Shares Filter Images

140612-Live05\_R3D\_539abc6533f36\_hrm.i

Image ID: E22787

Owner: Niko Ehrenfeuchter

Image Details

Add Description

Import Date: 2014-01-09 10:57:34

Dimensions (XY): 512 x 512

Pixel Type: float

Pixel Size (XYZ) (μm): 0.18 x 0.18 x 0.40

Z-sections/Timepoints: 20 x 6

Channels: 542.0, 587.0

ROI Count: 0

Tags

Key-Value Pairs

Attachments

Figure\_2014-12-8\_17:38:1.pdf (1.87 MB)

Ratings

Comments

Add Comment

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

# Scientific Record Keeping Best Practices

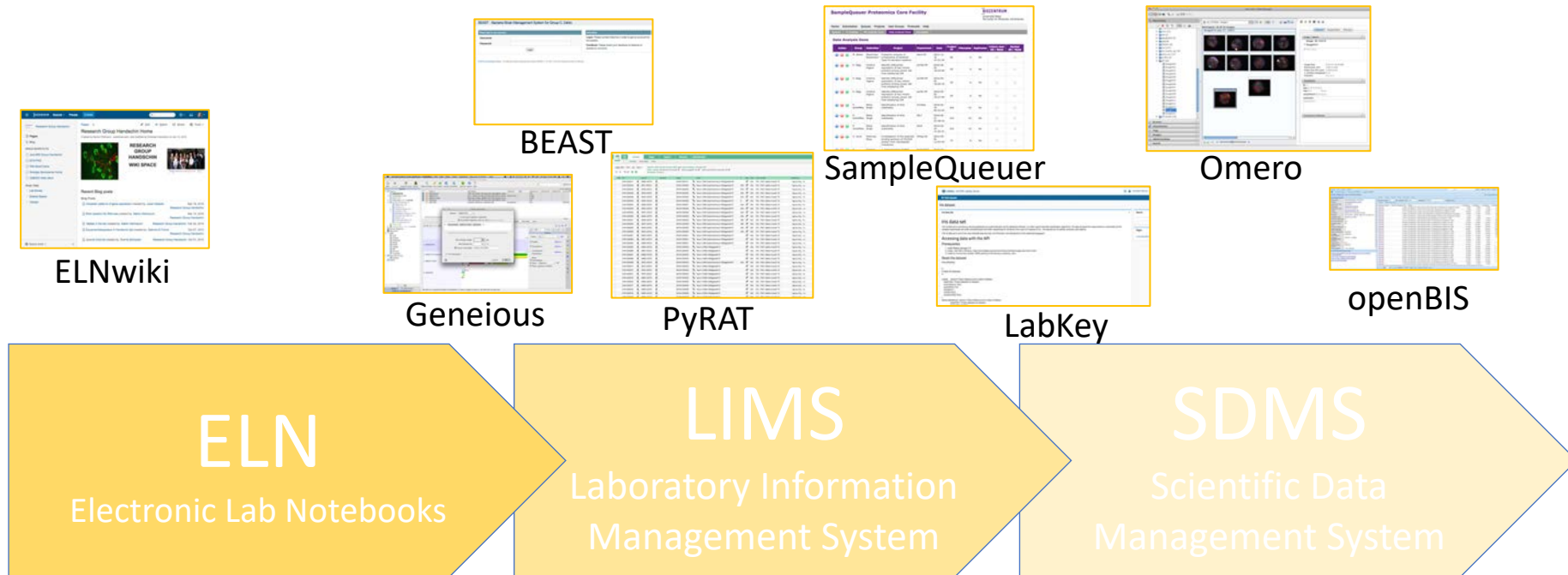
Useful & good research records should include these details:

- **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

# Tool Landscape



# Where to store your data: Data management systems



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

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

- **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

# 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

## 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.

## 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

# 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

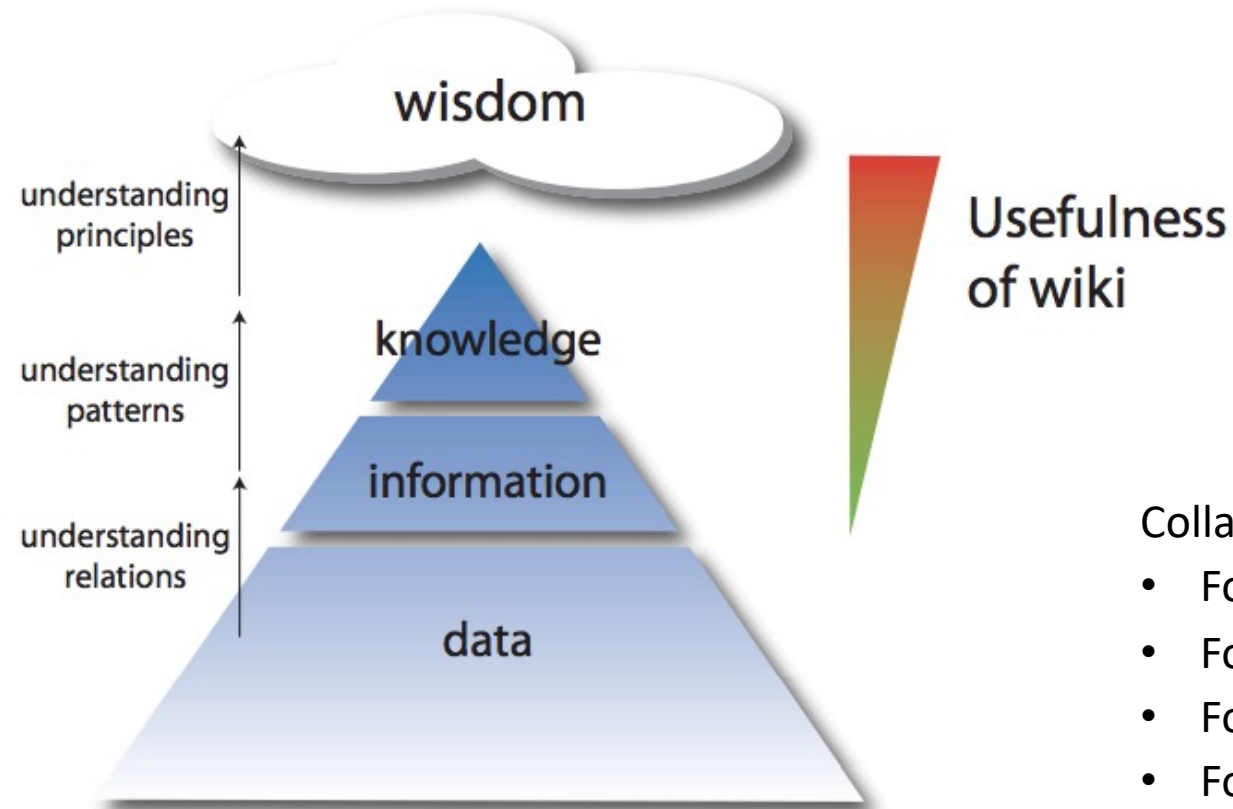
- Choosing an ELN: <https://www.nature.com/articles/d41586-018-05895-3>
- Collection of ELNs and LIMS: <https://www.limswiki.org/> or <https://eln-finder.ulb.tu-darmstadt.de/>



# 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

Bitte melden Sie sich mit Ihrem Uni Basel Account Namen an und nicht der Email Adresse!  
Please use your Uni Basel account name to login and not the email address!  
Log in

Username

Password

☐ Remember me

Log in

Čeština · Dansk · Deutsch · Eesti · English (UK) · English (US) · Español · Français · Íslenska · Italiano · Magyar · Nederlands · Norsk · Polski · Português · Română · Slovenščina · Suomi · Svenska · Русский · 中文 · 日本語 · 한국어

Powered by Atlassian Confluence 7.13.0 · Report a bug · Atlassian News

ATLASSIAN

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

## Advantage of a wiki:

Very flexible and adaptable

## Downside of a wiki:

Very flexible and adaptable

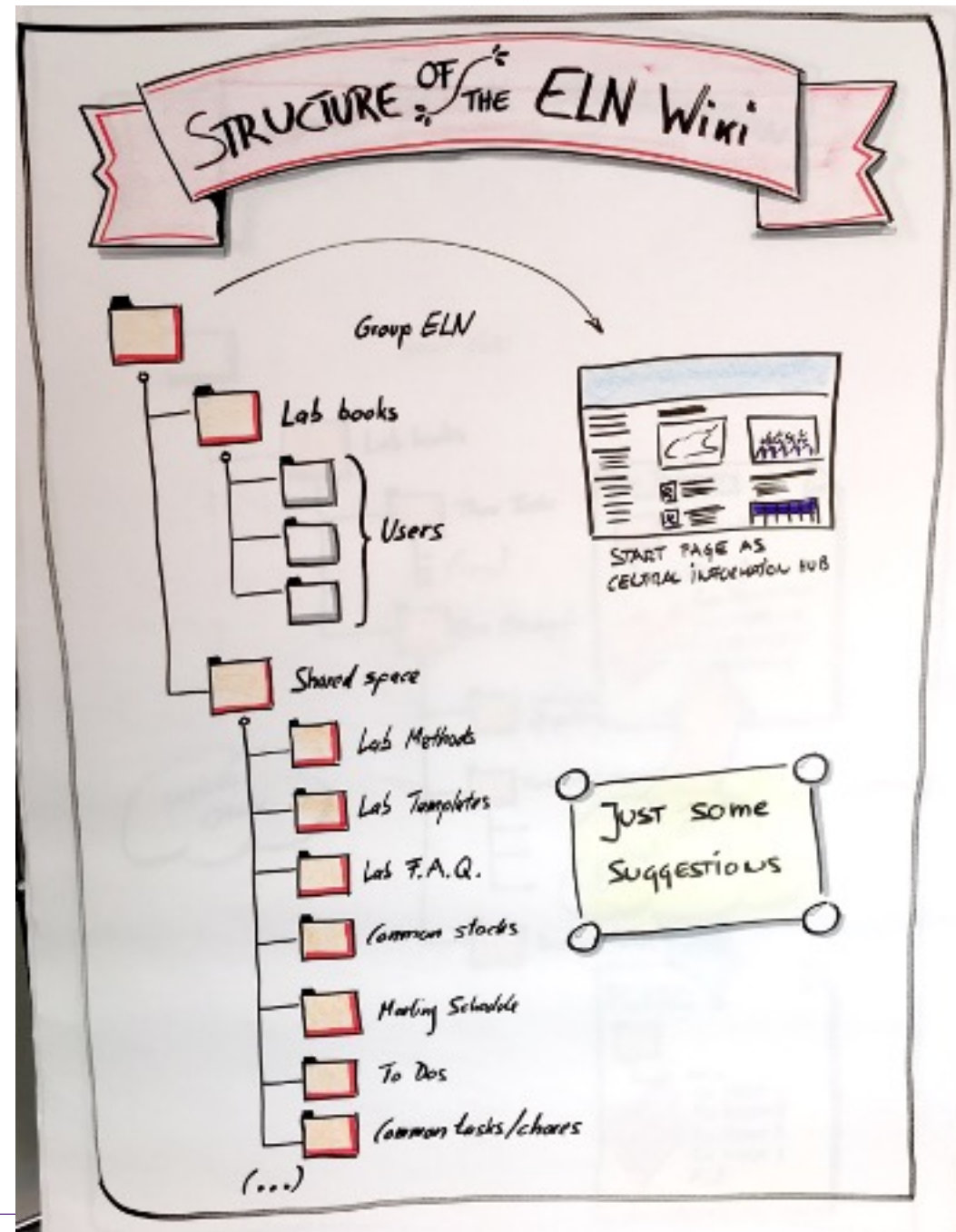
# ELN Wiki at Biozentrum++

## 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

The screenshot shows the 'Research Group Handschin Home' page on a MediaWiki instance. The page layout includes a top navigation bar, a left sidebar with navigation links, a main content area with a featured image and recent updates, and a right sidebar with popular content.

**Links to relevant pages or other resources**

**Group member lab books:**

- SPACE SHORTCUTS
  - JooLIMS Group Handschin
  - ELN-FAQ
  - Wiki Boot-Camp
  - Sinergia Sarcopenia Home
  - OMERO Web client
- PAGE TREE
  - Lab Books
    - Alumni
    - Anne Krämer
    - Barbara Kupr
    - Bettina Cardel
    - Christoph Handschin
    - Fabienne Battilana
    - Geraldine Maier
    - Gesa Santos
    - Jeannine Bosshard
    - Jonathan Gill
    - Julien Delezie
    - Martin Weihrach
    - Natasha Whitehead
    - Regula Furrer
    - Sabrina Di Fulvio
    - Stefan Steurer
    - Svenia Schnyder
  - Shared Space
    - Address Information
    - Animal protocols and mouse lines
    - Books in the lab
    - Companies
    - Events and important dates
    - File Lists
    - How-To Articles

**Recent Blog posts**

- Circadian patterns of gene expression created by Julien Delezie (Mar 18, 2016)
- RNA Isolation for RNA-seq created by Martin Weihrach (Mar 10, 2016)
- Tablets in the lab created by Martin Weihrach (Feb 25, 2016)
- Equipment/Apparatus in Handschin lab created by Sabrina Di Fulvio (Oct 27, 2015)
- Journal Club list created by Svenia Schnyder (Oct 01, 2015)

**Recent activity: See what's new**

- Geraldine Maier
  - 2016-04-13 EPS with Circa updated 41 minutes ago • view change
  - 2016-04-12 Forskolin updated 42 minutes ago • view change
- Stefan Steurer
  - Lab Retreat 2016: Transportation updated about 2 hours ago • view change
- Christoph Handschin
  - Cancelled mini meetings updated yesterday at 6:17 PM • view change
- Svenia Schnyder

**Recent space activity**

- Julien Delezie (17 hours ago)
- Jonathan Gill (17 hours ago)
- Barbara Kupr (18 hours ago)
- Martin Weihrach (19 hours ago)
- Gesa Brochmann Santana Santos (19 hours ago)
- Bettina Cardel (19 hours ago)
- ...

**Popular content**

Content	Views
Research Group Handschin Home	117
Lab Retreat 2016: Social program	73
Lab Retreat 2016: Detailed schedule	63
Lab Retreat 2016: Room list	39
Lab Retreat 2016	33
Problems/Issues/Thoughts on Wiki as ELN	31
Lab Retreat 2016: Thoughts/Suggestions/Comments/Feedback	30
SDF_C2C12 IRD-PAR-CLIP 012	24
Lab Retreat 2016: Transportation	20
SDF_HEK IRD-PAR-CLIP 011 - failed	20

# Example ELNwiki experiment page

Opening one member's lab book

BIOZENTRUM

Spaces

People

Create

Research Group Handschin

Pages

Blog

SPACE SHORTCUTS

JooLIMS Group Handschin

ELN-FAQ

Wiki Boot-Camp

Sinergia Sarcopenia Home

OMERO Web client

PAGE TREE

Lab Books

Alumni

Anne Krämer

Barbara Kupr

Bettina Cardel

Christoph Handschin

Fabienne Battilana

Geraldine Maier

Gesa Santos

Jeannine Bosshard

Jonathan Gill

Julien Delezie

Martin Weihrauch

Cell culture experiments (MW)

M3 - siGATA3 & Mss51/MuSK

**X1f - GFP transfection effici**

X1g - C2C12 improved myobli

X1h - C2C12 Cell Avalanche t

X1i - Avalanche myotube trans

X2 - PGC-1alpha gene repres

X3 - Mss51 (MW)

X4 - siGATA3/siDdit3/siDICER

X5 - Adenoviral overexpressio

X6 - PGC-1a time course (MW)

X7 - flag-PGC-1alpha & dCTD

X8 - GFP / PGC-1a / flag-PGC

Electroporation (MW)

Genotyping (MW)

Mouse resistance exercise (MW)

Mss51 (MW)

NIM1 transcript profiling (MW)

Pages / ... / Cell culture experiments (MW)

Edit

Watch

Share

Tools

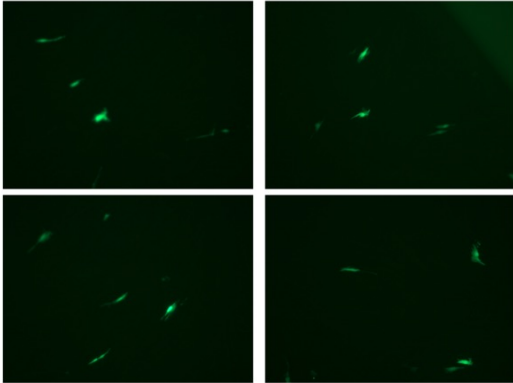
## X1f - GFP transfection efficiency pilot

Created by Martin Weihrauch, last modified on Dec 07, 2014

2014-11-25 - Added until next date.

**Aim of the experiment:** To investigate the transfection efficiency of myoblasts ("new method") vs. transfecting differentiated myotubes ("old method") directly. For this, different amounts of plasmid DNA and lipid reagent (Lipofectamine 3000) will be used to determine optimal transfection conditions. Furthermore, a different transfection reagent will be used in comparison to Lipo3000.

**(A) Representative pictures taken from the old myotube transfection method (two days after transfection of 4-day-old myotubes):**

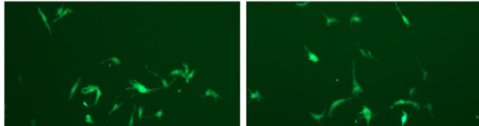


From above pictures it becomes apparent that even when attempting to transfect differentiated myotubes (A), only myoblasts in the background are transfected and not necessarily the myotubes themselves. Transfection efficiency appears to be much higher when transfecting myoblasts directly after plating (B), according to Joel Escobedo and Timothy J. Koh ("Improved transfection technique for adherent cells using a commercial lipid reagent").

2014-11-26

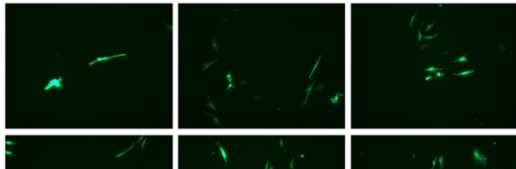
**(C) Representative pictures taken from the new myoblast transfection method (still myoblasts, two days after transfection):**

2nd day after transfection of myoblasts in suspension



2014-11-27

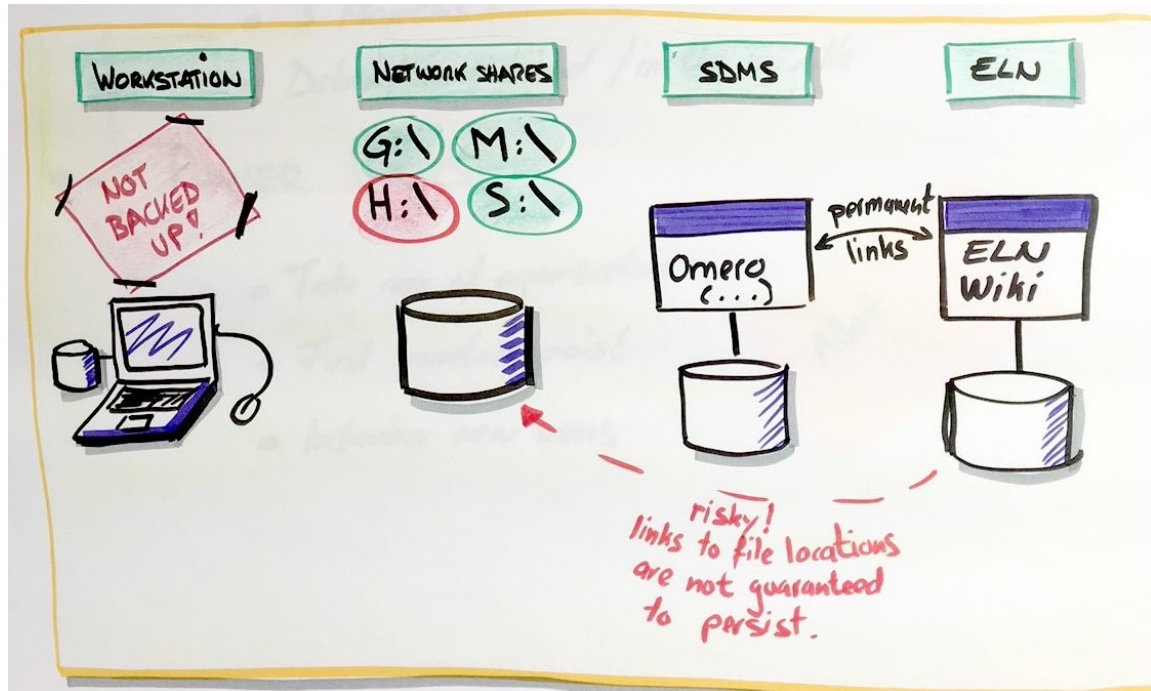
**(D) Representative pictures taken from the new myoblast transfection method (after one day of differentiation to myotubes):**



Biozentrum, University of Basel

21

# 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”**