

Electronic Lab Notebooks

From paper to screen, keeping track of your research



Electronic Lab
Notebook:
the easier way
to manage your
data

The amount of scientific data doubles every three years, but scientists mostly still rely on paper notebooks to keep track of their experiments, much like Marie Currie did 100 years ago.

However, today most of generated data is digital and more than 80% of it becomes untraceable, stored on some computer.

Introducing ELNs – a modern way to organize your scientific data and safely store it all in one place.

What are we talking about?

In this presentation you will learn:

- History of Electronic Lab Notebooks, ELNs
- How ELNs function and their features
- ELNs that are best suited for the research environment
- ELNs in clinical research and clinical data



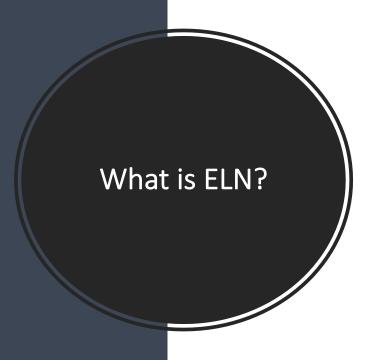
"Rigour, reproducibility & robustness.

These remind us of the reason
why we became scientists
in the first place."

nature

- "I need to find raw data from an experiment I performed years ago but do not recall exactly where I stored that information."
- "I want to replicate an experiment from a colleague, and need some additional information, but that person has already left our organization."
- "I cannot use the data needed to continue a group project, because the person who
 holds the specific data set went on holidays without a full handover, or unexpectedly
 took ill."

The electronic lab notebook provides the missing infrastructure for data recording, retrieval and integrity



• Electronic Lab Notebook (or ELN) is a digital version of the traditional lab notebook

- ELN is a software program designed to help you:
- Plan
- Track
- Manage
- Record
- Analyze your experiments digitally



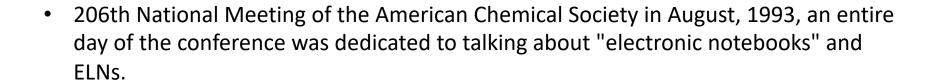




Why do you need an Electronic Notebook?

- 1. ELN can be designed specifically for the type of research you are doing
- 2. Data can be stored centrally and accessible by other members of your team.
- 3. No more cutting and pasting results activity into your paper notebook
- 4. ELN creates greater efficiency and produces a more historically accurate data management system.
- 5. ELN leads to reduced mistakes and lowered total research costs and time

When did ELNs begin?

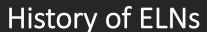


"These are all things you could never do with a paper notebook. The beauty is I can not only search the notebook but also use it to initiate searches of other databases."
 Dr. Reymond E. Dessy – Virginia Tech, 1980's

Dessy even predicted the future of the electronic notebook when he described the portable aspects:

"Laptop and palmtop PCs that can dock with a mother computer to discharge research results are available, and wireless communication linkages exist between truly portable computers and a host."

- First ELN came in 1997 Kodak ELN, implemented as a collection of Lotus Notes databases and applications
- In 1998 one of the first ELN web-based versions Virtual Notebook Environment



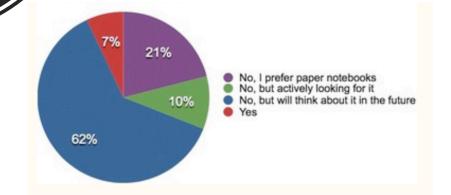
Where are we today?

✓ OVERSATURATED ELNs Market

✓ Scientific Community RESISTANCE to ELNs

✓ ELN usage and barriers to adoption

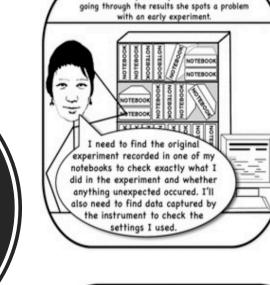
History of ELNs



The Barriers	Research lab	Diagnostic lab	
Limited budget	352		23
Time needed for implementation	235		21
Changes to existing working habits	266		25
Concerns about ELN being a system in the cloud	215		22
Contains features we do not need	130	I	7
Software in English only	76	I	10
No need for improvement	112	I	7

Example: Searching and Backup procedures

Scenario 1: Trying to search for some work/data 6 months later



Overcome the

barriers

Alejandra has been writing up her research from the last year for publication. As she is

Lukas has had an accident and is going to be in hospital for a few weeks. Lukas was working on a paper and presentation for an important conference.

It's good to see that Lukas is getting better, but we can't wait for him to come out of hospital. We'll need access to his notes and results to finish the paper before the deadline.

Scenario 2: What would happen if your lab was set on fire and you lost everything in there

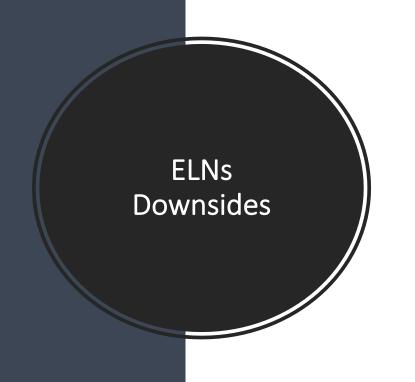


Scenario 3: If you were indisposed for a while how would your supervisor/research group access your work

Kanza S, et al. Electronic lab notebooks: can they replace paper? J. Cheminform 2017

ELNs Advantages

- Easy to search, copy and archive
- Templates, scientists don't have to rewrite protocols
- Researchers can link experiments to specific samples or files
- Share information easily with other lab members and collaborators
- Facilitating reproducibility
- Supervisors can monitor the activity of their teams remotely



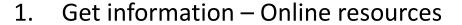
Free versions, BUT limited:

- Number of users
- Data storage
- File size
- Network interruptions could temporarily restrict access to data

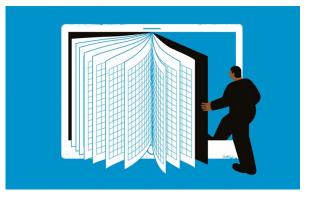
What do researchers think and want?

- "Our department was looking for something simple to use, cheap, and with ability to backup on the cloud and share notes/files." (Hani Ebrahimi, postdoc at NIH, 2017)
- "Will NIH or NSF be making a rule or recommendation? The gov't makes rules about software in other fields, they may insist on something that integrates with, for example, grants.gov." (Dany S. Adams, scientist at Ion Diagnostics LLC, 2015)
- "The discussion about all these softwares / apps should be about how reliable are they in terms of privacy if you use their server. It's common sense that you want to have the data on a cloud." (Ioannis V. Pavlidis, Assistant Professor at University of Crete, 2013)

To find a software solution that suits your needs:



- 2. Calculate Costs
- 3. Understand Legal issues
- 4. Evaluate Stability
- 5. Run on mobile devices
- 6. Software integration
- 7. Test-driving
- 8. Try Generic platforms
- 9. Commit to change



Nature, 2018

How to pick an ELN: STEPS

FEATURES

USER EXPERIENCE

- •Graphical user interface
- Intuitiveness
- •Support (on-line support, available manuals and video tutorials)

ABILITY AND FLEXIBILITY

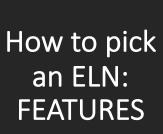
- Multi-device compatibility
- •Working with different operating systems and browsers
- Cloud
- Real-time collaboration
- •Instrument integration and open APIs

BUSINESS MODEL AND PRICING

- Licensing model
- •Free version (yes or no)
- Cost efficiency



The <u>Electronic Lab Notebook Matrix</u>, collated by Harvard Medical School in Boston, Massachusetts, lists the details of more than 50 features for 27 ELNs.

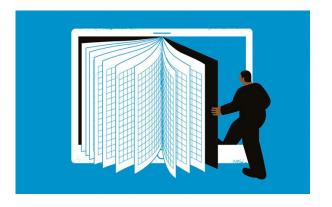


Features	Specifications															
	Benchling	Biovia	Confluence	Docollab	ECL	ELOG	Evernote	Exemplar	Findings	Hivebench	IDBS.	LabArchives	LabCollector	LabWare	LabVantage	Lab
Interactivity																
Intuitive Interface Design	0	No response received			No response received		No response received	No response received				0	No response received			$\overline{}$
Auto Metadata Harvest		No response received		0	No response received	B	No response received	No response received	X	0		0	No response received		0	
Search functions can search across file formats and beyond typos					No response received								No response received			
Ability to manipulate files and images		No response received			No response received		No response received						No response received			
Support for multiple open windows	0		0	0	No response received	0	0			0	0	0	No response received	0		
Ability to link out		No response received		0	0	0	0	0	0	0	0	0	No response received	0	0	
Support for Researcher Documentation		7400700														
Hyperlink support	0	No response received	0	0	0	0	0	0	0	0	0	0	No response received	0	0	-
Metadata Creation Promots	0	No response received		0	No response received	0		No response received		0	0	0	No response received		0	
Rights Management (licensing)		No response received		0	No response		No response received	No response received	0	0		0	0	0	0	
Protocol Integration	0	*	0	0	No response received	0		*	0	0	0			0		
Adaptability to Lab workflows	_		_	_	received	_	_	_	_	_	_	- 0		_		
Accounts/Permissions Levels	-	No response received		0	0	0	0			0	0	0	0	0		
Infernal Data Sharing	0			0	No response received	0	0	No response received	0	0	0	0	0	0	0	_
Adaptable to a Variety of Workflows		No response received			No response received		No response received	*								
Compatibility with authoring tools	0	No response received		0	No response received		No response received	No response received				0	No response received			
	0	No response	0	0	0	0	0	0		0	0	0	0	0	0	
Windows Compatitie	0	O	0	0	0	0	0	0	0	0	0	0	0	0	0	
Macintosh Compatible	0	8	0	0	No response	0	No response	0	8	0	0	0	No response	0	8	
Linux Competible	0	0	0	0	No response	0	O	0	8		0	0	Acceled O	0	0	-
Android Compatible	0	0	0	0	No response	0	0	0	0	0	0	0	0	0	0	
IOS Compatible	_	_		_	received	_	_	_	_	_	_					_
Storage		No response		_	No response	-	No response	No response	_	_	-					
Cloud Storage	0	received		0	received	0	received	received	0	0	0	0	0	0	0	
Local Storage	8	No response received	0		No response received	0	No response received	No response received	0	×	0	0	No response received	0	0	
Hybrid (cloud/local) Storage		No response received		-	No response received	×	No response received	No response received	0	0	×	0	No response received	×		
Versioning					No response received		No response received									
File Redundancy	:	No response received			No response received		No response received	No response received		:	:		No response received		:	
Creates stable URLs or persistant identifiers for entries	0	No response received	0	0	No response received	0	No response received	No response received		0	0	0	No response received	0	0	
Can unregistered users access the data found at pensistent links?	0	No response received	0		No response received	×	No response received	No response received		:	×		No response received	×	×	
Storage Capacity - Users		No response received			No response			No response					No response		0	
Storage Capacity - Max File Size		No response received			No response received		No response received	No response received					No response received		0	
surage Capacity - max Fire 5006		received.			received.	-	- PORTAGE	received.					received.	_		_

https://datamanagement.hms.harvard.edu/electronic-lab-notebooks

- Interactivity
- Support for research documentation
- Adaptability to Lab workflows
- Storage
- Hosting
- Support
- Security
- Other

Find a solution that fits your needs



How to pick an ELN

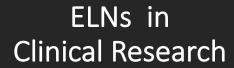
- 1. Data Creation & Retrieval
- 2. Data Storage: PUBLIC SOLUTION VS OWN SERVER
- **3. TEAM WORK:** balance between sharing information in a collaborative environment and protecting your data
 - Team administration
 - Sharing and Communication
 - Data Integrity Safeguards
- 4. Lab Inventory Management

Regulations and Legal Aspects

ELNs in Clinical Research

GLP Compliance, FDA 21 CFR Part 11, ISO certification

Good Laboratory Practices (GLP): How data should be stored, secured and managed



- **1. Security**: ELN must be able to archive, securely store, protect and extract the data and notes you create.
- **2. Confidentiality**: Lab notebook software must employ procedures that keep all stored records protected from unauthorized parties
- **3. Authenticity**: Multi-level authentication processes, secure user identification, electronic signatures, and a migration plan.
- **4. Integrity**: Restricted management rights, a full audit trail (version control, timestamps), secure data transfer, and organizationally defined controls on data availability, data retention, and data deletion.

Title 21 CFR Part 11 of the Code of Federal Regulations

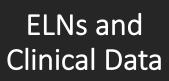
Your ELN must do the following:

ELNs and Clinical Data

- 1. Your data must be digitally recorded using a closed system that restricts access, and ensuring that only authorized personnel can access your records.
- 2. Your digital lab book must also be able to **create readable copies of your notes** at any time (ex. pdf format). These copies **must also be archived** for future retrieval.
- 3. FDA also mandates that electronic notes have an **audit trail with time stamps**, which cannot be edit or deleted.
- 4. FDA is also very specific about how **electronic signatures** should be instituted to prevent fraudulent use. For witnessing documents, it is required to securely record who is witnessing and at which date and time, in a manner that wouldn't allow a signer to easily repudiate the signed record as not being genuine.

ISO standards

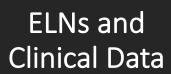
- ISO 9001 (general quality management)
- ISO 15189 (medical and diagnostic laboratories)
- ISO 17025 (testing and calibration laboratories)



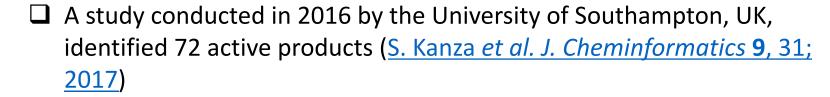
ELNs must:

- 1. Allow users to assign a title to documents.
- 2. Automatically create a timestamp for date creation and modification.
- 3. Assign a **unique ID** to each document.
- 4. Ensure that editing a document can only happen by one authorized person.
- 5.Add serial page numbers when printing the digital notes.
- 6. Identify the authors of each document.
- 7. Have a **full audit trail** recording the nature, the date/time and author of changes.
- 8. Make it possible to invalidate documents.
- 9.List all documents in a master list.
- 10. Review and revise processes and SOPs based on the latest guidelines.

HIPAA Compliance and Electronic Lab Notebooks



HIPAA: Health Insurance Portability and Accountability Act governs how personal health information (PHI) should be handled by healthcare providers and businesses they collaborate with.



Over 100 ELNs available to researchers - Research Insights, April 2018

https://www.limswiki.org/index.php/ELN_vendor

ELNs Market

- Benchling
- elabFTW
- BIOVIA Notebook
- eLabJournal
- Hivebench
- IDBS E-WorkBook
- LabArchives
 LabCollector
- Labfolder
- Labguru

- Labii
- Labstep
- LabWare
- Mbook
- OpenLab PerkinElmer
 Signals Notebook
- RSpace
- Scilligence
- sciNote

Something to note when choosing an ELN at Rockefeller University

When choosing an ELN to use here at Rockefeller University be aware of the IT Department's guidance regarding software and software support

http://it.rockefeller.edu/support



- Free for Academia
- Unlimeted storage
- Cloud-based
- Standard support services

ELNs Open Access Solution

SCINOTE

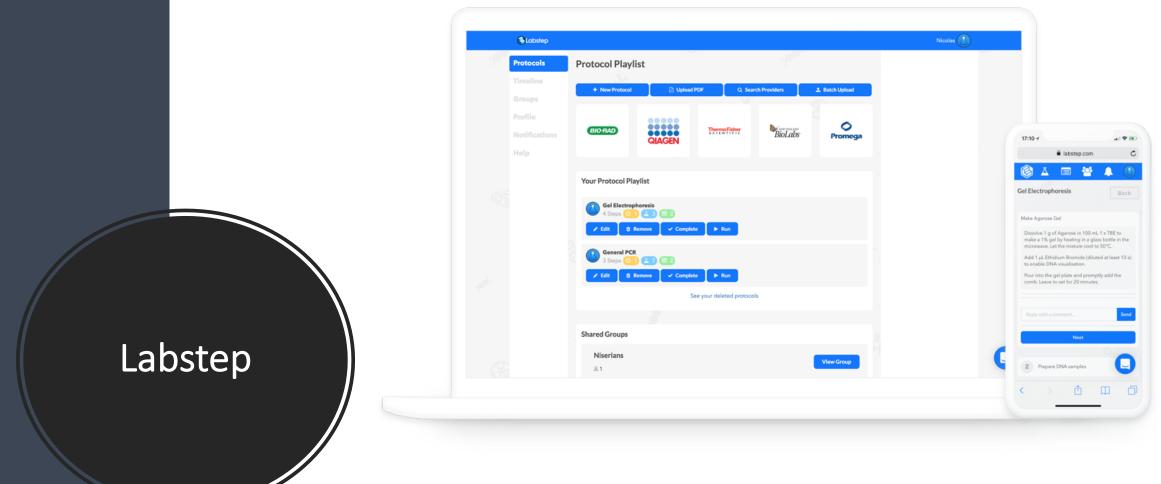
SciNote is a top-rated platform for researchers in academia or industry, who need electronic lab notebook, inventory management and project management functionalities.



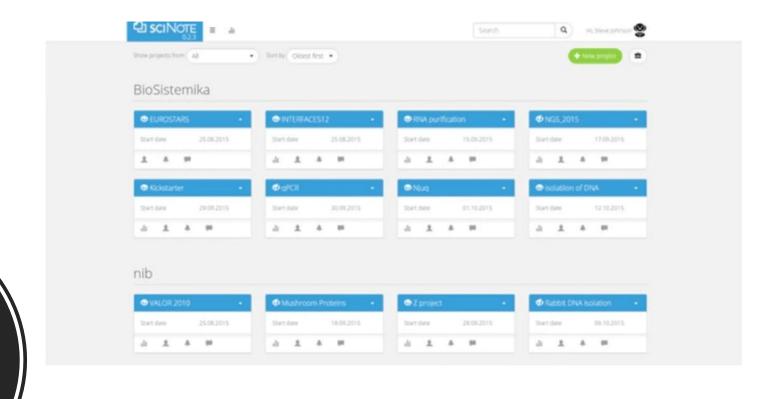
RSpace links to open data repositories



Open Science is directly encouraged by Hivebench. Hivebench makes it simple to directly export and share your data to Mendeley Data.



- Used in life sciences, chemistry, physics
- Free for academic users and offers unlimited storage capacity
- A limited file upload size (10MB initially, extended up to max 25MB).
- Strong on protocol and resource management and sharing
- API for automation of data collection.



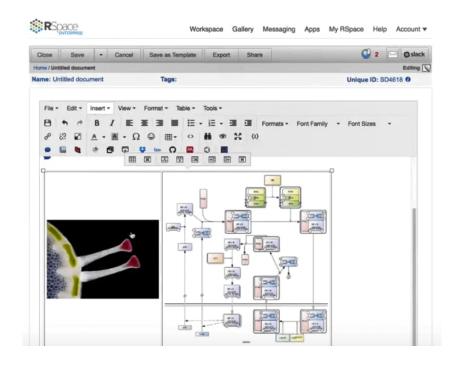
SciNote (Slovenia, USA)

PROS:

- •Intuitive and easy to use
- •Flexible workflows, experiment and protocol setup
- •Inventory management and MS Office integration
- •Export all data in a readable format and API
- •Automatically generates reports & manuscript drafts
- Free account option

CONS:

No option for drawing molecules





Rspace (Scotland)

PROS:

- •Possible archive management, built-in metrics, and analytics
- •Can connect to the eCAT sample tracking system
- •Supports chemical structures
- •Free to use
- Many integrations

CONS:

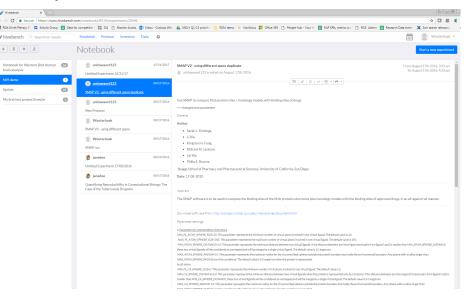
- Not open source
- •GUI could use improvements

RSpace ELN as a good option for a system with total research data management (RDM) integration



Data Notebook: Hivebench

Capture data and results in the lab



With Hivebench, researchers can:

- Keep track of experiments, results and data in the lab
- Use your own structured protocols or import and adapt from a protocols library
- Easily prepare data and results to share with collaborators and the world
- Share and collaborate
- Set-up and maintain groups
- Access to data after project ends

Data Repository

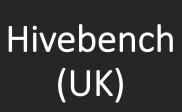
Hivebench is integrated with Mendeley Data (if you want)

PROS:

- Plate designer
- •Free account with 10 GB of storage space

CONS:

- Creating protocols is very rigid
- •No possibility to create tables
- •The free account is limited to 10 users
- •iOS version only



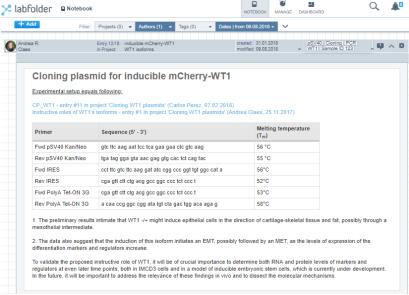


Free Edition:

- Create and manage notebooks
- Unlimited notebooks
- 25 MB storage

ELNs Commercial Solution

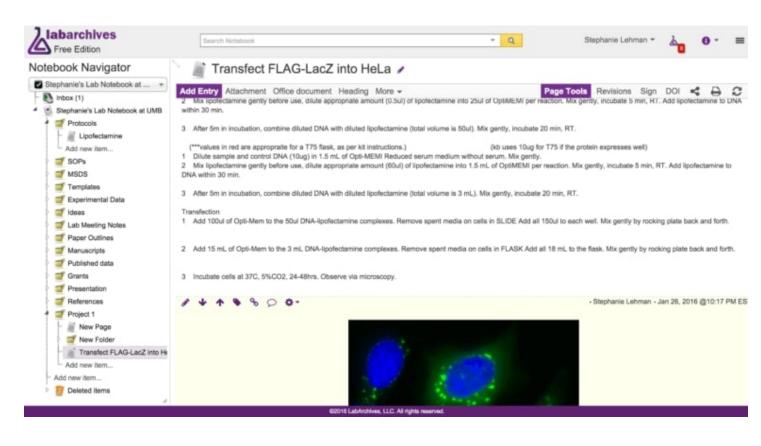






- Free (with capacity limitations) for academic users
- User-friendly
- Self-contained cloud service
- Molecular Biology bias
- CRISPR tools





PROS:

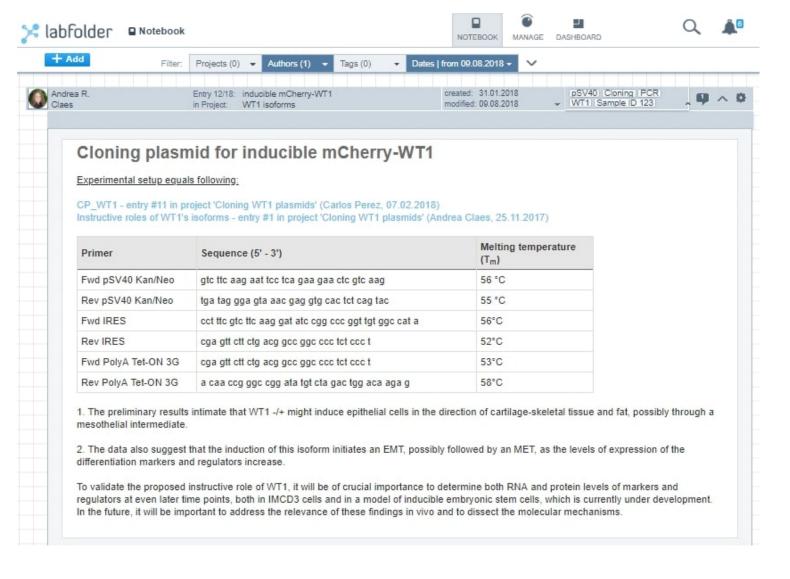
- Pubmed references entry editor
- •Interface with GraphPad Prism

CONS:

- •Graphical user interface needs improvements
- Quite complicated, additional training necessary
- •Not a lot of storage space in the free version
- Not open source

"It is easy to upload a photo snapped from a cellphone so there are often entries that wouldn't normally go into a standard hand written lab book."



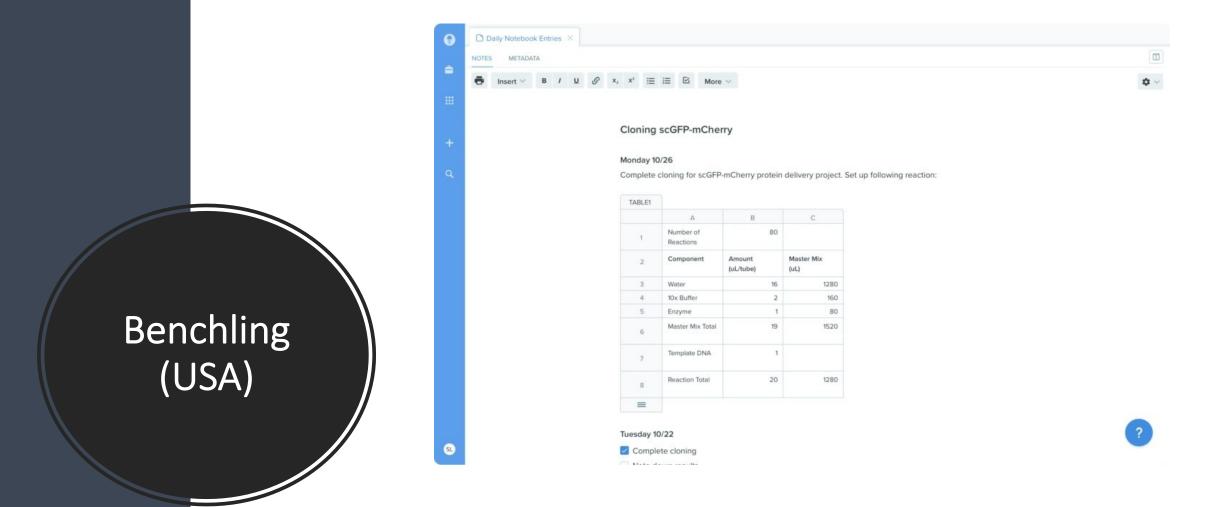


PROS:

- Sketching
- •Free account for smaller teams and free mobile app
- Integration with Mendeley

CONS:

- Not very intuitive
- Unflattering structured design
- •The free version is limited to 3 team members



PROS:

- Very user-friendly and quick to set up
- •Useful DNA tools (CRISPR guide and primer design)
- •Templates for sequence mapping and sharing
- •Free account with 10 GB of storage space

CONS:

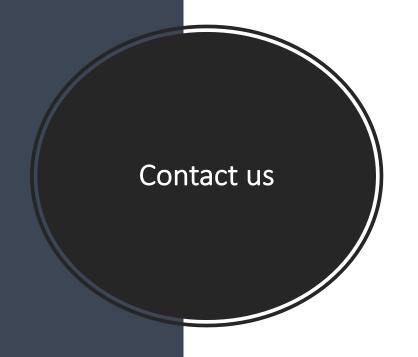
- •The free account is tied to a single user
- Report structure is not flexible

So, what will we keep in mind?



- 1. Electronic research notebook software implementation takes time, commitment and adaptability.
- 2. Don't try and do everything.
- 3. Good planning from the outset......
- 4. What will happen to my data if I stop using the software?
- 5. An electronic research notebook is only as good as it's user!

REMEMBER: ELNs ARE COFFEE-PROOF



For more information on Data Management please contact the following staff at the Rita and Frits Markus Library

- Matthew Covey University Librarian <u>mcovey@rockefeller.edu</u> x8909
- 2. Rie Goto Assistant University Librarian rgoto@rockefeller.edu x8980
- 3. Ilaria Ceglia Science Informationist ilariac@rockefeller.edu x8944