



CEPLAS

Cluster of Excellence on Plant Sciences

Good Data Management-Practices

November, 2020

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Before we start today

- Please download and install git
 - <https://git-scm.com/downloads>
- Register at <https://github.com/>
- Register at <https://elabftw.hhu.de/register.php>
 - Team “CEPLAS Demo”
 - Use your @hhu.de or @uni-koeln.de email address





Academic experts in data science



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Data management officer



Björn Usadel

- Head of Bioinformatics Institute (IGB-4) @ Jülich
- Head of Institute for Biological Data Science @ HHU



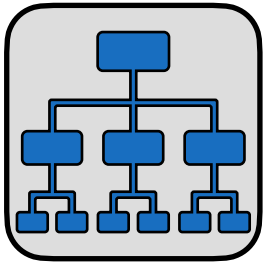
FAIR principles of data stewardship



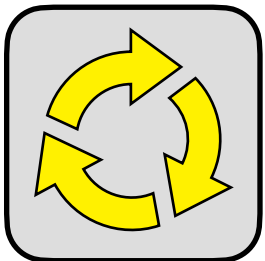
Findable



Accessible



Interoperable



Reusable

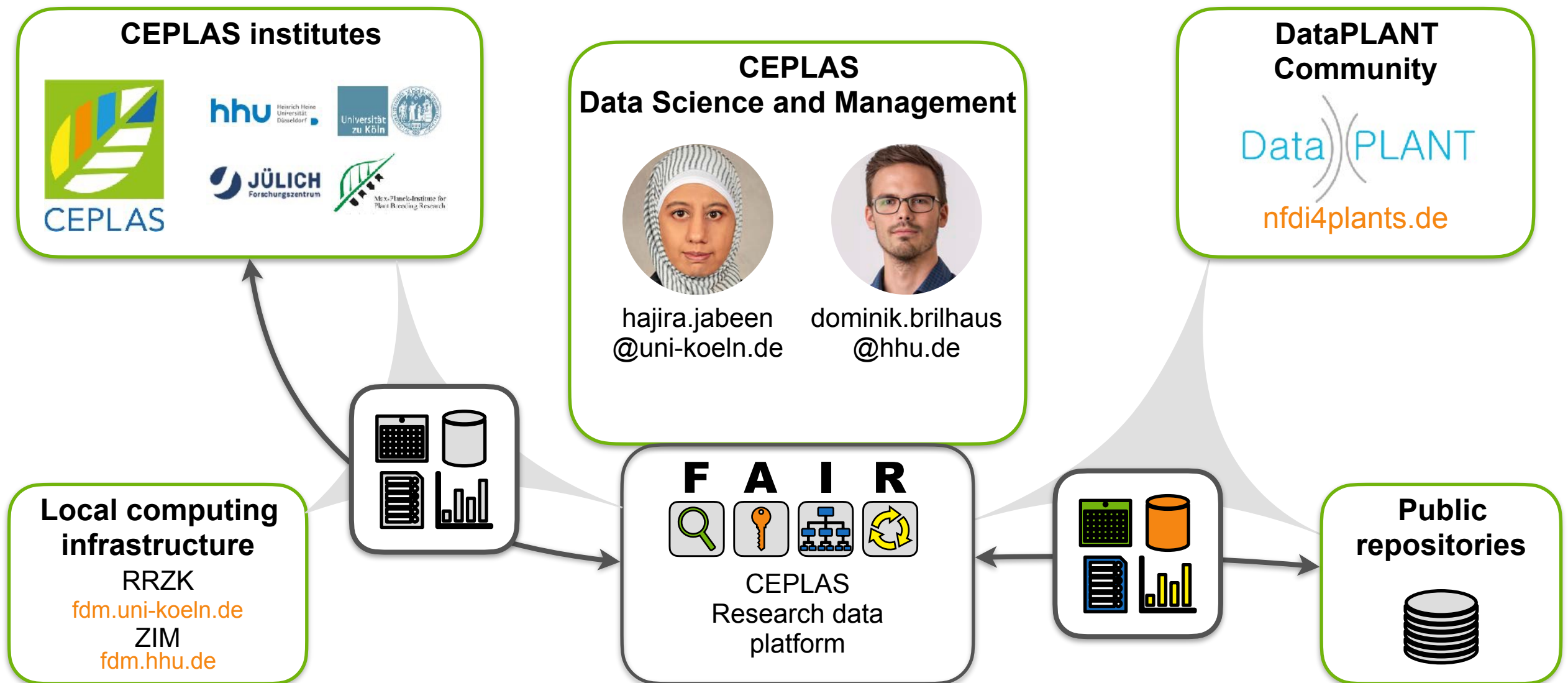
Wilkinson, M., et al. (2016)

The FAIR Guiding Principles for scientific data management and stewardship. *Sci Data* **3**, 160018.

<https://doi.org/10.1038/sdata.2016.18>



Community-integrated plant research data



*Findable, Accessible, Interoperable, Reusable



- Appreciate FAIR principles
- Provide tools for FAIR Data Management
- Communication and terminology is key
- Collect and structure metadata with your data as early as possible

Introduction to research data



- Any information;
 - Collected
 - Observed
 - Generated
 - Created
- . . to validate research findings
- Types of research data
 - Digital
 - Non-digital



- Observational data
 - Captured for research, often irreplaceable e.g. surveys, sample data, neuro-images etc
- Experimental data
 - Captured by lab equipment, reproducible(expensive), e.g. gene-sequences
- Reference/Canonical data
 - Collection of smaller, (published) datasets. e.g. data from gene sequence banks etc



- Simulation data
 - Generated by test models (model and metadata are more important than output) e.g. climate models
- Derived/Compiled data
 - Transformed from pre-existing data, reproducible if lost. e.g. data mining, compiled databases, 3D models etc



Research Data

What is it? Forms and formats

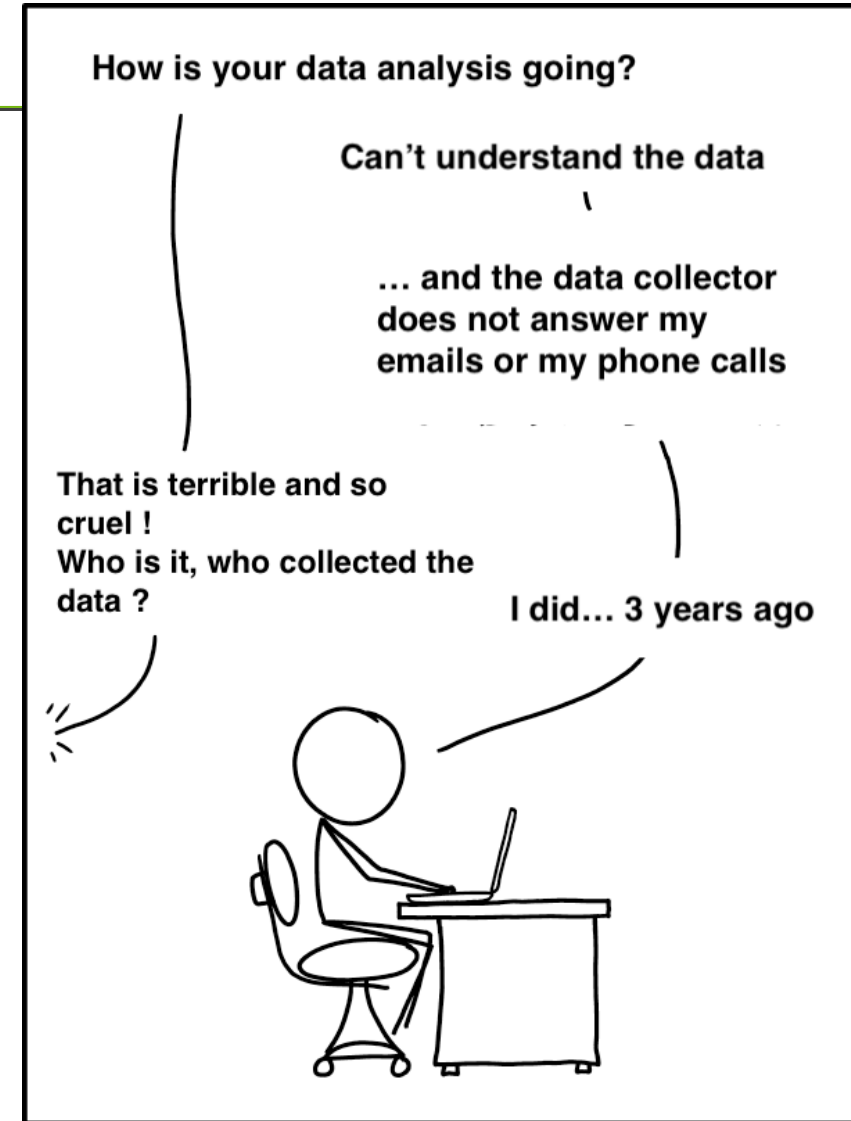
- Documents
- Spreadsheets
- Laboratory Notebooks
- Field Notebooks
- Diaries
- Questionnaires
- Transcripts
- Codebooks Audiotapes
- S O Ps
- Videotapes
- Photographs
- Films
- Test Responses
- Slides
- Artifacts
- Specimens
- Models
- Protocols
- Algorithms
- Scripts
- Contents Of An Application
- Input, Output,
- Analysis Software
- Simulation Software
- Schemas
- Methodologies
- Workflows



Research Data Management

Why ?

- Increase transparency
- Make data accessible
- Save time (writing, reusing)
- Reduce the risk of data loss
- Optimizes the costs
- Facilitate future reuse and sharing
- Improve citations



**Your first collaborators
are your future selves,
be nice to them !**

<https://rdmpromotion.rbind.io/promotion/>

your future self, by Julien Colomb, CC-BY-NC, derived from .NORM Normal File Format, CC-BY-NC, by Randall Munroe



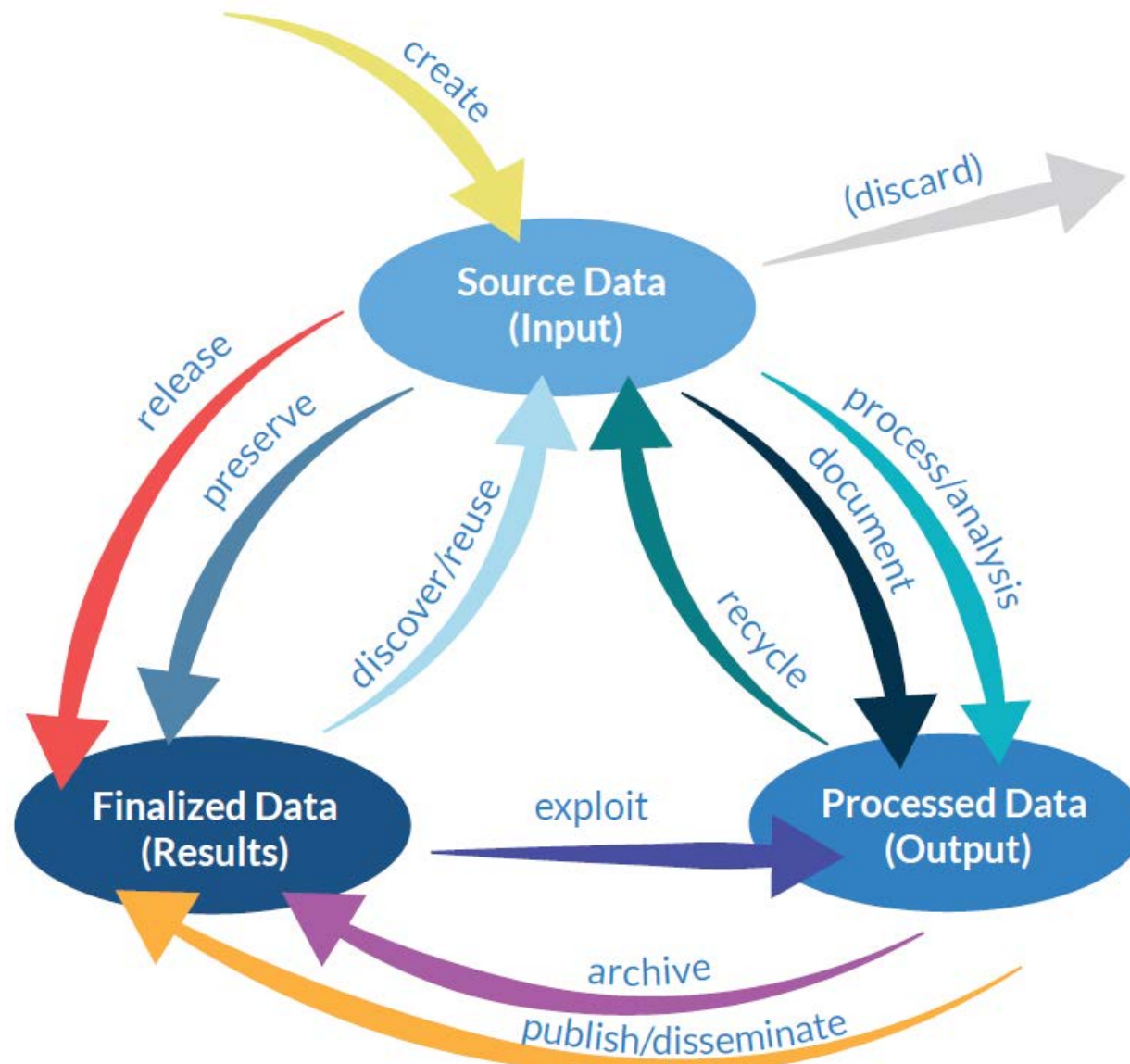
Research Data Management

What is it?

- Organization of Data
 - The process: from entry into research cycle, to dissemination and archiving of the results
 - Concerns
 - Data creation
 - Data organization
 - Data storage and backup
 - Data sharing and search



Research Data Lifecycle



<https://vidensportal.deic.dk/sites/default/files/uploads/FAIR/Diagram.png>



Source Data

- Data creation
 - Raw data
 - File format
 - Used for analysis
 - Used for sharing
 - Choose a format that is flexible to enable easy reuse, standard format highly utilised in your domain
 - Non proprietary and unencrypted



Research Data Lifecycle

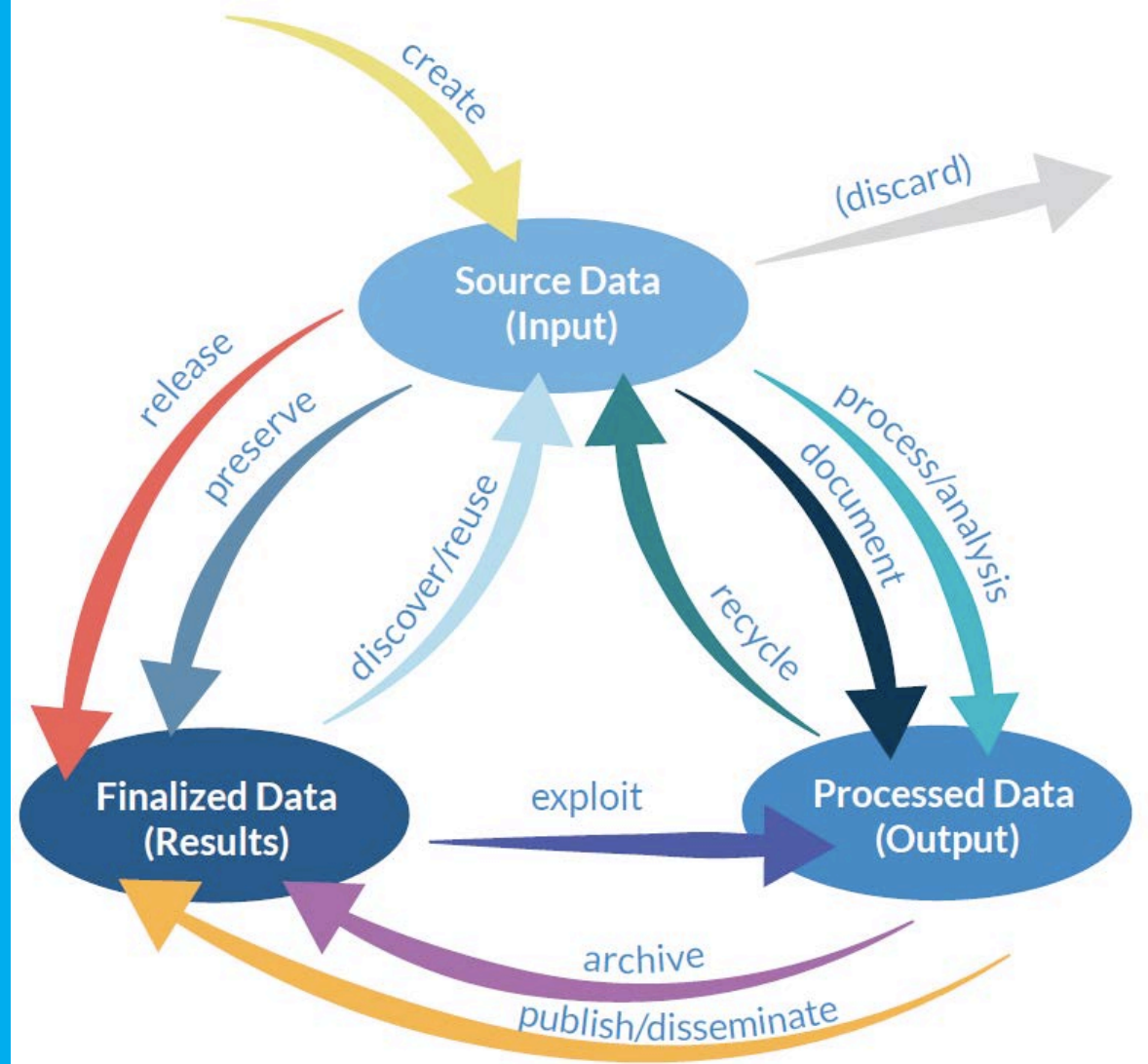
Processed Data (Analysis, methods and results)

- Use well known tools and compute environments
- Keep track of
 - tool versions
 - Parameters
 - Document everything
 - Keep raw data separate
 - Document changes to raw data
 - Create a version for analysis (more on this later..)

Finalised data (results)

- If best practices are followed during the lifecycle. The resulting data is
 - Understandable
 - Easily reusable
 - Findable
 - Accessible
 - Results are reproducible
 - Transparency in research
 - Facilitates reuse and helps in citations

Source Data



- Why do we care for file formats
 - Proprietary formats are mostly associated with tools
 - e.g xls , docx .. prefer txt, csv, instead

Data Stages	Examples
Raw Data	raw .txt file produced by an instrument
Processed Data	data with Z-scores calculated
Analyzed Data	rendered computational analysis
Finalized/Published Data	polished figures appear in Cell

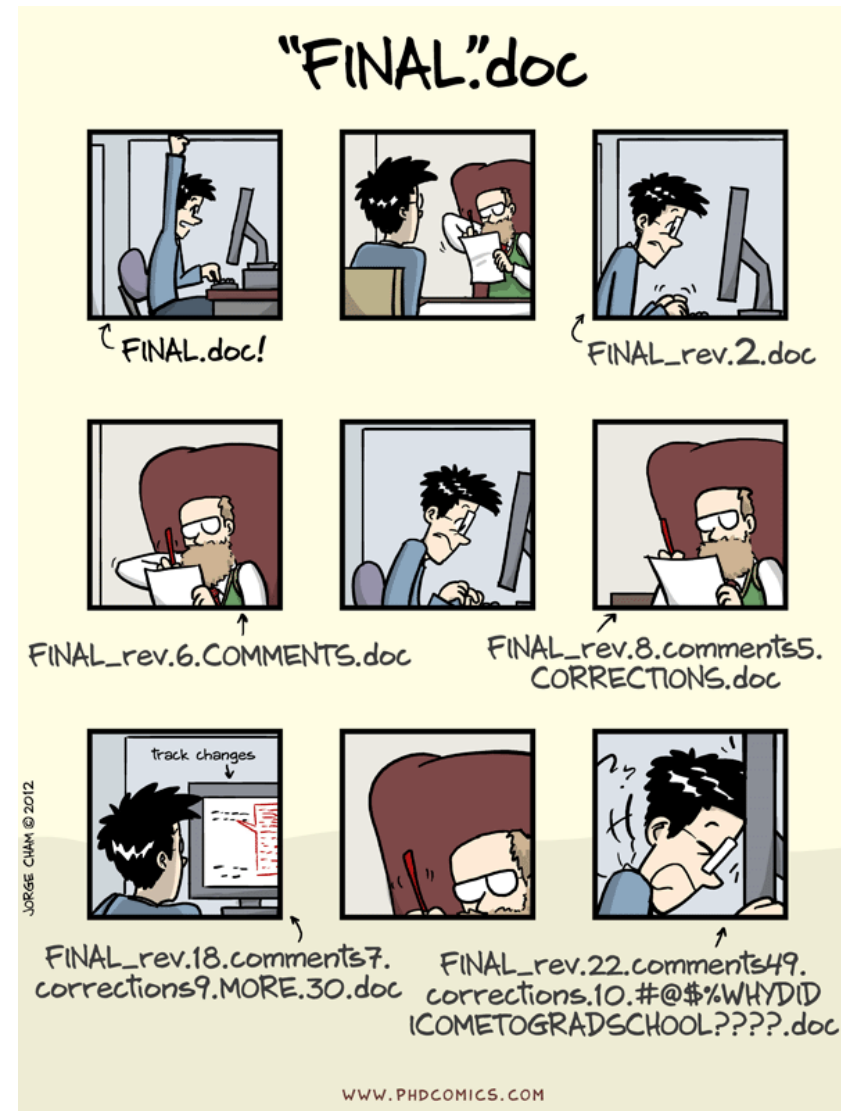


<https://twitter.com/cs3org/status/1309512729120698369/photo/1>

File naming and directory structure



Proper file naming



http://phdcomics.com/comics/archive_print.php?comid=1531

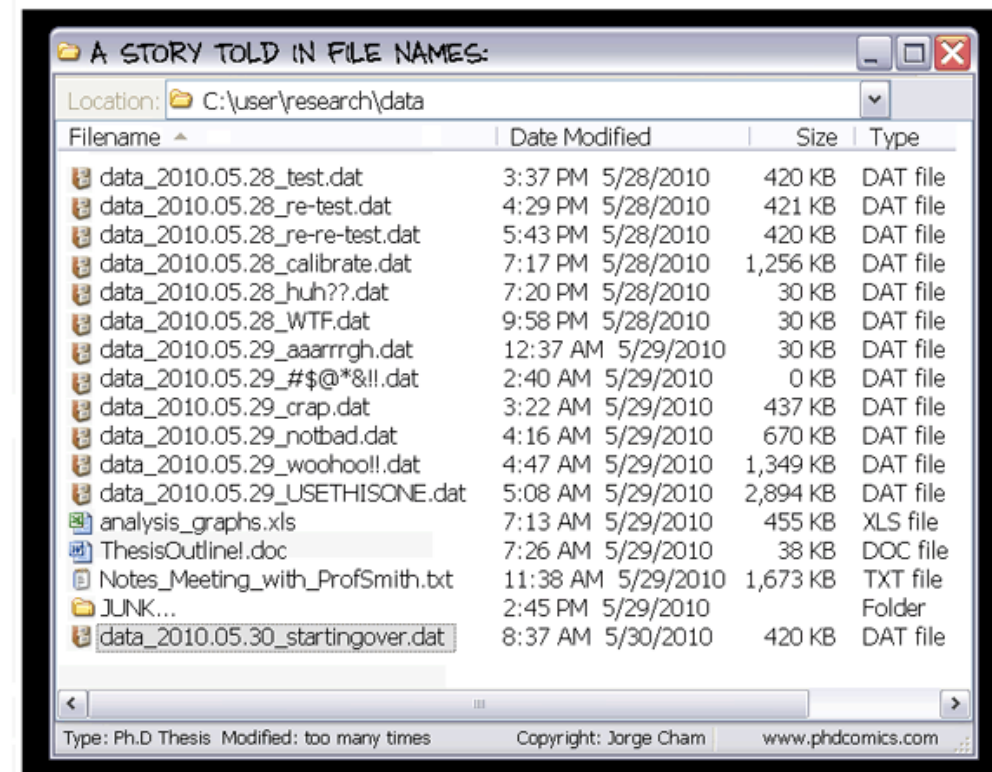




File naming

Descriptive and consistent → document your system

- Use YYYYMMDD date format
- Sequential numbering (e.g. 001, 010)
- Project or experiment acronym
- Lab name/location
- Researcher name/initials
- Version number of file
- Avoid spaces and special characters:
~ ! @ # \$ % ^ & * () ` ; : < > ? . , [] { } ' " |



Files with naming conventions:

20161104_ProjectA_Ex1Test1_SmithE_v1.xlsx

20180204-ProjectA-Report-SmithE-v5-FINAL.docx

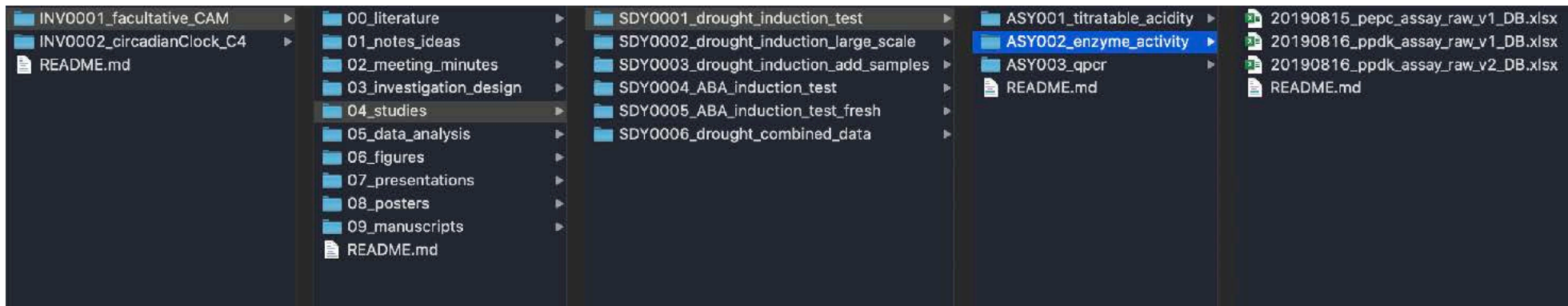
<http://phdcomics.com/comics.php?f=1323>



Directory structure

Any system is better than none → document your system

- Establish a system (e.g. in your lab) and use it consistently
- Example
 - One folder per project (investigation)
 - Subfolders for each study (experiment) and assay (measurement)
 - Separate folders for data or project stages
 - Date-based files folders (pairs well with lab notebook)



Metadata

What's metadata and why does it matter?



The peril of missing metadata

a

Pathogen: clinical or host-associated sample from Severe acute respiratory syndrome coronavirus 2

Identifiers	BioSample: SAMN14751340; Sample name: WA-UW-6185; SRA: SRS6545124	
Organism	Severe acute respiratory syndrome coronavirus 2 Viruses; Riboviria; Nidovirales; Coronaviridae; Orthocoronavirinae; Betacoronavirus; Sarbecovirus; Severe acute respiratory syndrome-related coronavirus	
Package	Pathogen: clinical or host-associated; version 1.0	
Attributes	isolate	WA-UW-6185
	collected by	University of Washington Virology Lab
	collection date	missing
	geographic location	USA
	host	Homo sapiens
	host disease	COVID-19
	isolation source	missing
	latitude and longitude	missing
Submission	University of Washington, Pavitra Roychoudhury; 2020-04-27	

b

Pathogen: clinical or host-associated sample from Severe acute respiratory syndrome coronavirus 2

Identifiers	BioSample: SAMN14656632; Sample name: hCoV-19/USA/WI-176/2020; SRA: SRS6514341	
Organism	Severe acute respiratory syndrome coronavirus 2 Viruses; Riboviria; Nidovirales; Coronaviridae; Orthocoronavirinae; Betacoronavirus; Sarbecovirus; Severe acute respiratory syndrome-related coronavirus	
Package	Pathogen: clinical or host-associated; version 1.0	
Attributes	strain	hCoV-19/USA/WI-176/2020
	isolate	Homo sapien
	collected by	Milwaukee Public Health Department
	collection date	2020-03-20
	geographic location	USA: Milwaukee, Wisconsin
	host	Homo sapiens
	host disease	COVID-19
	isolation source	nasal swab
	latitude and longitude	43.042180 N 87.908670 W
ARTIC barcode identifiers		NB23

Fig. 1 Lost opportunities for data reuse, SARS-CoV-2 (txid2697049[Organism:noexp]) BioSample records, where (a) **collection date** = “missing”: 143; **latitude and longitude** = “missing”: 1375; (b) SARS-CoV-2 BioSample record with complete metadata.

Schriml, L. M., Chuvoshina, M., Davies, N., Eloe-Fadrosh, E. A., Finn, R. D., Hugenholtz, P., et al. (2020). COVID-19 pandemic reveals the peril of ignoring metadata standards. Scientific Data, 1–4. <http://doi.org/10.1038/s41597-020-0524-5>



- "Data about data"
 - e.g. creator, project, PI, date
- Description of data
 - context, protocol
 - experimental & analysis information
 - Information to make the data
 - Understandable, reproducible, or reusable
- Would a new project member be able to step in and know how the data was created?

Documenting your metadata is key to reproducible science!!



Metadata

Who collects metadata and how?



Example README File

Create a plain text file (README.txt) to document:

- Basic project information
- Title, Contributions, Grant Info
- Contact information
- All locations of where data live, including backups
- Useful information about the files and how they are organized
- Explain file naming conventions and abbreviations

Precede any comment about the data with “#”

Have a README file for each distinct dataset

```
File Edit Format View Help
This DATASETNAMEreadme.txt file was generated on [YYYYMMDD] by [Name]

-----
GENERAL INFORMATION
-----

1. Title of Dataset

2. Author Information

Principal Investigator Contact Information
Name:
Institution:
Address:
Email:

Associate or Co-investigator Contact Information
Name:
Institution:
Address:
Email:

3. Date of data collection (single date, range, approximate date) <suggested format YYYYMMDD>
4. Geographic location of data collection (where was data collected?):
5. Information about funding sources that supported the collection of the data:

-----
DATA & FILE OVERVIEW
-----

1. File List
A. Filename:
Short description:

B. Filename:
Short description:

C. Filename:
Short description:

2. Relationship between files:
3. Additional related data collected that was not included in the current data package:
4. Are there multiple versions of the dataset? yes/no
If yes, list versions:
Name of file that was updated:
i. why was the file updated?
ii. when was the file updated?
Name of file that was updated:
i. why was the file updated?
ii. when was the file updated?
```

Example Template: <http://data.research.cornell.edu/content/readme>



Metadata standards

- Determine the (minimal) required information (content)
 - **Do not** determine the format (i.e. shape or file type)
-
- Examples (check <https://fairsharing.org> for more...)
 - MIAPPE | Minimum Information About a Plant Phenotyping Experiment
<https://www.miappe.org>
 - MIAME | Minimum Information About a Microarray Experiment
<http://fged.org/projects/miame/>
 - MIAPE | Minimum Information About a Proteomics Experiment
<http://www.psidev.info/miape>
 - MINSEQE | Minimum Information about a high-throughput SEQuencing Experiment
<http://fged.org/projects/minseqe/>



A closer look at MIAPPE

MIAPPE					
line #	MIAPPE Check list	Definition	Example	Format	Cardinality
DM-1	Investigation	Investigations are research programmes with defined aims. They can exist at various scales (for example, they could encompass a grant-funded programme of work, the various components comprising a peer-reviewed publication, or a single experiment).			1 per MIAPPE submission
DM-2	Investigation unique ID	Identifier comprising the unique name of the institution/database hosting the submission of the investigation data, and the accession number of the investigation in that institution.	EBI:12345678	Unique identifier	0-1
DM-3	Investigation title	Human-readable string summarising the investigation.	Adaptation of Maize to Temperate Climates: Mid-Density Genome-Wide Association Genetics and Diversity Patterns Reveal Key Genomic Regions, with a Major Contribution of the Vgt2 (ZCN8) Locus.	Free text (short)	1
DM-4	Investigation description	Human-readable text describing the investigation in more detail.	The migration of maize from tropical to temperate climates was accompanied by a dramatic evolution in flowering time. To gain insight into the genetic architecture of this adaptive trait, we conducted a 50K SNP-based genome-wide association and diversity investigation on a panel of tropical and temperate American and European representatives.	Free text	0-1
DM-5	Submission date	Date of submission of the dataset presently being described to a host repository.	2012-12-17	Date/Time (ISO 8601, optional time zone)	0-1
DM-6	Public release date	Date of first public release of the dataset presently being described.	2013-02-25	Date/Time (ISO 8601, optional time zone)	0-1
DM-7	License	License for the reuse of the data associated with this investigation. The Creative Commons licenses cover most use cases and are recommended.	CC BY-SA 4.0, Unreported	Unique identifier	0-1
DM-8	MIAPPE version	The version of MIAPPE used.	1.1	Version number	1
DM-9	Associated publication	An identifier for a literature publication where the investigation is described. Use of DOIs is recommended.	doi:10.1371/journal.pone.0071377	DOI	0+
DM-10	Study	A study (or experiment) comprises a series of assays (or measurements) of one or more types, undertaken to answer a particular biological question.			1+ per investigation
DM-11	Study unique ID	Unique identifier comprising the name or identifier for the institution/database hosting the submission of the study data, and the identifier of the study in that institution.	EBI:12345678 http://phenome-fppn.fr/maugio/2013/t2351	Unique identifier	0-1
DM-12	Study title	Human-readable text summarising the study	2002 evaluation of flowering time for a panel of 375 maize lines at the experimental station of Maugio (France).	Free text (short)	1
DM-13	Study description	Human-readable text describing the study	2002 evaluation of male and female flowering time for a panel of 375 maize lines representing the worldwide genetic diversity at the experimental station of Maugio, France.	Free text	0-1
DM-14	Start date of study	Date and, if relevant, time when the experiment started	2002-04-04 2006-09-27T10:23:21+00:00	Date/Time (ISO 8601, optional time zone)	1
DM-15	End date of study	Date and, if relevant, time when the experiment ended	2002-11-27	Date/Time (ISO 8601, optional time zone)	0-1
DM-16	Contact institution	Name and address of the institution responsible for the study.	UMR de Génétique Végétale, INRA – Université Paris-Sud – CNRS, Gif-sur-Yvette, France	Free text (short)	1
DM-17	Geographic location (country)	The country where the experiment took place, either as a full name or preferably as a 2-letter code.	FR	Country name or 2-letter code (ISO 3166)	1
DM-18	Experimental site name	The name of the natural site, experimental field, greenhouse, phenotyping facility, etc. where the experiment took place.	INRA, UE Diascope - Chemin de Mezouls - Domaine expérimental de Melguil - 34130 Mauguio - France	Free text (short)	1
DM-19	Geographic location (latitude)	Latitude of the experimental site in degrees, in decimal format.	+43.619264	Degrees in the decimal format (ISO 6709)	0-1 (1 if longitude is provided)
DM-20	Geographic location (longitude)	Longitude of the experimental site in degrees, in decimal format.	+3.967454	Degrees in the decimal format (ISO 6709)	0-1 (1 if latitude is provided)
DM-21	Geographic location (altitude)	Altitude of the experimental site, provided in metres (m).	100 m	Numeric + unit abbreviation	0-1
DM-22	Description of the experimental design	Short description of the experimental design, possibly including statistical design. In specific cases, e.g. legacy datasets or data computed from several studies, the experimental design can be "unknown"/"NA", "aggregated/reduced data", or simply "none".	Lines were repeated twice at each location using a complete block design. In order to limit competition effects, each block was organized into four sub-blocks corresponding to earliness groups based on a priori information.	Free text	1
DM-23	Type of experimental design	Type of experimental design of the study, in the form of an accession number from the Crop Ontology.	CO_715:0000145	Crop Ontology term (subclass of "CO_715:0000003")	0-1
DM-24	Observation unit level hierarchy	Hierarchy of the different levels of repetitions between each others	block>rep>plot	Formatted text (level>level)	0-1

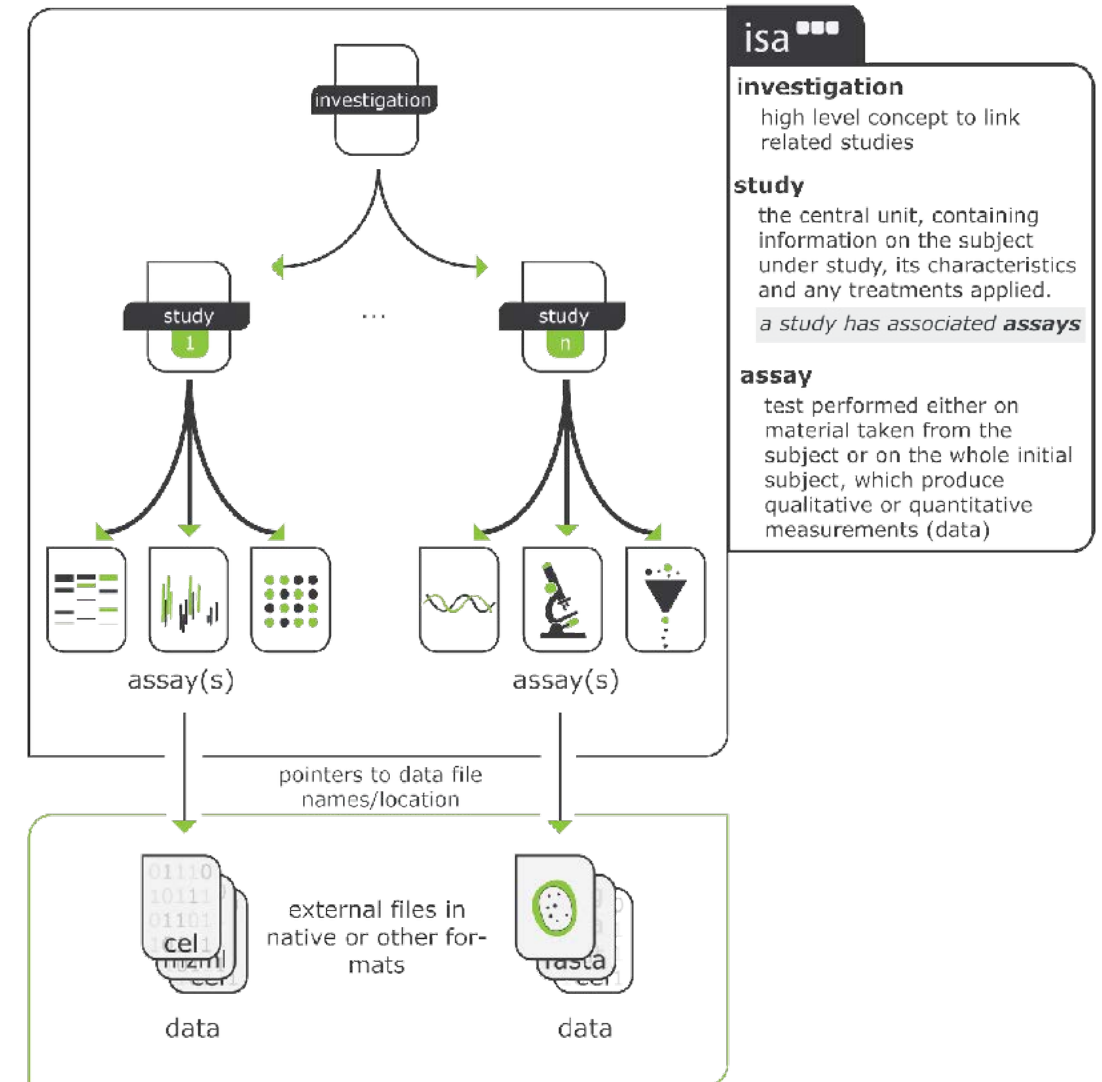
...this is just an excerpt...

https://github.com/MIAPPE/MIAPPE/blob/master/MIAPPE_Checklist-Data-Model-v1.1/MIAPPE_Checklist-Data-Model-v1.1.pdf



The ISA Model of (experimental) metadata

- **Investigation**
 - Overall goals
 - Scientific context
- **Study**
 - Experimental steps
- **Assay**
 - Leading to (raw) data



<https://isa-tools.org/format/specification.html>





A closer look at ISA(-tab)

i_investigation										
Home Insert Draw Page Layout Formulas Data Review View										
1	ONTOLOGY SOURCE REFERENCE									
2	Term Source Name									
3	Term Source File									
4	Term Source Version									
5	Term Source Description									
6	INVESTIGATION									
7	Investigation Identifier									
8	Investigation Title									
9	Investigation Description									
10	Investigation Submission Date									
11	Investigation Public Release Date									
12	Comment (Create With Configuration)									
13	Comment (Last Opened With Configuration)									
14	INVESTIGATION PUBLICATIONS									
15	Investigation PubMed ID									
16	Investigation Publication DOI									
17	Investigation Publication Author List									
18	Investigation Publication Title									
19	Investigation Publication Status									
20	Investigation Publication Status Term Accession Number									
21	Investigation Publication Status Term Source REF									
22	INVESTIGATION CONTACTS									
23	Investigation Person Last Name									
24	Investigation Person First Name									
25	Investigation Person Mid Initials									
26	Investigation Person Email									
27	Investigation Person Phone									
28	Investigation Person Fax									
29	Investigation Person Address									
30	Investigation Person Affiliation									
31	Investigation Person Roles									
32	Investigation Person Roles Term Accession Number									
33	Investigation Person Roles Term Source REF									
34	Comment (Investigation Person REF)									
35	STUDY									
36	Study Identifier									
37	Study Title									
38	Study Description									
39	Comment (Study Grant Number)									
40	Comment (Study Funding Agency)									
41	Study Submission Date									
42	Study Public Release Date									
43	Study File Name									
44	STUDY DESIGN DESCRIPTIONS									
45	Study Design Type									
46	Study Design Type Term Accession Number									
47	Study Design Type Term Source REF									
48	STUDY PUBLICATIONS									
49	Study PubMed ID									
50	Study Publication DOI									
51	Study Publication Author List									
52	Study Publication Title									
53	Study Publication Status									
54	Study Publication Status Term Accession Number									
55	Study Publication Status Term Source REF									
56	STUDY FACTORS									
57	Study Factor Name									
58	Study Factor Type									
59	Study Factor Type Term Accession Number									
60	Study Factor Type Term Source REF									
61	STUDY ASSAYS									
62	Study Assay Measurement Type									
63	Study Assay Measurement Type Term Accession Number									
64	Study Assay Measurement Type Term Source REF									
65	Study Assay Technology Type									
66	Study Assay Technology Type Term Accession Number									
67	Study Assay Technology Type Term Source REF									
68	Study Assay Technology Platform									
69	Study Assay File Name									
70	STUDY PROTOCOLS									
71	Study Protocol Name									
72	Study Protocol Type									
73	Study Protocol Type Term Accession Number									
74	Study Protocol Type Term Source REF									
75	Study Protocol Version									
76	Study Protocol URI									
77	Study Protocol Parameters									
78	Study Protocol Parameters Name									

a_transcriptome											a_transcriptome										
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2	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
3	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
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13	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
14	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
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16	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
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18	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
19	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
20	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
21	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
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24	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
25	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
26	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
27	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
28	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
29	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
30	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
31	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
32	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
33	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
34	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
35	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
36	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
37	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
38	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
39	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
40	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
41	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
42	Source Name	Characterization	Term	Source	Term	Source	Ref	Sample Name	Factor	Value	Term	Source	Ref	Sample Name	Factor	Value					
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A closer look at ISA(-tab)

Investigation

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1	ONTOLOGY SOURCE REFERENCE									
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3	Term Source File									
4	Term Source Version									
5	Term Source Description									
6	INVESTIGATION									
7	Investigation Identifier									
8	Investigation Title									
9	Investigation Description									
10	Investigation Submission Date									
11	Investigation Public Release Date									
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13	Comment (Last Opened With Configuration)									
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15	Investigation PubMed ID									
16	Investigation Publication DOI									
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18	Investigation Publication Title									
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20	Investigation Publication Status Term Accession Number									
21	Investigation Publication Status Term Source REF									
22	INVESTIGATION CONTACTS									
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32	Investigation Person Roles Term Source REF									
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34	STUDY									
35	Study Identifier									
36	Study Title									
37	Study Description									
38	Comment (Study Grant Number)									
39	Comment (Study Funding Agency)									
40	Study Submission Date									
41	Study Public Release Date									
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70	STUDY PROTOCOLS									
71	Study Protocol Name									
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Study file

Assay file

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1	Source Name	Characteristics (Baker's yeast)	Term	Characteristics (Baker's yeast)	Term	Characteristics (Baker's yeast)	Term	Term	Term	Term
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5	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
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9	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
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21	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
22	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
23	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
24	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
25	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
26	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
27	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
28	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
29	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
30	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
31	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
32	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
33	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
34	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
35	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
36	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
37	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
38	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
39	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
40	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
41	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
42	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
43	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
44	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
45	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
46	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
47	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
48	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
49	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
50	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
51	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
52	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
53	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
54	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
55	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
56	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
57	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
58	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
59	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
60	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
61	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
62	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
63	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
64	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
65	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
66	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
67	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
68	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
69	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
70	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
71	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
72	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
73	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
74	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
75	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
76	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
77	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
78	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
79	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
80	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
81	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
82	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
83	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
84	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
85	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
86	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
87	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
88	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
89	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
90	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
91	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
92	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
93	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
94	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
95	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
96	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
97	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
98	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
99	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
100	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
101	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
102	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
103	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
104	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
105	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
106	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
107	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
108	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
109	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
110	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
111	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
112	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
113	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
114	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
115	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
116	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
117	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
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120	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
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122	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
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124	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
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129	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
130	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
131	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
132	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
133	Source Name	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Characteristics (Baker's yeast)</td><td>Term<td>Term<td>Term<td>Term</td></td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Characteristics (Baker's yeast)</td> <td>Term<td>Term<td>Term<td>Term</td></td></td></td>	Characteristics (Baker's yeast)	Term <td>Term<td>Term<td>Term</td></td></td>	Term <td>Term<td>Term</td></td>	Term <td>Term</td>	Term
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137	Source Name</									



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	A	B	C	D	E	F	G	H	I	J	K
1	ONTOLOGY SOURCE REFERENCE										
2	Term Source Name	DBI	ETO	NDWT	UO	CH-EM	PATO	EPG			
3	Term Source File	http://kcp.sprb.hawaii.edu/ArrayExpress/Experimental_Factor/Ontology									
4	Term Source Version	47893	V.1.25	V.1.26	V.1.26	V.1.26	V.1.26	V.1.26			
5	Term Source Description	Ontology for Biomed BRNDNA tissue / MGMT UnitProt Tax Unit Ontology / Chemical Fat Phenotypic / ArrayExpress Experimental Factor Ontology									
6	INVESTIGATION										
7	Investigation Identifier	88.1.1									
8	Investigation Title	Growth control of the eukaryote cell: a systems biology study in yeast									
9	Investigation Description	Background: cell growth underlies many key cellular and developmental processes, yet the molecular mechanisms of growth control in the eukaryote cell are poorly understood. We wished to study the impact of growth rate on the total complement of mRNA molecules, proteins, and metabolites in <i>S. cerevisiae</i> , independent of any									
10	Investigation Submission Date	2004-07									
11	Investigation Public Release Date	2004-09									
12	Comment [Created With Configuration]										
13	Comment [Last Updated With Configuration]	is:snffg:default_2003-02-15									
14	INVESTIGATION PUBLICATIONS										
15	Investigation PubMed ID	17439646									
16	Investigation Publications DOI	doi:10.1186/1471-2107-4									
17	Investigation Publications Author List	Castillo J, Zeef LA, Hoyle EC, Zhang N, Hayes A, Gardner DC, Cornell MU, Petty J, Hales I, Wardleworth I, Fahs B, Brown M, Mann W3, Broadhurst D, O'Donoghue K									
18	Investigation Publication Title	Growth control of the eukaryote cell: a systems biology study in yeast									
19	Investigation Publication Status Term Accession Number										
20	Investigation Publication Status Term Source REF										
21	INVESTIGATION CONTACTS										
22	Investigation Person Last Name	Stephen	Castillo	Zeef							
23	Investigation Person First Name	Oliver	Joan	Lee							
24	Investigation Person Mid Initials	G	I	A							
25	Investigation Person Email										
26	Investigation Person Phone										
27	Investigation Person Fax										
28	Investigation Person Address	Oxford Road, Manx Oxford Road, Mx Oxford Road, Manchester M13 9PT, UK									
29	Investigation Person Affiliation	Faculty of Life Sciences, Faculty of Life Sciences, Michael Street Building, University of Manchester, corresponding author									
30	Investigation Person Roles										
31	Investigation Person Roles Term Accession Number										
32	Investigation Person Roles Term Source REF										
33	Comment [Investigation Person REF]										
34	STUDY										
35	Study Identifier	30-5.1									
36	Study Title	Study of the impact of changes in flux on the transcriptome, proteome, endometabolome and exometabolome of the yeast <i>S. cerevisiae</i> under									
37	Study Description	We wished to study the impact of growth rate on the total complement of mRNA molecules, proteins, and metabolites in <i>S. cerevisiae</i> , independent of any									
38	Comment [Study Grant Number]										
39	Comment [Study Funding Agency]										
40	Study Submission Date	2004									
41	Study Public Release Date	2004									
42	Study File Name	S_BI5-1.txt									
43	STUDY DESIGN DESCRIPTIONS										
44	Study Design Type	intervention design									
45	Study Design Type Term Accession Number	http://pubs.biomedcentral.com/doi/10.1186/1471-2107-4									
46	Study Design Type Term Source REF	DBI									
47	STUDY PUBLICATIONS										
48	Study PubMed ID	17439646									
49	Study Publication DOI	doi:10.1186/1471-2107-4									
50	Study Publication Author List	Castillo J, Zeef LA, Hoyle EC, Zhang N, Hayes A, Gardner DC, Cornell MU, Petty J, Hales I, Wardleworth I, Fahs B, Brown M, Mann W3, Broadhurst D, O'Donoghue K									
51	Study Publication Title	Growth control of the eukaryote cell: a systems biology study in yeast									
52	Study Publication Status										
53	Study Publication Status Term Accession Number										
54	Study Publication Status Term Source REF										
55	STUDY FACTORS										
56	Study Factor Name	limiting nutrient	rate								
57	Study Factor Type	chemical compound	rate								
58	Study Factor Term Accession Number										
59	Study Factor Term Source REF										
60	STUDY ASSAYS										
61	Study Assay Measurement Type	protein expression	metabolite profile	transcription profiling							
62	Study Assay Measurement Type Term Accession Number	http://pubs.biomedcentral.com/doi/10.1186/1471-2107-4	http://pubs.biomedcentral.com/doi/10.1186/1471-2107-4	424							
63	Study Assay Measurement Type Term Source REF	DBI	DBI	DBI							
64	Study Assay Technology Type	mass spectrometry	mass spectrometry	1D/2D array							
65	Study Assay Technology Type Term Accession Number	http://pubs.biomedcentral.com/doi/10.1186/1471-2107-4	http://pubs.biomedcentral.com/doi/10.1186/1471-2107-4	DBI							
66	Study Assay Technology Type Term Source REF	DBI	DBI	DBI							
67	Study Assay Technology Platform	TRAQ	LC-MS/MS	Affymetrix							
68	Study Assay File Name	a_growth_rate_0001_metabolome.txt	a_growth_rate_0001_metabolome.txt	a_growth_rate_0001_metabolome.txt							
69	STUDY PROTOCOLS										
70	Study Protocol Name	growth protocol	mRNA extraction	protein extraction	protein labeling	protein labeling	protein labeling	protein labeling	protein labeling	protein labeling	protein labeling
71	Study Protocol Type	growth	mRNA extraction	protein extraction	protein labeling	protein labeling	protein labeling	protein labeling	protein labeling	protein labeling	protein labeling
72	Study Protocol Type Term Accession Number										
73	Study Protocol Type Term Source REF										
74	Study Protocol Description	1. biomass samples 2. biomass samples (4x ml) were taken. This was done using a 100 ml centrifuge tube. 3. cells were harvested by centrifugation at 500 x g for 5 min. 4. cells were washed with water. 5. cells were resuspended in 1 ml of water. 6. cells were lysed by vortexing for 30 s. 7. cells were centrifuged at 14,000 x g for 10 min. 8. supernatant was transferred to a clean vial. 9. supernatant was dried by vacuum centrifugation for 2 h. 10. dried samples were stored at -80 C. 11. dried samples were resuspended in 100 µl of water. 12. dried samples were resuspended in 100 µl of water. 13. dried samples were resuspended in 100 µl of water. 14. dried samples were resuspended in 100 µl of water. 15. dried samples were resuspended in 100 µl of water. 16. dried samples were resuspended in 100 µl of water. 17. dried samples were resuspended in 100 µl of water. 18. dried samples were resuspended in 100 µl of water. 19. dried samples were resuspended in 100 µl of water. 20. dried samples were resuspended in 100 µl of water. 21. dried samples 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Study file

Protocols

Assay file

[illegible]



Study

Assay

Investigation

Assay file

Samples



Connecting (i.e. “mapping”) MIAPPE and ISA

Table 1 Mapping between MIAPPE and ISA-Tab sections.

MIAPPE section	ISA-Tab section	ISA-Tab section specification
Investigation	Investigation/investigation publications	
Study	Study/study design descriptors/study protocols	
Person	Investigation contacts/study contacts	
Data file	Study	With comment fields
Biological material	Source	
Environment	Study protocols	Growth type protocol
Experimental factor	Study Factors	
Event	Study protocols	Event type protocols and external Events file
Observation unit	Sample	
Sample	Extract/study protocols	Sampling type protocol
Observed variable	Observed variable	In external trait definition file

The table lists the MIAPPE sections with the ISA-Tab sections holding their fields. MIAPPE-exclusive fields have been added as comments in the corresponding sections. The detailed mapping can be found in Supporting Information Table S1, and in the MIAPPE repository (https://github.com/MIAPPE/MIAPPE/tree/master/MIAPPE_Checklist-Data-Model-v1.1/MIAPPE_mapping).

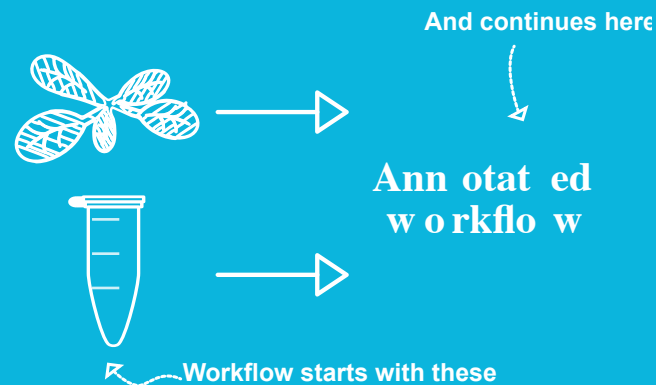
Papoutsoglou, E. A., Faria, D., Arend, D., Arnaud, E., Athanasiadis, I. N., Chaves, I., et al. (2020). Enabling reusability of plant phenomic datasets with MIAPPE 1.1. *New Phytologist*, 227(1), 260–273. <http://doi.org/10.1111/nph.16544>

Source Name

The Source Name column defines the source of biological material used for your experiments. The name used must be a unique identifier. It can be an organism, a sample, or both.

Every annotation table must start with the Source Name column

Source Name
Organism 1
Sample 1
...





<https://nfdi4plants.github.io/AnnotationPrinciples/>



Characteristics

Use characteristics columns to annotate interesting properties of the source material.

You can use any number of characteristics columns.

Source Name	Characteristics [strain]	Characteristics [LabelText]
 Organism 1	Col0	
 Sample 1		smpl- 1
...

Characteristics name in brackets

If there is no value for the respective source, leave blank

<https://nfdi4plants.github.io/AnnotationPrinciples/>

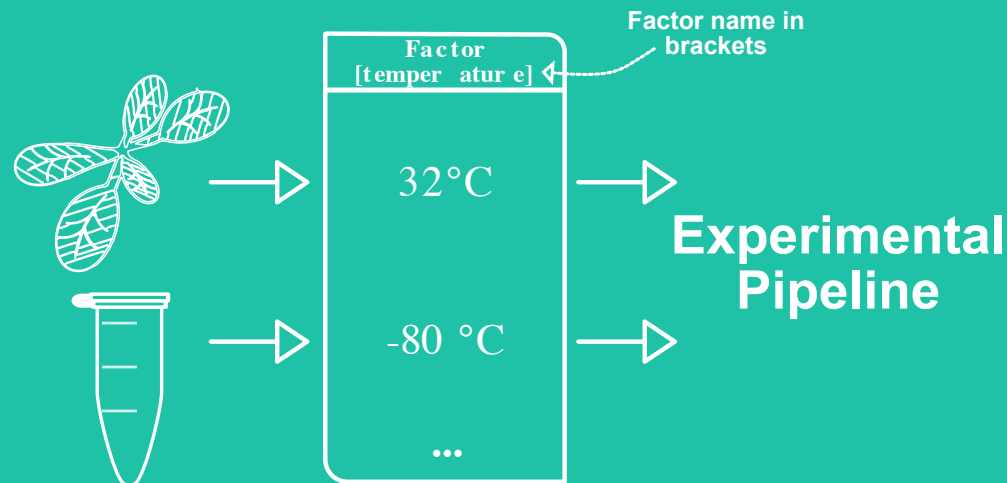




Factor

Use factor columns to track the experimental conditions that govern your study

Most of the time, factors are the most important building blocks for downstream computational analysis.



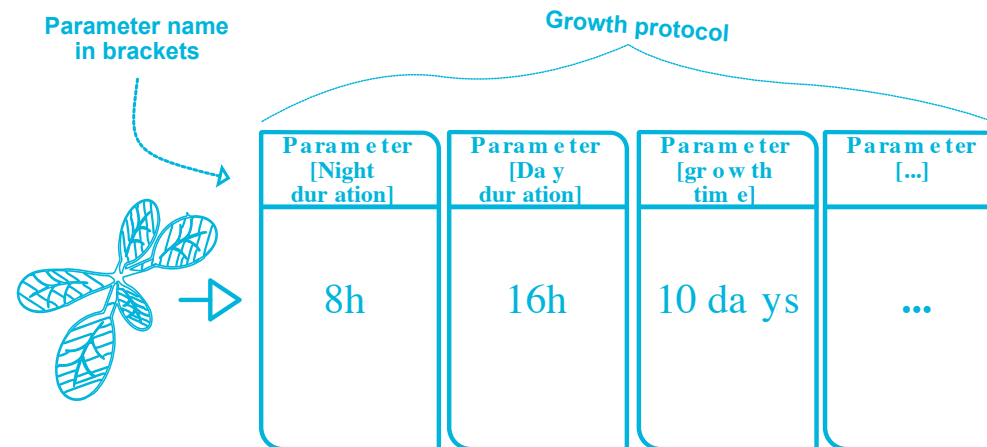
<https://nfdi4plants.github.io/AnnotationPrinciples/>



Parameter

Use parameters to annotate your experimental workflow.

You can group parameters to create a protocol.



<https://nfdi4plants.github.io/AnnotationPrinciples/>

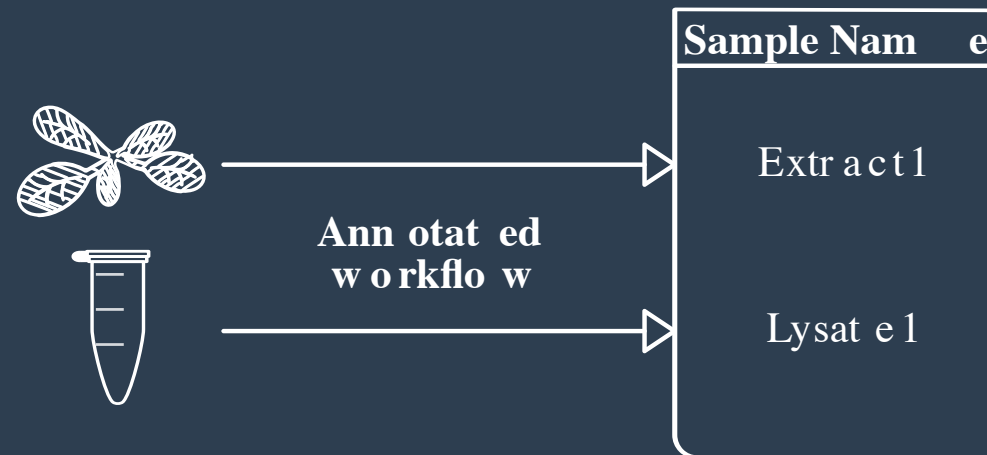




Sample name

The Sample Name column defines the resulting biological material of the annotated workflow. The name used must be a unique identifier.

Samples can again be sources for further experimental workflows.



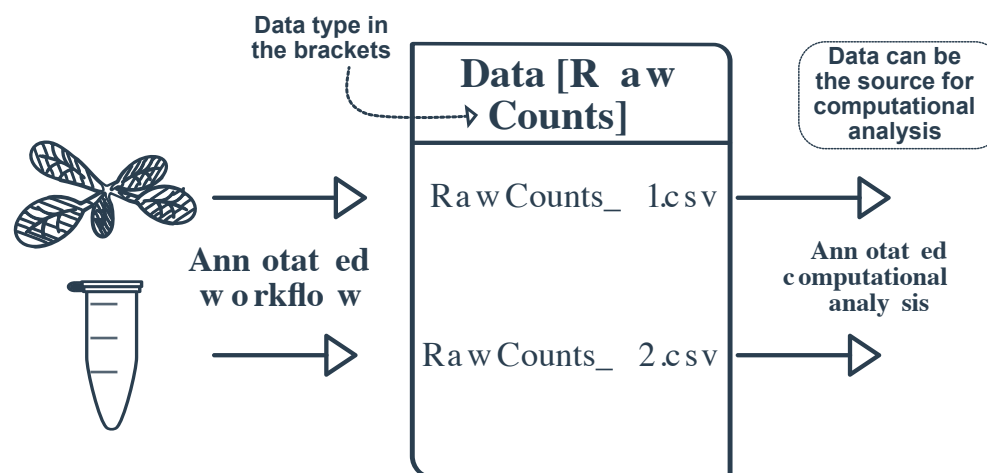
<https://nfdi4plants.github.io/AnnotationPrinciples/>



Data

The Data column describes data files that results from your experiments. Additionally to the type of data, the annotated files must have a unique name.

Data files can be sources for computational workflows.



<https://nfdi4plants.github.io/AnnotationPrinciples/>





A quick word on *words*

Kai joins a CEPLAS lab to pursue a PhD.

His supervisor Frida asks Kai to work on biomass conversion in algae.

Kai

- (1) grows the algae on different ^{13}C -labelled carbon sources
- (2) harvests some cells
- (3) extracts metabolites
- (4) submits the extracts to a metabolomics facility
- (5) where they are measured
- (6) and receives a nice dataset to be analyzed



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Ontologies

Standard for defining terms

- Structures a set of concepts in a particular area and the relations between them in a graph-like manner.
- Can be used in disambiguation, defining hierarchies, a standard to define terms
- Example: EDAM ontology
 - <http://edamontology.org/page>
 - <https://ifb-elixirfr.github.io/edam-browser/>
- Searching for desired terms at
 - <https://bioportal.bioontology.org/>



Ontologies for MIAPPE and ISA models

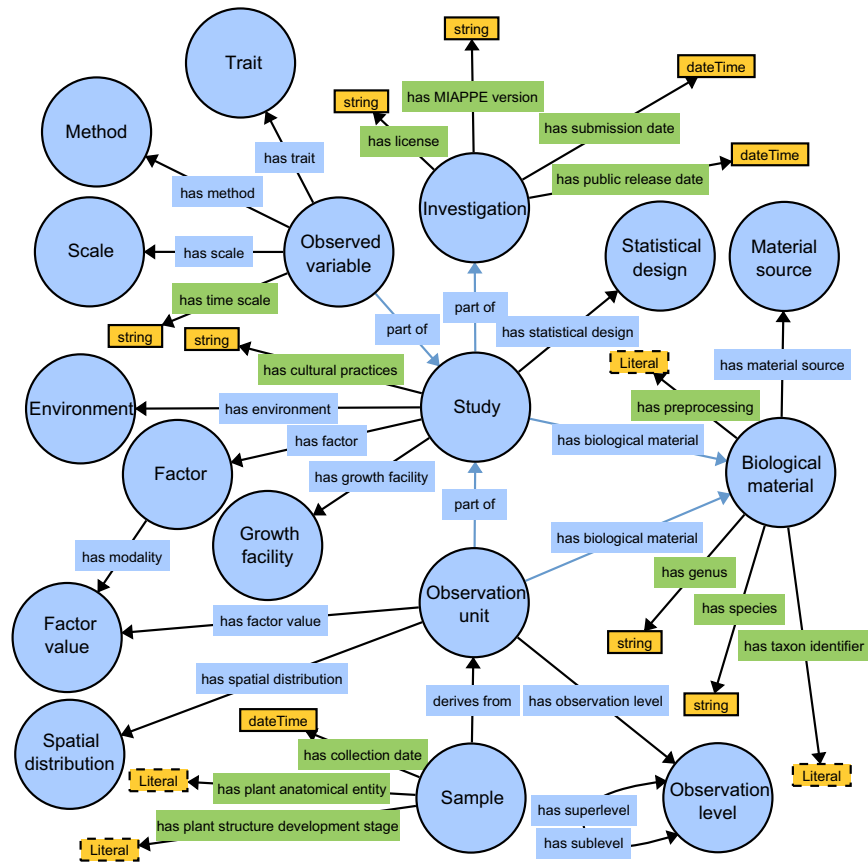
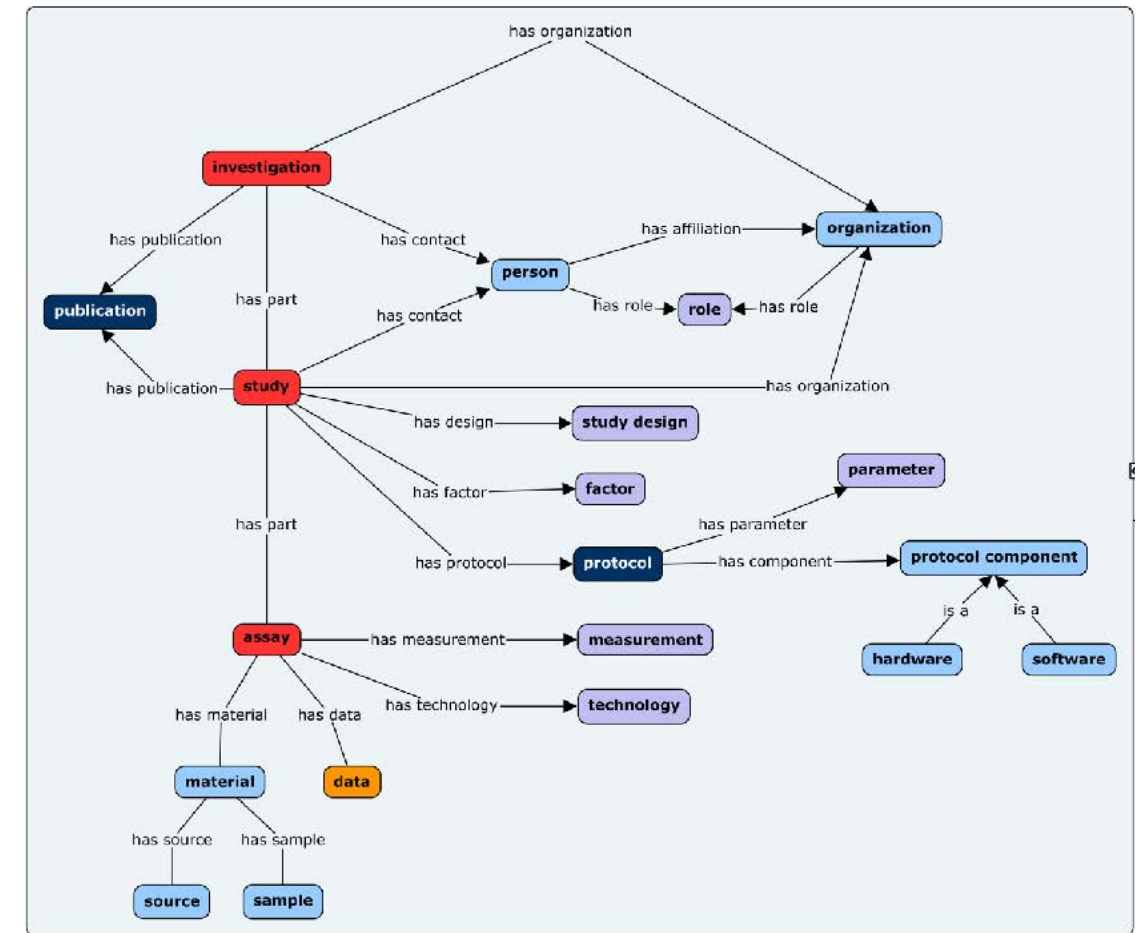


Fig. 1 Subset of the Plant Phenotyping Experiment Ontology representing the MIAPPE data model. Generated using WebVOWL (<http://editor.visualdataweb.org/>) and edited manually. Circles indicate classes. Object properties are shown in blue rectangles, and data properties are shown in green rectangles. Yellow rectangles represent literals.



Papoutsoglou, E. A., Faria, D., Arend, D., Arnaud, E., Athanasiadis, I. N., Chaves, I., et al. (2020). Enabling reusability of plant phenomic datasets with MIAPPE 1.1. *New Phytologist*, 227(1), 260–273. <http://doi.org/10.1111/nph.16544>

<https://isa-specs.readthedocs.io/en/latest/isamodel.html#>

Study

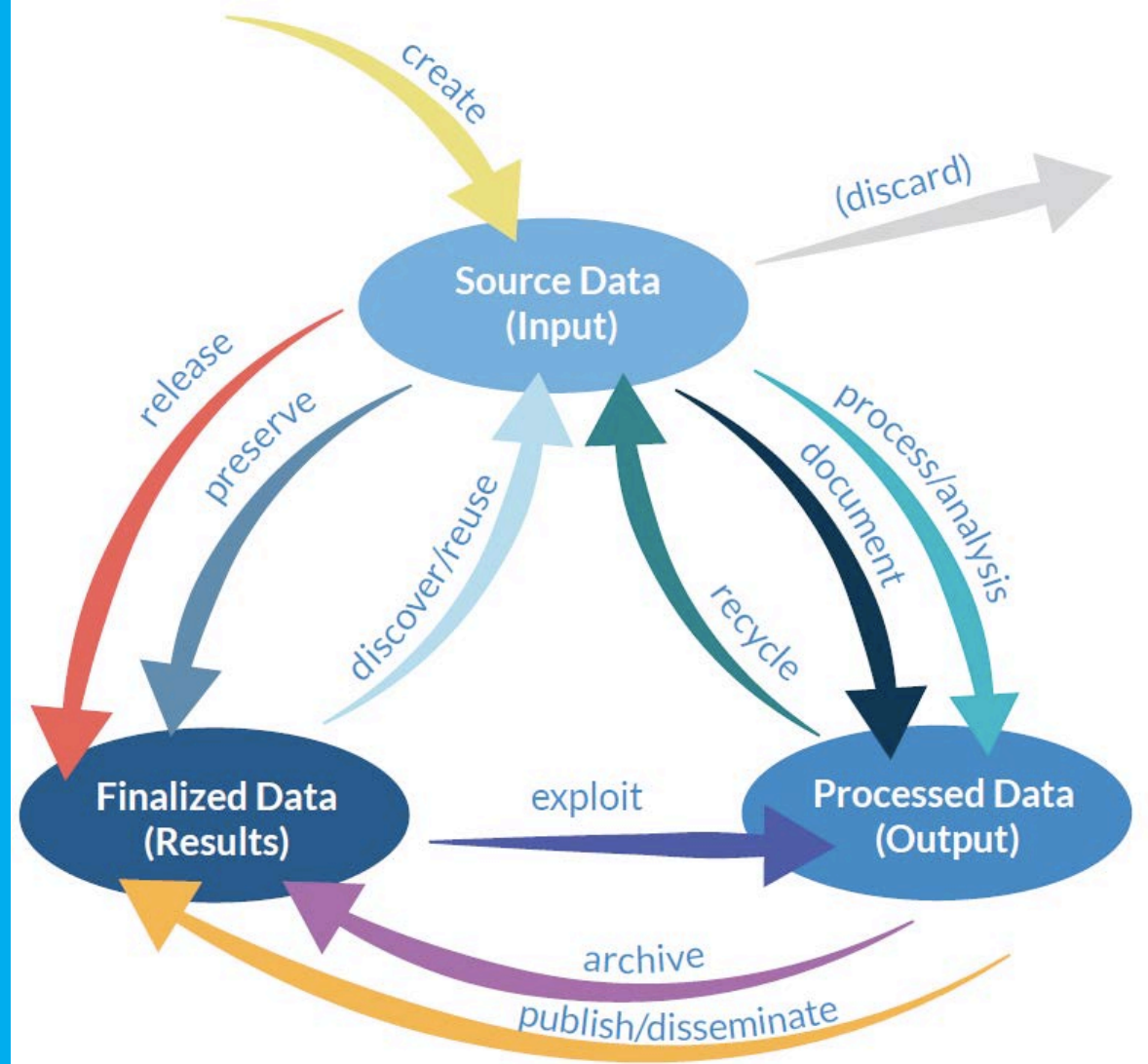
Assay

Investigation[illegible]

CHEB

PATO**OBI**

Processed(ing) Data



Versioning and version control



- It's good to document:
 - What was changed?
 - Who is responsible?
 - When did it happen?
 - Why the changes?



Git and Github hands-on

Why use git?

- Distributed version control system
 - Records changes to our files over time
 - Recall any version at any time
 - Allows easy collaboration on a project
 - Have own version of project files on their own computers



Version control

Revision control, source control

- Managing multiple versions of documents
 - Yourself
 - Time machine to go back to older versions
 - Team projects
 - Simplifies concurrent work & merging changes



Why use git?

- Store revisions as project history in one directory
- Rewind to any revision in the project
- Work on new features without messing with the main code
- Easily collaborate with others





- Online service to host our projects
- Share our code with other developers
- Others can download our projects and work on them
- They can upload their changes and merge them with the main project





Installing git

Basic commands

- <https://git-scm.com/downloads>
- ubuntu : `sudo apt install git-all`
-

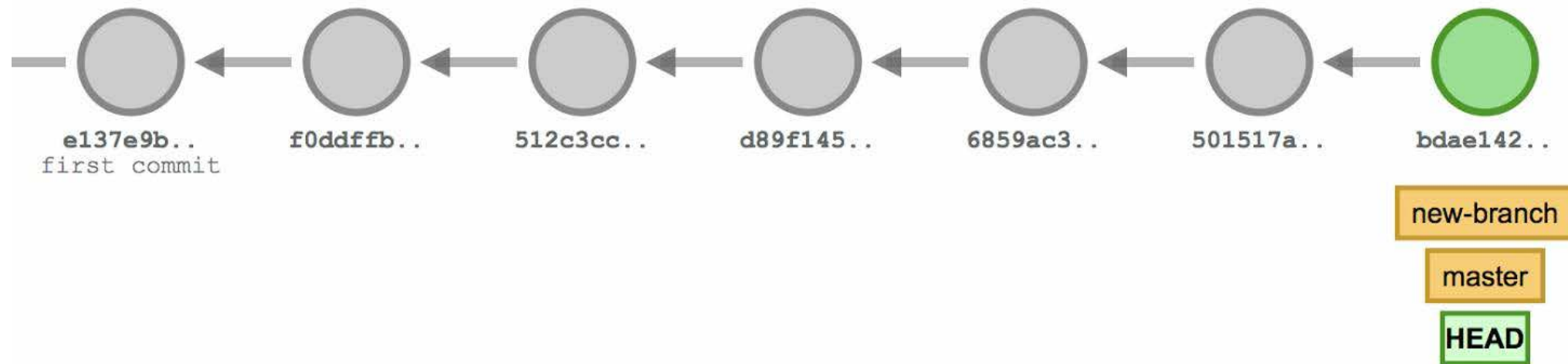


- A repo is a container for a project that you want to track with Git
- One can have different repos for different projects on your computer
- Like project folders where git tracks the contents for us
- - - demo





Git commits and history



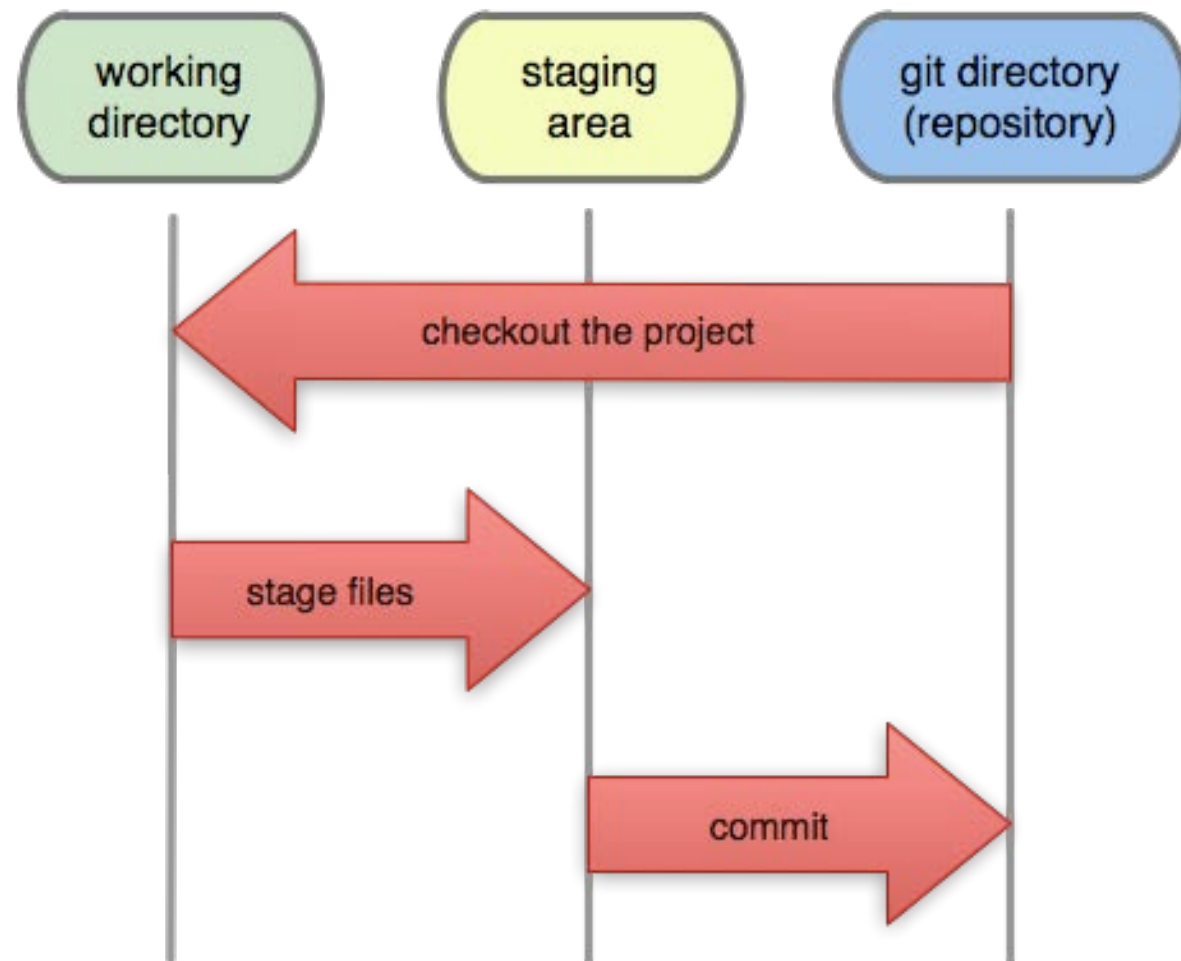
https://trailhead.salesforce.com/de/content/learn/modules/git-and-git-hub-basics/work-with-your-history-in-git?trail_id=set-up-your-workspace-and-install-developer-tools





Git workflow

- Modified
 - Changed files, not committed
- Staging
 - Add any changed files to staging that will be committed
- Committed
 - Files in the staging area are finally committed to the remote repo



<https://i.stack.imgur.com/zLTpo.png>



Create a Git Repo

- Checking the status
- Staging the changes
- Committing the changes
- Summary of commits
-





Commit history

- Checkout commit
- Revert commit
- Reset commit





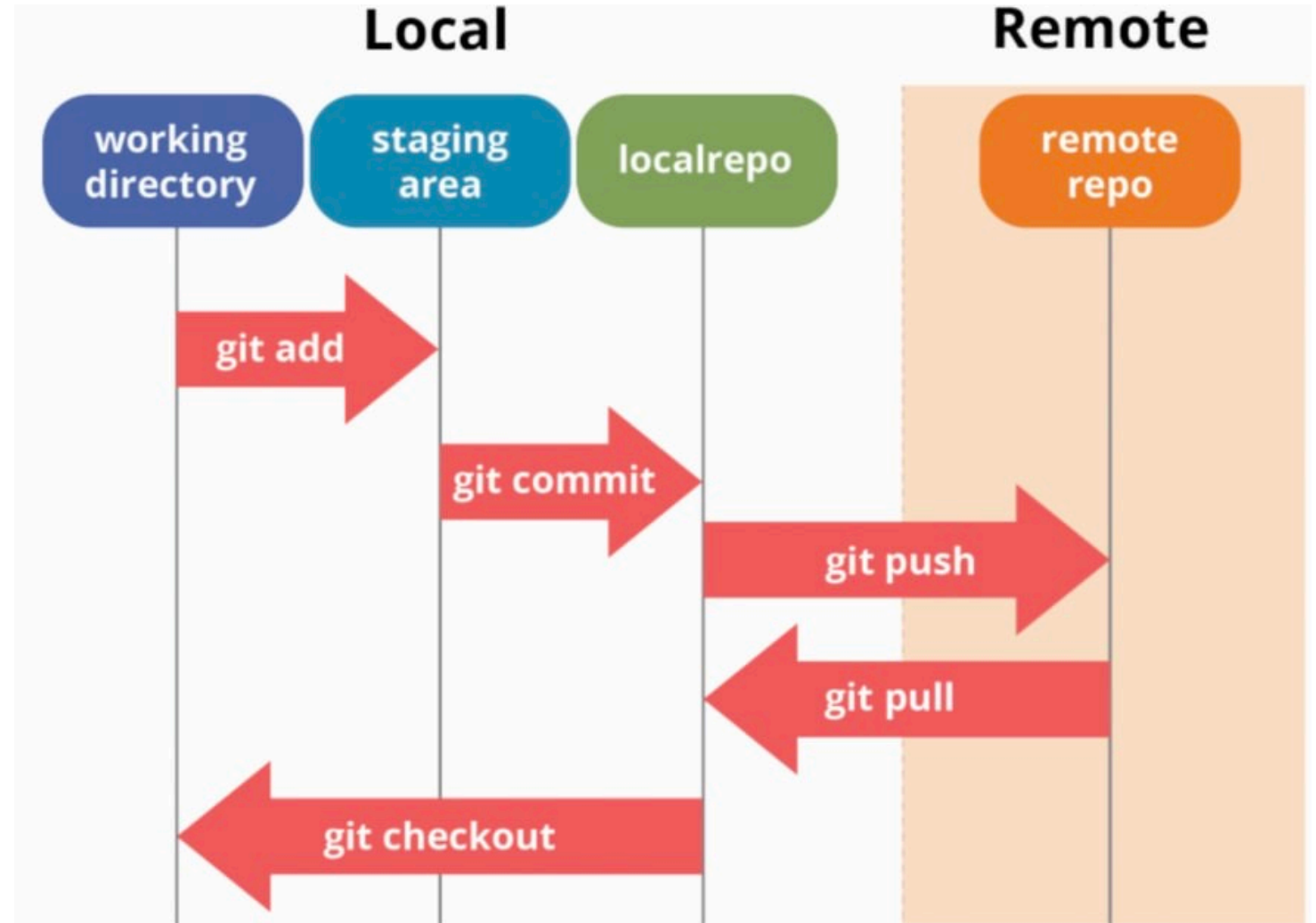
Working with branches

- Creating a branch
- Checking out a branch
- Deleting a branch
- Merging a branch with master
-



Git remote repo

- Sign-in to github
- Create a remote repo
- Upload your changes
- Using remote repos






https://res.cloudinary.com/practicaldev/image/fetch/s--M_fHUEqA--/c_limit%2Cf_auto%2Cfl_progressive%2Cq_auto%2Cw_880/https://thepracticaldev.s3.amazonaws.com/i/128hsgntnsu9bww0y8sz.png



Save your work !

In case of fire



-  1. **git commit**
-  2. **git push**
-  3. **leave building**

<https://bids.github.io/dats/posts/2018-09-10-github-oss.html>

Storage and backup



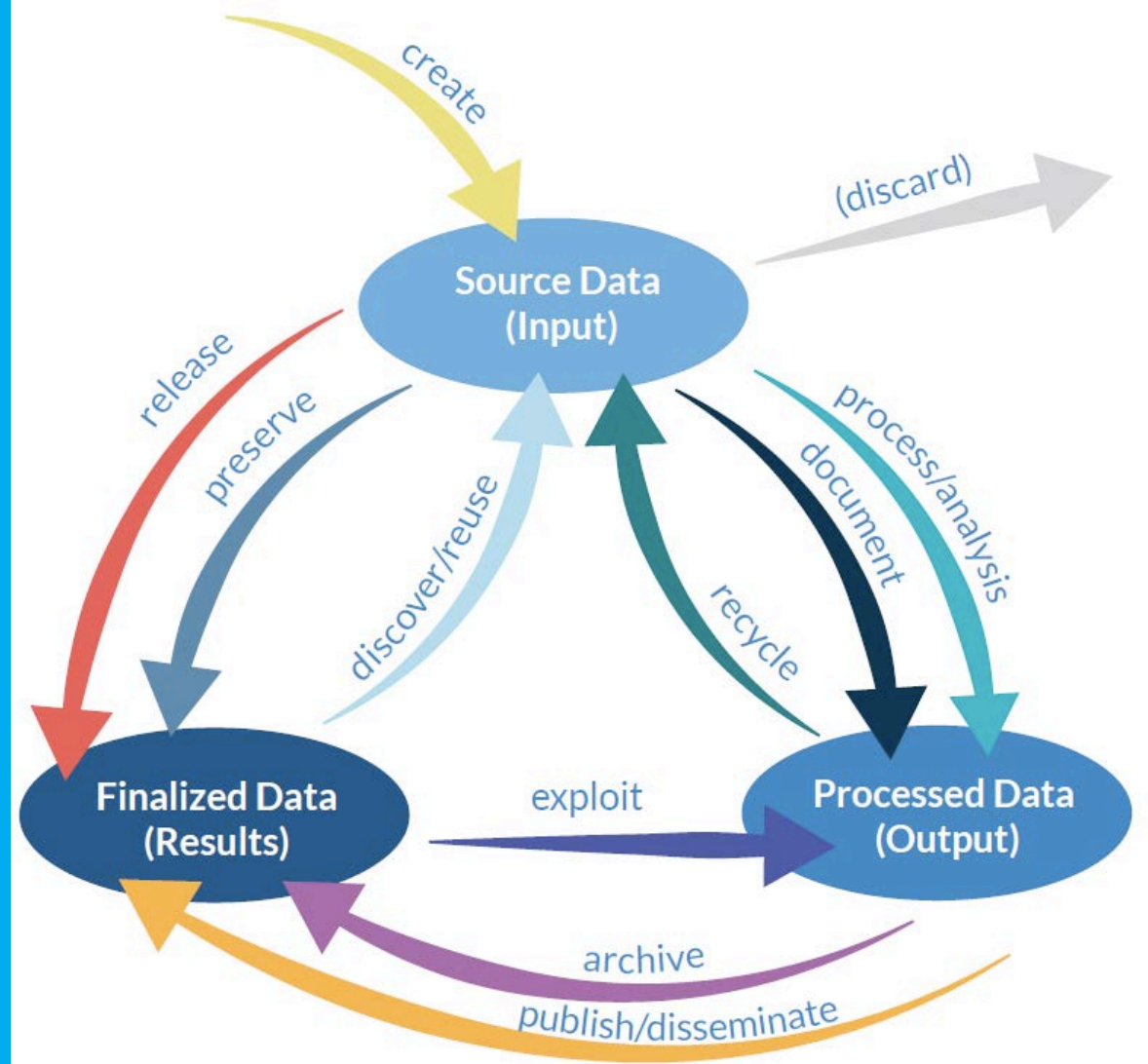
Storage and backup

- Storage plan is integral to DM
 - How will data be stored and protected
 - Short-term vs. Long-term
 - Appropriate tiers, proper security
 - Store locally on servers or in the cloud
 - (Documented) plan to maintain system



<https://www.thesslstore.com/blog/wp-content/uploads/2020/05/3-2-1-backup-rule.png>

Process-ing/ed Data



Digital Documentation



Digital documentation

*Of **anything** from green house to digital data object*

- Electronic lab notebook
 - Lab methods
 - Sample processing

- (Computational) processing steps
 - Data processing (excel sheets)
 - Analyses (excel, code, etc.)
 - Keep track of tools, versions and parameters used



Cataloging

To connect lab knowledge and resources

code	name
VEC	Vector
INS	Instrument
MTH	Method
PRM	Primer
INV	Investigation
EQP	Equipment
PLL	Plant line
ASY	Assay
SDY	Study



- HHU instance
 - <https://elabftw.hhu.de/login.php>
 - Register at <https://elabftw.hhu.de/register.php>
 - Team “CEPLAS Demo”
 - Use your @hhu.de or @uni-koeln.de email address
- More info: <https://www.fdm.hhu.de/fdm-tools/elektronische-laborbuecher.html>
- General demo: <https://demo.elabftw.net/login.php>



Word (.docx) alternatives (towards code)

For documents, articles, slides:

- Latex (<https://www.latex-project.org>)
 - See also: <https://www.overleaf.com>
- Markdown (<https://daringfireball.net/projects/markdown/>)
 - See also: <https://pad.hhu.de> or <https://demo.hedgedoc.org/>

For (interactive, commented) code:

- Rmarkdown (<https://rmarkdown.rstudio.com/>)
- Jupyter Notebooks (<https://jupyter.org/>)



- Please do not open markdown (.md) files in MS word
- Recommended text editors with code highlighting
 - BBEdit <https://www.barebones.com/products/bbedit/>
 - Sublime <https://www.sublimetext.com/>
 - Visual Studio Code <https://code.visualstudio.com/>
 - Atom <https://atom.io>
- These highlight the structure / hierarchy of markdowns and make them a bit more comprehensible than pure text editors



Computational workflows

Standards and management tools

- Describe analysis workflows and tools
- Make them portable and scalable
- across a variety of environments (software and hardware)



<https://www.docker.com>

nextflow

<https://www.nextflow.io>

nf-core 

<https://nf-co.re/>



<https://www.commonwl.org>



<https://snakemake.github.io>

 Galaxy
EUROPE

<https://galaxyproject.eu/>

Data Sharing



Sharing data with collaborators

- Data sharing agreement
 - what (meta)data or code
 - to whom
 - when
 - where (how)
 - for what purpose
- Regulate appropriate attribution (e.g. citation)

Registries and persistent IDs (PIDs)



Good URIs (Uniform Resource Identifiers)

- Globally unique
 - One URI should never refer to two different concepts at the same time
- Persistent
 - A URI should continue to resolve for the foreseeable future
- Stable
 - A URI should never be re-used [...] even if the original is deleted
- Resolvable
 - A URI should redirect to a suitable document

Adapted from https://www.ebi.ac.uk/rdf/documentation/good_practice_uri/





Globally unique, stable, persistent identifiers (PIDs)

- Make data, digital objects, people, ... uniquely identifiable
- See also
 - <https://pidservices.org/>
 - <https://datacite.org>
 - <https://www.project-freya.eu/en>

People



Open Researcher and Contributor ID (<https://orcid.org/>)

Digital objects



Digital Object Identifier (<https://www.doi.org>)



ePIC consortium (<https://www.pidconsortium.net>)

Resources



Research Resource Identifiers (<https://www.rrids.org>)

Institutions



Research Organization Registry (<https://ror.org>)



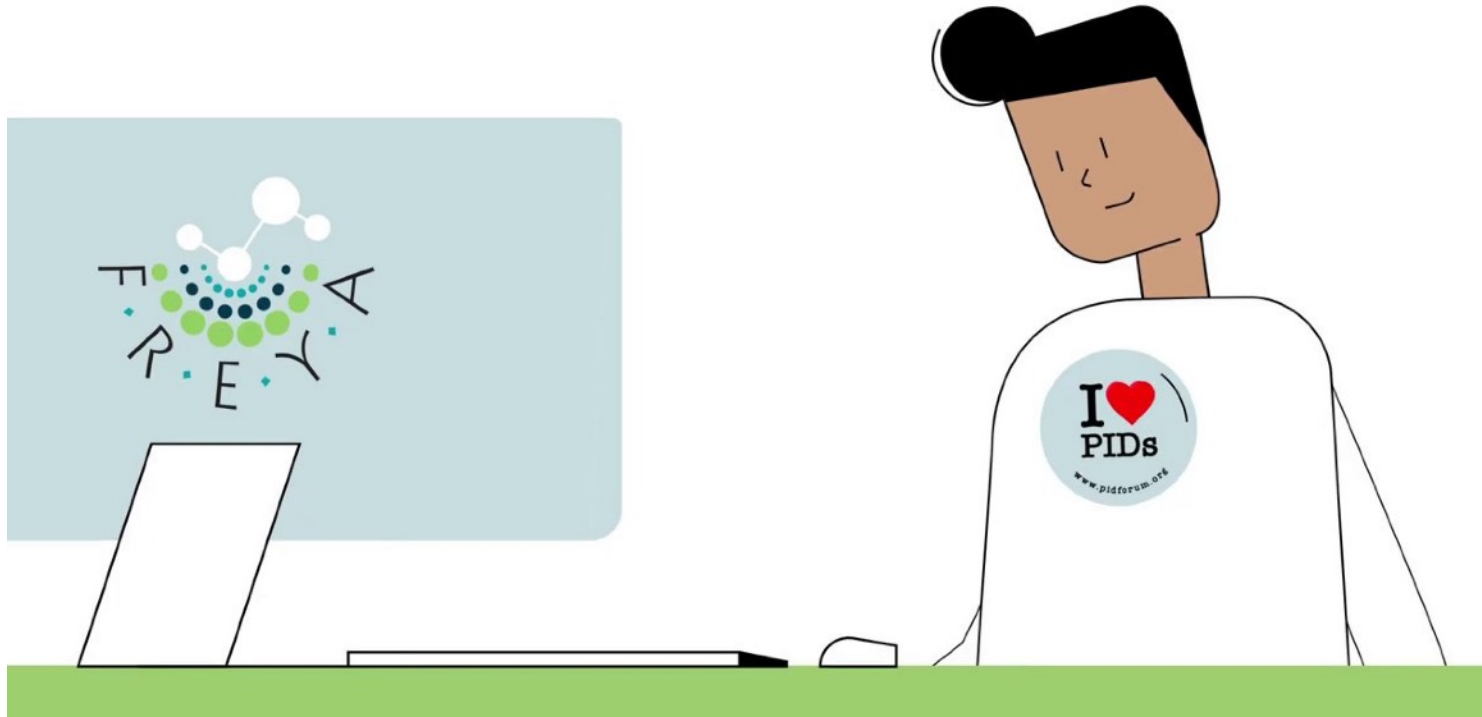
Global Research Identifier Database (<https://grid.ac>)

CEPLAS:
<https://ror.org/034waa237>

CEPLAS:
<https://grid.ac/institutes/grid.503026.2>



Freya Project on PIDs



<https://www.project-freya.eu/en>

There's also a PIDapalooza festival...

<https://www.pidapalooza.org/upcoming-festival>

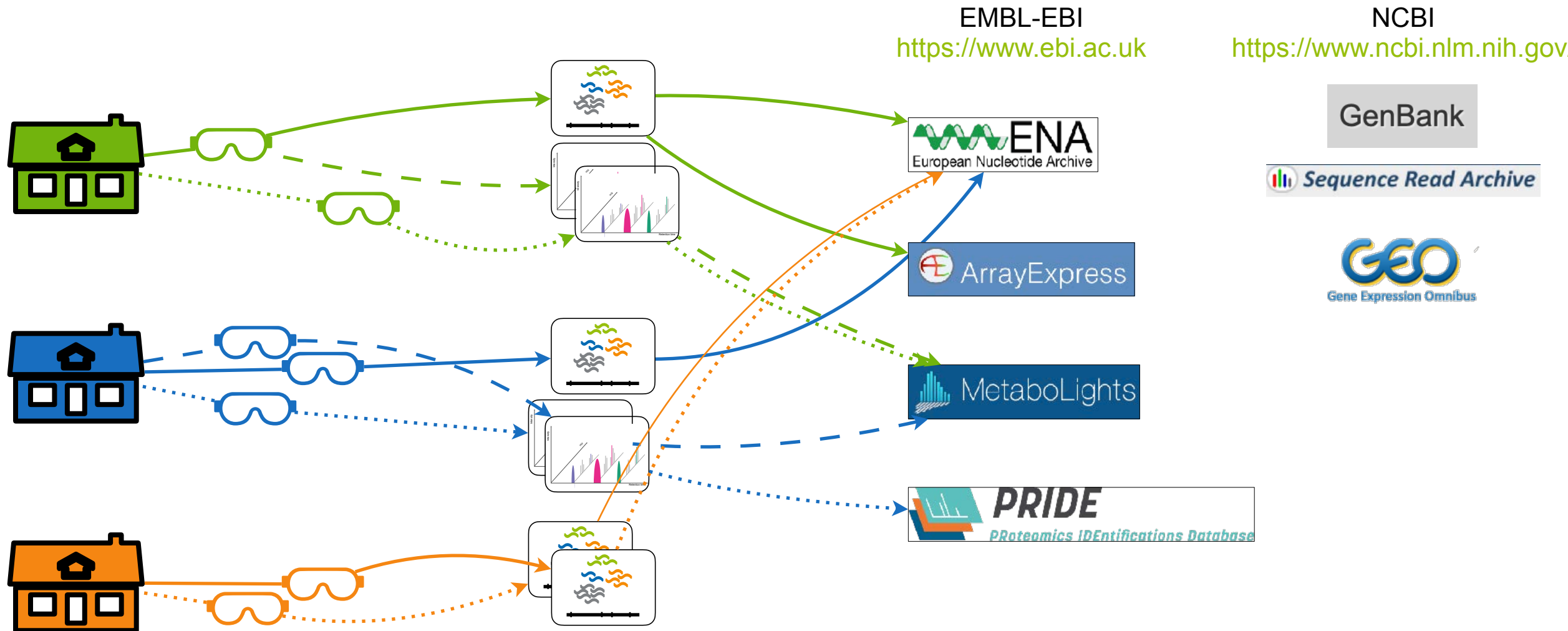


Public data repositories



Public domain-specific repositories

Examples for public end-point repositories of biological data hosted at





Public domain-specific repositories

	EBI	NCBI	Others
genome	EBI-ENA https://www.ebi.ac.uk/ena/	NCBI-GenBank https://www.ncbi.nlm.nih.gov/genbank/ NCBI-SRA https://www.ncbi.nlm.nih.gov/sra/	
imaging, microscopy	EBI-BioImage Archive https://www.ebi.ac.uk/bioimage-archive/ EBI-EMPIAR https://www.ebi.ac.uk/pdbe/emdb/empiar/		
meta - projects	EBI-BioStudies https://www.ebi.ac.uk/biostudies/	NCBI-BioProject https://www.ncbi.nlm.nih.gov/bioproject/	
meta - samples	EBI-BioSamples https://www.ebi.ac.uk/biosamples/	NCBI-BioSample https://www.ncbi.nlm.nih.gov/biosample	
metabolome	EBI-MetaboLights https://www.ebi.ac.uk/metabolights/		Metabolomics Workbench https://www.metabolomicsworkbench.org/
modeling	EBI-BioModels https://www.ebi.ac.uk/biomodels/		
phenome			e!DAL-PGP https://edal.ipk-gatersleben.de/index.html
proteome	EBI-PRIDE https://www.ebi.ac.uk/pride/		
transcriptome - quantification	EBI-ArrayExpress https://www.ebi.ac.uk/arrayexpress/	NCBI-GEO https://www.ncbi.nlm.nih.gov/geo/	
transcriptome - sequences	EBI-ENA https://www.ebi.ac.uk/ena/	NCBI-SRA https://www.ncbi.nlm.nih.gov/sra/	



- Zenodo <https://zenodo.org>
 - DRYAD <https://datadryad.org/>
 - FigShare <https://figshare.com>
-
- R3DATA Registry of Research Data Repositories <https://www.re3data.org>

Data Management Plan



The Data Management Plan (DMP)

- Helps you document and plan ***all*** your data management activities
- Covers the full research data lifecycle
- Frequently updated as your project develops
- Guidelines / templates:
 - <http://www.dcc.ac.uk/resources/data-management-plans>
 - https://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-data-mgt_en.pdf
 - <https://dmponline.dcc.ac.uk>
 - <https://ds-wizard.org>



Conclusion / Take-home

(i.e. “Do I need to remember all of these”)



Please be aware:

The following slides exemplarily show practices to get started with FAIR data management.

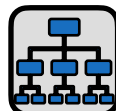
These examples are not the specific recommendations for data management within CEPLAS.



You can take action towards FAIR data **today!**

1

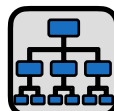
Rich metadata



2

Conventions for

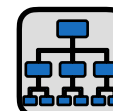
- folder structures -
- file naming -
- IDs -



3

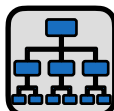
Digital documentation

- workflows -
- analyses -



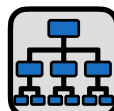
4

Versioning



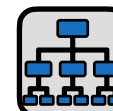
5

Storage and back-up plan



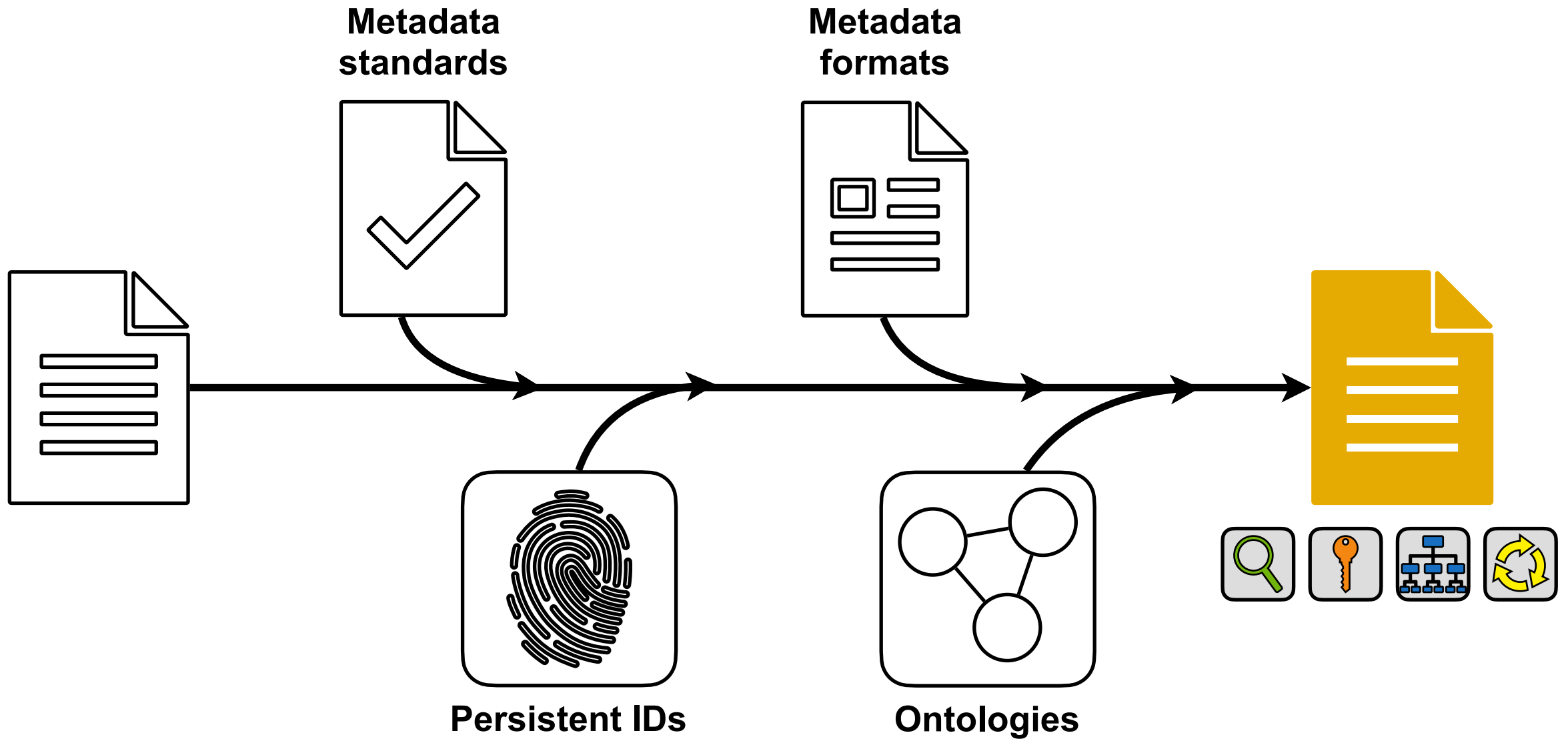
6

Data use agreements





From README to rich metadata



- R1: Freeze-backup the "current state" (i.e. bulk of data as handed to you).
- R2: Separate and structure datasets according to "ISA model"
 - → (example) folder structure with ARC incorporated
- R3: Annotate with rich metadata
 - Add a "README" on Investigation / study levels into the folders, based on:
<https://github.com/nfdi4plants/ARC/blob/master/isa.investigation.xlsx>
 - If you miss parameters add them in the first column using "Comment[*missing item*]"
- R4: Try to shape all data (experiment annotation, genes and functional annotation, raw data) into a single (data frame format) table
- R5: Check with PI, what data can be shared with whom
 - If your raw data is packed into little (ARC) packages (study, assay) together with rich metadata (incl. experiment conditions, contributors, protocols, etc.) it can be shared self-explanatory and referencable.
- R7: Document all of the above in a "FAIRification" document.