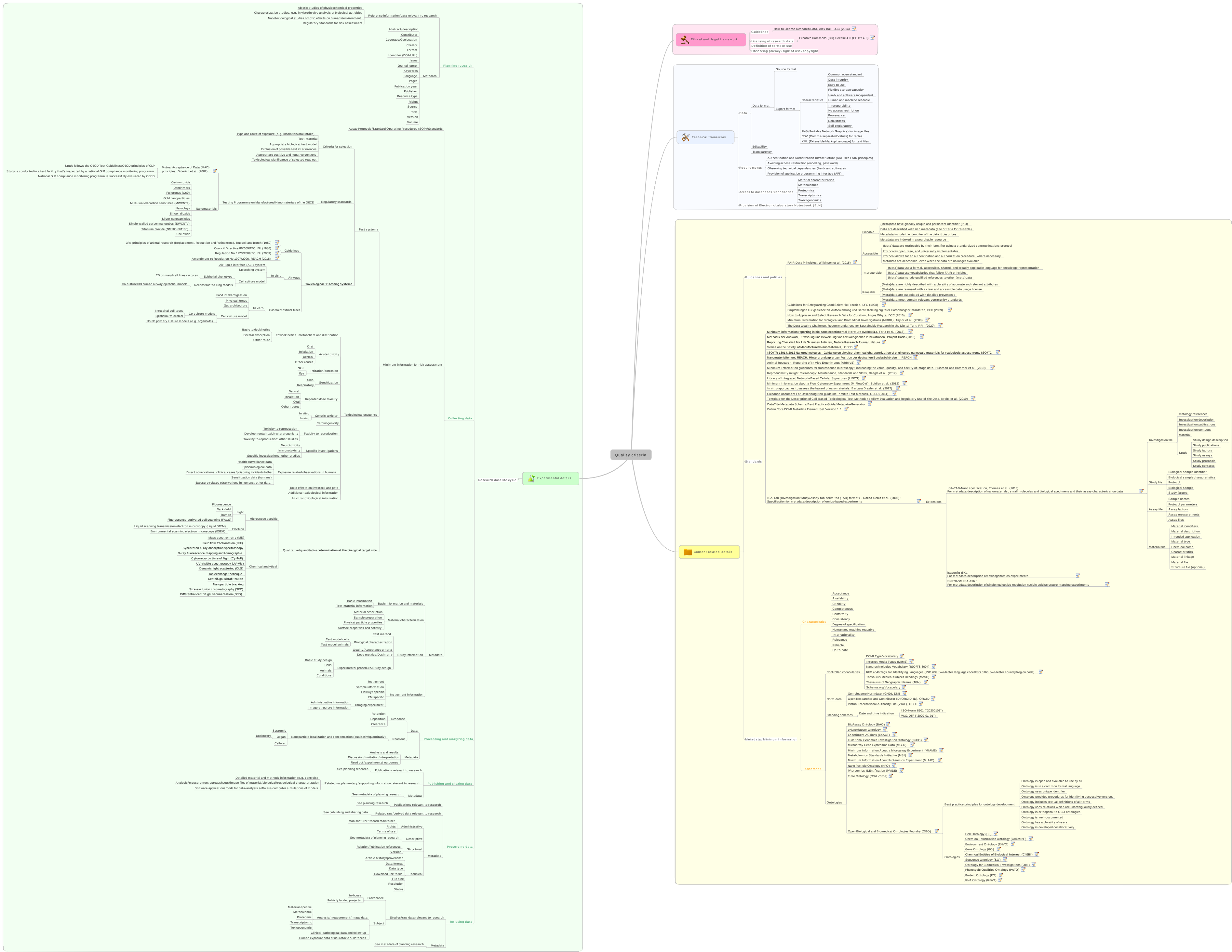

Quality criteria
Experimental details
Research data life cycle
Planning research
Reference information/data relevant to research
Abiotic studies of physicochemical properties
Characterization studies, e.g. in vitro/in vivo analysis of biological activities
Nanotoxicological studies of toxic effects on humans/environment
Regulatory standards for risk assessment
Metadata
Abstract/description
Contributor
Coverage/Geolocation
Creator
Format
Identifier (DOI-URL)
Issue
Journal name
Keywords
Language
Pages
Publication year
Publisher
Resource type
Rights
Source
Title
Version
Volume
Collecting data
Assay Protocols/Standard Operating Procedures (SOP)/Standards
Test systems
Criteria for selection
Type and route of exposure (e.g. inhalation/oral intake)
Test material
Appropriate biological test model
Exclusion of possible test interferences
Appropriate positive and negative controls
Toxicological significance of selected read out
Regulatory standards
Mutual Acceptance of Data (MAD) principles, Diderich et al. (2007)
Study follows the OECD Test Guidelines/OECD principles of GLP
Study is conducted in a test facility that's inspected by a national GLP compliance monitoring programm
National GLP compliance monitoring programm is successfully evaluated by OECD
Testing Programme on Manufactured Nanomaterials of the OECD
Nanomaterials
Cerium oxide
Dendrimers
Fullerenes (C60)
Gold nanoparticles
Multi-walled carbon nanotubes (MWCNTs)
Nanoclays
Silicon dioxide
Silver nanoparticles
Single-walled carbon nanotubes (SWCNTs)
Titanium dioxide (NM100-NM105)
Zinc oxide
Toxicological 3D testing systems
Guidelines
3Rs principles of animal research (Replacement, Reduction and Refinement), Russell and Borch (1959)
Council Directive 86/609/EEC, EU (1986)
Regulation No 1223/2009/EC, EU (2009)
Amendment to Regulation No 1907/2006, REACH (2018)
Airways
In vitro
Air-liquid interface (ALI) system
Stretching system
Cell culture model
Epithelial phenotype
2D primary/cell lines cultures
Reconstructed lung models
Co-culture/3D human airway epithelial models
Gastrointestinal tract
In vitro
Food intake/digestion
Physical forces
Gut architecture
Cell culture model
Co-culture models
Intestinal cell types
Epithelial/microbial
2D/3D primary culture models (e.g. organoids)
Minimum information for risk assessment
Toxicological endpoints
Toxicokinetics, metabolism and distribution
Basic toxicokinetics
Dermal absorption
Other route
Acute toxicity
Oral
Inhalation
Dermal
Other routes
Irritation/corrosion
Skin
Eye
Sensitization
Skin
Respiratory
Repeated dose toxicity
Dermal
Inhalation
Oral
Other routes
Genetic toxicity
In vitro
In vivo
Carcinogenicity
Toxicity to reproduction
Toxicity to reproduction
Developmental toxicity/teratogenicity
Toxicity to reproduction: other studies
Specific investigations
Neurotoxicity
Immunotoxicity
Specific investigations: other studies
Exposure related observations in humans
Health surveillance data
Epidemiological data
Direct observations: clinical cases/poisoning incidents/other
Sensitization data (humans)
Exposure related observations in humans: other data
Toxic effects on livestock and pets
Additional toxicological information
In vitro toxicological information
Qualitative/quantitative determination at the biological target site
Microscope specific
Light
Fluorescence
Dark-field
Raman
Fluorescence-activated cell scanning (FACS)
Electron
Liquid scanning transmission electron microscopy (Liquid STEM)
Environmental scanning electron microscope (ESEM)
Chemical analytical
Mass spectrometry (MS)
Field flow fractionation (FFF)
Synchroton X-ray absorption spectroscopy
X-ray fluorescence mapping and tomographie
Cytometry by time of flight (Cy-ToF)
UV-visible spectroscopy (UV-Vis)
Dynamic light scattering (DLS)
Ion exchange technique
Centrifugal ultrafiltration
Nanoparticle tracking
Size-exclusion chromatography (SEC)
Differential centrifugal sedimentation (DCS)
Metadata
Basic information and materials
Basic information
Test material information
Material characterization
Material description
Sample preparation
Physical particle properties
Surface properties and activity
Study information
Test method
Biological characterization
Test model cells
Test model animals
Quality/Acceptance criteria
Dose metrics/Dosimetry
Experimental procedure/Study design
Basic study design
Cells
Animals
Conditions
Instrument information
Instrument
Sample information
FlowCyt specific
EM specific
Imaging experiment
Administrative information
Image-structure information
Processing and analyzing data
Data
Response
Retention
Deposition
Clearance
Read out
Nanoparticle localization and concentration (qualitativ/quantitativ)
Dosimetry
Systemic
Organ
Cellular
Metadata
Analysis and results
Discussion/limitation/interpretation
Read out/experimental outcomes
Publishing and sharing data
Publications relevant to research
See planning research
Related supplementary/supporting information relevant to research
Detailed material and methods information (e.g. controls)
Analysis/measurement spreadsheets/image files of material/biological/toxicological characterization
Software applications/code for data-analysis software/computer simulations of models
Metadata
See metadata of planning research
Preserving data
Publications relevant to research
See planning research
Related raw/derived data relevant to research
See publishing and sharing data
Metadata
Administrative
Manufacturer/Record maintainer
Rights
Terms of use
Descriptive
See metadata of planning research
Structural
Relation/Publication references
Version
Technical
Article history/provenance
Data format
Data type
Download link to file
File size
Resolution
Status
Re-using data
Studies/raw data relevant to research
Provenance
In-house
Publicly funded projects
Subject
Analysis/measurement/image data
Material-specific
Metabolomic
Proteomic
Transcriptomic
Toxicogenomic
Clinical-pathological data and follow up
Human exposure data of neurotoxic substances
Metadata
See metadata of planning research
Ethical and legal framework
Guidelines
How to License Research Data, Alex Ball, DCC (2014)
Licensing of research data
Creative Commons (CC) License 4.0 (CC BY 4.0)
Definition of terms of use
Observing privacy / right of use / copyright
Technical framework
Data
Data format
Source format
Export format
Characteristics
Common open standard
Data integrity
Easy to use
Flexible storage capacity
Hard- and software independent
Human and machine readable
Interoperability
No access restriction
Provenance
Robustness
Self-explanatory
PNG (Portable Network Graphics) for image files
CSV (Comma-separated Values) for tables
XML (Extensible Markup Language) for text files
Editability
Transparency
Requirements
Authentication and Authorization Infrastructure (AAI; see FAIR principles)
Avoiding access restriction (encoding, password)
Observing technical dependencies (hard- and software)
Provision of application programming interface (API)
Access to databases / repositories
Material characterization
Metabolomics
Proteomics
Transcriptomics
Toxicogenomics
Provision of Electronic Laboratory Notesbook (ELN)
Content-related details
Guidelines and policies
FAIR Data Principles, Wilkinson et al. (2016)
Findable
(Meta)data have globally unique and persistent identifier (PID)
Data are described with rich metadata (see criteria for reusable)
Metadata include the identifier of the data it describes
Metadata are indexed in a searchable resource
Accessible
(Meta)data are retrievable by their identifier using a standardized communications protocol
Protocol is open, free, and universally implementable
Protocol allows for an authentication and authorization procedure, where necessary
Metadata are accessible, even when the data are no longer available
Interoperable
(Meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation
(Meta)data use vocabularies that follow FAIR principles
(Meta)data include qualified references to other (meta)data
Reusable
(Meta)data are richly described with a plurality of accurate and relevant attributes
(Meta)data are released with a clear and accessible data usage license
(Meta)data are associated with detailed provenance
(Meta)data meet domain-relevant community standards
Guidelines for Safeguarding Good Scientific Practice, DFG (1998)
Empfehlungen zur gesicherten Aufbewahrung und Bereitstellung digitaler Forschungsprimärdaten, DFG (2009)
How to Appraise and Select Research Data for Curation, Angus Whyte, DCC (2010)
Minimum Information for Biological and Biomedical Investigations (MIBBI), Taylor et al. (2008)
The Data Quality Challenge. Recommendations for Sustainable Research in the Digital Turn, RFII (2020)
Standards
Minimum information reporting in bio-nano experimental literature (MIRIBEL), Faria et al. (2018)
Methodik der Auswahl, Erfassung und Bewertung von toxikologischen Publikationen, Projekt DaNa (2016)
Reporting Checklist For Life Sciences Articles, Nature Research Journal, Nature
Series on the Safety of Manufactured Nanomaterials, OECD
ISO/TR 13014:2012 Nanotechnologies - Guidance on physico-chemical characterization of engineered nanoscale materials for toxicologic assessment, ISO/TC
Nanomaterialien und REACH. Hintergrundpapier zur Position der deutschen Bundesbehörden, REACH
Animal Research: Reporting of In Vivo Experiments (ARRIVE)
Minimum Information guidelines for fluorescence microscopy: increasing the value, quality, and fidelity of image data, Huisman and Hammer et al. (2019)
Reproducibility in light microscopy: Maintenance, standards and SOPs, Deagle et al. (2017)
Library of Integrated Network-Based Cellular Signatures (LINCS)
Minimum Information about a Flow Cytometry Experiment (MIFlowCyt), Spidlen et al. (2012)
In vitro approaches to assess the hazard of nanomaterials, Barbara Drasler et al. (2017)
Guidance Document For Describing Non-guideline In Vitro Test Methods, OECD (2014)
Template for the Description of Cell-Based Toxicological Test Methods to Allow Evaluation and Regulatory Use of the Data, Krebs et al. (2019)
DataCite Metadata Schema/Best Practice Guide/Metadata-Generator
Dublin Core DCMI Metadata Element Set Version 1.1
ISA-Tab (Investigation/Study/Assay tab-delimited (TAB) format), Rocca-Serra et al. (2008):
Specifiaction for metadata description of omics-based experiments
Extensions
ISA-TAB-Nano specification, Thomas et al. (2013):
For metadata description of nanomaterials, small molecules and biological specimens and their assay characterization data
Investigation file
Ontology references
Investigation description
Investigation publications
Investigation contacts
Material
Study
Study design description
Study publications
Study factors
Study assays
Study protocols
Study contacts
Study file
Biological sample identifier
Biological sample characteristics
Protocol
Biological sample
Study factors
Assay file
Sample names
Protocol parameters
Assay factors
Assay measurements
Assay files
Material file
Material identifiers
Material description
Intended application
Material type
Chemical name
Characteristics
Material linkage
Material file
Structure file (optional)
isaconfig-diXa:
For metadata description of toxicogenomics experiments
SNRNASM ISA-Tab :
For metadata description of single nucleotide resolution nucleic acid structure mapping experiments
Metadata / Minimum Information
Characteristics
Acceptance
Availability
Citability
Completeness
Conformity
Consistency
Degree of specification
Human and machine readable
Internationality
Relevance
Reliable
Up-to-date
Enrichment
Controlled vocabularies
DCMI Type Vocabulary
Internet Media Types (MIME)
Nanotechnologies Vocabulary (ISO/TS 8004)
RFC 4646 Tags for Identifying Languages (ISO 639 two-letter language code/ISO 3166 two-letter country/region code)
Thesaurus Medical Subject Headings (MeSH)
Thesaurus of Geographic Names (TGN)
Schema.org Vocabulary
Norm data
Gemeinsame Normdatei (GND), DNB
Open Researcher and Contributor ID (ORCID-ID), ORCID
Virtual International Authority File (VIAF), OCLC
Encoding schemes
Date and time indication
ISO-Norm 8601 ("20200101")
W3C DTF ("2020-01-01")
Ontologies
BioAssay Ontology (BAO)
eNanoMapper Ontology
EXperiment ACTions (EXACT)
Functional Genomics Investigation Ontology (FuGO)
Microarray Gene Expression Data (MGED)
Minimum Information About a Microarray Experiment (MIAME)
Metabolomics Standards Initiative (MSI)
Minimum Information About Proteomics Experiment (MIAPE)
Nano Particle Ontology (NPO)
PRoteomics IDEntification (PRIDE)
Time Ontology (OWL-Time)
Open Biological and Biomedical Ontologies Foundry (OBO)
Best practice principles for ontology development
Ontology is open and available to use by all
Ontology is in a common formal language
Ontology uses unique identifier
Ontology provides procedures for identifying successive versions
Ontology includes textual definitions of all terms
Ontology uses relations which are unambiguously defined
Ontology is orthogonal to OBO ontologies
Ontology is well-documented
Ontology has a plurality of users
Ontology is developed collaboratively
Ontologies
Cell Ontology (CL)
Chemical Information Ontology (CHEMINF)
Environment Ontology (ENVO)
Gene Ontology (GO)
Chemical Entities of Biological Interest (ChEBI)
Sequence Ontology (SO)
Ontology for Biomedical Investigations (OBI)
Phenotypic Qualities Ontology (PATO)
Protein Ontology (PO)
RNA Ontology (RnaO)