Instructions for evaluating the reliability and relevance of *in vitro* toxicity studies using the SciRAP tool.

Note: this guidance also applies to use of the SciRAP in vitro tool for evaluating in vitro studies on nano materials.

Introduction:

The SciRAP tools for evaluating *in vitro* studies and *in vitro* studies on nano materials allow for evaluation of reliability (divided into reporting quality and methodological quality) and relevance. The evaluation often has to be endpoint-specific, meaning that the evaluation is carried out focusing on one of several endpoints/effects investigated in the study. Separate evaluations may thus be necessary for different endpoints in one study.

Download the excel file containing the assessment sheet available on the SciRAP website. The assessment sheet contains pre-defined criteria/items to be evaluated in 3 sections for **reporting quality**, **methodological quality**, and **relevance**. The reporting and methodological quality sections are divided in specific categories: Test compound and controls, Test system, Administration of the test compound, Data collection and analysis, Funding and competing interests (only in the reporting quality section), and Other (**Fig. 1**). The SciRAP tool for studies on nano materials also contains a category of reporting quality criteria for Physicochemical properties of the test item.

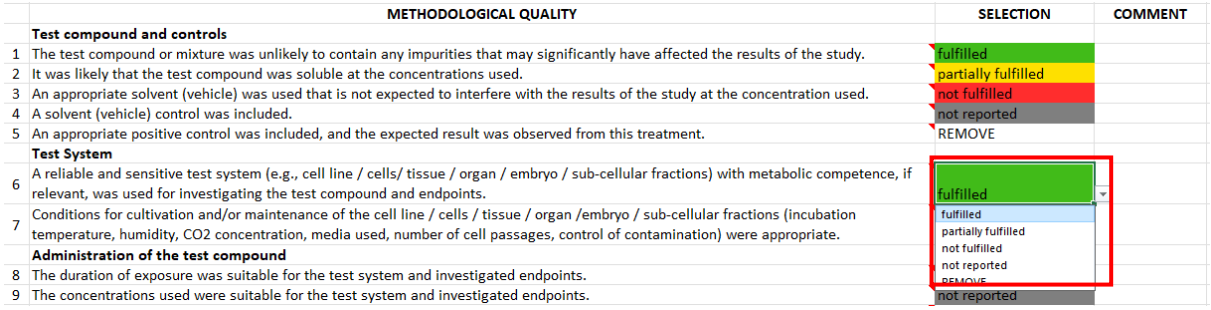
	METHODOLOGICAL QUALITY	SELECTION	COMMENT
	Test compound and controls		
1	The test compound or mixture was unlikely to contain any impurities that may significantly have affected the results of the study.		
2	It was likely that the test compound was soluble at the concentrations used.		
3	An appropriate solvent (vehicle) was used that is not expected to interfere with the results of the study at the concentration used.		
4	A solvent (vehicle) control was included.		
5	An appropriate positive control was included, and the expected result was observed from this treatment.		
	Test System		
6	A reliable and sensitive test system (e.g., cell line / cells/ tissue / organ / embryo / sub-cellular fractions) with metabolic competence, if relevant, was used for investigating the test compound and endpoints.		
7	Conditions for cultivation and/or maintenance of the cell line / cells / tissue / organ /embryo / sub-cellular fractions (incubation temperature, humidity, CO2 concentration, media used, number of cell passages, control of contamination) were appropriate.		
	Administration of the test compound		
8	The duration of exposure was suitable for the test system and investigated endpoints.		
9	The concentrations used were suitable for the test system and investigated endpoints.		
10	The test conditions during and after exposure to the test compound were suitable (media and serum used, cell density, incubation temperature, humidity, CO2 concentration).		
	Data collection and analysis		
11	Reliable and sensitive tests and/or analytical methods were used for investigating the endpoints.		
12	Sufficient numbers of replicates or repetitions of the experiment were used to generate reliable and valid results.		
13	Measurements were collected at suitable time points in order to generate sensitive, valid and reliable data.		
14	Cytotoxicity was measured and the test compound did not cause cytotoxicity that significantly affected the results.		
15	The statistical methods were clearly described and do not seem inappropriate, unusual or unfamiliar.		
	Other		
16	Are there any other aspects of study design, performance or reporting that influence reliability?		

***Fig. 1** Categories of criteria in Methodological Quality section of the SciRAP tool.*

Evaluation may be conducted for either reporting quality, methodological quality, or relevance, or all three, depending on the purpose of evaluation. Although not required, evaluating reporting quality of the study before moving into the evaluation of methodological quality and relevance may in some cases save time and resources as it allows for identification of studies that have obvious deficiencies in reporting, hampering further evaluation.

Evaluation of the criteria:

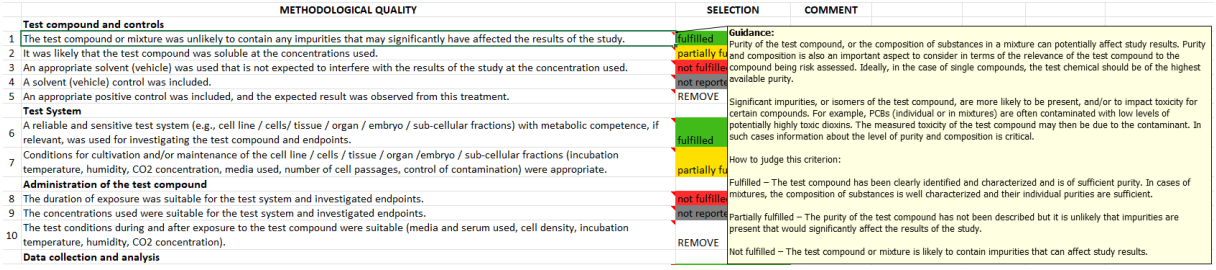
When you evaluate the criteria/items, choose one of the options from the drop-down menu in the "SELECTION" column (fulfilled, partially fulfilled, or not fulfilled for reporting and methodological quality, directly relevant, indirectly relevant, or not relevant in the relevance section, (**Fig. 2**). This drop-down menu is in almost every cell in the "SELECTION" column.



	METHODOLOGICAL QUALITY	SELECTION	COMMENT
	Test compound and controls		
1	The test compound or mixture was unlikely to contain any impurities that may significantly have affected the results of the study.	fulfilled	
2	It was likely that the test compound was soluble at the concentrations used.	partially fulfilled	
3	An appropriate solvent (vehicle) was used that is not expected to interfere with the results of the study at the concentration used.	not fulfilled	
4	A solvent (vehicle) control was included.	not reported	
5	An appropriate positive control was included, and the expected result was observed from this treatment.	REMOVE	
	Test System		
6	A reliable and sensitive test system (e.g., cell line / cells/ tissue / organ / embryo / sub-cellular fractions) with metabolic competence, if relevant, was used for investigating the test compound and endpoints.	fulfilled	
7	Conditions for cultivation and/or maintenance of the cell line / cells / tissue / organ /embryo / sub-cellular fractions (incubation temperature, humidity, CO2 concentration, media used, number of cell passages, control of contamination) were appropriate.		
	Administration of the test compound		
8	The duration of exposure was suitable for the test system and investigated endpoints.		
9	The concentrations used were suitable for the test system and investigated endpoints.	not reported	

Fig. 2 *Drop-down menu for the criteria in Methodological Quality section of the SciRAP tool.*

Guidance for evaluating individual methodological quality criteria and relevance items is available by pointing to the criterion with the cursor (the criterion containing the guidance has a red right corner, **Fig. 3**).

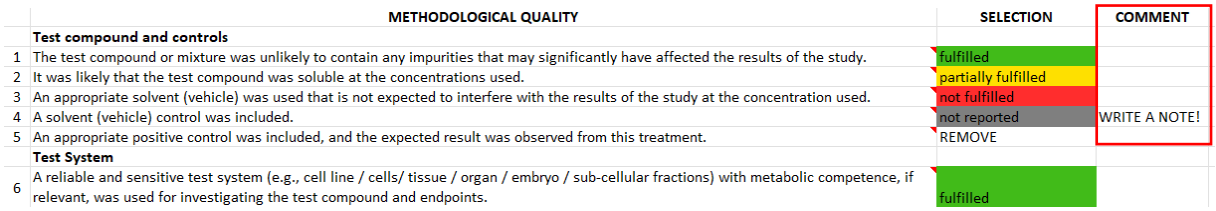


	METHODOLOGICAL QUALITY	SELECTION	COMMENT
	Test compound and controls		
1	The test compound or mixture was unlikely to contain any impurities that may significantly have affected the results of the study.	fulfilled	
2	It was likely that the test compound was soluble at the concentrations used.	partially fu	
3	An appropriate solvent (vehicle) was used that is not expected to interfere with the results of the study at the concentration used.	not fulfille	
4	A solvent (vehicle) control was included.	not reporte	
5	An appropriate positive control was included, and the expected result was observed from this treatment.	REMOVE	
	Test System		
6	A reliable and sensitive test system (e.g., cell line / cells/ tissue / organ / embryo / sub-cellular fractions) with metabolic competence, if relevant, was used for investigating the test compound and endpoints.	fulfilled	
7	Conditions for cultivation and/or maintenance of the cell line / cells / tissue / organ /embryo / sub-cellular fractions (incubation temperature, humidity, CO2 concentration, media used, number of cell passages, control of contamination) were appropriate.	partially fu	
	Administration of the test compound		
8	The duration of exposure was suitable for the test system and investigated endpoints.	not fulfille	
9	The concentrations used were suitable for the test system and investigated endpoints.	not reporte	
10	The test conditions during and after exposure to the test compound were suitable (media and serum used, cell density, incubation temperature, humidity, CO2 concentration).	REMOVE	
	Data collection and analysis		

Fig. 3 *Guidance for evaluating criterions in the SciRAP tool.*

Criterion no. 24 in the reporting quality section and criterion no. 16 in methodological quality section of the SciRAP *in vitro* tool, and no. 38 and 19 in the tool for studies on nano materials, provide space for free text comments on additional aspects that affect study reliability. These criteria do not contain the drop-down menu with options.

You may use the "COMMENT" column to write free text comments, for example explaining your evaluation of a specific criterion (**Fig. 4**).



	METHODOLOGICAL QUALITY	SELECTION	COMMENT
	Test compound and controls		
1	The test compound or mixture was unlikely to contain any impurities that may significantly have affected the results of the study.	fulfilled	
2	It was likely that the test compound was soluble at the concentrations used.	partially fulfilled	
3	An appropriate solvent (vehicle) was used that is not expected to interfere with the results of the study at the concentration used.	not fulfilled	
4	A solvent (vehicle) control was included.	not reported	WRITE A NOTE!
5	An appropriate positive control was included, and the expected result was observed from this treatment.	REMOVE	
	Test System		
6	A reliable and sensitive test system (e.g., cell line / cells/ tissue / organ / embryo / sub-cellular fractions) with metabolic competence, if relevant, was used for investigating the test compound and endpoints.	fulfilled	

Fig. 4 *Writing a note in the "COMMENT" column.*

Judging criteria as "not reported"

If a criterion cannot be judged, you can select the option "not reported" in the drop-down menu (**Fig. 2**). This is primarily intended for methodological quality criteria when sufficient information is lacking to make a judgment regarding whether the criterion is fulfilled or not. Note that for reporting quality, if information is missing you should select "not fulfilled".

Removing criteria

Individual criteria may be considered more or less critical in the specific case you are working on, and the SciRAP tool includes a function to remove criteria for reporting and methodological quality. In that case, choose "REMOVE" in the drop-down menu of the "SELECTION" column instead of fulfilled, partially fulfilled, not fulfilled (**Fig. 2**). Removed criteria will not be included in the colour profile or % fulfilled criteria calculation. Motivations for removing criteria can be provided in the "COMMENT" column (**Fig. 4**).

NOTE: removing criteria will have an impact on the colour profile and the % fulfilled criteria. It is therefore important that the same criteria are removed in evaluations that are going to be compared to each other. Items in the Relevance section cannot be removed.

<u>Interpreting the results of the SciRAP tool:</u>

Results of the study assessment are shown right below the relevance section of the SciRAP tool in the form of % fulfilled criteria, as well as a colour profile.

	% FULFILLED CRITERIA	
	REPORTING	METHOD
Study overall	50.00	37.50
Test compounds and controls	62.50	37.50
Test system	40.00	75.00
Administration of test compound	50.00	0.00
Data collection and analysis	62.50	37.50
Funding and competing interests	25.00	

Fig. 5 *Table with % fulfilled criteria.*

Percent fulfilled criteria

The results show % fulfilled criteria of for the study overall, as well as for the specific criteria categories (**Fig. 5**).

- The % fulfilled criteria is calculated as follows:
  $SciRAP\ score\ (\%) = \frac{F+(PF*0.5)}{T} * 100\%$ / $SciRAP\ score\ (\%) = \frac{DR+(IR*0.5)}{T} * 100\%$

where F is the number of fulfilled criteria, PF is the number of partially fulfilled criteria, and T is the total number of criteria. In other words, partially fulfilled criteria contribute half the value as fulfilled criteria. Criteria that have been removed are excluded from the calculation.

The % fulfilled criteria can have a value ranging from 0 (all criteria are judged as "not fulfilled"/"not reported") to 100 (all criteria are judged as "fulfilled").

NOTE:

- selecting “not reported” for a criterion will have the same impact as “not fulfilled” on the % fulfilled value. The user should take care to note the reason for leaving a criterion as "not reported".
- removing criteria will have an impact on the % fulfilled criteria, as well as the colour profile. It is therefore important that the same criteria are removed in evaluations that are going to be compared to each other.
- importantly, the % fulfilled criteria cannot be considered on its own but should be interpreted together with the colour profile when concluding on study reliability. The colour profile is crucial to identify where a study's strengths and weaknesses lie and is more informative than the % fulfilled criteria for this purpose.

Colour profile

In the colour profile, the evaluations of reliability and relevance are illustrated in bar charts (**Fig. 6**), showing green for fulfilled criteria, yellow for partially fulfilled and red for criteria that were not fulfilled. Criteria that were "not reported" will be shown as grey. Relevance items evaluated as relevant are shown as green, indirectly relevant items are shown as yellow, and if the item was evaluated as being not relevant for the risk assessment or problem formulation, it is shown as red. The bar charts do not include criteria that have been removed.

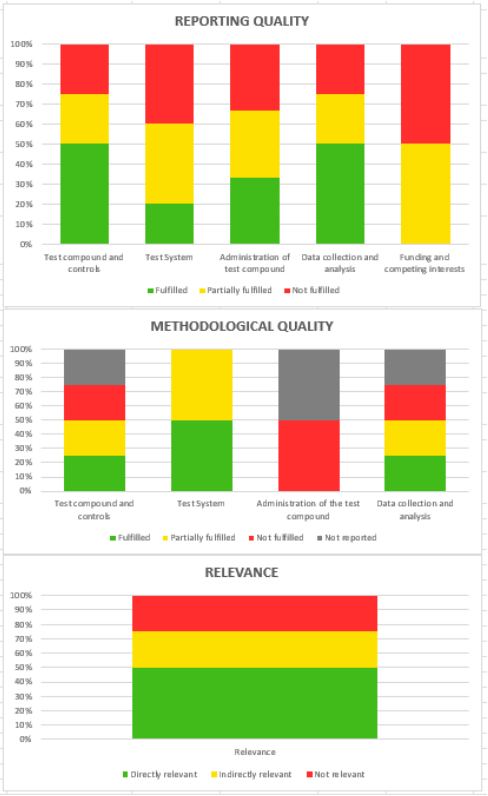


Fig. 6 *The evaluations of reliability and relevance are illustrated in bar charts.*

Categorisation of reliability

A general methodology to reliability categorisation based on SciRAP evaluations for *in vitro* studies is proposed in **Table 1**. It is recommended to apply an approach based on the use of predefined 'key criteria' considered critical for the reliability of the study in a specific assessment context. However, the selection of key criteria and exact categorisation principles should be decided on a case-by-case basis, depending on the research question, study type, endpoint, and intended use of the evidence. Examples are provided in e.g. Holmer et al., 2024; Wiklund & Beronius, 2022.

Table 1. *Rules for translating SciRAP evaluations into reliability categories (adapted from Holmer et al., 2024).*

Reliability category	**Rules for reliability categorisation**
Reliable without restriction	Percentage of fulfilled reliability criteria >80%*; all predefined key criteria are fulfilled; and there are no deficiencies in non-key criteria that may affect study reliability.
Reliable with restriction	Percentage of fulfilled reliability criteria >65%*; one or more predefined key criteria are partially fulfilled; or there are minor deficiencies in non-key criteria that may affect study reliability.
Not reliable	Percentage of fulfilled reliability criteria <65%*; one or more predefined key criteria are not fulfilled; or there are major deficiencies in key or non-key criteria that affect study reliability.
Not assignable	Reliability cannot be assigned due to insufficient reporting or because two or more predefined key criteria are not reported.

*the % used here is not prescriptive and should be decided on a case-by-case basis

References:

Holmer ML, Zilliacus J, Draskau MK, Hlisníková H, Beronius A, Svingen T. 2024. Methodology for developing data-rich Key Event Relationships for Adverse Outcome Pathways exemplified by linking decreased androgen receptor activity with decreased anogenital distance. Reprod Toxicol. 128:108662. doi: 10.1016/j.reprotox.2024.108662. Epub ahead of print. PMID: 38986849.

Wiklund L and Beronius A. 2022. Systematic evaluation of the evidence for identification of endocrine disrupting properties of Bisphenol F. Toxicology. 476:153255. doi: https://doi.org/10.1016/j.tox.2022.153255.

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