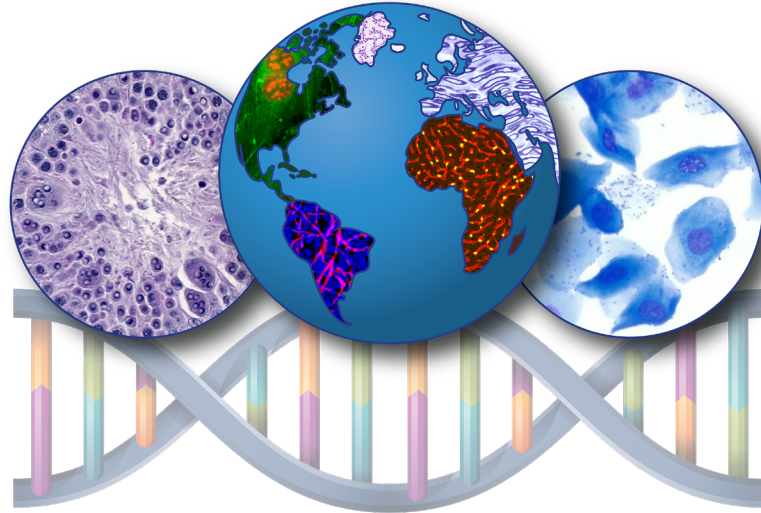


Animal Research: Reporting of In Vivo Experiments (ARRIVE) Guidelines



Division of Translational Toxicology Global Toxicologic Pathology Training Program

Why were the ARRIVE Guidelines developed?

- Researchers can follow recommendations, called the **ARRIVE guidelines**, to include in any publication describing animal research in biomedical science
 - ARRIVE (**A**nimal **R**esearch: **R**eporting of *In Vivo* **E**xperiments)
- Purpose of the guidelines:
 - To improve the **transparency, reproducibility, and quality** of animal research reporting
 - To ensure studies using animals are **clearly described and ethically justified**
- Over 1000 journals endorse the use of these guidelines
 - Many journals refer to the ARRIVE guidelines in their instructions for authors

What are the ARRIVE Guidelines?


- **ARRIVE guidelines** are a set of reporting standards designed to ensure animal research studies are described clearly, transparently, and completely so they can be properly evaluated and reproduced
- **A voluntary checklist of information to include in publications describing animal research**
 - Designed to give readers the ability to scrutinize the research adequately, evaluate its methodological rigor, and reproduce the methods or findings
 - Target audiences are researchers and reviewers
- Developed by the UK-based **National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs)** in 2010
 - A revised version, **ARRIVE 2.0**, was published in 2020. The Recommended Set was added to the Essential 10, to improve clarity and give additional rationale behind the guidelines.
 - ARRIVE 2.0 complements **planning** guidelines, such as Planning Research and Experimental Procedures on Animals: Recommendations for Excellence (PREPARE) Guidelines

Core Purpose of the ARRIVE Guidelines

- **Improve transparency in animal research reporting** so studies are clearly and completely described
- **Enhance reproducibility** by ensuring enough methodological detail is reported for others to replicate the study
- **Promote ethical use of animals** by supporting the principles of the **3Rs (Replacement, Reduction, Refinement)**
- **Increase research quality and reliability** so findings from animal studies can be better evaluated and translated to human health research

- The ARRIVE checklist is organized into **two main groups of items** that guide how animal research should be reported:
 - **ARRIVE Essential 10:** the basic minimum items that must be included in a report describing animal research
 - **The Recommended Set:** additional items that complement the Essential 10
- Most journals adopting the ARRIVE guidelines encourage reporting beyond the Essential 10 alone
 - In practice, the Essential 10 and Recommended Set are often interlinked, and addressing both helps ensure comprehensive and transparent reporting of animal research

Aim: Improve transparency, reproducibility, and ethical standards in animal research

 **Key Principles:** These are the **most critical items** needed in the manuscript to assess the reliability of a study:

1. **Study Design** – Clear, pre-defined structure
2. **Sample Size** – Justified and explained
3. **Inclusion/Exclusion Criteria** – Transparent selection
4. **Randomization** – Avoid selection bias
5. **Blinding** – Reduce observer bias
6. **Outcome Measures** – Pre-specified and relevant
7. **Statistical Methods** – Appropriate & detailed
8. **Experimental Animals** – Species, strain, sex, etc.
9. **Experimental Procedures** – What, how, when, where
10. **Results** – All outcomes, with clarity

 **Why It Matters:** Better reporting = better science = better outcomes for animals and people

In addition to the Essential 10, these are complementary items that may be included in a manuscript to provide more context and transparency:

- **Abstract** – Summarize the study clearly and transparently, including animal species, strain, and sex
- **Background** – Provide sufficient context and rationale for the research, experimental approach
- **Objective** – State the specific aim(s) or hypothesis
- **Ethical Statement (IACUC)** – Report approvals and adherence to welfare guidelines
- **Husbandry & Housing** – Describe environment, enrichment, diet, and living conditions
- **Animal Care & Monitoring** – Steps to minimize pain, stress, or adverse events
- **Interpretation / Scientific Implications** – Explain how results relate to hypotheses and prior knowledge
- **Translation** – Indicate relevance to other models or humans
- **Protocol Registration** – Report pre-registration or study plan if available
- **Data Access** – Availability of raw data and materials
- **Declaration of Interest** – Conflicts of interest, funding sources, or affiliations

ARRIVE Guidelines – Not as Rules, But Tools

- Study Design
 - Give brief details on the study design:
 - Describe groups being compared, including control groups. Explain rationale if no control group used.
 - Define the experimental unit (single animal, cage of animals, etc).

1

ARRIVE Guidelines – Not as Rules, But Tools

- Sample Size
 - Define the number of animals allotted to each experimental group.
 - Explain why this number was decided.

2

ARRIVE Guidelines – Not as Rules, But Tools

- Inclusion and exclusion criteria
 - Describe the criteria for including and excluding animals and data points during the analysis.
 - Report these in the manuscript.
 - For each analysis, report the exact values of n in each experimental group.

3

ARRIVE Guidelines – Not as Rules, But Tools

- Randomization
 - State if randomization was used and outline the method used to generate the order.
 - State the strategy used to minimize potential confounding variables.

4

ARRIVE Guidelines – Not as Rules, But Tools

- Blinding/Masking
 - Describe who was aware of the the group allotments at each step.
 - Allocation
 - Conduct of experiment
 - Outcome assessment
 - Data Analysis

5

ARRIVE Guidelines – Not as Rules, But Tools

- Outcome measures
 - Clearly define all outcome measures assessed.
 - For hypothesis-testing studies, specify the primary outcome measures.

6

ARRIVE Guidelines – Not as Rules, But Tools

- Statistical methods
 - Provide details of the statistical methods used for each analysis, including software used.
 - Describe any methods used to assess whether the data met the assumptions of the statistical approach, and what was done if the assumptions were not met.



ARRIVE Guidelines – Not as Rules, But Tools

- Experimental animals
 - Provide species-appropriate details of the animals used:
 - Species
 - Strain
 - Sex
 - Age or developmental stage
 - Immune status
 - If relevant, weight & genotype



ARRIVE Guidelines – Not as Rules, But Tools

- Experimental procedures
 - Describe the procedures in enough detail for others to replicate.
 - Including...
 - What was done, how it was done, & what was used
 - When and how often
 - Where including acclimation periods
 - Why (rationale)

9

ARRIVE Guidelines – Not as Rules, But Tools

- Results
 - Summary/descriptive statistics for each experimental group, with a measure of variability where applicable.
 - Report all data for experiment conducted; make data reported clear as possible.
 - If applicable, the effect size with a confidence interval.

10

How would you apply ARRIVE?

- The journal doesn't ask for strain or housing conditions. Should you still report this information in your paper?

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 - Reproducibility and external validity are compromised when these data are not publicly available

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- A researcher assigns animals in the order they came out the box. There is no mention of randomization or group allocation strategy.

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 - Randomization is needed to prevent selection bias and confounding of experimental results

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 - Needed for achieving transparency, reproducibility, and translatability of research findings

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 - These data are needed for achieving transparency and reproducibility of research findings

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Why should researchers use the ARRIVE 2.0 guidelines?

- The use of the ARRIVE 2.0 guidelines, including both the “Essential 10” and the “Recommended Set,” will strengthen biomedical research by promoting comprehensive and standardized reporting practices, reducing inefficient use of research resources, enhancing reproducibility, and increasing confidence in the validity and translatability of animal research findings.

Better reporting = better science = better outcomes for animals and people

References

- Percie du Sert, Nathalie et al. “The ARRIVE guidelines 2.0: Updated guidelines for reporting animal research.” *PLoS biology* vol. 18,7 e3000410. 14 Jul. 2020, doi:10.1371/journal.pbio.3000410
- “ARRIVE Guidelines.” *NC3Rs*, <https://arriveguidelines.org/>. Accessed 22 Apr. 2026.



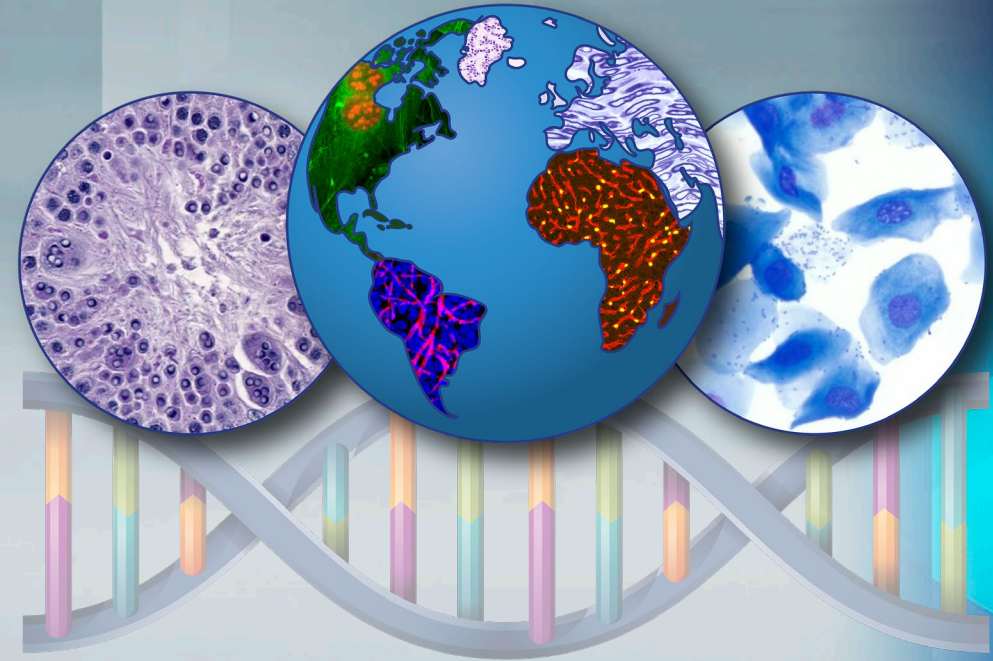
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