
Lecture: nanotoxicology / nanobiotechnology

Animal experiments and non-animal methods in nanomedicine and nanotechnology – the results of a critical literature survey from the point of view of animal welfare

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In the last years, nanotechnology and nanomedicine (the application of nanotechnology in the health care area) have evolved as new, important areas of research receiving increasingly more political attention and public funding. Nanotechnology involves investigations and technological developments on the scale of 1-100 nanometres, with one nanometre being one millionth of a millimetre. Due to their specific physical and chemical characteristics, substances and products with nanoscale sizes or nanoscale surface structures are being developed and produced for innovations in energy, environmental, or information technologies and in the healthcare area. Thus nanomedicine and the safety testing of nanomaterials and nanoproductions are new scientific areas potentially involving animal experiments. Considering the significance assigned to nanotechnology, a continuous increase in animal experiments in these areas over the coming years seems likely unless effective preventive measures are put in force.

It is against this background that the literature survey, funded by the Swiss Foundation Animalfree Research, provides an overview on animal experiments performed in nanotechnology aiming at addressing main areas of concern from the point of view of animal welfare, such as scientific areas using especially large numbers of animals or specific especially distressful animal experiments.

Scientific articles from Germany, France, the United Kingdom, Italy, the Netherlands, and Switzerland published between 2004 and 2007 form the basis of the literature survey. These are the European Countries with both the highest public expenditure in nanotechnology and high numbers of animals used in scientific research as such. In nanomedicine and nanotechnology, animal experiments were performed in pursuance of scientific goals relating to nanoparticle-based targeted drug, vaccine or gene delivery, nanoscale imaging technologies, magnetic-nanoparticle induced tumour thermotherapy, tissue engineering, and the toxicity of nanomaterials.

Examples for such experiments shall be presented, the harm inflicted upon the animals classified, and the scientific outcome of the experiments evaluated. Thereupon, a harm-benefit analysis of the experiments shall be performed. Likewise, a brief overview will reveal how the application of nanotechnology in cell culture technology provides new options and new realms for *in vitro* research. The indispensability and ethical acceptability of animal use in nanomedicine and nanotechnology will be discussed.

Subsequently, concrete recommendations for necessary political action shall be made addressed at the European Commission and at European Countries, aiming at avoiding an increase in animal use for nanotechnology and nanomedicine and at achieving a replacement of the animal tests depicted, in accordance with legal provisions, such as the Animal Welfare Protocol of the European Treaty and Directive 86/609/EEC on the protection of laboratory animals.

From the point of view of animal welfare, the time is right for a paradigm change in fundamental biomedical research, not least because of the new methodological options that nanotechnology offers in the realms of *in vitro* research, for example by enabling the evaluation of biochemical processes on the level of the single cell. It is time for a paradigm change that designs completely new research strategies that do away with animal experimentation altogether and founds scientific progress on non-animal testing strategies instead.

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