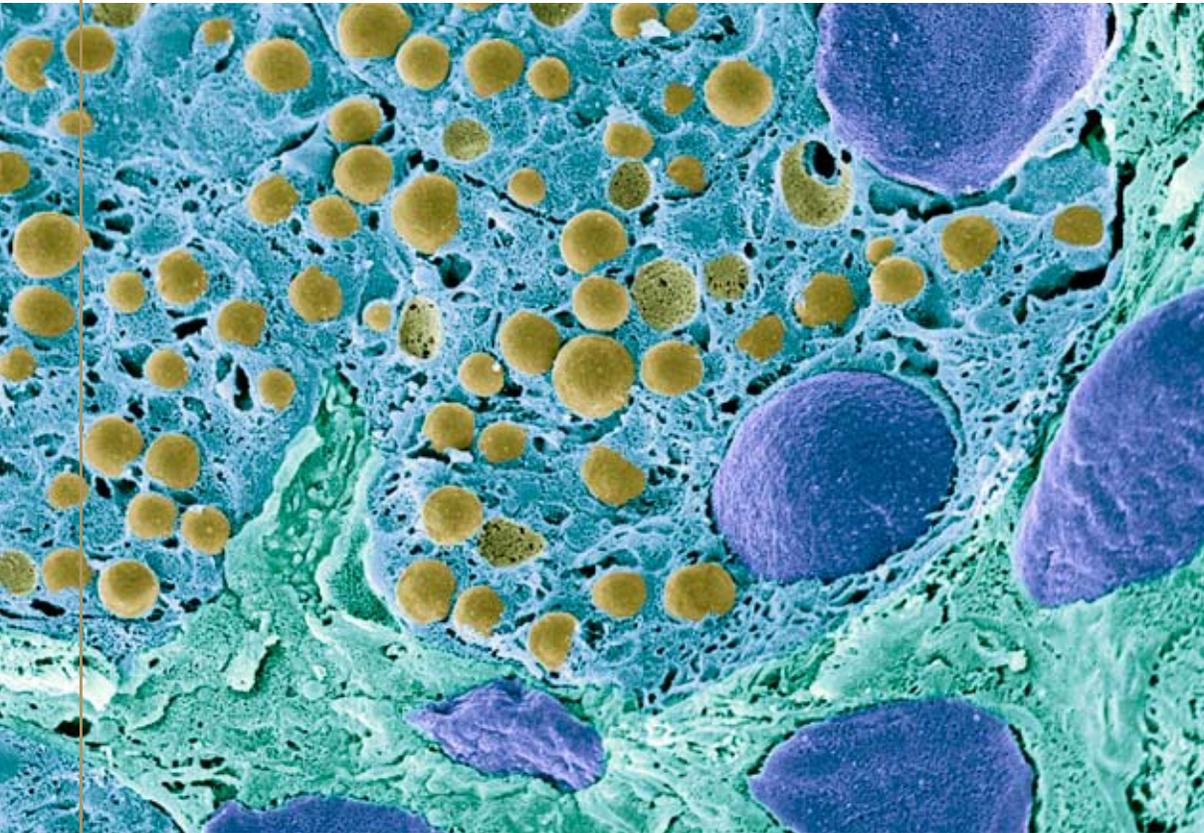




KONINKLIJKE NEDERLANDSE  
AKADEMIE VAN WETENSCHAPPEN

# WELL UNDERWAY

OPPORTUNITIES FOR REGENERATIVE MEDICINE  
IN THE NETHERLANDS



ROYAL NETHERLANDS ACADEMY OF ARTS AND SCIENCES

FORESIGHT STUDIES

# SUMMARY

The scientific discipline of regenerative medicine investigates how the body's natural ability to repair damaged tissues and organs can be stimulated or imitated so as to bring about functional recovery. Regenerative medicine has developed from a convergence of basic scientific disciplines – for example cell biology, materials science, and chemistry – with more application-oriented disciplines such as cell therapy and implantation technology. This convergence of disciplines into a new scientific field demands new collaborative structures, as well as structures for training and finance that can facilitate that collaboration. The involvement of social studies disciplines such as law and ethics is also essential if there is to be a solid basis of public support.

In this report, the Foresight Committee describes the results of its investigation on regenerative medicine. The Committee has considered the scientific achievements and challenges in this field and used bibliometric analysis to investigate the position of the Netherlands and of its collaborative structures. In addition, background studies were carried out on ethical dilemmas and legal aspects. By consultation of Dutch researchers and stakeholders, the Committee was able to derive a number of conditions and recommendations to do justice to this new field.

The Foresight Committee concludes that although the Netherlands has a strong position in this field of research, science has not yet advanced far enough to understand and completely regenerate the full complexity of tissues. It is also essential to acquire knowledge that enables more effectively the estimation of the risks associated with clinical usage of this technology. There are therefore major challenges facing us in the coming years. Specifically, this will involve knowledge regarding isolating, differentiation and replication of stem cells and a better understanding of the cellular and bio-material response in the tissue environment. The extracellular matrix will act hereby as a major source of inspiration. In order to make the transition from basic science to translational research and clinical application, it is vital to have “enabling technologies” at our disposal: biomarkers, imaging techniques, high-throughput technologies, *in vitro* and *in vivo* modelling systems, bioreactors, and minimally invasive technologies. However, the development of new technologies and the application of existing ones involves a high level of cost. The Foresight Committee recommends that financing for regenerative medicine should be structured in such a way that high priority is given to filling in gaps in our basic knowledge, with financing for the development of expensive enabling technologies being possible. When selecting studies to finance and granting subsidy applications, the quality criterion should be decisive.

The Netherlands is number ten in the world as regards the total volume of publications in the field of regenerative medicine. The country's contribution in this field is greater than the average contribution in all research fields. The level of collaboration

between various Dutch knowledge institutions in the field has increased significantly in recent years, as can be seen from the number of publications by a national partnership. The percentage of publications produced in collaboration with foreign institutions has also doubled. The increase is partly due to the large-scale investment for this purpose of the proceeds from natural gas. Since 2004, the Dutch government has invested more than 85 million euro from that source in research in regenerative medicine. That sum has to a large extent been matched by both private and public partners. As a result, an impetus has been given primarily to translational research, with a strong focus on the economic return. Although these aspects are of great importance, the Foresight Committee believes that high-quality basic scientific research without direct social and economic added value has been somewhat edged aside.

Regenerative medicine is pre-eminently a multidisciplinary field of research. None of the experts involved has the sum total of necessary expertise to help the discipline advance, and collaboration and contributions by various different parties are of major importance. In particular, the Netherlands could obtain a leading position in regenerative medicine if it integrates the disciplines (stem)cell biology and biomaterials more effectively. Such multidisciplinary collaboration should preferably be based not on incidental financing but should be given a structural basis at administrative level.

One of the areas where collaboration is of enormous value is education. Today's students of medicine and pharmacy are the doctors and pharmacists of the future. Up to now, however, it has been primarily the biomedically-oriented and technical programmes that have included regenerative medicine in their programmes. It is therefore vital that regenerative medicine should become a more high-profile component of programmes in medicine and pharmacy. In addition, structural educational links need to be created between the medical/biomedical faculties and technical faculties at bachelor's, master's and PhD's degree levels, with existing partnerships being extended.

The Foresight Committee also considers national collaboration essential as regards the preparation of regenerative medicine products under GMP conditions, both from the point of view of cost and of quality and safety. Such collaboration should focus on pooling legal knowledge and on creating possibilities for preparation at one another's facilities. This collaboration is also needed so as to retain small-scale GMP facilities for academic application as a means of reinforcing the development function of universities.

Regenerative medicine has legal aspects that are numerous and complex, and consequently difficult to understand. Correct and timely analysis of the relevant rules, followed by proper compliance, demands the explicit attention of researchers in this field. The Foresight Committee notes that there is no cohesive legal framework regarding control of bodily materials. In addition the exception clause and several definitions in the European regulation on 'Advanced Therapy Medicinal Products' are hard to interpret. A tension is noted between the altruism of the donor of bodily material on the one hand and the commercial generation of products on the basis of that material on the other. In many cases, it is not clear to researchers who wish to start a clinical

study what information must be provided, making the necessary procedures significantly more onerous. All of this legal complexity demands clarification on the part of the authorities. The Foresight Committee notes that although the Dutch authorities have set up an assessment body for clinical trials with innovative products, there is no possibility for consultation or advice. The Committee believes that such an advice possibility will greatly facilitate researchers.

Finally, the broad application of regenerative medicine requires public support, with the development possibilities being balanced against the interests of patients, doctors, policymakers, and insurers. Ethics plays a vital role in this regard, not only where guarding moral boundaries is concerned but definitely also in conducting and encouraging debate. It is essential for this debate to take place with interaction between all stakeholders, for example the authorities, researchers, patient organisations, and doctors' associations. In order to encourage this, it is important that financial scope is to be created within research programmes.