

---

## Executive summary

---

### Synthetic biology

*Synthetic biology is the engineering of biology: the synthesis of complex, biologically based (or inspired) systems, which display functions that do not exist in nature. This engineering perspective may be added at all levels of the hierarchy of biological structures – from individual molecules to whole cells, tissues and organisms. In essence, synthetic biology will enable the design of “biological systems” in a rational and systematic way.* The Committee has used this European consensus definition of synthetic biology in this advisory report. The Committee considers synthetic biology an innovative approach in the life sciences with potential significance for science and society. The advisory report addresses the questions posed by the minister of Education, Culture and Science.

### Current status in the Netherlands

Currently, internationally prominent initiatives in this field of research are being developed in the Netherlands. Dutch research focuses on two main directions, both of which have accumulated a large body of expertise over time. One involves metabolic reprogramming of biological systems (*in vivo*, top-down approach) and the other bio-nano-science (*in vitro* approach).

---

## Developments in synthetic biology

Developments in synthetic biology can be classified both by the degree of complexity and by the degree of divergence from nature. Metabolic reprogramming involves experimental systems with a high level of complexity and low divergence from nature. The experimental systems used in bio-nano-science are less complex but are very different from what exists in nature. To date synthetic biology has not yet enabled the construction of fully artificial systems with a high degree of complexity. In fact, many researchers doubt whether it will ever be possible to construct a fully synthetic organism, representative of the highest degree both of complexity and divergence from nature.

## Possible significance of synthetic biology

Despite the uncertainties surrounding future developments, synthetic biology is clearly a promising and innovative research area, with potential applications for society. Products arising from synthetic biology can benefit people's health and their quality of life, make medications cheaper and more accessible, and enhance the sustainability of society. In the field of health and quality of life, such products may include live therapeutic agents, biology-based drug delivery systems and sophisticated diagnostic agents. More efficient production platforms could make medicines cheaper and thus more accessible. In the field of sustainability, synthetic biology is focusing on sustainable bio-fuels. Apart from the above applications, which have a direct and tangible impact on people and society, synthetic biology can be applied in areas such as new materials and the establishment of production platforms for fine chemicals. All these potential applications are of interest to the biotechnology industry. For researchers investment in synthetic biology offers the opportunity to successfully compete with the international research community in this field.

Whether synthetic biology can live up to these promises depends on a number of factors. Some of these are external factors which are difficult to influence but which can boost or cut demand for specific products. One example is the combination of decreasing fossil fuel supplies, high oil prices, fears about climate change, and rising demand for food and agricultural land. This generates a need for sustainable production of bio-fuels that does not interfere with food supply. The second factor that will determine the success of synthetic biology is the extent to which society accepts this technology. It is essential to provide people with accurate and balanced information, in order to avoid disproportionate public concern and to curb unrealistic expectations. Similarly, it is important to take

---

society's concerns into account, in order to establish and maintain confidence in this technology.

### Legislation and risk control

The Netherlands Commission on Genetic Modification (COGEM) will advise the minister of Housing, Spatial Planning and the Environment (VROM) on legislation and risk control concerning synthetic biology. Furthermore, the working group *biosecurity* of the KNAW has formulated general rules of conduct.

### Recommendations

Synthetic biology offers opportunities to the Dutch knowledge economy, while universities are expanding their existing infrastructure in this area. Therefore, it would make sense for the government to invest in this area of research. Such investment in synthetic biology by the government could very well relate to existing initiatives or plans, such as the Netherlands Genomics Initiative, NanoNed, and the Systems Biology Programme to be launched by the Netherlands Organisation for Scientific Research (NWO). Accordingly, an obvious approach would be to incorporate a sub-programme for synthetic biology into each of these initiatives. Secondly, given the special nature of synthetic biology, it is important to invest in interdisciplinary research and to adapt relevant Master's degree programmes to these new developments. Thirdly, there should be a substantial focus on research into, and communication about, the societal aspects of synthetic biology. The Committee also recommends to, after a given period of time (e.g. five years), survey the Dutch research in the field of synthetic biology in order to assess the need for targeted incentives.