Priority List Issue Briefs[1]

Issue Title	**Integration of artificial intelligence and machine learning**
Description	Advances in machine learning and artificial intelligence have led to an increase in their utilization for the development of synthetic biology applications. These algorithms use mathematical models and large datasets (e.g., chemical information, sequence information) to inform the engineering or creation of synthetic biology organisms, products and parts. Specific examples include: • Protein folding predictions to streamline biosynthesis across various industries (e.g., Alpha Fold and ESMFold) • Machine learning models for the creation of novel, customized proteins (e.g., ProtGPT2, Protein DT and Chroma) • Genomic design using large language models are applied to DNA, RNA, and epigenetic elements, as well as for predicting novel DNA sequences for synthetic biology (e.g., DNA-Diffusion project uses AI to generate synthetic DNA sequences based on text instruction) • Use of artificial intelligence to improve bioproduction through informed modification of biosynthetic pathways • Bio-computation involving the application of synthetic biology to transform artificial intelligence using biology-based computing, DNA data storage and molecular circuits (e.g., to overcome the limitations in silicon-based computation, leveraging the computing capacity of engineered organisms like *Escherichia coli*) • Sensing and signalling for artificial intelligence systems, such as the development of responsive crops and artificial intelligence-guided precision agriculture (e.g., InnerPlant developed engineered stress-sensing plants which can be monitored by satellites and John Deere agricultural equipment cameras)

1 Information gathered from the members of the multidisciplinary Ad Hoc Technical Expert Group on Synthetic Biology. Descriptions complemented with publications published by the Secretariat of the Convention on Biological Diversity.

Timeline (<5 years, 5-10 years, >10 years) to realisation	Significant investments within 5 years. It was noted that several artificial intelligence and computing companies (e.g., Meta, Google/Deep Mind, Microsoft, NVIDIA and Stability AI) are entering into agreements or joint ventures with biotechnological companies (e.g., Gingko Bioworks) and/or institutes (e.g., Broad Institute). Given rapid development and use of artificial intelligence in other industries, it was suggested that impacts could be near-term.
Potential impacts on the objectives of the Convention	• Unknown biosafety risks of novel, synthetic sequences • Disruption of sustainable use practices • Facilitated use of genetic resources without benefits-sharing • Potential challenges to traceability for potential benefits-sharing
Other considerations	• Accelerated development of synthetic biology applications • Increased efficiency of bioproduction (e.g., through the use of improved genetic circuitry) • Lower barrier for the creation of modified organisms in low containment or without regulatory oversight • Potential challenges for environmental risk assessment due to automated construction of novel synthetic pathways and genetic circuits • Potential disruption of traditional industries and supply chains (e.g., economic losses for scall-scale farmers) • Intellectual property and ownership • Market concentration in a few companies • Dual-use potential (e.g., creation of toxins or harmful compounds) • Use of traditional knowledge and changes to traditional practices