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TIMELINE

SYNTHETIC BIOLOGY

June 2014

Timeline: Synthetic Biology

Science, Policy and Regulation in Canada, Australia, the European Union, the United Kingdom & the United States

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Note from the Series Editor

This timeline outlines important events related to synthetic biology science, policy and regulation in Canada, Australia, the European Union, the United Kingdom and the United States. For the purposes of this timeline, synthetic biology refers to genetic engineering —the ability to design and construct new biological parts, devices and systems. For background purposes, the author has also chosen to include broader developments in science policy as well as significant events outside of the focus regions where deemed appropriate. Please help us keep this timeline accurate and up-to-date by providing comments to issp@uottawa.ca.

Marc Saner
Director, ISSP

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About the Author

Barbara Kubica holds a Master of Science in Biology from the University of Ottawa (Canada) and a Joint Master of Arts in International Communication from Hanze University of Applied Sciences (Netherlands) and IULM University of Languages and Communication (Italy). She is currently pursuing a Doctorate in Communication and Culture at the University of Calgary (Canada). Her interests lie in the fields of science communication and public engagement in the assessment and regulation of emerging technologies.

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Timeline: Synthetic Biology Science, Policy and Regulation (Canada, Australia, the EU, UK and US)

Event	Who	When	Description
First isolated reference of the term "synthetic biology"	Stéphane Leduc	1912	Leduc (1912) publishes *La Biologie Synthétique*. In this volume, Leduc (1912) contradicts the theory of spontaneous generation and describes that some forms of life can be "created" through chemical and physical processes. Leduc (1912) maintains that, besides observational and experimental analyses, there also exists in science a "synthetic" method that attempts to reproduce observed phenomena.
Isolation of enzyme DNA ligase	Martin Gellert; Baldomero Olivera and Robert Lehman; Bernard Weiss and Charles Richardson; and Malcolm Gefter et al.	1967	Gellert (1967), Olivera and Lehman (1967), Weiss and Richardson (1967), and Gefter at al. (1967) independently discover DNA ligase. The joining of DNA chains by DNA ligase is an essential component for DNA repair, replication, and recombination in all organisms.
Isolation of type I restriction enzyme	Werner Arber and Stuart Linn	1969	Arber and Linn (1969) isolate the first type I restriction enzyme, EcoRI, in the bacterium *Escherichia coli*.
Isolation of type II restriction enzyme	Hamilton Smith and Kent Wilcox	1970	Smith and Wilcox (1970) purify the first type II restriction enzyme, HindII, from the bacterium *Haemophilus influenza*, and show that it can cut DNA in the center of a specific six-base-pair sequence. Smith and Wilcox (1970) also show that this enzyme does not cut at this very same DNA sequence when it occurs in *H. influenzae* host cell DNA.
Cutting DNA using restriction enzymes	Kathleen Danna and Daniel Nathans	1971	Building on the initial discoveries of restriction enzymes, Danna and Nathans (1971) first demonstrate the use of restriction enzymes as a tool to cut DNA molecules into fragments, making it easier to study, identify, and characterize genes.
First recombinant DNA molecules	Janet Mertz, Ronald Davis, and Paul Berg	1972	Mertz and Davis (1972) establish that the RI restriction enzyme from *Escherichia coli* cuts at a specific site on the DNA and reveal that the cleaved ends of the DNA are complementary. This demonstrates the use of restriction enzymes as a tool for recombining or joining different DNA fragments and opens the way for cloning and creating new combinations of DNA sequences. The same year, Berg creates the first recombinant DNA molecules from two different organisms — combining DNA from the simian virus 40 (SV40) with that of a bacterial virus known as the lambda bacteriophage (Jackson et al. 1972).

Event	Who	When	Description
First recombinant DNA organisms	Stanley Cohen, Rudolf Jaenisch, and Beatrice Mintz	1973	In the recombinant process, DNA ligase bonds the "sticky" ends of complimentary DNA strands previously cut by a restriction enzyme. Using this technique, Cohen et al. (1973) use restriction enzymes and DNA ligase to introduce recombinant DNA into a bacterial cell, and create the first functional recombinant DNA organism. The same year, Jaenisch and Mintz (1974) create the first transgenic animal, a mouse, by introducing simian virus 40 (SV40) viral DNA into the blastocoel cavity of embryos.
Berg Letter	Paul Berg	July 1974	Berg (1974) along with a group of prominent molecular biologists publish a piece known as the “Berg Letter” in *Science* requesting a (voluntary) moratorium on recombinant DNA research until hazards and safety measures are assessed.
NIH Recombinant DNA Advisory Committee	National Institutes of Health	October 1974	The National Institutes of Health (NIH) forms the Recombinant DNA Advisory Committee on October 7, 1974 in response to public concerns regarding the safety of manipulating genetic material through the use of recombinant DNA techniques (Office of Science Policy n.d.).
Asilomar Conference on Recombinant DNA	Paul Berg	February 1975	Berg et al. (1975) organize the Asilomar Conference on recombinant DNA in February 1975 to identify, evaluate, and discuss the perceived risks of genetic research and recombinant technology. During the conference, the voluntary moratorium on recombinant DNA is also called off (Berg et al. 1975). The conference leads to the creation of a set of guidelines in 1976 for the conduct of NIH-sponsored research that utilizes recombinant DNA and organisms (Gartland & Stetten 1976).
United Nations Biological Weapons Convention	United Nations	March 1975	The Biological Weapons Convention (BWC), also known as the Biological and Toxin Weapons Convention (BTWC), enters into force on March 26, 1975 (United Nations 1975). It is the first multilateral disarmament treaty prohibiting the development, production, and stockpiling of bacteriological (biological) and toxin weapons. The BWC supplements the Geneva Protocol of 1925, which prohibits the use of chemical and biological weapons during warfare.
NIH Guidelines	National Institutes of Health	June 1976	Guidelines for the conduct of experiments involving recombinant DNA molecules including biosafety and containment practices are released on June 23, 1976 by the National Institutes of Health (NIH). Commonly referred to as *NIH Guidelines*, they are the product of open deliberations in public forums (Fredrickson 1979; Gartland & Stetten 1976).

Event	Who	When	Description
First DNA sequencing	Allan Maxam, Walter Gilbert, and Fred Sanger	1977	Maxam and Gilbert (1977) develop a method for determining the sequence of DNA. The Maxam-Gilbert 'chemical degradation' method permits the sequence of a double-stranded DNA molecule to be determined by treatment with chemicals that cut the molecule at specific nucleotide positions. At the same time, Sanger et al. (1977) independently develop an alternative method (called 'chain termination'), which permits the sequence of a single-stranded DNA molecule to be determined by enzymatic synthesis of complementary polynucleotide chains terminating at specific nucleotide positions.
Patenting human-made microorganisms	U.S. Supreme Court	June 1980	The U.S. Supreme Court, in Diamond v. Chakrabarty, upholds the first patent on a newly created living organism, a bacterium derived from the *Pseudomonas* genus capable of digesting crude oil in oil spills. The court rules that "a live, human-made micro-organism is patentable subject matter (U.S. Supreme Court 1980)".
GenBank	International Nucleotide Sequence Database	1983	The National Center for Biotechnology Information (NCBI), part of the National Institutes of Health (NIH), creates GenBank (Benson et al. 2013). GenBank is a genetic sequence database, an annotated collection of all publicly available DNA sequences. GenBank, along with the DNA Data Bank of Japan (DDBJ) and the European Molecular Biology network (EMBnet), is member of the virtually unified International Nucleotide Sequence Database Collaboration (INSCDC).
Australia Group	Australia Group	1985	Australia Group is formed with the aim of harmonising export controls on chemical weapons in the wake of Iraq's use of chemical weapons in the Iran-Iraq war (Australia Group n.d.). Biological agents and dual use biological technology are later added to Australia Group's guidelines.
DNA Data Bank of Japan	International Nucleotide Sequence Database	1986	The DNA Data Bank of Japan (DDBJ) is established as the sole nucleotide sequence data bank in Asia (DDBJ 2013). DDBJ collects nucleotide sequences from researchers and issues the internationally recognized accession number to data submitters. DDBJ, along with GenBank and the European Molecular Biology network (EMBnet), is member of the virtually unified International Nucleotide Sequence Database Collaboration (INSCDC).
European Molecular Biology network	International Nucleotide Sequence Database	1988	The European Molecular Biology Laboratory (EMBL) establishes the European Molecular Biology network (EMBnet) (EMBL 2008). EMBnet is an international sequence database network that aims to enhance bioinformatics services by bringing together bioinformatics service providers. EMBnet, along with GenBank and the DNA Data Bank of Japan (DDBJ), is member of the virtually unified International Nucleotide Sequence Database Collaboration (INSCDC).

Event	Who	When	Description
National Center for Human Genome Research	National Institutes of Health	October 1989	The National Center for Human Genome Research (NCHRG) is established on October 1, 1989 to carry out the role of the National Institutes of Health's (NIH) component of the International Human Genome Project (NHGRI 2013). In 1997, the NCHRG is renamed the National Human Genome Research Institute (NHGRI).
Directives 90/219/EEC and 90/220/EEC	Council of the European Union	April 1990	The Council of the European Union (EU Council) adopts Directive 90/219/EEC on the contained use of genetically modified microorganisms (EU Council 1990a) and Directive 90/220/EEC on the deliberate release into the environment of genetically modified organisms (GMOs) (EU Council 1990b). These legislative frameworks introduce mandatory public consultation and GMO labelling. Organisms created by means of synthetic biology techniques are considered to be GMOs.
National Advisory Council for Human Genome Research	U.S. Department of Health and Human Services, National Institutes of Health, and National Human Genome Research Institute	May 1990	The National Advisory Council for Human Genome Research (NACHGR) is established on May 8, 1990 to advise the U.S. Department of Health and Human Services (DHHS), the National Institutes of Health (NIH), and the National Human Genome Research Institute (NHGRI), on genetics, genomic research, training and programs related to the human genome initiative (NHGRI 2013). The Advisory Council meets for the first time on January 22, 1991 in Bethesda, Maryland (United States).
Human Genome Project	National Human Genome Research Institute, U.S. Department of Energy, and International Human Genome Sequencing Consortium	October 1990	The National Human Genome Research Institute (NHGRI), the U.S. Department of Energy (DOE), and the International Human Genome Sequencing Consortium start a five-year Human Genome Project aimed at determining the physical linkage map of the human genome (NHGRI 2013). The project officially begins on October 1, 1990.
Agreement on Trade-Related Aspects of Intellectual Property Rights	World Trade Organization	April 1994	Administered by the World Trade Organization (WTO), the Agreement on Trade-Related Aspects of Intellectual Property (TRIPS) introduces intellectual property rules into the multilateral trading system for the first time (WTO 1994). The TRIPS Agreement is Annex 1C of the Marrakesh Agreement Establishing the World Trade Organization, signed on April 15, 1994.

Event	Who	When	Description
NIH Guidelines	National Institutes of Health	June 1994	The *NIH Guidelines* for the conduct of experiments involving recombinant DNA molecules including biosafety and containment practices are entered into force on June 24, 1994 and published on July 5, 1994 (DHHS 2013). Investigators and institutions must adhere to the guidelines when they perform research that is conducted at, or sponsored by, an entity receiving any NIH-support for recombinant DNA research.
Human Genome Project	David Cox et al.	September 1994	The first genetic mapping goal of the Human Genome Project is achieved on September 30, 1994 (Cox et al. 1994).
First offspring developed from a differentiated cell	Roslin Institute	1996	Scientists from the Roslin Institute at the University of Edinburgh (Edinburgh, United Kingdom) clone the first mammal, "Dolly" the sheep (Campbell et al. 1996).
Standard Parts List for Biological Circuitry	Adam Arkin and Drew Endy	1999	Arkin and Endy (1999) propose an initial list of useful standard biological parts of well-characterized and systematized biological components that can be generically assembled to create custom biological circuitry. Such a collection has not yet been fully realized.
Genome Canada	Government of Canada	February 2000	Genome Canada, a not-for-profit organization mandated by the Government of Canada, is created to develop and implement a national strategy for supporting genomics and proteomics research in Canada (Genome Canada 2001).
Cartagena Protocol on Biosafety	United Nations	May 2000	The Cartagena Protocol on Biosafety is signed into effect on May 15, 2000 and entered into force on September 11, 2003 (Convention on Biological Diversity n.d.). The Protocol aims to supplement the Convention on Biological Diversity and protect biological diversity from the potential risks posed by genetically modified organisms (GMOs), including those created by means of synthetic biology techniques.
Mousepox virus	Ronald Jackson et al.	July 2000	Researchers genetically engineer the *Ectromelia virus* (mousepox) designed to evade vaccines (Jackson et al. 2001). The virus, closely relating to the *Variola virus* (smallpox), is modified in an attempt to be used as a mouse contraceptive. When injected into mice, the altered virus suppresses the normal immune response and kills all of the infected mice. The discovery raises fears about the potential for misuse of biotechnology.
Directive 2001/18/EC	Council of the European Union	March 2001	The Council of the European Union (EU Council) adopts Directive 2001/18/EC on the deliberate release into the environment of genetically modified organisms (EU Council 2001). Directive 90/220/EEC is repealed by Directive 2001/18/EC.
Action Group on Erosion, Technology and Concentration	Action Group on Erosion, Technology and Concentration	September 2001	Action Group on Erosion, Technology and Concentration (ETC Group) is an international organization created to study and address the socioeconomic and ecological issues surrounding new technologies (Brodhead 2000).

Event	Who	When	Description
Anthrax attacks	United States Postal Service	October 2001	Letters containing anthrax are sent through the United States postal system resulting in five fatalities, over a dozen infections, and massive panic (Mueller 2001; Jernigan et al. 2002). The anthrax attacks motivate "official and unofficial reassessments of the threat from biological weapons" (Oye 2012).
Public Health Security and Bioterrorism Preparedness Response Act	107th United States Congress	June 2002	The Public Health Security and Bioterrorism Preparedness Response Act is signed into effect on June 12, 2002 and aims to improve the ability of the European Union to prevent, prepare for, and respond to bioterrorism and other public health emergencies (107th United States Congress 2002).
BioBricks	Thomas Knight	2003	Knight (2003) introduces BioBrick™ standard biological parts (or "BioBricks") in an effort to standardize the assembly of genetic parts of defined structure and function. "BioBricks" are functional pieces of DNA that are easily assembled and that interact predictably when part of larger structures.
Completion of the Human Genome Project	National Institutes of Health	April 2003	The International Human Genome Sequencing Consortium announces the successful completion of the Human Genome Project, a completed sequence of the human genome, on April 14, 2003 (NHGRI 2013).
First synthetic virus	J. Craig Venter Institute	November 2003	The J. Craig Venter Institute announces the creation of the first synthetic virus, that of the bacteriophage PhiX 174 (Smith et al. 2003).
Intercollegiate Genetically Engineered Machine Competition	Massachusetts Institute of Technology	November 2003	The first intercollegiate genetically engineered machine competition is held at Massachusetts Institute of Technology in Cambridge (United States) (iGEM Foundation n.d.). In 2005, this becomes the international GEM (iGEM) competition (iGEM Foundation n.d.).
Registry of Standard Biological Parts	Thomas Knight and Drew Endy	2004	Thomas Knight and Drew Endy establish the open source Registry of Standard Biological Parts (Regis 2008).
SB1.0	Massachusetts Institute of Technology	June 2004	SB1.0, the First International Meeting on Synthetic Biology, is held at the Massachusetts Institute of Technology in Cambridge (United States) from June 10 to 12, 2004 (Synthetic biology research community n.d.).
BioBricks Foundation	Thomas Knight, Randy Rettberg, and Drew Endy	2005	Thomas Knight, Randy Rettberg, and Drew Endy co-found the BioBricks Foundation (BBF) (BioBricks Foundation 2013).

Event	Who	When	Description
Sloan's Synthetic Biology initiative	Alfred P. Sloan Foundation	2005	The Alfred P. Sloan Foundation launches the Synthetic Biology Initiative to identify the risks associated with research in, and applications of, synthetic biology and to assess the ethical, regulatory, and public policy implications of these risks (Alfred P. Sloan Foundation n.d.).
Biological Innovation for an Open Society	Cambia	February 2005	The Biological Innovation for an Open Society (BiOS) initiative, created by Cambia, emerges in response to business and legal landscapes, which prevent many groups within the developed and developing world from accessing and harnessing biological science technologies (Broothaerts et al. 2005).
DIYbio	Community of amateur biologists	May 2005	Among many reasons, including but not limited to, advances in biotechnology, the Registry of Standard Biological Parts, and the annual iGEM competitions, enable a growing community of amateur or do-it-yourself (DIY) biologists to experiment outside a formal laboratory, without guidance of a university or a corporation (Carlson 2005).
Reconstruction of Spanish influenza	Terrence Tumpey et al.	October 2005	Researchers sequence the genome of the 1918 H1N1 Spanish influenza pandemic virus (Tumpey et al. 2005).
SynBERC	National Science Foundation	2006	Funded by the National Science Foundation (NSF), the Synthetic Biology Engineering Research Center (SynBERC) is launched (SynBERC n.d.). SynBERC is a multi-institution research effort aimed at laying the foundation for the emerging field of synthetic biology. It is a consortium of UC Berkeley, UC San Francisco, Stanford, Harvard, and Massachusetts Institute of Technology.
Semi-synthetic artemisinin	Dae-Kyun Ro et al.	February 2006	Researchers produce a small amount of the precursor artemisinic acid in engineered *Saccharomyces cerevisiae* yeast (Ro et al. 2006).
Mail ordering genes for smallpox	The Guardian	June 2006	*The Guardian* publishes an article showing that fragments of pathogenic DNA could be ordered from commercial DNA synthesis houses without detection or safeguards (Randerson 2006).
International Consortium for Polynucleotide Synthesis	Gene-synthesis companies in the United States and Europe	June 2006	Seven leading gene-synthesis companies in the United States and Europe (Blue Heron Biotechnology, GeneArt, Codon Devices, Coda Genomics, BaseClear, Bioneer and Integrated DNA Technologies) form the International Consortium for Polynucleotide Synthesis (ICPS) to promote safety and security in the emerging field of synthetic biology and harmonize biosecurity practices in use across the industry (Tucker 2008).
Addressing Biosecurity Concerns Related to the Synthesis of Select Agents,	National Science Advisory Board for Biodefense	December 2006	The National Science Advisory Board for Biosecurity (NSABB) releases *Addressing Biosecurity Concerns Related to the Synthesis of Select Agents*, a report that considers the impact of synthetic biology and DNA synthesis technology on biosecurity and the current Select Agents Regulations (SAR) (NSABB 2006).

Event	Who	When	Description
International Association Synthetic Biology	Gene-synthesis companies in Germany	April 2007	Six German gene-synthesis companies (ATG:Biosynthetics GmbH, Biomax Informatics AG, Entelechon GmbH, febit synbio GmbH, MWG Biotech AG and Sloning BioTechnology GmbH) form the International Association Synthetic Biology (IASB) (Kelle 2010; Bernauer et al. 2008).
Oversight framework for the DNA-synthesis industry	Hans Bügl et al.	June 2007	A group of academics, industry executives, and security experts outline a practical plan for developing an effective oversight framework for the DNA-synthesis industry (Bügl et al. 2007).
Proposed Framework for the Oversight of Dual Use Life Sciences Research	National Science Advisory Board for Biosecurity	June 2007	The National Science Advisory Board for Biosecurity (NSABB) advises the United States government on a *Proposed Framework for the Oversight of Dual Use Life Sciences Research* as a means of minimizing the potential that information, products, or technologies resulting from this research will be misused for harmful purposes (NSABB 2007).
NEST PATHFINDER initiative	European Union	June 2007	The goal of the NEST Pathfinder initiative, an activity of the Sixth European Union Framework Programme for Research and Technological Development, is to stimulate forward-looking cross-disciplinary research to demonstrate the key principles as well as to generate the tools and parts to progress the field of synthetic biology in Europe (European Commission 2007).
Synthetic Genomics: Options for Governance	Michele Garfinkel, Gerald Epstein, and Drew Endy	October 2007	Garfinkel, Epstein, and Endy (2007) publish *Synthetic Genomics: Options for Governance*, a report that outlines areas for interventions and policy options to help mitigate potential risks with the field of synthetic genomics. The report is funded by a grant from the Alfred P. Sloan Foundation.
iGEM addresses safety and security	Massachusetts Institute of Technology	2008	The iGEM competition requires every team to answer basic questions on safety and security as a condition of participation (Guan et al. 2013). A Safety Committee is formed to review iGEM projects prior to the 2010 competition. The review process is reformed for the 2011 competition, with more thorough review at a much earlier stage of the iGEM process.
First synthesis of bacterial genome	J. Craig Venter Institute	February 2008	The J. Craig Venter Institute announces the complete synthesis, cloning, and assembly of a bacterial genome named *Mycoplasma genitalium* JCVI-1.0 (Gibson et al. 2008).
Synthetic Biology: Social and Ethical Challenges	Biotechnology and Biological Sciences Research Council	May 2008	The Biotechnology and Biological Sciences Research Council's (BBSB) Bioscience for Society Strategy Panel release *Synthetic Biology: Social and Ethical Challenges*, a report on the social and ethical challenges within the field of synthetic biology (Balmer & Martin 2008).

Event	Who	When	Description
Synthetic Biology Project	Woodrow Wilson International Center for Scholars	August 2008	The Synthetic Biology Project is established as an initiative of the Science and Technology Innovation Program of the Woodrow Wilson International Center for Scholars (or Wilson Center) (Wilson Center 2008). Work of the Synthetic Biology Project is supported by a grant from the Alfred P. Sloan Foundation.
Gene-synthesis screening standards	International Association of Synthetic Biology, and International Gene Synthesis Consortium	2009	The International Association of Synthetic Biology (IASB) and the International Gene Synthesis Consortium (IGSC) publish competing standards specifying the precautions that companies should take before they provide artificial DNA to customers (IASB 2009; IGSC 2009). The standards aim to outline current best practice in synthetic biology to companies, academic, and public institutions involved in gene synthesis.
Directive 2009/14/EC	Council of the European Union	March 2009	The Council of the European Union (EU Council) adopts Directive 2009/14/EC on the contained use of genetically modified microorganisms (GMOs) as to limit their possible negative consequences for human health and the environment (EU Council 2009). Directive 90/219/EEC is repealed by Directive 2009/14/EC.
Synthetic Biology: scope, applications and implications	Royal Academy of Engineering and People, Science and Policy Ltd	May 2009	The Royal Academy of Engineering commissions an exploratory public dialogue project to explore uninformed and informed perceptions of, and attitudes to, synthetic biology in the United Kingdom. The study is conducted by People Science & Policy Ltd (PSP) and published in *Synthetic Biology: scope, applications and implications* (The Royal Academy of Engineering 2009).
Human Pathogens and Toxins Act	Public Health Agency of Canada	June 2009	The Government of Canada passes the Human Pathogens and Toxins Act (Minister of Justice 2013). The Public Health Agency of Canada (PHAC) is charged with enforcing the Act and developing a program and regulatory framework.
Ethics of Synthetic Biology	European Group on Ethics in Science and New Technologies	November 2009	The European Group on Ethics (EGE) in Science and New Technologies to the European Commission publish *Ethics of Synthetic Biology*, an Opinion on the ethical, legal, and social implications that may derive from synthetic biology (Salvi 2009).
Presidential Commission for the Study of Bioethical Issues	U.S. Department of Health and Human Services	November 2009	The Presidential Commission for the Study of Bioethical Issues is established on November 24, 2009 within the U.S. Department of Health and Human Services (HHS) (White House Office of the Press Secretary 2009). The Commission advises the President on bioethical issues that may emerge as a consequence of advances in biomedicine and related areas of science and technology.
International Gene Synthesis Consortium	Gene-synthesis companies	November 2009	Five leading gene-synthesis companies (DNA2.0, GenScript, Blue Heron Biotechnology, Integrated DNA Technologies and Life Technologies) form an industry group called the International Gene Synthesis Consortium (IGSC) (Hayden 2009).

Event	Who	When	Description
BIOFAB	National Science Foundation	December 2009	The International Open Facility Advancing Biotechnology (BIOFAB) is established with funding from the National Science Foundation (NSF) (Sanders 2010). BIOFAB, the world's first biological design-build facility, is operated in partnership with Lawrence Berkeley National Laboratory (LBNL), the BioBricks Foundation (BBF), and the Synthetic Biology Engineering Research Center (SynBERC).
Sequence-Based Classification of Select Agents: A Brighter Line	National Research Council	2010	A National Research Council (NRC) releases *Sequence-Based Classification of Select Agents: A Brighter Line*, a report that considers the scientific advances necessary to develop an oversight system for synthesized Select Agents and other potential pathogens based on the predicted features and properties of the genes encoded by their DNA (NRC 2010).
Synthia	J. Craig Venter Institute	May 2010	The J. Craig Venter Institute (JCVI) announces the creation of the first-ever artificial self-replicating organism known as the “synthetic cell” named Synthia (Gibson et al. 2010).
Emerging Technologies Interagency Policy Coordination Committee	Emerging Technologies Interagency Policy Coordination Committee	May 2010	The Emerging Technologies Interagency Policy Coordination Committee (ETIPC) is formed to give special attention to new and emerging technologies, such as synthetic biology, and to examine their policy implications (Evans 2010).
SBSTTA 14 Recommendation	Subsidiary Body on Scientific, Technical and Technological Advice	June 2010	Recommendations adopted by the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) at its fourteenth meeting in Nairobi (Kenya) from May 10 to 21, 2010 are published (SBSTTA 2010). The SBSTTA invites Parties, other Governments, and relevant organizations to submit information on synthetic biology and geo-engineering while applying the precautionary approach to the field release of synthetic life, cell, or genome into the environment.
Screening Framework Guidance for Providers of Synthetic Double Stranded DNA	U.S. Department of Health and Human Services	October 2010	The U.S. Department of Health and Human Services (HHS) develops the *Screening Framework Guidance for Providers of Synthetic Double Stranded DNA* (DHHS 2010). The framework assists providers in knowing to whom they are distributing a product, and if the product that they are synthesizing and distributing contains in part, or in whole, a sequence of concern. The Guidance provides voluntary standards, not regulations.
New directions: The ethics of synthetic biology and emerging technologies	Presidential Commission for the Study of Bioethical Issues	December 2010	The Presidential Commission for the Study of Bioethical Issues releases *New directions: The ethics of synthetic biology and emerging technologies*, a report that makes recommendations for the oversight and conduct of the emerging field of synthetic biology (PCSBI 2010).

Event	Who	When	Description
Moratorium on uncontained commercial applications of synthetic biology	Friends of the Earth	December 2010	In response to the Presidential Commission for the Study of Bioethical Issues' *New directions: The ethics of synthetic biology and emerging technologies* report, a coalition of non-governmental organizations, led by Eric Hoffman of Friends of the Earth (FOE), calls for a moratorium on the release and commercial use of synthetic organisms and their products until the potential risks are fully understood (Friends of the Earth 2010).
H5N1 Research Controversy	University of Wisconsin and Erasmus Medical Center	September 2011	Two research groups announce that independent experiments have produced highly pathogenic avian influenza A (H5N1) strains with enhanced transmissibility between mammals (Imai et al. 2012; Herfst et al. 2012). The NIH-funded projects seek to evaluate the potential for a human pandemic and to provide an animal model that could be used to develop ways of preventing and controlling outbreaks in humans.
H5N1 Research Controversy	World Health Organization and National Science Advisory Board for Biosecurity	2012	In February 2012, the World Health Organization (WHO) convenes a technical consultation to clarify key facts about two studies published in *Science* and *Nature* in 2011 and to address the most urgent issues concerning the management of these laboratory-modified viruses and how access to, and dissemination of, any findings should be handled (WHO 2012). In March 2012, the National Science Advisory Board for Biosecurity (NSABB) convenes to examine both manuscripts and recommends that both be communicated in a redacted form (NSABB 2012).
Rapport sur les enjeux de la biologie de synthèse	French National Assembly and Senate	February 2012	The French National Assembly and Senate adopt Minister Geneviève Fioraso's *Issues facing synthetic biology* (« *Rapport sur les enjeux de la biologie de synthèse* ») (Fioraso 2012).
United States Government Policy for Oversight of Life Sciences Dual Use Research of Concern	U.S. Department of Health and Human Services	March 2012	The U.S. Department of Health and Human Services (HHS) releases *United States Government Policy for Oversight of Life Sciences Dual Use Research of Concern* (OSTP 2012). The Policy requires formal risk assessment and regular review of federally-funded life sciences dual use research of concern.
Globalizing adherence to gene-synthesis screening standards	International Council for the Life Sciences	March 2012	The International Council for the Life Sciences (ICLS) organizes a meeting in Heidelberg (Germany) from March 5 to 7, 2012, to initiate discussion on how to globalize adherence to the *Codes of Conduct* developed by the International Gene Synthesis Consortium (IGSC) and the International Association of Synthetic Biology (IASB) (ICLS n.d.).
Principles for the Oversight of Synthetic Biology	Friends of the Earth	March 2012	Hoffman et al. (2012) release *Principles for the Oversight of Synthetic Biology*, a report that represents the first global declaration from civil society to outline principles to be adopted to protect public health and the environment from the risks posed by synthetic biology.

Event	Who	When	Description
Virus-based piezoelectric energy generation	Lawrence Berkeley National Laboratory	June 2012	Scientists from the U.S. Department of Energy's Lawrence Berkeley National Laboratory (LBNL) develop a way to generate power using harmless viruses that convert mechanical energy into electricity (Lee et al. 2012).
United States Government Policy for Institutional Oversight of Life Sciences Dual Use Research of Concern	U.S. Department of Health and Human Services	February 2013	The U.S. Department of Health and Human Services (HHS) invites comments on the proposed *United States Government Policy for Institutional Oversight of Life Sciences Dual Use Research of Concern* (OSTP 2013). The proposed Policy establishes institutional review and oversight requirements for certain categories of life sciences research at institutions that accept federal funding for such research.
H7N9 influenza A	Tokiko Watanabe at al. and Jessica Belser et al.	July 2013	Two research teams publish manuscripts in the same issue of *Nature* about the transmissibility, characteristics, and pandemic potential of the novel H7N9 influenza virus (Watanabe et al. 2013; Belser et al. 2013).
Canadian Biosafety Standards	Public Health Agency of Canada	June 2013	The Public Health Agency of Canada (PHAC) publishes *Canadian Biosafety Standards and Guidelines for Facilities Handling Human and Terrestrial Animal Pathogens, Prions, and Biological Toxins* (Government of Canada 2013). The document is a harmonized national standard for the handling and storing of human and terrestrial animal pathogens and toxins in Canada.
New synthetic biology research centres	Biotechnology and Biological Sciences Research Council	January 2014	It is announced that three new multidisciplinary research centres in synthetic biology will be established in Bristol, Nottingham and through a Cambridge/Norwich partnership, with funding from the Biotechnology and Biological Sciences Research Council (BBSRC) and the Engineering and Physical Sciences Research Council (EPSRC) (BBSRC 2014).
First synthetic eukaryotic chromosome	Narayana Annaluru et al.	March 2014	An international team of scientists synthesize a functional *Saccharomyces cerevisiae* chromosome (Annaluru et al. 2014). This is the first report of a synthetic chromosome in a eukaryote.
Realising Global Potential in Synthetic Biology: Scientific Opportunities and Good Governance	InterAcademy Panel	May 2014	The InterAcademy Panel: The Global Network of Science Academies (IAP) publishes a statement on *Realising Global Potential in Synthetic Biology: Scientific Opportunities and Good Governance* (IAP 2014). The statement highlights different areas in which researchers are currently working with synthetic biology and among several recommendations, the importance of taking an evidence-based view of the potential benefits as well as risks of synthetic biology.
Synthorx Inc. launches Synthetic Biology Technology	Synthorx Inc.	May 2014	Synthorx Inc. announces the official launch of the company, which will be focused on using synthetic biology to improve the discovery and development of new medicines, diagnostics and vaccines (PR Newswire 2014).

Event	Who	When	Description
In vivo replication of a synthetic DNA base pair	Denis A. Melyshev et al.	May 2014	Scientists create the first living organism that replicates itself using an expanded genetic code that includes two entirely synthetic DNA bases (Malyshev et al. 2014; Thyer & Ellefson 2014).

Please send suggestions for updates to issp@uottawa.ca

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