



Convention on Biological Diversity

Distr.
GENERAL

CBD/SBSTTA/24/INF/6
15 April 2020

ENGLISH ONLY

SUBSIDIARY BODY ON SCIENTIFIC,
TECHNICAL AND TECHNOLOGICAL ADVICE

Twenty-fourth meeting

Montreal, Canada, 17-22 August 2020

Item 4 of the provisional agenda*

LIST OF REFERENCES ON SYNTHETIC BIOLOGY

I. INTRODUCTION

1. In [decision 14/19](#), the Conference of the Parties requested the Subsidiary Body on Scientific, Technical and Technological Advice to consider the work of the Open-ended Online Forum and the Ad Hoc Technical Expert Group (AHTEG) on Synthetic Biology.
2. To support the work of the AHTEG on Synthetic Biology, the Secretariat compiled a list of references¹ from various sources that were relevant for discussion on the various agenda items. The AHTEG expressed its appreciation for the compilation of the bibliographic references and suggested that it would be beneficial if the Secretariat continued to update this document as new research on synthetic biology was published.
3. The present document is an updated version of the compilation. It includes references emanating from submissions on synthetic biology (section II), references shared during the Open-Ended Online Forum on Synthetic Biology (section III) and additional references that may be useful for the deliberations of the Subsidiary Body on Scientific, Technical and Technological Advice at its twenty-fourth meeting.
4. It is worth noting that, due to the cross-cutting nature of some of the topics and references provided herein, they may fit in more than one of the categories listed below.
5. The present document contains peer-reviewed articles, opinion documents and perspectives.

* CBD/SBSTTA/24/1.

¹ <https://www.cbd.int/doc/c/335e/d1bf/4764e0323393df18f259a291/synbio-ahteg-2019-01-inf-03-en.pdf>

II. REFERENCES FROM THE SUBMISSIONS ON SYNTHETIC BIOLOGY

Cellular sensors, cell-free systems, genetic circuits, and bio-based design

- Andrews, Nielsen and Voigt, 2018, Cellular checkpoint control using programmable sequential logic, *Science* 361 (6408), eaap8987, DOI: 10.1126/science.aap8987
- Benítez-Mateos, A., Llarena, I., Sánchez-Iglesias, A., & López-Gallego, F., 2018, Expanding One-Pot Cell-Free Protein Synthesis and Immobilization for On-Demand Manufacturing of Biomaterials, *ACS Synthetic Biology* 7 (3), 875-884, DOI: 10.1021/acssynbio.7b0038
- Chang, HJ et al., 2017, Microbially derived biosensors for diagnosis, monitoring and epidemiology. *Microb Biotechnol.* 10 : 1031–1035. Doi : 10.1111/1751-7915.12791
- Gao et al., 2018, Programmable protein circuits in living cells, *Science* 361 (6408), 1252-1258, doi : 10.1126/science.aat5062.
- Jiang, L., Zhao, J., Lian, J., & Xu, Z., 2018, Cell-free protein synthesis enabled rapid prototyping for metabolic engineering and synthetic biology, *Synthetic and Systems Biotechnology*, Volume 3, Issue 2, Pages 90-96, ISSN 2405-805X, <https://doi.org/10.1016/j.synbio.2018.02.003>
- Karig DK. Cell-free synthetic biology for environmental sensing and remediation., 2017, *Curr Opin Biotechnology*; 45:69–75. <http://dx.doi.org/10.1016/j.copbio.2017.01.010>
- Lu Y., 2017, Cell-free synthetic biology: Engineering in an open world. *Synth Syst Biotechnol*; 2(1):23–7. <http://dx.doi.org/10.1016/j.synbio.2017.02.003>
- Ma D, Shen L, Wu K, Diehnelt CW, Green AA., 2018, Low-cost detection of norovirus using paperbased cell-free systems and synbody-based viral enrichment. *Synth Biol* 2018 3(1). Available from: <https://academic.oup.com/synbio/article/doi/10.1093/synbio/ysy018/5102817>
- Martin, R., Mjewska, N., Chen, C., Albanetti, T., Jimenez, B., Schmelzer, A., Jewett, M., & Roy, V., 2017, Development of a CHO-Based Cell-Free Platform for Synthesis of Active Monoclonal Antibodies, *ACS Synthetic Biology* 2017 6 (7), 1370-1379, DOI: 10.1021/acssynbio.7b00001
- Nowogrodzki, A., 2018, The automatic-design tools that are changing synthetic biology, *Nature* 564.7735, 291.
- Ogonah, O., Polizzi, K., & Bracewell, D., 2017, Cell free protein synthesis: a viable option for stratified medicines manufacturing?, *Current Opinion in Chemical Engineering*, Volume 18, 2017, Pages 77-83, ISSN 2211-3398, <https://doi.org/10.1016/j.coche.2017.10.003>
- Pardee K, Green AA, Ferrante T, Cameron DE, Daleykeyser A, Yin P, et al., 2014, Paper-based synthetic gene networks. *Cell* 2014;159(4):940–54. <http://dx.doi.org/10.1016/j.cell.2014.10.004>
- Pardee K, Green AA, Takahashi MK, Braff D, Lambert G, Lee JW, et al. Rapid, Low-Cost Detection of Zika Virus Using Programmable Biomolecular Components., 2016, *Cell*, 165(5):1255–66. <https://doi.org/10.1016/j.cell.2016.04.059>
- Park et al., 2019, Engineering Epigenetic Regulation Using Synthetic Read-Write Modules, *Cell* 176 (1), 227-238, doi: 10.1016/j.cell.2018.11.002
- Perez, J., Stark, J., & Jewett, M., 2016, Cell-Free Synthetic Biology: Engineering Beyond the Cell, *Cold Spring Harb Perspect Biol* December 2016;8:a023853, doi:10.1101/cshperspect.a023853

Sheth, Ravi U., and Harris H. Wang., 2018, DNA-based memory devices for recording cellular events, *Nature Reviews Genetics* (2018): 1.

Soltani, M. Davis, B., Ford, H., Nelson, J.A.D., & Bundy, B., 2018, Reengineering cell-free protein synthesis as a biosensor: Biosensing with transcription, translation, and protein-folding, *Biochemical Engineering Journal*, Volume 138, Pages 165-171, ISSN 1369-703X, <https://doi.org/10.1016/j.bej.2018.06.014>

Takahashi MK, Tan X, Dy AJ, Braff D, Akana RT, Furuta Y, et al., 2018, A low-cost paper-based synthetic biology platform for analyzing gut microbiota and host biomarkers. *Nat Commun* 2018 ;9(1):3347. Available from: <http://www.nature.com/articles/s41467-018-05864-4>

Tang, Q et al., 2018, Developing a Synthetic Biology Toolkit for *Comamonas 3griculture3*, an Emerging Cellular Chassis for Bioremediation. *ACS Synth Biol.* 20:1753-1762.

Wen et al., 2017, Cell-Free Biosensor for Detecting Quorum Sensing Molecules in *P. aeruginosa*-Infected Respiratory Samples, *ACS Synthetic Biology* 2017 6 (12), 2293-2301, DOI: 10.1021/acssynbio.7b00219

Wilding, K., Schinn, S-M, Long, E., & Bundy, B., 2018, The emerging impact of cell-free chemical biosynthesis, *Current Opinion in Biotechnology*, Volume 53, Pages 115-121, ISSN 0958-1669, <https://doi.org/10.1016/j.copbio.2017.12.019>

Yousefi, H., Ali, M. M., Su, H.-M., Filipe, C. D. M., & Didar, T. F. (2018). Sentinel Wraps: Real-Time Monitoring of Food Contamination by Printing DNzyme Probes on Food Packaging. *ACS Nano*, 12(4), 3287–3294. <https://doi.org/10.1021/acsnano.7b08010>

Zhou et al., 2018, Circuit design features of a stable two-cell system, *Cell*, 172 (4), 744-757 <https://doi.org/10.1016/j.cell.2018.01.015>

Gene Drives

Adelman, Z. N., Pledger, D., & Myles, K. M. (2017). Developing standard operating procedures for gene drive research in disease vector mosquitoes. *Pathogens and Global Health*, 111(8), 436–447. <https://doi.org/10.1080/20477724.2018.1424514>

Akbari OS, Bellen HJ, Bier E, Bullock SL, Burt A, Church GM, Cook KR, Duchek P, Edwards OR, Esvelt KM, Gantz VM, Golic KG, Gratz SJ, Harrison MM, Hayes KR, James AA, Kaufman TC, Knoblich J, Malik HS, Matthews KA, O’Conner-Giles KM, Parks AL, Perrimon N, Port F, Russell S, Ueda R, Wildonger J, 2015, Safeguarding gene drive experiments in the laboratory – Multiple stringent confinement strategies should be used whenever possible, *Science* 349: 927-929

Baltzegar J., Barnes J. C., Elsensohn J. E., Gutzmann N., Jones M. S., King S., Sudweeks J, 2018, Anticipating complexity in the deployment of gene drive insects in agriculture. *J. Responsible Innovation* 5 (S1): 81-97

Beech, C.J., Vasan, S.S., Quinlan, M.M., Capurro, M.L., Alphey, L., Bayard, V., Bouaré, M., McLeod, M.C., Kittayapong, P., Lavery, J.V., et al., 2009, Deployment of Innovative Genetic Vector Control Strategies: Progress on Regulatory and Biosafety Aspects, Capacity Building and Development of Best-Practice Guidance. *Asia Pac J Mol Biol Biotechnol* 17, 75-85.

Benedict et al., 2018, Recommendations for Laboratory containment and management of gene drive systems in arthropods, *Vector borne zoonotic dis.* 2018 Jan 1; 18(1):2-13 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5846571/>

- Brossard, D., Belluck, P., Gould, F., and Wirz, C.D., 2019, Promises and perils of gene drives: Navigating the communication of complex, post-normal science. PNAS 201805874.
- Buchman, A., Marshall, J.M., Ostrovski, D., Yang, T., and Akbari, O.S., 2018, Synthetically engineered Medea gene drive system in the worldwide crop pest *Drosophila suzukii*. Proceedings of the National Academy of Sciences of the United States of America 115, 4725–4730.
- Burt, A., and Crisanti, A., 2018, Gene Drive: Evolved and Synthetic. ACS Chemical Biology 13.
- Burt, A., and Trivers, R., 2006, Genes in Conflict: the Biology of Selfish Genetic Elements (Belknap Press of Harvard University Press).
- Burt, D. 2018, Self-limiting population genetic control with sex-linked genome editors, 285, Proceedings of the Royal Society B: Biological Sciences
<https://royalsocietypublishing.org/doi/10.1098/rspb.2018.0776>
- Callaway, E., 2017, Gene drives meet the resistance. Nature 542:15.
- Callaway, E, 2018, Controversial CRISPR gene drives tested in mammals for the first time. Nature 559, 164 DOI: 10.1038/d41586-018-05665-1. <https://www.nature.com/articles/d41586-018-05665-1>
- Campbell KJ, Beek J, Eason CT, Glen AS, Godwin J, Gould F, Holmes ND, Howald GR, Madden FM, Ponder JB, Threadgill DW, Wegmann AS, Baxter GS, 2015, The next generation of rodent eradications: Innovative technologies and tools to improve species specificity and increase their feasibility on islands. Biological Conservation 185: 47–58.
- Champer et al., 2019, Molecular safeguarding of CRISPR gene drive experiments, eLife, <https://elifesciences.org/articles/41439>
- Champer J, Liu J, Oh SY, Reeves R, Luthra A, Oakes N, Clark AG, Messer PW (2018) Reducing resistance allele formation in CRISPR gene drive. Proceedings of the National Academy of Sciences USA 115: 5522-5527
- Collins CH. Gene drive: A genetic tool that can alter – and potentially eliminate – entire species has taken a dramatic leap forward. Scientific American 14 September 2018.
<https://www.scientificamerican.com/article/gene-drive1/>
- Collins, J., 2018, Gene drives in our future: challenges of and opportunities for using a self-sustaining technology in pest and vector management, BMC Proceedings, Jul 19;12(Suppl 8):9. Doi: 10.1186/s12919-018-0110-4
- Conklin BR, 2019, On the road to a gene drive in mammals. Nature 566: 43-45. Doi: 10.1038/d41586-019-00185-y
- Courtier-Orgogozo V, Morizot B, Boëte Ch, 2017, Agricultural pest control with CRISPR-based gene drive: time for public debate. Should we use gene drive for pest control? EMBO Reports, May 16, 2017
- de Jong TJ, 2017), Gene drives do not always increase in frequency: from genetic models to risk assessment. Journal of Consumer Protection and Food Safety 12: 299-307
- Dhole et al., 2018, Invasion and migration of spatially self-limiting gene drives: A comparative analysis, Evol. Appl. 11:797-808 <https://onlinelibrary.wiley.com/doi/full/10.1111/eva.12583>

Drury DW, Dapper AL, Siniard DJ, Zentner GE, Wade MJ, 2017, CRISPR/Cas9 gene drives in genetically variable and nonrandomly mating wild populations. *Science Advances* 3: e1601910 DOI: 10.1126/sciadv.1601910

Eckhoff, PA, Wenger, EA, Godfray H,C, Burt,A., 2017, Impact of mosquito gene drive on malaria elimination in a computational model with explicit and temporal dynamics. *Proceedings of the National Academy of Sciences*. 114 (2): E255-E264; DOI: 10.1073/pnas.1611064114

Emerson, C., James, S., Littler, K., and Randazzo, F. (Fil) (2017). Principles for gene drive research. *Science*, 01 Dec 2017: Vol 358, issues 6367, pp. 1135-1136.
<http://science.sciencemag.org/content/358/6367/1135.full>

Esvelt, KM & Gemmell, NJ (2017). Conservation demands safe gene drive. *PloS Biology* 15, e2003850. Doi:10.1371/journal.pbio.2003850

Esvelt, K.M., Smidler, A.L., Catteruccia, F., and Church, G.M. (2014). Concerning RNA-guided gene drives for the alteration of wild populations. *Elife* 3, 1–21.

Gantz, V.M., Jasinskiene, N., Taratenkova, O., Fazekas, A., Macias, V.M., Bier, E., and James, A.A., 2015, Highly efficient Cas9-mediated gene drive for population modification of the malaria vector mosquito *Anopheles stephensi*. *Proc. Natl. Acad. Sci. USA* 215, E6736–E6743.

Grunwald et al., 2019, Super-Mendelian inheritance mediated by CRISPR–Cas9 in the female mouse germline, *Nature* 566 (7742), 105-109, <https://doi.org/10.5281/zenodo.2003087>

Hammond, A., Galizi, R., Kyrou, K., Simoni, A., Siniscalchi, C., Katsanos, D., Gribble, M., Baker, D., Marois, E., Russell, S., et al. (2016). A CRISPR-Cas9 gene drive system targeting female reproduction in the malaria mosquito vector *Anopheles gambiae*. *Nature Biotechnology* 34, 78–83

Hammond et al. 2019, The creation and selection of mutations resistant to a gene drive over multiple generations in the malaria mosquito, *PloS Genetics*. 13(10):e100703
doi:10.1371/journal.pgen.1007039

Hayes KR, Hosack GR, Dana GV, Foster SD, Ford JH, Thresher R, Ickowicz A, Peel D, Tizard M, De Barro P, Strive T, Dambacher JM, 2018, Identifying and detecting potentially adverse ecological outcomes associated with the release of gene-drive modified organisms, *Journal of Responsible Innovation*, 5:sup1, S139-S158, DOI: 10.1080/23299460.2017.1415585 6

Journal of Responsible Innovation, vol 5, 2018: Roadmap to gene drives
<https://www.tandfonline.com/toc/tjri20/5/sup1?nav=tocList>

Kandul, N, Liu, J., Sanchez, H., Wu, S., Marshall, J., & Akbari, O. S., 2019, Transforming insect population control with precision guided sterile males with demonstration in flies, *Nature Communications*, 2019. <http://dx.doi.org/10.1038/s41467-018-07964-7>

Kyrou, K., Hammond, A.M., Galizi, R., Kranjc, N., Burt, A., Beaghton, A.K., Nolan, T., and Crisanti, A., 2018, A CRISPR–Cas9 gene drive targeting doublesex causes complete population suppression in caged *Anopheles gambiae* mosquitoes. *Nature Biotechnology* 36, 1062–1066.

Lindholm, A.K., Dyer, K.A., Firman, R.C., Lila Fishman, Wolfgang Forstmeier, Luke Holman, Hanna Johannesson, Ulrich Knief, Hanna Kokko, Amanda M. Larracuenta, et al. (2016). The Ecology and Evolutionary Dynamics of Meiotic Drive. *Trends in Ecology & Evolution* 31, 315–326.
12

Marshall JM, Akbari OS., 2018, Can CRISPR-Based Gene Drive Be Confined in the Wild? A Question for Molecular and Population Biology. ACS Chem Biol. Vol 13(2):424-430.

Min, J., Smidler, A.L., Najjar, D., and Esvelt, K.M., 2018, Harnessing gene drive. Journal of Responsible Innovation 5.

Mitchell P. D., Brown Z., McRoberts N., 2018, Economic issues to consider for gene drives. J. Responsible Innovation 5 (S1) 180-202

Moro D, Byrne M, Kennedy M, Campbell S, Tizard M, 2018, Identifying knowledge gaps for gene drive research to control invasive animal species: The next CRISPR step. Global Ecology and Conservation 13: e00363 DOI: 10.1016/j.gecco.2017.e00363

Neve, P., 2018, Gene drive systems: do they have a place in agricultural weed management?, Pest Management Science, 74, 12, <https://doi.org/10.1002/ps.5137>

Neves MP, Drumi C, 2017, Ethical implications of fighting malaria with CRISPR/Cas9. BMJ Global Health 2: e000396 DOI:10.1136/bmjgh-2017-000396

Noble C, Adlam B, Church GM, Esvelt KM, Nowak MA, 2018, Current CRISPR gene drive systems are likely to be highly invasive in wild populations. Elife. Vol 19;7.

Noble, Ch., Olejarz, J., Esvelt, K. M., Church, G. M., Nowak, M. A., 2017, Evolutionary dynamics of CRISPR gene drives. Science Advances 3: e1601964.

Nolan T, Crisanti A, 2017, Using gene drives to limit the spread of Malaria. The Scientist <https://www.thescientist.com/features/using-gene-drives-to-limit-the-spread-of-malaria-32286>.

Oberhofer, G., Ivy, T., and Hay, B.A., 2018, Behavior of homing endonuclease gene drives targeting genes required for viability or female fertility with multiplexed guide RNAs. Proceedings of the National Academies of Sciences, Engineering, and Medicine USA. 115 E9343-E9352.

Okumu, F., de Andrade, P.P., Savadogo, M., James, S., Roberts, A., Quemada, H., and Singh, J.A., 2017, Results from the Workshop “Problem Formulation for the Use of Gene Drive in Mosquitoes.” The American Journal of Tropical Medicine and Hygiene 96, 530–533

Oye, K. A., Esvelt, K., Appleton, E., Catteruccia, F., Church, G. M., Kuiken, T., Lightfoot, S. B. Y., McNamara, J., Smidler, A. L., Collins, J. P., 2014, Regulating gene drives. Scienceexpress. Doi: 10.1126/science.1254287

Rudenko, L., Palmer, M.J., and Oye, K, 2018, Considerations for the governance of gene drive organisms. Pathogens and Global Health. <https://www.tandfonline.com/doi/full/10.1080/20477724.2018.1478776>

Sandler, L., Hiraizumi, Y., and Sandler, I., 1959, Meiotic Drive in Natural Populations of *Drosophila melanogaster*. I. the Cytogenetic Basis of Segregation-Distortion. Genetics 44, 233-50.

Simon S., Otto M., Engelhard M, 2018, Synthetic gene drive: between continuity and novelty. EMBO reports 19:e45760, p 4

Gene Editing

Adikusuma, F, Piltz, S., Corbett, M Turvey, M, McColl, S, Helbig, K. Beard, M, Hughes, J, Pomerantz, R & Thomas, P, 2018, Large deletions induced by Cas9 cleavage. Nature 560 (7717)

- Adikusuma F, Williams N, Grutzner F, Hughes J, Thomas P., 2017, Targeted Deletion of an Entire Chromosome Using CRISPR/Cas9. *Molecular Therapy* 25, 1736-1738
- Adli, M., 2018, The CRISPR tool kit for the genome editing and beyond, *Nature Communications*, 9, Article number 191, 2018, <https://www.nature.com/articles/s41467-018-04252-2>
- Akcakaya et al., 2018, In vivo CRISPR editing with no detectable genome-wide off-target mutations, *Nature* 561 (7723), 416-419, doi: 10.1038/s41586-018-0500-9
- Alateeq S, Ovchinnikov D, Tracey T, Whitworth D, Al-Rubaish A, Al-Ali A, Wolvetang E, 2018, Identification of on-target mutagenesis during correction of a beta-thalassemia splice mutation in iPS cells with 7gricultu CRISPR/Cas9-double nickase reveals potential safety concerns. *APL BIOENGINEERING* 2, 046103
- Anderson KR, Haeussler M, Watanabe C, Janakiraman V, Lund J, Modrusan Z., et al., 2018, CRISPR o5- target analysis in genetically engineered rats and mice. *Nat. Methods* 15, 512–514. Doi: 10.1038/s41592- 018-0011-5
- Borrelli VMG, Brambilla V, Rogowsky P, Marocco A, Lanubile A, 2018, The enhancement of plant disease resistance using CRISPR/Cas9 technology. *Frontiers in Plant Science* 9: article 1245 DOI: 10.3389/fpls.2018.01245.
- Braatz J, Harlo5 HJ., Mascher M, Stein N, Himmelbach A., and Jung C., 2017, CRISPR-Cas9 targeted mutagenesis leads to simultaneous modification of di5erent homoeologous gene copies in polyploid oilseed rape (*Brassica napus*). *Plant Physiol.* Vol 174, 935–942. Doi: 10.1104/pp.17.00426
- Chen W, Zhang Y, Zhang Y, Pi Y, Gu T, Song L, Wang Y, Ji Q, 2018, CRISPR/Cas9-based Genome Editing in *Pseudomonas aeruginosa* and Cytidine Deaminase-Mediated Base Editing in *Pseudomonas* Species. *iScience*. Vol 6:222-231
- Custers R, Casacuberta JM, Eriksson D, Sági L, Schiemann J, 2019, Genetic alterations that do or do not occur naturally; Consequences for genome edited organisms in the context of regulatory oversight. *Frontiers in Bioengineering and Biotechnology* 6: DOI: 10.3389/fbioe.2018.00213.
- Feng X, Zhao D, Zhang X, Ding X, Bi C, 2018, CRISPR/Cas9 assisted multiplex genome editing technique in *Escherichia coli*. *Biotechnology Journal* 13: e1700604 DOI: 10.1002/biot.201700604.
- Feng, Z., Mao, Y., Xu, N., Zhang, B., Wei, P., Yang, D. L., et al., 2014, Multigeneration analysis reveals the inheritance, specificity, and patterns of CRISPR/Cas-induced gene modifications in *Arabidopsis*. *Proc. Natl. Acad. Sci. U.S.A.* Vol 111, 4632–4637. Doi: 10.1073/pnas.1400822111
- Gil-Humanes, J., Wang, Y., Liang, Z., Shan, Q., Ozuna, C.V., Sanchez-Leon, S., et al. (2017). High-efficiency gene targeting in 7gricultur wheat using DNA replicons and CRISPR/Cas9. *Plant J* 89(6), 1251-1262. Doi: 10.1111/tpj.13446
- Gapinske M, Luu A, Winter J, Woods WS, Kostan KA, Shiva N, Song JS, Perez-Pinera P (2018) CRISPRSKIP: programmable gene splicing with single base editors. *Genome Biology* 19:107 DOI: 10.1186/s13059-018- 1482-5
- Glantz, Valention M. and Akbari, Omar S. Gene editing technologies and applications for insects. *Current Opinions in Insect Science*. 2018. 28:66-72
- Guo X, Chavez A, Tung A, Chan Y, Kaas C, Yin Y, Cecchi R, Garnier SL, Kelsic ED, Schubert M, DiCarlo JE, Collins JJ, Church GM, 2018, High-throughput creation and functional profiling of

DNA sequence variant libraries using CRISPR–Cas9 in yeast. *Nature Biotechnology*
DOI:10.1038/nbt.4147

Haapaniemi E, Botla S, Persson J, Schmierer B, and Taipale J., 2018, CRISPR-Cas9 genome editing induces a p53-mediated DNA damage response. *Nat. Med.* 24, 927–930. Doi: 10.1038/s41591-018-0049-z

Hua K, Tao X, Zhu J-K, 2018, Expanding the base editing scope in rice by using Cas9 variants. *Plant Biotechnology Journal* DOI: 10.1111/pbi.12993

Ihry RJ, Worringer KA, Salick MR, Frias E, Ho D, Theriault K, et al., 2018, p53 inhibits CRISPR-Cas9 engineering in human pluripotent stem cells. *Nat. Med* Vol 24, 939–946. Doi: 10.1038/s41591-018-0050-6

Jouanin A, Boyd L, Visser RGF, Smulders MJM (2018) Development of wheat with hypoimmunogenic gluten obstructed by the gene editing policy in Europe. *Frontiers in Plant Science* DOI: 10.3389/fpls.2018.01523.

Jung, C., Capistrano-Gossmann, G., Braatz, J., Sashidhar, N. & Melzer, S., 2017, Recent developments in genome editing and applications in plant breeding. *Plant Breeding* 137: 1-9

Kaminski, R., Chen, Y., Fischer, T., Tedaldi, E., Napoli, A., Zhang, Y., Karn, J., Hu, W., & Khalili, K., 2016, Elimination of HIV-1 Genomes from Human T-lymphoid Cells by CRISPR/Cas9 Gene Editing, *Scientific Reports*, 6:22555, DOI: 10.1038/srep22555

Kang B-C, Yun J-Y, Kim S-T, Shin Y, Ryu J, Choi M, Woo JW, Kim J-S, 2018, Precision genome engineering through adenine base editing in plants. *Nature Plants* DOI: 10.1038/s41477-018-0178-x

Kannan B, Jung JH, Moxley GW, Lee S-M, Altpeter F, 2018, TALEN-mediated targeted mutagenesis of more than 100 COMT copies/alleles in highly polyploid sugarcane improves saccharification efficiency without compromising biomass yield. *Plant Biotechnology Journal* 16: 856–866.

Kosicki, Tomberg, and Bradley, 2018, Repair of double-strand breaks induced by CRISPR-Cas9 leads to large deletions and complex rearrangements, *Nature Biotechnology*, 36, 765-771 (2018)
<https://www.nature.com/articles/nbt.4192>

Kumlehn et al., 2018, The CRISPR/Cas revolution continues: From efficient gene editing for crop breeding to plant synthetic biology, *Journal of Integrative Plant Biology*, 60 (12): 1127-1153

Ledford, H., 2018, CRISPR gene editing produces unwanted DNA deletions. DNA-cutting enzyme used for genetic modification can create large deletions and shuffle genes. In: *Nature. International Journal of Science*, 16 July 2018. Available at: www.nature.com/articles/d41586-018-05736-3

Lemmon ZH, Reem NT, Dalrymple J, Soyk S, Swartwood KE, Rodriguez-Leal D, Van Eck J, Lippman ZB (2018). Rapid improvement of domestication traits in an orphan crop by genome editing. *Nat Plants*. Vol 4(10):766-770

Li A, Jia S, Yobi A, Ge Z, Sato SJ, Zhang C, Angelovici R, Clemente TE, Holding DR (2018) Editing of an alphakafirin gene family increases digestibility and protein quality in sorghum. *Plant Physiology* 177: 1425–1438

- Li C, Zong Y, Wang Y, Jin S, Zhang D, Song Q, Zhang R, Gao C, 2018, Expanded base editing in rice and wheat using a Cas9-adenosine deaminase fusion. *Genome Biology* 19:59 DOI: 10.1186/s13059-018-1443-z.
- Li L, Wei K, Zheng G, Liu X, Chen S, Jiang W, Lu Y, 2018, CRISPR-Cpf1-assisted multiplex genome editing and transcriptional repression in *Streptomyces*. *Applied and Environmental Microbiology* 84:e00827-18 DOI: 10.1128/AEM.00827-18.
- Li, T., Yang, X., Yu, Y., Si, X., Zhai, X., Zhang, H., et al., 2018, Domestication of wild tomato is accelerated by genome editing. *Nature Biotechnology* 36, 1160. Doi: 10.1038/nbt.4273
- Liang, G., Zhang, H.M., Lou, D.J., and Yu, D.Q., 2016, Selection of highly efficient sgRNAs for CRISPR/Cas9-based plant genome editing. *Scientific Reports* 6, 8. Doi: 10.1038/srep21451.
- Liu et al., 2019, CasX enzymes comprise a distinct family of RNA-guided genome editors, *Nature*, 566, 218-223 <https://www.nature.com/articles/s41586-019-0908-x>
- Ma X, Zhang Q, Zhu Q, Liu W, Chen Y, Qiu R, Wang B, Yang Z, Li H, Lin Y, Lin Y, Xie Y, Shen R, Chen S, Wang Z, Chen Y, Guo J, Chen L, Zhao X, Dong Z, Liu Y-G, 2015, A robust CRISPR/Cas9 system for convenient, high efficiency multiplex genome editing in monocot and dicot plants. *Molecular Plant* 8: 1274–1284.
- Marzec and Hansel, 2018, Targeted based editing systems are available for plants, *Trends in plant Science*, 23 (11): 995-957 <https://doi.org/10.1016/j.tplants.2018.08.011>
- Nakamura et al., 2019, Anti-CRISPR-mediated control of gene editing and synthetic circuits in eukaryotic cells, *Nature Communications*, 10, Article number 194(2019) <https://www.nature.com/articles/s41467-018-08158-x>
- Nogué F, Mara K, Collonnier C, Casacuberta JM, 2016, Genome engineering and plant breeding: impact on trait discovery and development. *Plant Cell Reports* 35: 1475-1486.
- Phelps MP, Seeb LW, Seeb JE, 2019, Transforming ecology and conservation biology through genome editing. *Conserv Biol*. Doi: 10.1111/cobi.13292.
- Phithakrotchanakoon et al, 2018, CRISPR-Cas9 enabled targeted mutagenesis in the thermotolerant methylotrophic yeast *Ogataea thermomethanolica*, *FEMS Microbiology Letters*, 365(11)
- Podevin N, Davies HV, Hartung F, Nogue F, Casacuberta JM, 2013, Site-directed nucleases: A paradigm shift in predictable, knowledge-based plant breeding. *Trends in Biotechnology* 31: 375-383
- Qi, W.W., Zhu, T., Tian, Z.R., Li, C.B., Zhang, W., and Song, R.T., 2016, High-efficiency CRISPR/Cas9 multiplex gene editing using the glycine tRNA-processing system-based strategy in maize. *Bmc Biotechnology* 16, 8. Doi: 10.1186/s12896-016-0289-2.
- Sánchez-León, S., Gil-Humanes, J., Ozuna, C.V., Gimenez, M.J., Sousa, C., Voytas, D.F., et al. , 2018, Low-gluten, nontransgenic wheat engineered with CRISPR/Cas9. *Plant Biotechnol J* 16(4), 902-910. Doi: 10.1111/pbi.12837.
- Shen et al., 2018, Predictable and precise template-free CRISPR editing of pathogenic variants, *Nature* 563 (7733), 646-651, doi: 10.1038/s41586-018-0686-x

Singh M, Kumar M, Albertsen MC, Young JK, Cigan AM, 2018, Concurrent modifications in the three homeologs of Ms45 gene with CRISPR-Cas9 lead to rapid generation of male sterile bread wheat (*Triticum aestivum* L.) *Plant Molecular Biology* 97: 371–383.

Strecker, J., Jones, S., Koopal, B., Schmid-Burgk, J., Zetsche, B., Gao, L., Makarova, K., Koonin, E., & Zhang, F., 2019, Engineering of CRISPR-Cas12b for human genome editing, *Nature Communications*, 10: 212 <https://doi.org/10.1038/s41467-018-08224-4>

Tabebordbar, M. et al., In vivo gene editing in dystrophic mouse muscle and muscle stem cells, *Science*, 351, 407, 2016. DOI: 10.1126/science.aad5177

Tycko, J., Hess, G.T., Jeng, E.E., Dubreuil, M., and Bassik, M.C., 2017, The expanding CRISPR toolbox [Online]. *Nature Methods*. Available: http://s3-service-broker-live-19ea8b98-4d41-4cb4-be4c-d68f4963b7dd.s3.amazonaws.com/uploads/ckeditor/attachments/7742/CRISPR_poster-WEB.pdf

Unckless RL, Clark AG, Messer PW (2017) Evolution of resistance against CRISPR/Cas9 gene drive. *Genetics* 205: 827-841.

Wang, C., Liu, Q., Shen, Y., Hua, Y., Wang, J., Lin, J., ... Wang, K. (2019). Clonal seeds from hybrid rice by simultaneous genome engineering of meiosis and fertilization genes. *Nature Biotechnology*, 37(3), 283–286. <https://doi.org/10.1038/s41587-018-0003-0>

Wang, Y., Cheng, X., Shan, Q., Zhang, Y., Liu, J., Gao, C., et al., 2014, Simultaneous editing of three homoeoalleles in 10gricultur bread wheat confers heritable resistance to powdery mildew. *Nature Biotechnology* 32(9), 947-951. Doi: 10.1038/nbt.2969.

Wei, Y., Yang, L., Zhang, X., Sui, D., Wang, C., Wang, K., et al., 2018, Generation and characterization of a CYP2C11-Null rat model by using the CRISPR/Cas9 method. *Drug Metab. Dispos.* Vol 46, 525–531. Doi: 10.1124/dmd.117.07 8444

West, J. & Gill, W.W. (2016) Genome editing in large animals. *Journal of Equine Veterinary Science* 41: 1–6.

Xu, R.F., Yang, Y.C., Qin, R.Y., Li, H., Qiu, C.H., Li, L., et al., 2016, Rapid improvement of grain weight via highly efficient CRISPR/Cas9-mediated multiplex genome editing in rice. *Journal of Genetics and Genomics* 43(8), 529-532. Doi: 10.1016/j.jgg.2016.07.003.

Yin, H., Kauffman, K, and Anderson, D., 2017, Delivery Technologies for genome editing. *Nature Reviews Drug Discovery*. Volume 16, June 2017, 387. <http://dx.doi.org/10.1038/nrd.2016.280>

Zhang H, Bahamondez-Canas TF, Zhang Y, Leal J, Smyth HDC., 2018, PEGylated Chitosan for Nonviral Aerosol and Mucosal Delivery of the CRISPR/Cas9 System in Vitro. *Mol Pharm* Vol 15(11):4814-4826

Zsögön, A., Čermák, T., Naves, E.R., Notini, M.M., Edel, K.H., Weinl, S., et al., 2018, *De novo* domestication of wild tomato using genome editing. *Nature Biotechnology* 36, 1211. Doi: 10.1038/nbt.4272

Metabolic engineering, multi-enzyme pathways, and synthetic bio-products

Ankanahalli N, Urs N, Hu Y, Li P, Yuchi Z, Chen Y, Zhang Y, 2018, Cloning and expression of a nonribosomal peptide synthetase to generate blue rose. *ACS Synthetic Biology* DOI: 10.1021/acssynbio.8b00187

- Behrendorff, JBYH & Gillam, EMJ, 2017, Prospects for Applying Synthetic Biology to Toxicology: Future Opportunities and Current Limitations for the Repurposing of Cytochrome P450 Systems. *Chem. Res. Toxicol.* 30: 453–468. Doi: 10.1021/acs.chemrestox.6b00396
- Berthaeu, 2019, New Breeding Techniques: Detection and Identification of the Techniques and Derived Products. *Encyclopedia of Food Chemistry*, Vol 1 <https://doi.org/10.1016/B978-0-08-100596-5.21834-9>
- Chen et al., 2018, Synthetic biology toolkits and applications in *Saccharomyces cerevisiae*. 2018 *Biotechnology Advances*. 36:1870- 1881, doi: 10.1016/j.biotechadv.2018.07.005
- de Lorenzo V, Prather KL, Chen G, O'Day E, von Kameke C, Oyarzún DA, et al., 2018, The power of synthetic biology for bioproduction, remediation and pollution control. *EMBO*; e45658. <http://embor.embopress.org/lookup/doi/10.15252/embr.201745658>
- De Steur H, Demont M, Gellynck X, Stein AJ, 2017, The social and economic impact of biofortification through genetic modification. *Current Opinion in Biotechnology* 44: 161-168
- Diwo, C.; Budisa, N., 2019, Alternative Biochemistries for Alien Life: Basic Concepts and Requirements for the Design of a Robust Biocontainment System in Genetic Isolation. *Genes*, 10, 17 <https://doi.org/10.3390/genes10010017>
- Dou et al., 2018, De novo design of a fluorescence-activating β -barrel, *Nature* 561 (7724), 485-491, doi: 10.1038/s41586-018-0509-0
- Foo M, Gherman I, Zhang P, Bates DG, Denby KJ, 2018, A framework for engineering stress resilient plants using genetic feedback control and regulatory network rewiring. *ACS Synthetic Biology* 7: 1553 DOI: 10.1021/acssynbio.8b00037
- Gallage NJ, Møller BL, 2015, Vanillin–bioconversion and bioengineering of the most popular plant flavor and its *de novo* biosynthesis in the vanilla orchid. *Molecular Plant* 8: 40-57.
- Garg M, Sharma N, Sharma S, Kapoor P, Kumar A, Chunduri V, Arora P, 2018, Biofortified crops generated by breeding, agronomy and transgenic approaches are improving the lives of millions of people around the world. *Frontiers in Nutrition* DOI: 10.3389/fnut.2018.00012
- Hale V, Keasling JD, Renninger N, Diagana TT. Microbially derived artemisinin: A biotechnology solution to the global problem of access to affordable antimalarial drugs, 2007, *Am J Trop Med Hyg*, 77(SUPPL. 6):198–202. <https://doi.org/10.4269/ajtmh.2007.77.198>
- Jagadevan et al., 2018, Recent developments in synthetic biology and metabolic engineering in micro algae towards biofuel production. *Biotechnology for Biofuels* 11: 185-. Doi.org/10.1186/s13068-018-1181-1
- Jeenor et al., 2017, Diacylglycerol acyltransferase 2 of *Mortierella alpine* with specificity on long chain polyunsaturated fatty acids: a potential tool for reconstituting lipids with nutritional value, *Journal of Biotechnology*, 263:45-51
- Kan et al., 2017, Genetically programmed chiral organoborane synthesis, *Nature* 552 (7683) 132-136, <https://www.nature.com/articles/nature24996>
- Kung SH, Lund S, Murarka A, McPhee D, Paddon CJ., 2018, Approaches and Recent Developments for the Commercial Production of Semi-synthetic Artemisinin. *Front Plant Sci*, 9:87. Doi: 10.3389/fpls.2018.00087

Kunjapur, Aditya M., Philipp Pflingst, and Neil C. Thompson. "Gene synthesis allows biologists to source genes from farther away in the tree of life." *Nature communications* 9.1 (2018): 4425.

Maloney T, Phelan R, Simmons N. Saving the horseshoe crab: A synthetic alternative to horseshoe crab blood for endotoxin detection., 2018, *PLOS Biology*; 16(10):e2006607.
<http://dx.plos.org/10.1371/journal.pbio.2006607>

Naves ER, de Ávila Silva L, Sulpice R, Araújo WL, Nunes-Nesi A, Peres LPE, Zsögön A, 2019, Capsaicinoids: Pungency beyond Capsicum. *Trends in Plant Science* (in press, published online <https://www.cell.com/action/showPdf?pii=S1360-1385%2818%2930261-9>

Pardee, K. et al., 2016, Portable, On-Demand Biomolecular Manufacturing, *Cell*, Volume 167, Issue 1, 248 – 259.e12, <https://doi.org/10.1016/j.cell.2016.09.013>

Paul J-Y, Harding R, Tushemereirwe W, Dale J, 2018, Banana21: From gene discovery to deregulated golden bananas. *Frontiers in Plant Science* 9: DOI: 10.3389/fpls.2018.00558.

Peplow M., 2016, Synthetic biology's first malaria drug meets market resistance. *Nature*, 530(7591):389–90, <http://www.nature.com/doifinder/10.1038/530390a>

Ro D-K, Paradise EM, Ouellet M, Fisher KJ, Newman KL, Ndungu JM, Ho KA, Eachus RA, Ham TS, Kirby J, Chang MCY, Withers ST, Shiba Y, Sarpong R, Keasling JD, 2006, Production of the antimalarial drug precursor artemisinic acid in engineered yeast. *Nature* 440: 940-943.

Schmied et al., 2018, Controlling orthogonal ribosome subunit interactions enables evolution of new function, *Nature* 564 (7736), 444-651, doi: 10.1038/s41586-018-0773-z

Shen B-R, Wang L-M, Lin X-L, Yao Z, Xu H-W, Zhu C-H, Teng H-Y, Cui L-L, Liu E-E Liu, Zhang J-J, He Z-H, Peng X-X, 2019, Engineering a new chloroplastic photorespiratory bypass to increase photosynthetic efficiency and productivity in rice. *Molecular Plant* (in press DOI: 10.1016/j.molp.2018.11.013).

Shih PM, Liang Y, Loque D, 2016, Biotechnology and synthetic biology approaches for metabolic engineering and bioenergy crops. *Plant Journal* 87: 103-117

Silva et al., 2019, De novo design of potent and selective mimics of IL-2 and IL-15, *Nature* 565 (7738), 186-191, doi: 10.1038/s41586-018-0830-7

Siripong et al., 2018, Metabolic engineering of *Pichia pastoris* for production of isobutanol and isobutyl acetate, *Biotechnology of Biofuels*, 11(1)

Waltz E, 2015, Engineers of scent. *Nature Biotechnology* 33: 329-332.

Zhang L, Routsong R, Strand SE, 2018, Greatly enhanced removal of volatile organic carcinogens by a genetically modified houseplant, pothos ivy (*Epipremnum aureum*) expressing the mammalian cytochrome P450 2e1 gene. *Environmental Science & Technology* DOI: 10.1021/acs.est.8b04811.

Zhao et al., 2018, Optogenetic regulation of engineered cellular metabolism for microbial chemical production, *Nature* 555 (7698), 683-687, doi: 10.1038/nature26141

RNA interference

Cagliari D, Avila dos Santos E, Dias N, Smagghe G, Zotti M, 2018, Nontransformative Strategies for RNAi in Crop Protection. *Modulating Gene Expression – Abridging the RNAi and CRISPR-Cas9 Technologies*. Intechopen Publishers.

Heinemann JA., 2018, Biosafety by definition: an analysis of the New Zealand Environmental Protection Authority's reasons for not classifying organisms treated with double-stranded RNA as genetically modified or new organisms. *Current Environmental Health Reports*. [under review]. Pre-print available at: <https://peerj.com/preprints/27108/>

Synthetic genomes, organisms, and ecosystems

Adams, WM, 2017, Geographies of conservation I: De-extinction and precision conservation. *Progress in Human Geography* 41: 534–545. Doi.org/10.1177/0309132516646641

Bennett JR et al., 2017, Spending limited resources on de-extinction could lead to net biodiversity loss. *Nat Ecol and Evol.* 1: -. Doi: 10.1038/s41559-016-0053.

Butterfield et al., 2017, Evolution of a designed protein assembly encapsulating its own RNA genome, *Nature* 552 (7685), 415-420, doi: 10.1038/nature25157

Chari, R., and Church, G.M., 2017, Beyond editing to writing large genomes. *Nat Rev Genet* 18(12), 749-760. Doi: 10.1038/nrg.2017.59.

Glass and Riedel-Kruse, 2018, A Synthetic Bacterial Cell-Cell Adhesion Toolbox for Programming Multicellular Morphologies and Patterns, *Cell* 174 (3), 649-658, doi: 10.1016/j.cell.2018.06.041

Levin, RA et al. (2017). Engineering Strategies to Decode and Enhance the Genomes of Coral Symbionts. *Frontiers in Microbiology* 8: 1220-. Doi:10.3389/fmicb.2017.01220

Luo et al., 2018, Karyotype engineering by chromosome fusion leads to reproductive isolation in yeast, *Nature* 560 (7718), 392-396, doi: 10.1038/s41586-018-0374-x

Malyshev DA, Dhama K, Lavergne T, Chen T, Dai N, Forster JM, Correa IR, Romesberg FE (2014) A semisynthetic organism with an expanded genetic alphabet. *Nature* 509: 385-388.

Piaggio AJ, Segelbacher G, Seddon PJ, Alphey L, Bennett EL, Carlson RH, Friedman RM, Kanavy D, Phelan R, Redford KH, Rosales M, Slobodian L, Wheeler K, 2017, Is it Time for Synthetic Biodiversity Conservation? *Trends in Ecology and Evolution* 32: 97-107. Doi: 10.1016/j.tree.2016.10.016.

Praetorius et al., 2017, Biotechnological mass production of DNA origami, *Nature* 552 (7683) 84-87, <https://www.nature.com/articles/nature24650>

Salehi-Reyhani, A et al., 2017, Artificial cell mimics as simplified models for the study of cell biology. *Ex Biol Med* 242: 1309–1317. Doi: 10.1177/1535370217711441

Service, R (2018) New way to write DNA could turbocharge synthetic biology and data storage. Doi:10.1126/science.aav6033

Shao et al., 2018, Creating a functional single-chromosome yeast, *Nature* 560 (7718), 331-335, doi: 10.1038/s41586-018-0382-x

Spasic J, Mandic M, Djokic L, Nikodinovic-Runic J, 2018, *Streptomyces* spp. In the biocatalysis toolbox. *Applied Microbiology and Biotechnology* 102: 3513-3536

Torres L, Krüger A, Csibra E, Gianni E, Pinheiro VB., 2016, Synthetic biology approaches to biological containment: pre-emptively tackling potential risks. *Essays Biochem* 2016;60(4):393–410. <http://essays.biochemistry.org/lookup/doi/10.1042/EBC20160013>

Trianti et al., 2018, Recombinant neuraminidase pseudotyped baculovirus: a dual vector for delivery of angiotensin II peptides and DNA vaccine, *AMB Express*, 8(170)

Wannier, TM et al., 2018, Adaptive evolution of genomically recoded *Escherichia coli*. *PNAS* 115: 3090-3095. Doi.org/10.1073/pnas.1715530115

Zhang Y, Lamb BM, Feldman AW, Zhou AX, Lavergne T, Li L, Romesberg FE, 2017, A semisynthetic organism engineered for the stable expansion of the genetic alphabet. *Proceedings of the National Academy of Sciences USA* 114: 1317- 1322

Miscellaneous information

Alphey et al., 2010, Sterile-Insect methods for control of mosquito-borne diseases: An analysis, *Vector borne and zoonotic diseases*, 10(3): 295-311 <https://dx.doi.org/10.1089%2Fvzb.2009.0014>

Arber W, 2010, Genetic engineering compared to natural genetic variations. *New Biotechnology* 27: 517-521

Besansky, N. J., Lehmann, T., Fahey, G. T., Fontenille, D., Braack, L. E. O., Hawley, W. A., Collins, F. H., 1997, Patterns of mitochondrial variation within and between African Malaria vectors, *Anopheles gambiae* and *A. ambiensis*, suggest extensive gene flow. *Genetics* 147 (1817): 1817-1828.

Biden S, Smyth SJ, Hudson D, 2018, The economic and environmental cost of delayed GM crop adoption: The case of Australia's GM canola moratorium. *GM Crops and Food* 2: 13-20

Bowornsakulwong et al, 2017, The expression and purification of WSSV134 from white root spot syndrome virus and its inhibitory effect on caspase activity from *Penaeus monodon*, *Protein Expression and Purification*, 130: 123-128

Boyle J, Dalgleish H, Puzey J. Monarch butterfly and milkweed declines substantially predate the use of genetically modified crops., 2019, *Proc Natl Acad Sci U S A*, <http://dx.doi.org/10.1101/378299>

Brookes G, Barfoot P (2018) Farm income and production impacts of using GM crop technology 1996-2016. *GM Crops and Food* 9: 59-89. See also Brookes G, 2018, The farm level economic and environmental contribution of Intacta soybeans in South America: The first five years. *GM Crops and Food* 9: 140-151

Bugge MM, Hansen T, Klitkou A, 2016, What is the bioeconomy? A review of the literature. *Sustainability* 8: 691 DOI:10.3390/su8070691

Bukitbayeva S, Qaim M, Swinnen J, 2016, A black (white) hole in the global spread of GM cotton. *Trends in Biotechnology* 34: 260-263

Bull, J. J., 2015, Evolutionary decay and the prospects for long-term disease intervention using engineered insect vectors. *Evolution, Medicine, and Public Health*. Doi: 10.1093/emph/eov013

Chakraborty K, 2010, The economics of BT cotton production in India – a meta analysis. *Indian Journal of Economics and Business* 9(4)

Chookajorn T., 2018, How to combat emerging artemisinin resistance: Lessons from “The Three Little Pigs”. *PloS Pathog*, 14(4):e1006923. Doi: 10.1371/journal.ppat.1006923

Collins, C.M., Bonds, J.A.S., Quinlan, M.M., and Mumford, J.D., 2019, Effects of the removal or reduction in density of the malaria mosquito, *Anopheles gambiae s.l.*, on interacting predators and

competitors in local ecosystems: Malaria mosquito effects on ecosystems. *Medical and Veterinary Entomology* 33, 1–15.

Corlett, RT, 2017, A Bigger Toolbox: Biotechnology in Biodiversity Conservation. *Trends in Biotechnology* 35: 55-65.

CropLife International: Database of the safety and benefits of biotechnology
<http://biotechbenefits.croplife.org/>

D’Alessandro U & Buttiens H, 2002, History and importance of antimalarial drug resistance. *Trop Med Int Health*, 6(11):845–8. <https://doi.org/10.1046/j.1365-3156.2001.00819.x>

Daniell H (2002) Molecular containment strategies for gene containment in transgenic crops. *Nature Biotechnology* 20:581-586

Daudzai, Treesubstunton, and Thiravetyan, 2018, Inoculated *Clitoria ternatea* with *Bacillus cereus* ERBP for enhancing gaseous ethylbenzene phytoremediation: Plant metabolites and expression of ethylbenzene degradation genes, *Ecotoxicity and Environmental Safety*, 164: 50-60

David, A. S., Kaser, J. M., Morey, A.C., Roth, A. M., Andow, D. A., 2013, Re-lease of genetically engineered insects: a framework to identify potential ecological effects. *Ecology and Evolution* 3 (11): 4000-4015.

Denny et al., 2018, High-Throughput Investigation of Diverse Junction Elements in RNA Tertiary Folding, *Knight Cell* 174 (2), 377-390, doi: 10.1016/j.cell.2018.05.038

Dively GP, Venugopal PD, Bean D, Whalen J, Holmstrom K, Kuhar TP, Doughty HB, Patton T, Cissel W, Hutchison WD, 2018, Regional pest suppression associated with widespread Bt maize adoption benefits vegetable growers. *Proceedings of the National Academy of Sciences USA* 115: 3320-3325;

Djimde AA, Makanga M, Kuhen K, Hamed K., 2015, The emerging threat of artemisinin resistance in malaria: focus on artemether-lumefantrine. *Expert Rev Anti Infect Ther*, 13(8):1031–45. Doi: 10.1586/14787210.2015.1052793

Dunbar, C., 2018, Gene therapy comes of age, *Science* 359(6372) doi: 10.1126/science.aan4672

Duvall et al., 2019, Small-Molecule Agonists of Ae. Aegypti Neuropeptide Y Receptor Block Mosquito Biting, *Cell* 176 (4), 687-701, <https://doi.org/10.1016/j.cell.2018.12.004>

Gantz, V.M., and Bier, E., 2015, The mutagenic chain reaction: A method for converting heterozygous to homozygous mutations. *Science* 348, 442–444.

Gauvry G., 2019, Current Horseshoe Crab Harvesting Practices Cannot Support Global Demand for TAL/LAL: The Pharmaceutical and Medical Device Industries’ Role in the Sustainability of Horseshoe Crabs In: *Changing Global Perspectives on Horseshoe Crab Biology, Conservation and Management*. Cham: Springer International Publishing; page 475–82.
http://link.springer.com/10.1007/978-3-319-19542-1_27

Gerday C, Aittaleb M, Bentahir M, Chessa J, Claverie P, Collins T, D’Amico S, Dumont J, Garsoux G, Georlette D, Hoyoux A, Lonhienne T, Meuwis M, Feller G, 2000, Cold-adapted enzymes: from fundamentals to biotechnology. *Trends in Biotechnology* 18: 103-107

- Gurung N, Ray S, Bose S, Rai V, 2013, A broader view: Microbial enzymes and their relevance in industries, medicine, and beyond. *BioMed Res International* 329121 DOI: 10.1155/2013/329121
- Hanlon SJO, Rieux A, Farrer RA, Rosa GM, Waldman B, Bataille A, et al., 2018, Research causing global amphibian declines, *627(May):621–7*
- Hartley, S., & Kokotovich, A. (2018). “Disentangling risk assessment”. In *Science and the politics of openness*. Manchester, England: Manchester University Press. Retrieved Feb 20, 2019, from <https://www.manchesteropenhive.com/view/9781526106476/9781526106476.00019.xml>
- Harvey, C., 2018, Climate Change Is Becoming a Top Threat to Biodiversity – *Scientific American*, Sci. Am.2018, <https://www.scientificamerican.com/article/climate-change-is-becoming-a-top-threat-tobiodiversity/>
- Hoffmann, Ross, and Rasic, 2015, Wolbachia strains for disease control: ecological and evolutionary considerations, *Evolutionary Applications*, pp 751-768 <https://doi.org/10.1111/eva.12286>
- Holst et al., 2019, PIK3CA amplification associates with aggressive phenotype but not markers of AKT-MTOR signaling in endometrial carcinoma, *Clinical Cancer Research*, 25(1)
- Hryhorowicz, M et al., 2017, Genetically Modified Pigs as Organ Donors for Xenotransplantation. *Mol Biotechnol*. 59: 435-444. Doi: 10.1007/s12033-017-0024-9
- Jennings, Duan, and Follet, 2017, Environmental Impacts of Arthropod Biological Control: An Ecological Perspective, *Environmental Pest Management*, <https://doi.org/10.1002/9781119255574.ch5>
- Jones HP, Holmes ND, Butchart SHM, Tershye BR, Kappesf PJ, Corkery I, Aguirre-Muñozh A, Armstrong DP, Bonnaud E, Burbidge AA, Campbell K, Courchamp F, Cowan PE, Cuthbert RJ, Ebbert S, Genovesi P, Howald GR, Keitt BS, Kress SW, Miskelly C, Oppel S, Poncet S, Rauzon MJ, Rocamora G, Russell JC, Samaniego-Herrera A, Seddon PJ, Spatz DR, Towns DD, Croll DA, 2016, Invasive mammal eradication on islands results in substantial conservation gains. *Proceedings of the National Academy of Science USA* 113: 4033-4038
- Juma C., 2016, *Innovation and Its Enemies: Why People Resist New Technologies*. Oxford University Press; <http://www.oxfordscholarship.com/view/10.1093/acprof:oso/9780190467036.001.0001/acp-rof-9780190467036>
- Kaskey, J. (2018) BASF to crank up R&D `two gears' with Bayer seeds, next CEO says. *Bloomberg Technology* April 12. Retrieved from <https://www.bloomberg.com/news/articles/2018-04-12/basf-to-crank-up-r-d-two-gears-with-bayer-seeds-next-ceo-says>
- Kayani WK, Kiani BH, Dilshad E, Mirza B., 2018, Biotechnological approaches for artemisinin production in *Artemisia*. *World J Microbiol Biotechnol*, 34(4):1–14. <http://dx.doi.org/10.1007/s11274-018-2432-9>
- Khaksar, Treesubstunton, and Thiravetyan, 2017, Effect of exogenous, methyl jasmonate on airborne benzene removal by *Zamioculcas zaiifolia*: The role of cytochrome P450 expression, salicylic acid, IAA, ROS and antioxidant activity, *Environmental Experimental Botany*, 138: 130-138
- Klanchui et al., 2018, An improved genome-scale metabolic model of *Athrospira platensis* C1 (iAK888) and its application in glycogen overproduction, *Metabolites*, 8(84)

Klocko AL, Lu H, Magnuson A, Brunner AM, Ma C, Strauss SH, 2018, Phenotypic expression and stability in a large-scale field study of genetically engineered poplars containing sexual containment transgenes. *Frontiers in Bioengineering and Biotechnology* DOI: 10.3389/fbioe.2018.00100

Kouser S, Abedullah, Qaim M, 2017, Bt cotton and employment effects for female agricultural laborers in Pakistan. *New Biotechnology* 34: 40-46

Lalane et al., 2018, Evolutionary Convergence of Pathway-Specific Enzyme Expression Stoichiometry, *Cell* 173 (3), 749-761, doi: 10.1016/j.cell.2018.03.007

Lees et al., 2015, Back to the future: the sterile insect technique against mosquito disease vectors, *Current Opinion in Insect Science*, 10, 156-162 <https://doi.org/10.1016/j.cois.2015.05.011>

Lehmann T. et al. Wind-borne migration of mosquitoes and pathogens: Potential for bio-surveillance. 2018 ESA, ESC and ESBC joint annual meeting, Vancouver, November 14, 2018.

Lukindu M, Bergey CM, Wiltshire RM, Small ST, Bourke BP, Kayondo JK, Besansky NJ., 2018, Spatiotemporal genetic structure of *Anopheles gambiae* in the Northwestern Lake Victoria Basin, Uganda: implications for genetic control trials in malaria endemic regions. *Parasit Vectors*. Vol 11(1):246.

Mahajan et al., 2018, Computational affinity maturation of camelid single-domain intrabodies against the nonamyloid component of alpha-synuclein, *Scientific Reports*, 8 (17611)

Mata et al., 2018, Quinolone-resistant phenotype of *Flavobacterium columnare* isolates harboring point mutations both in gyrA abd parC but not in gyrB or pare, *Journal of Global Antimicrobial resistance*, 15:55-60

Matsakas L, Gao Q, Jansson S, Rova U, Christakopoulos P., 2017, Green conversion of municipal solid wastes into fuels and chemicals. *Electron J Biotechnol*; 26:69–83. <https://www.sciencedirect.com/science/article/pii/S0717345817300040>

Mjos et al., 2017, PIK3CA exon9 mutations associate with reduced survival, and are highly concordant between matching primary tumors and metastases in endometrial cancer, *Scientific Reports* 7:10240

Najjar D., Normandin A. M., Strait E. A., Esvelt K. M., 2017, Driving towards ecotechnologies. *Pathogens and Global Health* 111 (8): 448-458

O'Connor, T. P. & Crystal, R. G., 2006, Genetic medicines: treatment strategies for hereditary disorders. *Nature Rev. Genet.* 7, 261, 2006. <http://dx.doi.org/10.1038/nrg1829>

Oliveira, C. M., Auad, A. M., Mendes, S. M., & Frizzas, M. R., 2013, Economic impact of exotic insect pests in Brazilian Agriculture. *Journal of Applied Entomology*. Vol. 137, Issue 1-2, <https://doi.org/10.1111/jen.12018>

Oliveira, E., Salgueiro, P., Palsson, K., Vicente, J. L., Arez, A. P., Jaenson, T. G., Caccone, A., Pinto, J., 2008, High levels of hybridization between molecular forms of *Anopheles gambiae* from Guinea Bissau. *Journal of Medical Entomology* 45 (6): 1057-1063.

Ow DW, De Wet JR, Helinski DR, Howell SH, Wood KV, Deluca M, 1986, Transient and stable expression of the firefly luciferase gene in plant cells and transgenic plants. *Science* 234: 856-85

Oye, K., 2014, Proceed With Caution. *MIT Technology Review* 117, 11.

Packard RM, 2014, The Origins of Antimalarial-Drug Resistance. *N Engl J Med*, 371(5):397–9. Doi: 10.1056/NEJMp1403340.

Pellegrino L, Bedini S, Nuti M, Ercoli L, 2018, Impacts of genetically engineered maize on agronomic, environmental and toxicological traits: A metaanalysis of 21 years of field data. *Nature* 8: 3113 DOI: 10.1038 /s41598-018-21284-2.

Poonlapdechcha et al., 2018, Antibody conjugated ferromagnetic nanoparticles with lateral flow test strip assay for rapid detection of *Campylobacter jejuni* in poultry samples, *international Journal of Food Microbiology*, 286:6-14

Puseenam et al., 2018, A novel sucrose-based expression system for heterologous protein expression in thermotolerant methytrophic yeast *Ogataea thermomethanolica*, *FEMS Microbiology Letters*, 365(20)

Pye RJ, Pemberton D, Tovar C, Tubio JMC, Dun KA, Fox S, et al., 2016, A second transmissible cancer in Tasmanian devils. www.pnas.org/cgi/doi/10.1073/pnas.1519691113

Ravikumar et al., 2018, Scalable, Continuous Evolution of Genes at Mutation Rates above Genomic Error Thresholds, *Cell* 175 (7), 1946-1957, <https://doi.org/10.1016/j.cell.2018.10.021>

Robinson PK (2015) *Enzymes: principles and biotechnological applications*. *Essays in Biochemistry* 59: 1–41.

Ruangman et al., 2017, A deletion of gene encoding amino aldehyde dehydrogenase enhances the “pandan-like” aroma of winter melon (*Benincasa hispida*) and is a functional marker for the development of the aroma, *Theoretical and Applied Genetics*, 130(12): 2557-2565

Sadelain, M., Riviere, I., & Riddell, S., 2017, Therapeutic T-cell engineering, *Nature*, 545, 423–431, <https://doi.org/10.1038/nature22395>

Sae-Lee et al., 2017, Improvement of Phenolic Antioxidant-linked cancer cell cytotoxicity of grape cell culture elicited by chitosan and chemical treatments, *HortScience*, 52(11):1157-1584

Schnell J, Steele M, Bean J, Neuspiel M, Girard C, Dormann N, Peason C, Savoie A, Bourbonni re L, Macdonald P (2015) A comparative analysis of insertional effects in genetically engineered plants: Considerations for pre-market assessment. *Transgenic Research* 24: 1-17. 95

Stammnitz MR, Coorens THH, Gori KC, Hayes D, Fu B, Wang J, et al., 2018, The Origins and Vulnerabilities of Two Transmissible Cancers in Tasmanian Devils. *Cancer Cell*, 33(4):607–619.e15. doi: 10.1016/j.ccell.2018.03.013.

Sutthibutpong, Rattanarojpong, and Khunrae, 2018, Effect of helic and fingertip mutations on the thermostability of xyn11A investigated by molecular dynamics simulations and enzyme activity assays, *Journal of Biomolecular Structure and Dynamics*, 36(15): 3978-3992

Toopaang et al., 2017, Targeted disruption of the polyketide synthase gene pks15 affects virulence against insects and phagocytic survival in the fungus *Beauveria bassiana*, *Fungal Biology*, 12(8): 665-675

Vitale J, Vognan G, Vitale PP, 2016, The socio-economic impacts of GM cotton in Burkina Faso: does farm structure affect how benefits are distributed? *AgBioForum* 19: 120-135

Werren, J.H., Nur, U., and Wu, C. I., 1988, Selfish genetic elements. *Trends in Ecology & Evolution* 3, 297–302. [https://doi.org/10.1016/0169-5347\(88\)90105-X](https://doi.org/10.1016/0169-5347(88)90105-X)

Wilson B., 2012, *Consider the Fork: A History of How We Cook and Eat*. Penguin; 2012. Available from: <https://www.cheric.org/research/tech/periodicals/view.php?seq=1078758>

Wongin et al., 2018, Effect of Cell sheet manipulation techniques on the expression of collagen type II and stress fiber formation in human chondrocyte sheets, *Tissue Engineering Part A* 24(5-6)

Wongwilaiwin and Tachaapaikoon, 2018, Structural and metabolic adaptation of cellulolytic microcosm in co-digested Napier grass-swine manure and its application in enhancing thermophilic biogas production, *RSC Advances*, 8:29806-29815

Opinions, regulation and perspectives from organizations and countries

African Center for Biodiversity/Third World Network/GeneWatch UK (2018), GM Mosquitoes in Burkina Faso. Briefing Paper, November 2018, available at: https://acbio.org.za/sites/default/files/documents/GM_mosquitoes_in_Burkina_Faso_A_briefing_for_the_Parties_to_the_Cartagena_Protocol_on_Bio_safety.pdf

African Union decision – July 2017 https://au.int/sites/default/files/decisions/33559-assembly_au_dec_642_-_664_xxix_e_1.pdf

Agapito-Tenzen, Okoli AS, Bernstein MJ, Wikmark OG, Myhr AI, 2018, Revisiting Risk Governance of GM Plants: The Need to Consider New and Emerging Gene-Editing Techniques. *Frontiers of Plant Science*, Vol 9, doi: 10.3389/fpls.2018.01874. 5

Australian Academy of Science. 2017, May. Discussion Paper. Synthetic Gene Drives in Australia: Implications of Emerging Technologies. www.science.org.au/gene-drives.

Australian Office of Gene Technology Regulator
<http://www.ogtr.gov.au/internet/ogtr/publishing.nsf/Content/amendment%20proposals-1>

Bailey, C., Metcalf, H., Crook, B. 2012. Synthetic biology. A review of the technology, and current and future needs from the regulatory framework in Great Britain. Research Report RR944. Health and Safety Laboratory for the Health and Safety Executive, UK.

Carter, S.R., Rodomeyer, M., Garfinkel, M.S., Friedman, R.M. 2014, May. Synthetic Biology And the US Biotechnology Regulatory System: Challenges and Options. J. Craig Venter Institute.

Carter, Sarah R. and Warner, Christopher M. Trends in Synthetic Biology Applications, Tools, Industry, and Oversight and Their Security Implications. 2018 *Health Security*. 16: 320-333

Cotter, J. & Perls, D., 2018, Gene-edited organisms in agriculture: Risks and unexpected consequences, *Friends of the Earth US*, <https://foe.org/resources/gene-edited-organisms-agriculture-risks-unexpected-consequences/>

Council for Agricultural Science and Technology (CAST). 2018. Genome Editing in Agriculture: Methods, Applications, and Governance—A paper in the series on The Need for Agricultural Innovation to Sustainably Feed the World by 2050. Issue Paper 60. CAST, Ames, Iowa

Court of Justice of the European Union press release, No. 111/18, Luxembourg, 25 July 2018: <https://curia.europa.eu/jcms/upload/docs/application/pdf/2018-07/cp180111en.pdf>

Delaney B, Goodman RE, Ladics GS, 2017, Food and feed safety of genetically engineered crops. *Toxicological Sciences* 162: 361-371; Society of Toxicology Issue Statement Food and Feed Safety of Genetically Engineered Food Crops (November 2017). Available at:

https://www.toxicology.org/pubs/statements/SOT_Safety_of_GE_Food_Crops_Issue_Statement_FINAL.pdf

Dronov, R. and Howard, W. 2014. Gene Editing and CRISPR. Occasional Paper Series Issue 14, September 2014. Office of the Chief Scientist, Australian Government Chief Scientist. 11

Duensing, N., Sprink, T., Parrott, W.A., Fedorova, M., Lema, M.A., Wolt, J.D., and Bartsch, D., 2018, Novel Features and Considerations for ERA and Regulation of Crops Produced by Genome Editing. *Frontiers in Bioengineering and Biotechnology* 6, 79.

Dutch National Institution for Health and the Environment (RIVM), Netherlands, 2016, Gene policy report,

https://www.rivm.nl/en/Documents_and_publications/Scientific/Reports/2016/februari/Gene_drives_Policy_report

ETC Group, 2014, Artemisinin & Synthetic Biology-A Case Study

http://www.etcgroup.org/en/issues/synthetic_biology

ETC Group, 2017, Who Will Feed Us? The Peasant Food Web vs. The Industrial Food Chain, 3rd edition, available at <https://www.etcgroup.org/content/who-will-feed-us-industrial-food-chain-vs-peasant-food-web>

ETC Group, 2018, Forcing the Farm. How Gene Drive Organisms could entrench industrial agriculture and threaten food sovereignty. ETC Group and Heinrich Böll Foundation, October 2018.

www.etcgroup.org/sites/www.etcgroup.org/files/files/etc_hbf_forcing_the_farm_web.pdf.

European Academies Science Advisory Council (EASAC) 2010, December. Policy Report 13. Realising European potential in synthetic biology: scientific opportunities and good governance. ISBN: 978-3-8047-2866-0. This report can be found at www.easac.eu

European Academies Science Advisory Council, 2017, Genome editing: Scientific opportunities, public interests and policy options in the EU,

https://easac.eu/fileadmin/PDF_s/reports_statements/Genome_Editing/EASAC_Report_31_on_Genome_Editing.pdf

FAO/IAEA, 2011, Plant Mutation Breeding and Biotechnology. Available at:

<http://www.fao.org/3/ai2388e.pdf>.

FAO/IAEA Mutant Variety Database available at <https://mvd.iaea.org/#!/Home> (accessed 16 January 2019)

Fernández-Niño M, Islam Z., 2017, The potential of synthetic biology for improving environmental quality and human health in developing countries. *Rev la Univ Ind Santander Salud*, 49(1):93–101

Food Standards Australia New Zealand, 2017, A1143 – Food derived from DHA Canola Line NS-B50027-4. <http://www.foodstandards.gov.au/code/applications/Pages/A1143-DHA-Canola-Line-NS%E2%80%93B500274.aspx>

German Central Committee on Biological Safety (ZKBS), 2018, 2nd Interim report of the German Central Committee on Biological Safety, available at:

[https://www.zkbsonline.de/ZKBS/SharedDocs/Downloads/02_Allgemeine_Stellungnahmen_englis h/01_general_subjects/2nd%20report%20Synthetic%20Biology%20\(2018\).html?nn=8569050](https://www.zkbsonline.de/ZKBS/SharedDocs/Downloads/02_Allgemeine_Stellungnahmen_englis h/01_general_subjects/2nd%20report%20Synthetic%20Biology%20(2018).html?nn=8569050)

German Central Committee on Biological Safety, 2016, Position statement of the on the classification of genetic engineering operations for the production and use of higher organisms using recombinant gene drive systems <https://bch.cbd.int/database/record.shtml?documentid=110745>

Glover et al., 2018, Strengthening regulatory capacity for gene drives in Africa: leveraging NEPAD's experience in establishing regulatory systems for medicines and GM crops in Africa, BMC proceedings 12(Suppl. 8):11 <https://doi.org/10.1186/s12919-018-0108-y>

Gray, P., Meek, S., Griffiths, P., Trapani, J., Small, I., Vickers, C., Waldby, C., and Wood, R, 2018, Synthetic Biology in Australia: An Outlook to 2030. Report for the Australian Council of Learned Academies, www.acola.org.au

Haut Conseil des Biotechnologies, France, 2017, Avis relative a l'utilisation de moustiques GM dans le cadre de la lutte antivectorielle, <http://www.hautconseildesbiotechnologies.fr/fr/avis/avis-relatif-a-lutilisationmoustiques-gm-dans-cadre-lutte-antivectorielle>

HCB Scientific Committee, 2017, Scientific Opinion in response to the referral of 12 October 2015 concerning use of genetically modified mosquitoes for vector control (Haut Conseil des Biotechnologies (France)).

Hogervorst et al., 2018, Assessment of human health and environmental risks of new developments in modern biotechnology – a policy report (2018). RIVM report <https://www.rivm.nl/bibliotheek/rapporten/2018-0089.html> DOI 10.21945/RIVM-2018-0089

International Service for the Acquisition of Agri-biotech Applications, 2018, Global status of 21griculture2121d biotech/GM crops in 2017: Biotech crop adoption surges as economic benefits accumulate in 22 years. ISAAA Brief 53-2017.

Island Conservation 2017 CBD submission, available at: <https://bch.cbd.int/database/record.shtml?documentid=112072>

Ishii, T., 2017, Genome-edited livestock: Ethics and social acceptance. *Animal Frontiers* 7: 24–32.

James, S., Collins, F.H., Welkhoff, P.A., Emerson, C., Godfray, H.C.J., Gottlieb, M., Greenwood, B., Lindsay, S.W., Mbogo, C.M., Okumu, F.O., et al., 2018, Pathway to Deployment of Gene Drive Mosquitoes as a Potential Biocontrol Tool for Elimination of Malaria in Sub-Saharan Africa: Recommendations of a Scientific Working Group. *The American Journal of Tropical Medicine and Hygiene* 98, 1–49. Doi:10.4269/ajtmh.18-0083

Kofler N., Collins J. P., Kuzma J., Marris E., Esvelt K. et al., 2018, Editing nature: local roots of global governance. *Science* 362 (6414): 527-529.

Kupferschmidt, K., 2018, Crop-protecting insects could be turned into bioweapons, critic warn, *Science*, doi:10.1126/science.aav6274

La Via Campesina, 2015, 'Peasant Agroecology for Food Sovereignty and Mother Earth', No. 7 Notebook, La Via Campesina, November 2015, available at <https://viacampesina.org/en/peasant-agroecology-for-food-sovereignty-and-mother-earth-experiences-of-la-via-campesina-now-available/>

Murphy, B., Jansen, C., Murray, J., De Barro, P., 2010, Risk analysis on the Australian release of *Aedes aegypti* (L.) (Diptera: Culicidae) containing *Wolbachia*. www.cisro.au

NAS (2016): Gene Drives on the Horizon: Advancing Science, Navigating Un-certainty, and Aligning Research with Public Values. Washington DC. Doi: 10.17226/23405

National Academies of Sciences, Engineering, and Medicine, 2016, Gene Drives on the Horizon: Advancing Science, Navigating Uncertainty, and Aligning Research with Public Values (Washington, D.C.: National Academies Press). DOI: 10.17226/23405

National Academies of Sciences, Engineering, and Medicine. 2017. Preparing for Future Products of Biotechnology. Washington, DC: The National Academies Press. <https://doi.org/10.17226/24605>

National Academies of Sciences, Engineering, and Medicine 2019. Forest Health and Biotechnology: Possibilities and Considerations. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25221>

New Partnership for Africa's Development, 2018, Gene Drives for Malaria Control and Elimination in Africa, African Union, <https://www.nepad.org/publication/gene-drives-malaria-control-and-elimination-africa>

Norwegian Biotechnology Advisory Board, 2017, Statement on gene drives (Norwegian Biotechnology Advisory Board) <http://www.bioteknologiradet.no/filarkiv/2017/02/Statement-on-gene-drives.pdf>

Organization for Economic Growth Co-operation and Development, 2009, The bioeconomy to 2030: Designing a policy agenda. Organization for Economic Cooperation and Development, Paris

Organization for Economic Growth Co-operation and Development, 2014, Emerging Policy Issues in Synthetic Biology, OECD Publishing. <http://dx.doi.org/10.1787/9789264208421-en>

Organization for Economic Growth Co-operation and Development, 2018, Conference on Genome Editing: Applications in Agriculture, Paris: Organization for Economic Cooperation and Development (OECD). <http://www.oecd.org/environment/genome-editing-agriculture/>

Office of Gene Technology Regulator of Australia, 2018, Commercial release of DHA canola (DIR155), <http://www.ogtr.gov.au/internet/ogtr/publishing.nsf/Content/DIR155>

Pharmaceutical Research and Manufacturers of America. 2013. Rare Diseases: A Report On Orphan Drugs In The Pipeline. Presented By America's Biopharmaceutical Research Companies. Medicines In Development

Presidential Commission for the Study of Bioethical Issues (PBSCI), 2010, December. New Directions. The Ethics of Synthetic Biology and Emerging Technologies. Washington DC, USA. www.bioethics.gov

Raimbault B, Cointet J-P, Joly P-B, 2016, Mapping the emergence of synthetic biology, PloS ONE DOI: 10.1371/journal.pone.0161522

Reardon S., 2019, How machine learning could keep dangerous DNA out of terrorists' hands. Nature 2019 5667742 2019

Rodomeyer, M. 2009, March. New Life, Old Bottles. Regulating First-Generation Products of Synthetic Biology. Synthetic Biology Project. Woodrow Wilson International Center for Scholars.

Royal Netherlands Academy of Arts and Sciences, 2016, Genome Editing, Position Paper of the Royal Netherlands Academy of Arts and Sciences. Amsterdam, KNAW.

- Royal Society, 2018, Statement: Gene drive research: why it matters <https://royalsociety.org/-/media/policy/Publications/2018/08-11-18-gene-drive-statement.pdf>
- SCENIHR, SCCS, SCHER, 2014, Synthetic Biology I Definition, Opinion, September 2014. Available from: http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_044.pdf
- SCENIHR, SCCS, SCHER, 2015, Synthetic Biology II – Risk assessment methodologies and safety aspects, Opinion, May 2015. Available from: http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_048.pdf
- SCENIHR, SCCS, SCHER, 2015, Synthetic Biology III – Research priorities, Opinion, December 2015. Available from: http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_050.pdf
- SCHEER (Scientific Committee on Health, Environmental and Emerging Risks), 2018, Emerging Issues and the Role of the SCHEER. Position Paper, 5-6 June 2018. https://ec.europa.eu/health/sites/health/files/scientific_committees/scheer/docs/scheer_s_001.pdf
- SCHEER (Scientific Committee on Health, Environmental and Emerging Risks), 2018, Statement on emerging health and environmental issues, 20 December 2018. https://ec.europa.eu/health/sites/health/files/scientific_committees/scheer/docs/scheer_s_002.pdf
- Schmidt CW. Synthetic biology: environmental health implications of a new field, 2010, Environ Health Perspectives ;118(3):A 118-23. <http://www.ncbi.nlm.nih.gov/pubmed/20194062>
- Science for Environment Policy (2016) Synthetic biology and biodiversity. Future Brief 15. Produced for the European Commission DG Environment by the Science Communication Unit, UWE, Bristol. Available at: <http://ec.europa.eu/science-environment-policy>
- Scientific Advice Mechanism (SAM) High Level Group of Scientific Advisors, Explanatory Note 02 – New Techniques in Agricultural Biotechnology, Brussels, 28 April 2017. <https://ec.europa.eu/research/sam/index.cfm?pg=agribiotechnology>
- Secretariat of the Convention on Biological Diversity (2000). Cartagena Protocol on Biosafety to the Convention on Biological Diversity. (Montreal: Secretariat of the Convention on Biological Diversity).
- Shukla-Jones, A., S. Friedrichs and D. Winickoff, 2018, Gene editing in an international context: Scientific, economic and social issues across sectors”. OECD Science, Technology and Industry Working Papers, 2018/04, OECD Publishing, Paris.
- Strauss SH & Sax JK, 2016, Ending event-based regulation of GMO crops. Nature Biotechnology 34: 474-477
- Synthorx 2018. Synthorx to Present Preclinical Data for THOR-707, a “Not-Alpha” IL-2 Synthorin, for the Treatment of Solid Tumors at SITC 2018. Available at: <https://www.prnewswire.com/news-releases/synthorx-to-present-preclinical-data-for-thor-707-a-not-alpha-il-2-synthorin-for-the-treatment-of-solid-tumors-at-sitc2018-300747293.html>
- Target Malaria (2016) Open Letter on Gene Drive Technology. Available at: <https://targetmalaria.org/openletter/>

United States Environmental Protection Agency, USA, 2017, 2017 Update to the Coordinated Framework for the Regulation of Biotechnology, <https://www.epa.gov/regulation-biotechnology-under-tsca-and-fifra/update-coordinated-framework-regulation-biotechnology>

Van der Vlugt CJB, Brown DD, Lehmann K, Leunda A, Willemarck N, 2018, A framework for the risk assessment and management of gene drive technology in contained use. *Applied Biosafety* 23: 25-3

Van der Vlugt, C.J.B., van den Akker, H.C.M, Roesink, C.H., and Westra, J., 2018, Risk assessment method for activities involving organisms with a gene drive under contained use (National Institute for Public Health and the Environment (RIVM), Netherlands).

Westra, J., van der Vlugt, C.J.B., Roesink, C.H., Hogervorst, P.A.M., and Glandorf, D.C.M. (2016). Gene Drives Policy Report (National Institute for Public Health and the Environment (RIVM), Netherlands).

Whelan, A.I. and Lema. M.A. 2015. Regulatory framework for gene editing and other new breeding techniques (NBTs) in Argentina. *GM Crops Food*. 6(4):253-265.
Doi:10.1080/21645698.2015.1114698

Wolt, J.D., Wang, K., and Yang, B., 2016, The Regulatory Status of Genome-edited Crops. *Plant Biotechnology Journal* 14, 510–518.

World Health Organization, 2018, Global Malaria Diagnostic and Artemisinin treatment commodities demand forecast, <https://unitaid.org/assets/Global-malaria-diagnostic-and-artemisinin-treatment-commodities-demand-forecast-2017---2021-Report-May-2018.pdf>

World Health Organization, 2018, World malaria report. Available at: <https://www.who.int/malaria/publications/world-malaria-report-2018/report/en>

ZKBS – Synthetic Biology, 2018, Synthetic Biology_2nd Interim report, 2nd Interim Rep. Ger. Cent. Comm. Biol. Saf. June 2018: https://www.zkbs-online.de/ZKBS/SharedDocs/Downloads/02_Allgemeine_Stellungnahmen_englisch/general_subjects/2nd_report_Synthetic_Biology_2018.html?sessionId=B4BB28189CD0A23A60FB1EEA44EED199.2_cid350?nn=11794948#download=1

III. REFERENCES FROM THE OPEN-ENDED ONLINE FORUM ON SYNTEHTIC BIOLOGY

Topic 1: New technological developments in synthetic biology since the last meeting of the Ad Hoc Technical Expert Group

Articles

Abudayyeh, O. O., Gootenberg, J. S., Konermann, S., Joung, J., Slaymaker, I. M., Cox, D. B. T., ... Zhang, F. (2016). C2c2 is a single-component programmable RNA-guided RNA-targeting CRISPR effector. *Science*, 353(6299), aaf5573. <http://doi.org/10.1126/science.aaf5573>

Adams, S. (2017). Bayer And Ginkgo Bioworks, A Startup, Aim To Make Crops Produce Their Own Nitrogen Fertilizer. Retrieved April 1, 2019, from <https://www.forbes.com/sites/susanadams/2017/09/14/new-venture-aims-to-make-crops-produce-their-own-nitrogen-fertilizer/#56dec07c1db0>

Akcakaya, P., Bobbin, M. L., Guo, J. A., Malagon-Lopez, J., Clement, K., Garcia, S. P., ... Joung, J. K. (2018). In vivo CRISPR editing with no detectable genome-wide off-target mutations. *Nature*, 561(7723), 416–419. <http://doi.org/10.1038/s41586-018-0500-9>

Alexander, W. G. (2019). Marionette strains aim to make refining metabolic pathways faster and easier. *Synthetic Biology*, 4(1). <http://doi.org/10.1093/synbio/ysz007>

Bailey-Serres, J., & Ma, W. (2017). An immunity boost combats crop disease. *Nature*, 545, 420. Retrieved from <https://doi.org/10.1038/nature22497>

Baltzegar, J., Cavin Barnes, J., Elsensohn, J. E., Gutzmann, N., Jones, M. S., King, S., & Sudweeks, J. (2018). Anticipating complexity in the deployment of gene drive insects in agriculture. *Journal of Responsible Innovation*, 5(sup1), S81–S97. <http://doi.org/10.1080/23299460.2017.1407910>

Bancroft, D. (2016). Infographic: Handy Guide to the EU SynBio Startup Scene. Retrieved April 1, 2019, from <https://labiotech.eu/infographics/infographic-a-handy-guide-to-the-european-synthetic-biology-startup-scene/>

Bangera, M. G., & Hyde, R. A. (2016). Systems and Methods for Controlling Animal Behaviour via Optogenetics. United States Patent Office. Retrieved from <http://www.freepatentsonline.com/y2016/0310754.html>

Behrendorff, J. B. Y. H., & Gillam, E. M. J. (2017). Prospects for Applying Synthetic Biology to Toxicology: Future Opportunities and Current Limitations for the Repurposing of Cytochrome P450 Systems. *Chemical Research in Toxicology*, 30(1), 453–468. <http://doi.org/10.1021/acs.chemrestox.6b00396>

Belkin, S., Yagur-Kroll, S., Kabessa, Y., Korouma, V., Septon, T., Anati, Y., ... Agranat, A. J. (2017). Remote detection of buried landmines using a bacterial sensor. *Nature Biotechnology*, 35, 308. Retrieved from <https://doi.org/10.1038/nbt.3791>

Bohannon, J. (2017). A new breed of scientist, with brains of silicon. *Science*. <http://doi.org/10.1126/science.aan7046>

Bojar, D. (2019). New adaptive laboratory evolution database highlights the need for consolidating directed evolution data. *Synthetic Biology*, 4(1). <http://doi.org/10.1093/synbio/ysz004>

Bojar, D. (2019). Arch enemy no more: designing the first synthetic globular all-beta proteins with beta-arches. *Synthetic Biology*, 4(1). <http://doi.org/10.1093/synbio/ysz002>

Boles, K. S., Kannan, K., Gill, J., Felderman, M., Gouvis, H., Hubby, B., ... Gibson, D. G. (2017). Digital-to-biological converter for on-demand production of biologics. *Nature Biotechnology*, 35, 672. Retrieved from <https://doi.org/10.1038/nbt.3859>

Bona, A. C. D., Chitolina, R. F., Fermino, M. L., de Castro Poncio, L., Weiss, A., Lima, J. B. P., ... Maori, E. (2016). Larval application of sodium channel homologous dsRNA restores pyrethroid insecticide susceptibility in a resistant adult mosquito population. *Parasites & Vectors*, 9(1), 397. <http://doi.org/10.1186/s13071-016-1634-y>

- Boonekamp, F. J., Solis-Escalante, D., van den Broek, M., Kuijpers, N. G. A., Pronk, J. T., Bisschops, M. M. M., ... Luttik, M. A. H. (2016). Pathway swapping: Toward modular engineering of essential cellular processes. *Proceedings of the National Academy of Sciences*, *113*(52), 15060–15065. <http://doi.org/10.1073/pnas.1606701113>
- Bourzac, K. (2017). Synthetic Spider Silk for Sale in a \$314 Necktie – MIT Technology Review. Retrieved April 1, 2019, from <https://www.technologyreview.com/s/603817/synthetic-spider-silk-for-sale-in-a-314-necktie/>
- Bourzac, K. (2015). Spinning Synthetic Spider Silk – MIT Technology Review. Retrieved March 29, 2019, from <https://www.technologyreview.com/s/541361/spinning-synthetic-spider-silk/>
- Bower, A. G., McClintock, M. K., & Fong, S. S. (2010). Synthetic biology. *Bioengineered Bugs*, *1*(5), 309–312. <http://doi.org/10.4161/bbug.1.5.12391>
- Braman, J. C. (Ed.). (2018). *Synthetic Biology* (Vol. 1772). New York, NY: Springer New York. <http://doi.org/10.1007/978-1-4939-7795-6>
- Buchman, A., Marshall, J. M., Ostrovski, D., Yang, T., & Akbari, O. S. (2018). Synthetically engineered Medea gene drive system in the worldwide crop pest Drosophila suzukii. *Proceedings of the National Academy of Sciences*, *115*(18), 4725 LP-4730. <http://doi.org/10.1073/pnas.1713139115>
- Butterfield, G. L., Lajoie, M. J., Gustafson, H. H., Sellers, D. L., Nattermann, U., Ellis, D., ... Baker, D. (2017). Evolution of a designed protein assembly encapsulating its own RNA genome. *Nature*, *552*, 415. Retrieved from <https://doi.org/10.1038/nature25157>
- Callaway, E. (2017). Gene drives thwarted by emergence of resistant organisms. *Nature*, *542*(7639), 15–15. <http://doi.org/10.1038/542015a>
- Callaway, E. (2018). Entire yeast genome squeezed into one lone chromosome. *Nature*. <http://doi.org/10.1038/d41586-018-05857-9>
- Carbonell, P., Jarvis, A. J., Robinson, C. J., Yan, C., Dunstan, M., Swainston, N., ... Scrutton, N. S. (2018). An automated Design-Build-Test-Learn pipeline for enhanced microbial production of fine chemicals. *Communications Biology*, *1*(1), 66. <http://doi.org/10.1038/s42003-018-0076-9>
- Cello, J., Paul, A. V., & Wimmer, E. (2002). Chemical Synthesis of Poliovirus cDNA: Generation of Infectious Virus in the Absence of Natural Template. *Science*, *297*(5583), 1016 LP-1018. <http://doi.org/10.1126/science.1072266>
- Champer, J., Chung, J., Lee, Y. L., Liu, C., Yang, E., Wen, Z., ... Messer, P. W. (2019). Molecular safeguarding of CRISPR gene drive experiments. *Elife*, *8*, e41439. <http://doi.org/10.7554/eLife.41439>
- Champer, J., Liu, J., Oh, S. Y., Reeves, R., Luthra, A., Oakes, N., ... Messer, P. W. (2018). Reducing resistance allele formation in CRISPR gene drive. *Proceedings of the National Academy of Sciences*, *115*(21), 5522 LP-5527. <http://doi.org/10.1073/pnas.1720354115>

Chang, H.-J., Voyvodic, P. L., Zúñiga, A., & Bonnet, J. (2017). Microbially derived biosensors for diagnosis, monitoring and epidemiology. *Microbial Biotechnology*, *10*(5), 1031–1035.

<http://doi.org/10.1111/1751-7915.12791>

Chari, R., & Church, G. M. (2017). Beyond editing to writing large genomes. *Nature Reviews Genetics*, *18*, 749. Retrieved from <https://doi.org/10.1038/nrg.2017.59>

Cheng, H.-Y., Masiello, C. A., Del Valle, I., Gao, X., Bennett, G. N., & Silberg, J. J. (2018). Ratiometric Gas Reporting: A Nondisruptive Approach To Monitor Gene Expression in Soils. *ACS Synthetic Biology*, *7*(3), 903–911. <http://doi.org/10.1021/acssynbio.7b00405>

Cohen, J. (2019). Corn and other important crops can now be gene edited by pollen carrying CRISPR. *Science*. <http://doi.org/10.1126/science.aax2207>

Crozet, P., Navarro, F. J., Willmund, F., Mehrshahi, P., Bakowski, K., Lauersen, K. J., ... Lemaire, S. D. (2018). Birth of a Photosynthetic Chassis: A MoClo Toolkit Enabling Synthetic Biology in the Microalga *Chlamydomonas reinhardtii*. *ACS Synthetic Biology*, *7*(9), 2074–2086.

<http://doi.org/10.1021/acssynbio.8b00251>

Cummings, C. L., & Kuzma, J. (2017). Societal Risk Evaluation Scheme (SRES): Scenario-Based Multi-Criteria Evaluation of Synthetic Biology Applications. *PLOS ONE*, *12*(1), e0168564. Retrieved from <https://doi.org/10.1371/journal.pone.0168564>

Cyranoski, D., & Ledford, H. (2018). How the genome-edited babies revelation will affect research. *Nature*. <http://doi.org/10.1038/d41586-018-07559-8>

Dankwa, S., Lim, C., Bei, A. K., Jiang, R. H. Y., Abshire, J. R., Patel, S. D., ... Duraisingh, M. T. (2016). Ancient human sialic acid variant restricts an emerging zoonotic malaria parasite. *Nature Communications*, *7*(1), 11187. <http://doi.org/10.1038/ncomms11187>

Datz, T. (2016). Potential pathway for emergence of zoonotic malaria identified. Retrieved from <https://www.hsph.harvard.edu/news/press-releases/zoonotic-malaria-pathway/>

DeAngelis, A. (2018). Synlogic data shows reduction in disability-causing disease in mice – Boston Business Journal. Retrieved April 1, 2019, from

<https://www.bizjournals.com/boston/news/2018/08/16/synlogic-data-shows-40-reduction-in-disability.html>

Dinjaski, N., Ebrahimi, D., Qin, Z., Giordano, J. E. M., Ling, S., Buehler, M. J., & Kaplan, D. L. (2018). Predicting rates of in vivo degradation of recombinant spider silk proteins. *Journal of Tissue Engineering and Regenerative Medicine*, *12*(1), e97–e105. <http://doi.org/10.1002/term.2380>

Diwo, C., & Budisa, N. (2018). Alternative Biochemistries for Alien Life: Basic Concepts and Requirements for the Design of a Robust Biocontainment System in Genetic Isolation. *Genes*, *10*(1), 17. <http://doi.org/10.3390/genes10010017>

Diwo, C., & Budisa, N. (2019). Alternative Biochemistries for Alien Life : Basic Concepts and Requirements for the Design of a Robust Biocontainment System in Genetic Isolation.

<http://doi.org/10.3390/genes10010017>

- Drury, D. W., Dapper, A. L., Siniard, D. J., Zentner, G. E., & Wade, M. J. (2017). CRISPR/Cas9 gene drives in genetically variable and nonrandomly mating wild populations. *Science Advances*, 3(5), e1601910. <http://doi.org/10.1126/sciadv.1601910>
- Durrer, K. E., Allen, M. S., & Hunt von Herbing, I. (2017). Genetically engineered probiotic for the treatment of phenylketonuria (PKU); assessment of a novel treatment in vitro and in the PAHenu2 mouse model of PKU. *PLOS ONE*, 12(5), e0176286. <http://doi.org/10.1371/journal.pone.0176286>
- Duvall, L. B., Ramos-Espiritu, L., Barsoum, K. E., Glickman, J. F., & Vosshall, L. B. (2019). Small-Molecule Agonists of *Ae. Aegypti* Neuropeptide Y Receptor Block Mosquito Biting. *Cell*, 176(4), 687–701.e5. <http://doi.org/10.1016/j.cell.2018.12.004>
- Esvelt, K. M. (2017). Precaution: Open gene drive research. *Science*, 355(6325), 589 LP-590. <http://doi.org/10.1126/science.aal5325>
- ETC Group. (2018). *Forcing the Farm: How gene drive organisms could entrench industrial agriculture and threaten food sovereignty*. Retrieved from www.etcgroup.com
- Flores Bueso, Y., & Tangney, M. (2017). Synthetic Biology in the Driving Seat of the Bioeconomy. *Trends in Biotechnology*, 35(5), 373–378. <http://doi.org/10.1016/j.tibtech.2017.02.002>
- Gibson, D. G., Glass, J. I., Lartigue, C., Noskov, V. N., Chuang, R.-Y., Algire, M. A., ... Venter, J. C. (2010). Creation of a Bacterial Cell Controlled by a Chemically Synthesized Genome. *Science*, 329(5987), 52 LP-56. <http://doi.org/10.1126/science.1190719>
- Gray, P., Meek, S., Griffiths, P., Trapani, J., Small, I., Vickers, C., ... Wood, R. (2018). *Synthetic Biology in Australia: An Outlook to 2030*. Melbourne, Australia: Australian Council of Learned Academies. Retrieved from www.acola.org.au
- Gregoire, M. C. (2017). Southern Gardens Citrus Nursery, LLC; Notice of Intent To Prepare an Environmental Impact Statement for Permit for Release of Genetically Engineered Citrus tristeza virus. *Federal Register*, 82(67), 17179–17180.
- Grunwald, H. A., Gantz, V. M., Poplawski, G., Xu, X.-R. S., Bier, E., & Cooper, K. L. (2019). Super-Mendelian inheritance mediated by CRISPR–Cas9 in the female mouse germline. *Nature*, 566(7742), 105–109. <http://doi.org/10.1038/s41586-019-0875-2>
- Guo, J., Suástegui, M., Sakimoto, K. K., Moody, V. M., Xiao, G., Nocera, D. G., & Joshi, N. S. (2018). Light-driven fine chemical production in yeast biohybrids. *Science*, 362(6416), 813 LP-816. <http://doi.org/10.1126/science.aat9777>
- Haellman, V., & Fussenegger, M. (2016). Synthetic Biology—Toward Therapeutic Solutions. *Journal of Molecular Biology*, 428(5, Part B), 945–962. <http://doi.org/https://doi.org/10.1016/j.jmb.2015.08.020>
- Hallmann, C. A., Sorg, M., Jongejans, E., Siepel, H., Hofland, N., Schwan, H., ... de Kroon, H. (2017). More than 75 percent decline over 27 years in total flying insect biomass in protected areas. *PLOS ONE*, 12(10), e0185809. Retrieved from <https://doi.org/10.1371/journal.pone.0185809>

- Héder, M. (2017). From NASA to EU: the evolution of the TRL scale in Public Sector Innovation, 22(2), 1–23.
- Hirsch, T., Rothoefl, T., Teig, N., Johann, W., Scaglione, D., Reichelt, J., ... Bondanza, S. (2017). Regeneration of the entire human epidermis using transgenic stem cells. *Nature Publishing Group*, 551(7680), 327–332. <http://doi.org/10.1038/nature24487>
- Hogervorst, P. A. M., van den Akker, H. C. M., Glandorf, D. C. M., Klaassen, P., van der Vlugt, C. J. B., & Westra, J. (2018). Assessment of human health and environmental risks of new developments in modern biotechnology, 85. <http://doi.org/10.21945/RIVM-2018-0089>
- Horton, C. A., Lips, D., Schäfer, E., Stirling, F., Kuo, J., Way, J. C., ... Gibson, D. G. (2017). Large-scale recoding of a bacterial genome by iterative recombineering of synthetic DNA. *Nucleic Acids Research*, 45(11), 6971–6980. <http://doi.org/10.1093/nar/gkx415>
- Hoshika, S., Leal, N. A., Kim, M.-J., Kim, M.-S., Karalkar, N. B., Kim, H.-J., ... Benner, S. A. (2019). Hachimoji DNA and RNA: A genetic system with eight building blocks. *Science*, 363(6429), 884 LP-887. <http://doi.org/10.1126/science.aat0971>
- Hoshika, S., Leal, N. A., Kim, M.-J., Kim, M.-S., Karalkar, N. B., Kim, H.-J., ... Benner, S. A. (2019). Hachimoji DNA and RNA: A genetic system with eight building blocks. *Science*, 363(6429), 884 LP-887. <http://doi.org/10.1126/science.aat0971>
- Hoshika, S., Leal, N. A., Kim, M.-J., Kim, M.-S., Karalkar, N. B., Kim, H.-J., ... Benner, S. A. (2019). Hachimoji DNA and RNA: A genetic system with eight building blocks. *Science*, 363(6429), 884 LP-887. <http://doi.org/10.1126/science.aat0971>
- Hoskin, C. E. G., Cazimoglu, I., Darlington, A. P. S., Grigonyte, A., Liu, J., Oppenheimer, R., ... Papachristodoulou, A. (2019). Developing a graduate training program in Synthetic Biology: SynBioCDT. *Synthetic Biology*, 4(1). <http://doi.org/10.1093/synbio/ysz006>
- Hryhorowicz, M., Zeyland, J., Słomski, R., & Lipin, D. (2017). Genetically Modified Pigs as Organ Donors for Xenotransplantation, 435–444. <http://doi.org/10.1007/s12033-017-0024-9>
- Isabella, V. M., Ha, B. N., Castillo, M. J., Lubkowicz, D. J., Rowe, S. E., Millet, Y. A., ... Falb, D. (2018). Development of a synthetic live bacterial therapeutic for the human metabolic disease phenylketonuria. *Nature Biotechnology*, 36, 857. Retrieved from <https://doi.org/10.1038/nbt.4222>
- Julve Parreño, J. M., Huet, E., Fernández-del-Carmen, A., Segura, A., Venturi, M., Gandía, A., ... Orzáez, D. (2018). A synthetic biology approach for consistent production of plant-made recombinant polyclonal antibodies against snake venom toxins. *Plant Biotechnology Journal*, 16(3), 727–736. <http://doi.org/10.1111/pbi.12823>
- Kan, S. B. J., Huang, X., Gumulya, Y., Chen, K., & Arnold, F. H. (2017). Genetically programmed chiral organoborane synthesis. *Nature*, 552, 132. Retrieved from <https://doi.org/10.1038/nature24996>
- KaramiNejadRanjbar, M., Eckermann, K. N., Ahmed, H. M. M., Sánchez C., H. M., Dippel, S., Marshall, J. M., & Wimmer, E. A. (2018). Consequences of resistance evolution in a Cas9-based sex conversion-suppression gene drive for insect pest management. *Proceedings of the National Academy of Sciences*, 115(24), 6189 LP-6194. <http://doi.org/10.1073/pnas.1713825115>

Karim, M. N., Singh, M., Weerathunge, P., Bian, P., Zheng, R., Dekiwadia, C., ... Bansal, V. (2018). Visible-Light-Triggered Reactive-Oxygen-Species-Mediated Antibacterial Activity of Peroxidase-Mimic CuO Nanorods. *ACS Applied Nano Materials*, 1(4), 1694–1704. <http://doi.org/10.1021/acsnm.8b00153>

Kassam, Z. (2017). Synthetic-biological hybrid nanocapsule combats diseased cells. Retrieved April 1, 2019, from <https://www.europeanpharmaceuticalreview.com/news/69901/synthetic-biological-nanocapsule/>

Kelliher, T., Starr, D., Su, X., Tang, G., Chen, Z., Carter, J., ... Que, Q. (2019). One-step genome editing of elite crop germplasm during haploid induction. *Nature Biotechnology*, 37(3), 287–292. <http://doi.org/10.1038/s41587-019-0038-x>

Kelly, C. L. (2019). Degrading an enzyme to increase its product: a novel approach to decoupling biosynthesis and growth. *Synthetic Biology*, 4(1). <http://doi.org/10.1093/synbio/ysz001>

Kim, S., Kerns, S. J., Ziesack, M., Bry, L., Gerber, G. K., Way, J. C., & Silver, P. A. (2018). Quorum Sensing Can Be Repurposed To Promote Information Transfer between Bacteria in the Mammalian Gut. *ACS Synthetic Biology*, 7(9), 2270–2281. <http://doi.org/10.1021/acssynbio.8b00271>

Koch, A., Biedenkopf, D., Furch, A., Weber, L., Roszbach, O., Abdellatif, E., ... Kogel, K.-H. (2016). An RNAi-Based Control of *Fusarium graminearum* Infections Through Spraying of Long dsRNAs Involves a Plant Passage and Is Controlled by the Fungal Silencing Machinery. *PLOS Pathogens*, 12(10), e1005901. Retrieved from <https://doi.org/10.1371/journal.ppat.1005901>

Konermann, S., Lotfy, P., Brideau, N. J., Oki, J., Shokhirev, M. N., & Hsu, P. D. (2018). Transcriptome Engineering with RNA-Targeting Type VI-D CRISPR Effectors. *Cell*, 173(3), 665–676.e14. <http://doi.org/10.1016/j.cell.2018.02.033>

Krinsky, N., Kaduri, M., Zinger, A., Shainsky-Roitman, J., Goldfeder, M., Benhar, I., ... Schroeder, A. (2018). Synthetic Cells Synthesize Therapeutic Proteins inside Tumors. *Advanced Healthcare Materials*, 7(9), 1701163. <http://doi.org/10.1002/adhm.201701163>

Kyriakakis, P., Catanho, M., Hoffner, N., Thavarajah, W., Hu, V. J., Chao, S.-S., ... Coleman, T. P. (2018). Biosynthesis of Orthogonal Molecules Using Ferredoxin and Ferredoxin-NADP+ Reductase Systems Enables Genetically Encoded PhyB Optogenetics. *ACS Synthetic Biology*, 7(2), 706–717. <http://doi.org/10.1021/acssynbio.7b00413>

Kyrou, K., Hammond, A. M., Galizi, R., Kranjc, N., Burt, A., Beaghton, A. K., ... Crisanti, A. (2018). A CRISPR–Cas9 gene drive targeting doublesex causes complete population suppression in caged *Anopheles gambiae* mosquitoes. *Nature Biotechnology*, 36, 1062. Retrieved from <https://doi.org/10.1038/nbt.4245>

Lan, L., Junnan, T., Kodai, N., Chen, Y., Phuong-Uyen, D., Jhon, C., ... Ke, C. (2017). Fabrication of Synthetic Mesenchymal Stem Cells for the Treatment of Acute Myocardial Infarction in Mice. *Circulation Research*, 120(11), 1768–1775. <http://doi.org/10.1161/CIRCRESAHA.116.310374>

Lemmon, Z. H., Reem, N. T., Dalrymple, J., Soyk, S., Swartwood, K. E., Rodriguez-Leal, D., ... Lippman, Z. B. (2018). Rapid improvement of domestication traits in an orphan crop by genome editing. *Nature Plants*, 4(10), 766–770. <http://doi.org/10.1038/s41477-018-0259-x>

- Leonard, S. P., Perutka, J., Powell, J. E., Geng, P., Richhart, D. D., Byrom, M., ... Barrick, J. E. (2018). Genetic Engineering of Bee Gut Microbiome Bacteria with a Toolkit for Modular Assembly of Broad-Host-Range Plasmids. *ACS Synthetic Biology*, 7(5), 1279–1290. <http://doi.org/10.1021/acssynbio.7b00399>
- Li, J., & Handler, A. M. (2017). Temperature-dependent sex-reversal by a transformer-2 gene-edited mutation in the spotted wing drosophila, *Drosophila suzukii*. *Scientific Reports*, 7(1), 12363. <http://doi.org/10.1038/s41598-017-12405-4>
- Li, T., Yang, X., Yu, Y., Si, X., Zhai, X., Zhang, H., ... Xu, C. (2018). Domestication of wild tomato is accelerated by genome editing. *Nature Biotechnology*, 36, 1160. Retrieved from <https://doi.org/10.1038/nbt.4273>
- Liti, G. (2018). Yeast chromosome numbers minimized using genome editing. *Nature*, 560(7718), 317–318. <http://doi.org/10.1038/d41586-018-05309-4>
- Liu, C. C., Jewett, M. C., Chin, J. W., & Voigt, C. A. (2018). Toward an orthogonal central dogma. *Nature Chemical Biology*, 14, 103. Retrieved from <https://doi.org/10.1038/nchembio.2554>
- Liu, D., Zuris, J. A., & Thompson, D. (2014). Delivery system for functional nucleases. US Patent Office.
- Liu, G., Li, J., & Godwin, I. D. (2019). Genome Editing by CRISPR/Cas9 in Sorghum Through Biolistic Bombardment (pp. 169–183). Humana Press, New York, NY. http://doi.org/10.1007/978-1-4939-9039-9_12
- Lu, Y. (2017). Cell-free synthetic biology: Engineering in an open world. *Synthetic and Systems Biotechnology*, 2(1), 23–27. <http://doi.org/https://doi.org/10.1016/j.synbio.2017.02.003>
- Luo, J., Sun, X., Cormack, B. P., & Boeke, J. D. (2018). Karyotype engineering by chromosome fusion leads to reproductive isolation in yeast. *Nature*, 560(7718), 392–396. <http://doi.org/10.1038/s41586-018-0374-x>
- Luo, X., Reiter, M. A., d’Espaux, L., Wong, J., Denby, C. M., Lechner, A., ... Keasling, J. D. (2019). Complete biosynthesis of cannabinoids and their unnatural analogues in yeast. *Nature*, 567(7746), 123–126. <http://doi.org/10.1038/s41586-019-0978-9>
- Lussier, Y. A., Xing, H. R., Salama, J. K., Khodarev, N. N., Huang, Y., Zhang, Q., ... Weichselbaum, R. R. (2011). MicroRNA Expression Characterizes Oligometastasis(es). *PLOS ONE*, 6(12), e28650. Retrieved from <https://doi.org/10.1371/journal.pone.0028650>
- Major, C., & Membrane, O. (2017). Using synthetic biology for chlamydia vaccines, (September), 2017–2019.
- Mammoth BioSciences. (2018). Mammoth Biosciences Launches to Develop World’s First CRISPR-Based Detection Platform – SynBioBeta. Retrieved April 1, 2019, from <https://synbiobeta.com/mammoth-biosciences-launches-to-develop-worlds-first-crispr-based-detection-platform/>

Mannino, M. C., Paixão, F. R., & Pedrini, N. (2019). The limpet transcription factors of *Triatoma infestans* regulate the response to fungal infection and modulate the expression pattern of defensin genes. *Insect Biochemistry and Molecular Biology*.
<http://doi.org/https://doi.org/10.1016/j.ibmb.2019.03.010>

Marshall, J. M., Buchman, A., Sánchez C., H. M., & Akbari, O. S. (2017). Overcoming evolved resistance to population-suppressing homing-based gene drives. *Scientific Reports*, 7(1), 3776.
<http://doi.org/10.1038/s41598-017-02744-7>

Marshall, J. M., & Akbari, O. S. (2018). Can CRISPR-Based Gene Drive Be Confined in the Wild? A Question for Molecular and Population Biology. *ACS Chemical Biology*, 13(2), 424–430.
<http://doi.org/10.1021/acscchembio.7b00923>

May, A. P., Donohoue, P., Nye, C., Slorach, E., & Haurwitz, R. (2016). RNA Modification to Engineer Cas9 Activity. United States: United States Patent Office.

Miller, I. C., Gamboa Castro, M., Maenza, J., Weis, J. P., & Kwong, G. A. (2018). Remote Control of Mammalian Cells with Heat-Triggered Gene Switches and Photothermal Pulse Trains. *ACS Synthetic Biology*, 7(4), 1167–1173. <http://doi.org/10.1021/acssynbio.7b00455>

Mitter, N., Worrall, E. A., Robinson, K. E., Li, P., Jain, R. G., Taochy, C., ... Xu, Z. P. (2017). Clay nanosheets for topical delivery of RNAi for sustained protection against plant viruses. *Nature Plants*, 3, 16207. Retrieved from <https://doi.org/10.1038/nplants.2016.207>

Molteni, M. (2018). A New Startup Wants to Use Crispr to Diagnose Disease. Retrieved from <https://www.wired.com/story/a-new-startup-wants-to-use-crispr-to-diagnose-disease/>

Molteni, M. (2018). The Rise of DNA Data Storage. Retrieved April 1, 2019, from <https://www.wired.com/story/the-rise-of-dna-data-storage/>

Molteni, M. (2018). Farmers Can Now Buy Designer Microbes to Replace Fertilizer. Retrieved from <https://www.wired.com/story/farmers-can-now-buy-designer-microbes-to-replace-fertilizer/>

Motomura, K., Sano, K., Watanabe, S., Kanbara, A., Gamal Nasser, A.-H., Ikeda, T., ... Hirota, R. (2018). Synthetic Phosphorus Metabolic Pathway for Biosafety and Contamination Management of Cyanobacterial Cultivation. *ACS Synthetic Biology*, 7(9), 2189–2198.
<http://doi.org/10.1021/acssynbio.8b00199>

Nanjaraj Urs, A. N., Hu, Y., Li, P., Yuchi, Z., Chen, Y., & Zhang, Y. (2018). Cloning and Expression of a Nonribosomal Peptide Synthetase to Generate Blue Rose. *ACS Synthetic Biology*.
<http://doi.org/10.1021/acssynbio.8b00187>

Nash, A., Urdaneta, G. M., Beaghton, A. K., Hoermann, A., Papathanos, P. A., Christophides, G. K., & Windbichler, N. (2019). Integral gene drives for population replacement. *Biology Open*, 8(1), bio037762. <http://doi.org/10.1242/bio.037762>

National Academies of Sciences Engineering and Medicine. (2017). *Preparing for Future Products of Biotechnology*. Washington, D.C.: National Academies Press. Retrieved from <https://www.nap.edu/catalog/24605>

Nguyen, N. T., He, L., Martinez-Moczygemba, M., Huang, Y., & Zhou, Y. (2018). Rewiring Calcium Signaling for Precise Transcriptional Reprogramming. *ACS Synthetic Biology*, 7(3), 814–821. <http://doi.org/10.1021/acssynbio.7b00467>

Nies, P. Van, Westerlaken, I., Blanken, D., Salas, M., Mencía, M., & Danelon, C. (n.d.). Self-replication of DNA by its encoded proteins in liposome-based synthetic cells. *Nature Communications*, (2018), 1–12. <http://doi.org/10.1038/s41467-018-03926-1>

Noble, C., Olejarz, J., Esvelt, K. M., Church, G. M., & Nowak, M. A. (2017). Evolutionary dynamics of CRISPR gene drives. *Science Advances*, 3(4), e1601964. <http://doi.org/10.1126/sciadv.1601964>

Noyce, R. S., Lederman, S., & Evans, D. H. (2018). Construction of an infectious horsepox virus vaccine from chemically synthesized DNA fragments. *PLOS ONE*, 13(1), e0188453. Retrieved from <https://doi.org/10.1371/journal.pone.0188453>

Ogaugwu, C. E., Agbo, S. O., & Adekoya, M. A. (2019). CRISPR in Sub-Saharan Africa: Applications and Education. *Trends in Biotechnology*, 37(3), 234–237. <http://doi.org/10.1016/j.tibtech.2018.07.012>

Pane, K., Cafaro, V., Avitabile, A., Torres, M. D. T., Vollarò, A., De Gregorio, E., ... Notomista, E. (2018). Identification of Novel Cryptic Multifunctional Antimicrobial Peptides from the Human Stomach Enabled by a Computational–Experimental Platform. *ACS Synthetic Biology*, 7(9), 2105–2115. <http://doi.org/10.1021/acssynbio.8b00084>

Pasin, F., Menzel, W., & Daròs, J.-A. (2019). Harnessed viruses in the age of metagenomics and synthetic biology: an update on infectious clone assembly and biotechnologies of plant viruses. *Plant Biotechnology Journal*, 0(0). <http://doi.org/10.1111/pbi.13084>

Perez, J. G., Stark, J. C., & Jewett, M. C. (2016). Cell-Free Synthetic Biology: Engineering Beyond the Cell. *Cold Spring Harbor Perspectives in Biology*, 8(12), a023853. <http://doi.org/10.1101/cshperspect.a023853>

Phelps, M. P., Seeb, L. W., & Seeb, J. E. (2019). Transforming ecology and conservation biology through genome editing. *Conservation Biology*. <http://doi.org/10.1111/cobi.13292>

Praetorius, F., Kick, B., Behler, K. L., Honemann, M. N., Weuster-Botz, D., & Dietz, H. (2017). Biotechnological mass production of DNA origami. *Nature*, 552, 84. Retrieved from <https://doi.org/10.1038/nature24650>

Prowse, T. A. A., Cassey, P., Ross, J. V., Pfitzner, C., Wittmann, T. A., & Thomas, P. (2017). Dodging silver bullets: good CRISPR gene-drive design is critical for eradicating exotic vertebrates. *Proceedings of the Royal Society B: Biological Sciences*, 284(1860), 20170799. <http://doi.org/10.1098/rspb.2017.0799>

Pty, N. (2018). Applicant: Nuseed Pty Ltd February 2018, (February).

Qian, F., Zhu, C., Knipe, J. M., Ruelas, S., Stolaroff, J. K., DeOtte, J. R., ... Baker, S. E. (2019). Direct Writing of Tunable Living Inks for Bioprocess Intensification. *Nano Letters*. <http://doi.org/10.1021/acs.nanolett.9b00066>

- Ranzau, B. L., & Komor, A. C. (2019). Genome, Epigenome, and Transcriptome Editing via Chemical Modification of Nucleobases in Living Cells. *Biochemistry*, 58(5), 330–335. <http://doi.org/10.1021/acs.biochem.8b00958>
- Reed, F. A. (2017). CRISPR/Cas9 Gene Drive: Growing Pains for a New Technology, 205(March), 1037–1039. <http://doi.org/10.1534/genetics.116.198887>
- Reed, J., & Osbourn, A. (2018). Engineering terpenoid production through transient expression in *Nicotiana benthamiana*. *Plant Cell Reports*, 37(10), 1431–1441. <http://doi.org/10.1007/s00299-018-2296-3>
- Reeves, R. G., Voeneky, S., Caetano-Anollés, D., Beck, F., & Boëte, C. (2018). Agricultural research, or a new bioweapon system? *Science*, 362(6410), 35–37. <http://doi.org/10.1126/science.aat7664>
- Robaey, Z., Spruit, S. L., & van de Poel, I. (2018). The Food Warden: An Exploration of Issues in Distributing Responsibilities for Safe-by-Design Synthetic Biology Applications. *Science and Engineering Ethics*, 24(6), 1673–1696. <http://doi.org/10.1007/s11948-017-9969-0>
- Saito, Y., Oikawa, M., Nakazawa, H., Niide, T., Kameda, T., Tsuda, K., & Umetsu, M. (2018). Machine-Learning-Guided Mutagenesis for Directed Evolution of Fluorescent Proteins. *ACS Synthetic Biology*, 7(9), 2014–2022. <http://doi.org/10.1021/acssynbio.8b00155>
- Salehi-reyhani, A., Ces, O., & Elani, Y. (2017). Minireview Artificial cell mimics as simplified models for the study of cell biology, 1309–1317. <http://doi.org/10.1177/1535370217711441>
- Sánchez-León, S., Gil-Humanes, J., Ozuna, C. V., Giménez, M. J., Sousa, C., Voytas, D. F., & Barro, F. (2018). Low-gluten, nontransgenic wheat engineered with CRISPR/Cas9. *Plant Biotechnology Journal*, 16(4), 902–910. <http://doi.org/10.1111/pbi.12837>
- Schmidt, C. (2017). These Fifty Synthetic Biology Companies Raised \$1.7B in 2017 – SynBioBeta. Retrieved April 1, 2019, from <https://synbiobeta.com/fifty-synthetic-biology-companies-raised-1-7b-2017/>
- Schmidt, M. (2018). Synthetic Vaccines. Retrieved from <http://blogs.nature.com/tradesecrets/2018/01/18/synthetic-vaccines>
- Sen, R., Gahtory, D., Carvalho, R. R., Albada, B., van Delft, F. L., & Zuilhof, H. (2017). Ultrathin Covalently Bound Organic Layers on Mica: Formation of Atomically Flat Biofunctionalizable Surfaces. *Angewandte Chemie International Edition*, 56(15), 4130–4134. <http://doi.org/10.1002/anie.201701301>
- Shao, Y., Lu, N., Wu, Z., Cai, C., Wang, S., Zhang, L.-L., ... Qin, Z. (2018). Creating a functional single-chromosome yeast. *Nature*, 560(7718), 331–335. <http://doi.org/10.1038/s41586-018-0382-x>
- Shen, B.-R., Wang, L.-M., Lin, X.-L., Yao, Z., Xu, H.-W., Zhu, C.-H., ... Peng, X.-X. (2019). Engineering a New Chloroplastic Photorespiratory Bypass to Increase Photosynthetic Efficiency and Productivity in Rice. *Molecular Plant*, 12(2), 199–214. <http://doi.org/https://doi.org/10.1016/j.molp.2018.11.013>

- Shen, M. W., Arbab, M., Hsu, J. Y., Worstell, D., Culbertson, S. J., Krabbe, O., ... Sherwood, R. I. (2018). Predictable and precise template-free CRISPR editing of pathogenic variants. *Nature*, 563(7733), 646–651. <http://doi.org/10.1038/s41586-018-0686-x>
- Simon, S., Otto, M., & Engelhard, M. (2018). Scan the horizon for unprecedented risks. *Science*, 362(6418), 1007.2-1008. <http://doi.org/10.1126/science.aav7568>
- South, P. F., Cavanagh, A. P., Liu, H. W., & Ort, D. R. (2019). Synthetic glycolate metabolism pathways stimulate crop growth and productivity in the field. *Science*, 363(6422), eaat9077. <http://doi.org/10.1126/science.aat9077>
- Stark, J. C., Huang, A., Nguyen, P. Q., Dubner, R. S., Hsu, K. J., Ferrante, T. C., ... Jewett, M. C. (2018). BioBits™ Bright: A fluorescent synthetic biology education kit. *Science Advances*, 4(8), eaat5107. <http://doi.org/10.1126/sciadv.aat5107>
- Takahashi, M. K., Tan, X., Dy, A. J., Braff, D., Akana, R. T., Furuta, Y., ... Collins, J. J. (2018). A low-cost paper-based synthetic biology platform for analyzing gut microbiota and host biomarkers. *Nature Communications*, 9(1), 3347. <http://doi.org/10.1038/s41467-018-05864-4>
- Tang, G.-Q. (2012). Methods and compositions for introduction of exogenous dsrna into plant cells. WIPO. Retrieved from <https://patents.google.com/patent/WO2013025670A1/en?q=WO2013025670A1>
- Tastanova, A., Folcher, M., Müller, M., Camenisch, G., Ponti, A., Horn, T., ... Fussenegger, M. (2018). Synthetic biology-based cellular biomedical tattoo for detection of hypercalcemia associated with cancer. *Science Translational Medicine*, 10(437), eaap8562. <http://doi.org/10.1126/scitranslmed.aap8562>
- Unckless, R. L., Clark, A. G., & Messer, P. W. (2017). Evolution of Resistance Against CRISPR/Cas9 Gene Drive. *Genetics*, 205(2), 827 LP-841. <http://doi.org/10.1534/genetics.116.197285>
- van de Poel, I., & Robaey, Z. (2017). Safe-by-Design: from Safety to Responsibility. *NanoEthics*, 11(3), 297–306. <http://doi.org/10.1007/s11569-017-0301-x>
- Vavitsas, K. (2018). OpenMTA, a paradigm shift in exchanging biological material. *Synthetic Biology*, 3(1). <http://doi.org/10.1093/synbio/ysy021>
- Wannier, T. M., Kunjapur, A. M., Rice, D. P., McDonald, M. J., Desai, M. M., & Church, G. M. (2018). Adaptive evolution of genomically recoded *Escherichia coli*, 115(12). <http://doi.org/10.1073/pnas.1715530115>
- Wilson Center. (2015). *U.S. Trends in Synthetic Biology Research Funding*.
- Woodrow Wilson International Center for Scholars. (2010). *Trends in Synthetic Biology Research Funding in the United States and Europe*.
- Wu, M.-R., Jusiak, B., & Lu, T. K. (2019). Engineering advanced cancer therapies with synthetic biology. *Nature Reviews Cancer*, 19(4), 187–195. <http://doi.org/10.1038/s41568-019-0121-0>

Xu, G., Greene, G. H., Yoo, H., Liu, L., Marqués, J., Motley, J., & Dong, X. (2017). Global translational reprogramming is a fundamental layer of immune regulation in plants. *Nature*, 545, 487. Retrieved from <https://doi.org/10.1038/nature22371>

Yan, Y., Linger, R. J., & Scott, M. J. (2017). Building early-larval sexing systems for genetic control of the Australian sheep blow fly *Lucilia cuprina* using two constitutive promoters. *Scientific Reports*, 7(1), 2538. <http://doi.org/10.1038/s41598-017-02763-4>

Yang, G., Cozad, M. A., Holland, D. A., Zhang, Y., Luesch, H., & Ding, Y. (2018). Photosynthetic Production of Sunscreen Shinorine Using an Engineered Cyanobacterium. *ACS Synthetic Biology*, 7(2), 664–671. <http://doi.org/10.1021/acssynbio.7b00397>

Zemella, A., Thoring, L., Hoffmeister, C., & Kubick, S. (2015). Cell-Free Protein Synthesis: Pros and Cons of Prokaryotic and Eukaryotic Systems. *ChemBioChem*, 16(17), 2420–2431. <http://doi.org/10.1002/cbic.201500340>

Zhang, F., Zetsche, B., Gootenberg, J., Abudayyeh, O., & Slaymaker, I. (2015). Novel crispr enzymes and systems. European Patent Office. Retrieved from <https://patents.google.com/patent/EP3009511A2/ko>

Zhang, H., Bahamondez-Canas, T. F., Zhang, Y., Leal, J., & Smyth, H. D. C. (2018). PEGylated Chitosan for Nonviral Aerosol and Mucosal Delivery of the CRISPR/Cas9 System in Vitro. *Molecular Pharmaceutics*, 15(11), 4814–4826. <http://doi.org/10.1021/acs.molpharmaceut.8b00434>

Zhang, Y., Lamb, B. M., Feldman, A. W., Zhou, A. X., Lavergne, T., Li, L., & Romesberg, F. E. (2017). A semisynthetic organism engineered for the stable expansion of the genetic alphabet. *Proceedings of the National Academy of Sciences*, 114(6), 1317–1322. <http://doi.org/10.1073/pnas.1616443114>

Zheng, J. H., Nguyen, V. H., Jiang, S.-N., Park, S.-H., Tan, W., Hong, S. H., ... Min, J.-J. (2017). Two-step enhanced cancer immunotherapy with engineered *Salmonella typhimurium* secreting heterologous flagellin. *Science Translational Medicine*, 9(376), eaak9537. <http://doi.org/10.1126/scitranslmed.aak9537>

Zsögön, A., Čermák, T., Naves, E. R., Notini, M. M., Edel, K. H., Weigl, S., ... Peres, L. E. P. (2018). De novo domestication of wild tomato using genome editing. *Nature Biotechnology*, 36, 1211. Retrieved from <https://doi.org/10.1038/nbt.4272>

Zych, A. O., Bajor, M., & Zagozdzon, R. (2018). Application of Genome Editing Techniques in Immunology. *Archivum Immunologiae et Therapiae Experimentalis*, 66(4), 289–298. <http://doi.org/10.1007/s00005-018-0504-z>

Conferences

-CRISPR Con (CRISPR Cas9 Technology and Genetic Engineering) <https://crisprcon.org/>
<https://crisprcongress.conferenceseries.com/events-list/crispr-technologies-beyond-genome-editing-and-gene-regulation>

-Fifth Annual Genome Editing Conference <https://www.oxfordglobal.co.uk/genomeediting-congress/>

-Sixth International Mammalian Synthetic Biology Workshop <http://mammalian-synbio.org/2019>

-Global Biofoundry Meeting <http://www.synbocite.com/news-events/2018/jun/25/global-biofoundry-meeting-london-june-2018/>

- iGEM 2018 http://2018.igem.org/Main_Page
- Metabolic Engineering 12 <https://www.aiche.org/sbe/conferences/metabolic-engineering-conference/2018>
- OECD Conference on Genome Editing: Applications in Agriculture Synbiobeta 2019 <http://www.oecd.org/environment/genome-editing-agriculture/>
- Second International Conference on Plant Genome Editing & Genome Engineering <http://viscea.org/plant-genome-editing-genome-engineering-ii-july-5-6-2019/>
- Synbiobeta 2019 <https://2019.synbiobeta.com/>
- Synthetic Biology: Engineering, Evolution & Design (SEED) <http://synbioconference.org/2019>
- 3rd International Conference on CRISPR Technologies <https://www.showsbee.com/fairs/CRISPR-Technologies-Conference.html>

Websites

- BMC Molecular Biology <https://bmcmolbiol.biomedcentral.com/articles>
- Build-a-cell <http://buildacell.io/>
- Calyxt <http://www.calyxt.com/>
- Cibus <https://www.cibus.com/our-technology.php>
- Current Synthetic and Systems Biology <https://www.omicsonline.org/scholarly/synthetic-biology-journals-articles-ppts-list.php>
- Discover: Science for the curious <http://discovermagazine.com/tags?tag=synthetic+biology>
- The Genome Project-Write <https://engineeringbiologycenter.org/>
- Haseloff lab – synthetic biology reports <https://data.plantsci.cam.ac.uk/Haseloff/reports/index.html>
- IBISBA project <https://www.ibisba.eu/>
- IUCN Synthetic Biology <https://www.iucn.org/theme/science-and-economics/our-work/other-work/synthetic-biology-and-biodiversity-conservation>
- Leaf Expression Systems <https://www.leafexpressionsystems.co.uk/>
- London DNA Foundry <http://www.londondnafoundry.co.uk/foundry>
- MIT-Broad Foundry <http://web.mit.edu/foundry/>
- MIT News <http://news.mit.edu/topic/synthetic-biology>
- The SynBioOnt <https://biotechnologie.rivm.nl/>
- Synthetic Biology <https://academic.oup.com/synbio>
- TEDX <https://www.ted.com/tedx>
- Вести.Ру <https://www.vesti.ru/theme.html?tid=107945>

Topic 2: Recommend options for carrying out the regular horizon scanning, monitoring and assessing of developments referred to in para 3 of decision 14/19

Articles

ETC Group. (2017). *The Wisdom of G.O.A.T.S. (Global Overview Assessment of Technological Systems)*.

ETC Group. (2012). *Moving Beyond Technology Transfer: The Case for Technology Assessment*. Etc Group.

Gray, P., Meek, S., Griffiths, P., Trapani, J., Small, I., Vickers, C., ... Wood, R. (2018). *Synthetic Biology in Australia: An Outlook to 2030*. Melbourne, Australia: Australian Council of Learned Academies. Retrieved from www.acola.org.au

Model, C. (2010). Reinventing technology Assessment 3 STIP | reinventing technology Assessment, (April). Retrieved from <http://wilsoncenter.org/techassessment>

van der Vlugt C, van den Akker E, CH, R., & J, W. (2018). Risicobeoordelingsmethode voor organismen met een gene drive toegepast onder ingeperkt gebruik. Rijksinstituut voor Volksgezondheid en Milieu RIVM. Retrieved from <http://hdl.handle.net/10029/622022>

van der Vlugt, C., van den Akker, E., Roesink, C., & Westra, J. (2018). *Risicobeoordelingsmethode voor organismen met een gene drive toegepast onder ingeperkt gebruik*. Retrieved from www.rivm.nl

van der Vlugt, C. J. B., Brown, D. D., Lehmann, K., Leunda, A., & Willemarck, N. (2018). A Framework for the Risk Assessment and Management of Gene Drive Technology in Contained Use. *Applied Biosafety*, 23(1), 25–31. <http://doi.org/10.1177/1535676018755117>

Wakeford, T. (2004). *Democratising technology Reclaiming science for sustainable development*.

Wilson Center. (2015). *U.S. Trends in Synthetic Biology Research Funding*.

Wintle, B. C., Boehm, C. R., Rhodes, C., Molloy, J. C., Millett, P., Adam, L., ... Sutherland, W. J. (2017). A transatlantic perspective on 20 emerging issues in biological engineering. *Elife*, 6, e30247. <http://doi.org/10.7554/eLife.30247>

Woodrow Wilson International Center for Scholars. (2010). *Trends in Syntehtic Biology Research Funding in the United States and Europe*.

Websites

-BioRxiv <https://www.biorxiv.org/collection/synthetic-biology>

-Feedly <http://feedly.com>

-Pink Chicken Project <http://www.pinkchickenproject.com/>

Topic 3: Review of the current state of knowledge

Articles

Adli, M. (2018). The CRISPR tool kit for genome editing and beyond. *Nature Communications*, 9(1), 1911. <http://doi.org/10.1038/s41467-018-04252-2>

Alaniz, A. J., Grez, A. A., & Zaviezo, T. (2018). Potential spatial interaction of the invasive species *Harmonia axyridis* (Pallas) with native and endemic coccinellids. *Journal of Applied Entomology*, 142(5), 513–524. <http://doi.org/10.1111/jen.12498>

Animal Health and Welfare. (2015). Update on oral vaccination of foxes and raccoon dogs against rabies. *EFSA Journal*, 13(7). <http://doi.org/10.2903/j.efsa.2015.4164>

Baltzegar, J., Cavin Barnes, J., Elsensohn, J. E., Gutzmann, N., Jones, M. S., King, S., & Sudweeks, J. (2018). Anticipating complexity in the deployment of gene drive insects in agriculture. *Journal of Responsible Innovation*, 5(sup1), S81–S97. <http://doi.org/10.1080/23299460.2017.1407910>

Besansky, N. J., Lehmann, T., Fahey, G. T., Fontenille, D., Braack, L. E. O., Hawley, W. A., & Collins, F. H. (1997). Patterns of mitochondrial variation within and between African malaria vectors, *Anopheles gambiae* and *An. Arabiensis*, suggest extensive gene flow. *Genetics*, 147(4), 1817–1828.

- Betts, K. (Ed.). (2018). *The Promise of Genome Editing Tools to Advance Environmental Health Research*. Washington, D.C.: National Academies Press. <http://doi.org/10.17226/25136>
- Brown, P. M. J., Roy, D. B., Harrower, C., Dean, H. J., Rorke, S. L., & Roy, H. E. (2018). Spread of a model invasive alien species, the harlequin ladybird *Harmonia axyridis* in Britain and Ireland. *Scientific Data*, 5, 180239. Retrieved from <https://doi.org/10.1038/sdata.2018.239>
- Buchman, A. B., Ivy, T., Marshall, J. M., Akbari, O. S., & Hay, B. A. (2018). Engineered Reciprocal Chromosome Translocations Drive High Threshold, Reversible Population Replacement in *Drosophila*. *ACS Synthetic Biology*, 7(5), 1359–1370. <http://doi.org/10.1021/acssynbio.7b00451>
- Bull, J. J. (2015). Evolutionary decay and the prospects for long-term disease intervention using engineered insect vectors: Figure 1. *Evolution, Medicine, and Public Health*, 2015(1), 152–166. <http://doi.org/10.1093/emph/eov013>
- Callaway, E. (2017). Gene drives meet the resistance. *Nature*, 542, 15. <http://doi.org/10.1038/542015a>
- Collins, C. M., Bonds, J. A. S., Quinlan, M. M., & Mumford, J. D. (2019). Effects of the removal or reduction in density of the malaria mosquito, *Anopheles gambiae* s.l., on interacting predators and competitors in local ecosystems. *Medical and Veterinary Entomology*, 33(1), 1–15. <http://doi.org/10.1111/mve.12327>
- Collins, J. P. (2018). Gene drives in our future: challenges of and opportunities for using a self-sustaining technology in pest and vector management. *BMC Proceedings*, 12(8), 9. <http://doi.org/10.1186/s12919-018-0110-4>
- Congressional Research Service. (2018). Advanced Gene Editing: CRISPR. Retrieved from <https://crsreports.congress.gov>
- Consortium, T. A. *gambiae* 1000 G., Miles, A., Harding, N. J., Bottà, G., Clarkson, C. S., Antão, T., ... Kwiatkowski, D. P. (2017). Genetic diversity of the African malaria vector *Anopheles gambiae*. *Nature*, 552, 96. Retrieved from <https://doi.org/10.1038/nature24995>
- Courtier- Orgogozo, V., Morizot, B., & Boëte, C. (2017). Agricultural pest control with CRISPR-based gene drive: time for public debate. *EMBO Reports*, 18(6), 878–880. <http://doi.org/10.15252/embr.201744205>
- David, A. S., Kaser, J. M., Morey, A. C., Roth, A. M., & Andow, D. A. (2013). Release of genetically engineered insects: a framework to identify potential ecological effects. *Ecology and Evolution*, 3(11), 4000–4015. <http://doi.org/10.1002/ece3.737>
- De Steur, H., Demont, M., Gellynck, X., & Stein, A. J. (2017). The social and economic impact of biofortification through genetic modification. *Current Opinion in Biotechnology*, 44, 161–168. <http://doi.org/10.1016/j.copbio.2017.01.012>
- Dhole, S., Vella, M. R., Lloyd, A. L., & Gould, F. (2018). Invasion and migration of spatially self-limiting gene drives: A comparative analysis. *Evolutionary Applications*, 11(5), 794–808. <http://doi.org/10.1111/eva.12583>

ETC Group. (2018). *Forcing the Farm: How gene drive organisms could entrench industrial agriculture and threaten food sovereignty*. Retrieved from www.etcgroup.com

ETC Group, & Third World Network. (2018). *Impulsores genéticos sintéticos: la ingeniería genética enloqueció Informe para los delegados del CDB*. Retrieved from www.synbiogovernance.org

Friends of the Earth. (2018). Gene-edited organisms in agriculture. Retrieved from www.foe.org

Garg, M., Sharma, N., Sharma, S., Kapoor, P., Kumar, A., Chunduri, V., & Arora, P. (2018). Biofortified Crops Generated by Breeding, Agronomy, and Transgenic Approaches Are Improving Lives of Millions of People around the World. *Frontiers in Nutrition*, 5. <http://doi.org/10.3389/fnut.2018.00012>

Gronvall, G. K. (2016). Synthetic Biology: Safety, Security, and Promise.

Hayes, K. R., Hosack, G. R., Dana, G. V., Foster, S. D., Ford, J. H., Thresher, R., ... Dambacher, J. M. (2018). Identifying and detecting potentially adverse ecological outcomes associated with the release of gene-drive modified organisms. *Journal of Responsible Innovation*, 5(sup1), S139–S158. <http://doi.org/10.1080/23299460.2017.1415585>

Hoshika, S., Leal, N. A., Kim, M.-J., Kim, M.-S., Karalkar, N. B., Kim, H.-J., ... Benner, S. A. (2019). Hachimoji DNA and RNA: A genetic system with eight building blocks. *Science*, 363(6429), 884 LP-887. <http://doi.org/10.1126/science.aat0971>

IPBES. (2018). *Summary for policymakers of the regional assessment report on biodiversity and ecosystem services for Europe and Central Asia of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Bonn, Germany. Retrieved from www.ipbes.net

IPBES. (2018). *Summary for policymakers of the regional assessment report on biodiversity and ecosystem services for Asia and the Pacific of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. M. Bonn, Germany.

IPBES. (2018). *Summary for policymakers of the regional assessment report on biodiversity and ecosystem services for the Americas of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Bonn, Germany.

IPBES. (2018). *Summary for policymakers of the regional assessment report on biodiversity and ecosystem services for Africa of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Bonn, Germany. Retrieved from www.ipbes.net

Janzen, D. H., & Hallwachs, W. (2019). Perspective: Where might be many tropical insects? *Biological Conservation*, 233, 102–108. <http://doi.org/10.1016/J.BIOCON.2019.02.030>

Kaminski, R., Chen, Y., Fischer, T., Tedaldi, E., Napoli, A., Zhang, Y., ... Khalili, K. (2016). Elimination of HIV-1 Genomes from Human T-lymphoid Cells by CRISPR/Cas9 Gene Editing. *Scientific Reports*, 6, 22555. Retrieved from <https://doi.org/10.1038/srep22555>

Kofler, N., Collins, J. P., Kuzma, J., Marris, E., Esvelt, K., Nelson, M. P., ... Schmitz, O. J. (2018). Editing nature: Local roots of global governance. *Science*, 362(6414), 527–529. <http://doi.org/10.1126/science.aat4612>

- Kyrou, K., Hammond, A. M., Galizi, R., Kranjc, N., Burt, A., Beaghton, A. K., ... Crisanti, A. (2018). A CRISPR–Cas9 gene drive targeting doublesex causes complete population suppression in caged *Anopheles gambiae* mosquitoes. *Nature Biotechnology*, *36*, 1062. Retrieved from <https://doi.org/10.1038/nbt.4245>
- Lehmann, T., Yaro, A. S., Diallo, M., Sanogo, Z. L., Djibril, S., Huestis, D. L., ... Dao, A. (2018). SP2026: Wind-borne migration of mosquitoes and pathogens: Potential for bio-surveillance. In *Entomology 2018*. Vancouver, Canada. Retrieved from <https://esa.confex.com/esa/2018/meetingapp.cgi/Paper/137964>
- Leitschuh, C. M., Kanavy, D., Backus, G. A., Valdez, R. X., Serr, M., Pitts, E. A., ... Godwin, J. (2018). Developing gene drive technologies to eradicate invasive rodents from islands. *Journal of Responsible Innovation*, *5*(sup1), S121–S138. <http://doi.org/10.1080/23299460.2017.1365232>
- Lindholm, A. K., Dyer, K. A., Firman, R. C., Fishman, L., Forstmeier, W., Holman, L., ... Price, T. A. R. (2016). The Ecology and Evolutionary Dynamics of Meiotic Drive. *Trends in Ecology & Evolution*, *31*(4), 315–326. <http://doi.org/10.1016/j.tree.2016.02.001>
- Lundgren, J. G., & Fergen, J. K. (2014). Predator community structure and trophic linkage strength to a focal prey. *Molecular Ecology*, *23*(15), 3790–3798. <http://doi.org/10.1111/mec.12700>
- Maki, J., Guiot, A.-L., Aubert, M., Brochier, B., Cliquet, F., Hanlon, C. A., ... Lankau, E. W. (2017). Oral vaccination of wildlife using a vaccinia–rabies–glycoprotein recombinant virus vaccine (RABORAL V-RG®): a global review. *Veterinary Research*, *48*(1), 57. <http://doi.org/10.1186/s13567-017-0459-9>
- Masetti, A., Magagnoli, S., Lami, F., Lanzoni, A., & Burgio, G. (2018). Long term changes in the communities of native ladybirds in Northern Italy: impact of the invasive species *Harmonia axyridis* (Pallas). *BioControl*, *63*(5), 665–675. <http://doi.org/10.1007/s10526-018-9891-7>
- Mexico. Secretaría de Salubridad y Asistencia., C. W., Instituto Nacional de Salud Pública (Mexico), & Centro Nacional de Información y Documentación en Salud (Mexico). (2010). *Salud pública de México. Salud Pública de México* (Vol. 52). [Secretaría de Salubridad y Asistencia]. Retrieved from http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0036-36342010000300012
- Mitchell, P. D., Brown, Z., & McRoberts, N. (2018). Economic issues to consider for gene drives. *Journal of Responsible Innovation*, *5*(sup1), S180–S202. <http://doi.org/10.1080/23299460.2017.1407914>
- Mooney, P. (2018). Blocking the Chain.
- Müller, T. F., Schröder, R., Wysocki, P., Mettenleiter, T. C., & Freuling, C. M. (2015). Spatio-temporal Use of Oral Rabies Vaccines in Fox Rabies Elimination Programmes in Europe. *PLOS Neglected Tropical Diseases*, *9*(8), e0003953. <http://doi.org/10.1371/journal.pntd.0003953>
- Mundial, B. (2009). América Latina y el Caribe. *Situación de Los Bosques Del Mundo 2009*, 34–43.
- Murphy, B., & Jansen, C. (2010). Risk analysis on the Australian release of *Aedes aegypti* (L.) (Diptera: Culicidae) containing *Wolbachia*. *CSIRO, Canberra, Australia*, *209*(March), 109. Retrieved from

<http://www.eliminatedengue.org/LinkClick.aspx?fileticket=nMtZNaIayzw=&tabid=3911%5Chttp://www.eliminatedengue.com/library/publication/document/riskanalysisfinalreportcsiro.pdf>

Najjar, D. A., Normandin, A. M., Strait, E. A., & Esvelt, K. M. (2017). Driving towards ecotechnologies. *Pathogens and Global Health*, 111(8), 448–458. <http://doi.org/10.1080/20477724.2018.1452844>

National Academies of Sciences Engineering and Medicine. (2016). *Gene Drives on the Horizon*. Washington, D.C.: National Academies Press. Retrieved from <http://www.nap.edu/catalog/23405>

National Academies of Sciences Engineering and Medicine. (2017). *Preparing for Future Products of Biotechnology*. Washington, D.C.: National Academies Press. Retrieved from <https://www.nap.edu/catalog/24605>

National Academies of Sciences Engineering and Medicine. (2018). *Biodefense in the Age of Synthetic Biology*. Washington, D.C.: National Academies Press. Retrieved from <https://www.nap.edu/catalog/24890>

Neve, P. (2018). Gene drive systems: do they have a place in agricultural weed management? *Pest Management Science*, 74(12), 2671–2679. <http://doi.org/10.1002/ps.5137>

Noble, C., Olejarz, J., Esvelt, K. M., Church, G. M., & Nowak, M. A. (2017). Evolutionary dynamics of CRISPR gene drives. *Science Advances*, 3(4), e1601964. <http://doi.org/10.1126/sciadv.1601964>

Oliveira, E., Salgueiro, P., Palsson, K., Vicente, J. L., Arez, A. P., Jaenson, T. G., ... Pinto, J. (2008). High Levels of Hybridization between Molecular Forms of *Anopheles gambiae* from Guinea Bissau. *Journal of Medical Entomology*, 45(6), 1057–1063. <http://doi.org/10.1093/jmedent/45.6.1057>

Oye, K. A., Esvelt, K., Appleton, E., Catteruccia, F., Church, G., Kuiken, T., ... Collins, J. P. (2014). Regulating gene drives. *Science*, 345(6197), 626–628. <http://doi.org/10.1126/science.1254287>

Paul, J.-Y., Harding, R., Tushemereirwe, W., & Dale, J. (2018). Banana21: From Gene Discovery to Dereglated Golden Bananas. *Frontiers in Plant Science*, 9. <http://doi.org/10.3389/fpls.2018.00558>

Simon, S., Otto, M., & Engelhard, M. (2018). Synthetic gene drive: between continuity and novelty. *EMBO Reports*, 19(5), e45760. <http://doi.org/10.15252/embr.201845760>

South, P. F., Cavanagh, A. P., Liu, H. W., & Ort, D. R. (2019). Synthetic glycolate metabolism pathways stimulate crop growth and productivity in the field. *Science*, 363(6422), eaat9077. <http://doi.org/10.1126/science.aat9077>

Then, C. (2019). *Am I Regulated? The US example: why new methods of genetically engineering crop plants need to be regulated*. Munich, Germany.

Williamson, L. L., & Moore, N. W. (1990). *The Bird of Time: The Science and Politics of Nature Conservation*. *The Journal of Wildlife Management* (Vol. 54). <http://doi.org/10.2307/3809060>

Websites

-Journal of Responsible Innovation, Special Issue: Roadmap to Gene Drives: Research and Governance Needs in Social, Political, and Ecological Context
<https://www.tandfonline.com/toc/tjri20/5/sup1>
 -Target Malaria www.targetmalaria.org

Topic 4: Possible impacts of synthetic biology applications that are in early stages of research and development on the three objectives of the Convention
Articles

African Union, & NEPAD. (2018). *Gene drives for malaria control and elimination in Africa*. Midrand, South Africa. Retrieved from www.nepad.org

Akbari, O. S., Bellen, H. J., Bier, E., Bullock, S. L., Burt, A., Church, G. M., ... Wildonger, J. (2015). Safeguarding gene drive experiments in the laboratory. *Science*, 349(6251), 927–929. <http://doi.org/10.1126/science.aac7932>

Akbari, O. S., Matzen, K. D., Marshall, J. M., Huang, H., Ward, C. M., & Hay, B. A. (2013). A Synthetic Gene Drive System for Local, Reversible Modification and Suppression of Insect Populations. *Current Biology*, 23(8), 671–677. <http://doi.org/10.1016/j.cub.2013.02.059>

Alphey, L., Benedict, M., Bellini, R., Clark, G. G., Dame, D. A., Service, M. W., & Dobson, S. L. (2009). Sterile-Insect Methods for Control of Mosquito-Borne Diseases: An Analysis. *Vector-Borne and Zoonotic Diseases*, 10(3), 295–311. <http://doi.org/10.1089/vbz.2009.0014>

Anderson, K. R., Haeussler, M., Watanabe, C., Janakiraman, V., Lund, J., Modrusan, Z., ... Warming, S. (2018). CRISPR off-target analysis in genetically engineered rats and mice. *Nature Methods*, 15(7), 512–514. <http://doi.org/10.1038/s41592-018-0011-5>

Barnhill-Dilling, S., Serr, M., Blondel, D., & Godwin, J. (2019). Sustainability as a Framework for Considering Gene Drive Mice for Invasive Rodent Eradication. *Sustainability*, 11(5), 1334. <http://doi.org/10.3390/su11051334>

Buchman, A. B., Ivy, T., Marshall, J. M., Akbari, O. S., & Hay, B. A. (2018). Engineered Reciprocal Chromosome Translocations Drive High Threshold, Reversible Population Replacement in *Drosophila*. *ACS Synthetic Biology*, 7(5), 1359–1370. <http://doi.org/10.1021/acssynbio.7b00451>

Bull, J. J. (2019). Gene drive extinction is thwarted by evolution of sib mating, 1–23. <http://doi.org/10.1101/558924>

Burt, A., Coulibaly, M., Crisanti, A., Diabate, A., & Kayondo, J. K. (2018). Gene drive to reduce malaria transmission in sub-Saharan Africa. *Journal of Responsible Innovation*, 5(sup1), S66–S80. <http://doi.org/10.1080/23299460.2017.1419410>

Butterfield, G. L., Lajoie, M. J., Gustafson, H. H., Sellers, D. L., Nattermann, U., Ellis, D., ... Baker, D. (2017). Evolution of a designed protein assembly encapsulating its own RNA genome. *Nature*, 552, 415. Retrieved from <https://doi.org/10.1038/nature25157>

Centers for Disease Control and Prevention. (2014). *Report on the Inadvertent Cross-Contamination and Shipment of a Laboratory Specimen with Influenza Virus H5N1*. Retrieved from <http://www.cdc.gov/about/pdf/lab-safety/investigationcdch5n1contaminationeventaugust15.pdf>

Chappell, B. (2015). Live Anthrax Was Mistakenly Sent To 9 States And A U.S. Military Base : The Two-Way : NPR. Retrieved April 1, 2019, from <https://www.npr.org/sections/thetwo-way/2015/05/28/410220914/live-anthrax-was-mistakenly-sent-to-9-states-and-a-u-s-military-base>

Christensen, J. (2014). CDC: Smallpox found in NIH storage room is alive – CNN. Retrieved April 1, 2019, from <https://edition.cnn.com/2014/07/11/health/smallpox-found-nih-alive/index.html>

Clout, M. N., Martin, A. R., Russell, J. C., & West, C. J. (2017). Island invasives: scaling up to meet the challenge.

Courtier- Orgogozo, V., Morizot, B., & Boëte, C. (2017). Agricultural pest control with CRISPR-based gene drive: time for public debate. *EMBO Reports*, 18(6), 878–880. <http://doi.org/10.15252/embr.201744205>

Cyranoski, D., & Ledford, H. (2018). Genome-edited baby claim provokes international outcry. *Nature*, 563(7733), 607–608. <http://doi.org/10.1038/d41586-018-07545-0>

de Lorenzo, V., Prather, K. L., Chen, G., O'Day, E., von Kameke, C., Oyarzún, D. A., ... Lee, S. Y. (2018). The power of synthetic biology for bioproduction, remediation and pollution control. *EMBO Reports*, 19(4), e45658. <http://doi.org/10.15252/embr.201745658>

DeRosa, T. F. (2006). *Advances in synthetic organic chemistry and methods reported in US patents*. Elsevier.

Eckhoff, P. A., Wenger, E. A., Godfray, H. C. J., & Burt, A. (2016). Impact of mosquito gene drive on malaria elimination in a computational model with explicit spatial and temporal dynamics. *Proceedings of the National Academy of Sciences*, 114(2), E255–E264. <http://doi.org/10.1073/pnas.1611064114>

Esvelt, K. M., & Gemmell, N. J. (2017). Conservation demands safe gene drive. *PLOS Biology*, 15(11), e2003850. <http://doi.org/10.1371/journal.pbio.2003850>

Fries, L. A. (2005). *A Vanços D O U So D Os R Ecursos G Enéticos E B Iotécnicas R Eprodutivas C Om.*

Galonska, C., Charlton, J., Mattei, A. L., Donaghey, J., Clement, K., Gu, H., ... Meissner, A. (2018). Genome-wide tracking of dCas9-methyltransferase footprints. *Nature Communications*, 9(1), 597. <http://doi.org/10.1038/s41467-017-02708-5>

Gantz, V. M., Jasinskiene, N., Tatarenkova, O., Fazekas, A., Macias, V. M., Bier, E., & James, A. A. (2015). Highly efficient Cas9-mediated gene drive for population modification of the malaria vector mosquito Anopheles stephensi. *Proceedings of the National Academy of Sciences*, 112(49), E6736 LP-E6743. <http://doi.org/10.1073/pnas.1521077112>

Gong, F., Cai, Z., & Li, Y. (2016). Synthetic biology for CO2 fixation. *Science China Life Sciences*, 59(11), 1106–1114. <http://doi.org/10.1007/s11427-016-0304-2>

Goold, H. D., Wright, P., & Hailstones, D. (2018). Emerging opportunities for synthetic biology in agriculture. *Genes*, 9(7). <http://doi.org/10.3390/genes9070341>

- Haapaniemi, E., Botla, S., Persson, J., Schmierer, B., & Taipale, J. (2018). CRISPR–Cas9 genome editing induces a p53-mediated DNA damage response. *Nature Medicine*, 24(7), 927–930. <http://doi.org/10.1038/s41591-018-0049-z>
- Hammond, A., Galizi, R., Kyrou, K., Simoni, A., Siniscalchi, C., Katsanos, D., ... Nolan, T. (2015). A CRISPR-Cas9 gene drive system targeting female reproduction in the malaria mosquito vector *Anopheles gambiae*. *Nature Biotechnology*, 34, 78. Retrieved from <https://doi.org/10.1038/nbt.3439>
- Haque, E., Taniguchi, H., Hassan, M. M., Bhowmik, P., Karim, M. R., Śmiech, M., ... Islam, T. (2018). Application of CRISPR/Cas9 Genome Editing Technology for the Improvement of Crops Cultivated in Tropical Climates: Recent Progress, Prospects, and Challenges . *Frontiers in Plant Science* . Retrieved from <https://www.frontiersin.org/article/10.3389/fpls.2018.00617>
- Harvey-Samuel, T., Ant, T., & Alphey, L. (2017). Towards the genetic control of invasive species. *Biological Invasions*, 19(6), 1683–1703. <http://doi.org/10.1007/s10530-017-1384-6>
- Hayes, K. R., Hosack, G. R., Dana, G. V., Foster, S. D., Ford, J. H., Thresher, R., ... Dambacher, J. M. (2018). Identifying and detecting potentially adverse ecological outcomes associated with the release of gene-drive modified organisms. *Journal of Responsible Innovation*, 5(sup1), S139–S158. <http://doi.org/10.1080/23299460.2017.1415585>
- Heinemann, J. A., Coray, D. S., & Thaler, D. S. (2018). *Exploratory Fact-Finding scoping study on “Digital Sequence Information” on Genetic Resources for Food and Agriculture*. Retrieved from www.fao.org
- Heipieper, H., Blank, L., & Wierckx, N. (2018). *P4SB – From Plastic waste to Plastic value using Pseudomonas putida Synthetic Biology*.
- Hochkirch, A., Beninde, J., Fischer, M., Krahnert, A., Lindemann, C., Matenaar, D., ... Veith, M. (2018). License to Kill?—Disease Eradication Programs May Not be in Line with the Convention on Biological Diversity. *Conservation Letters*, 11(1), e12370. <http://doi.org/10.1111/conl.12370>
- Hoffmann, A. A., Ross, P. A., & Rašić, G. (2015). Wolbachia strains for disease control: ecological and evolutionary considerations. *Evolutionary Applications*, 8(8), 751–768. <http://doi.org/10.1111/eva.12286>
- Ilhry, R. J., Worringer, K. A., Salick, M. R., Frias, E., Ho, D., Theriault, K., ... Kaykas, A. (2018). P53 inhibits CRISPR–Cas9 engineering in human pluripotent stem cells. *Nature Medicine*, 24(7), 939–946. <http://doi.org/10.1038/s41591-018-0050-6>
- International Finance Corporation (2012). Performance Standard 1 Assessment and Management of Environmental and Social Risks and Impacts Overview of Performance Standards on Environmental and Social Sustainability. Retrieved from http://www.ifc.org/wps/wcm/connect/3be1a68049a78dc8b7e4f7a8c6a8312a/PS1_English_2012.pdf?MOD=AJPERES
- James, S., Collins, F. H., Welkhoff, P. A., Emerson, C., J Godfray, H. C., Gottlieb, M., ... Toure, Y. T. (2018). Pathway to deployment of gene drive mosquitoes as a potential biocontrol tool for elimination of malaria in sub-Saharan Africa: Recommendations of a scientific working group. *American Journal of Tropical Medicine and Hygiene*, 98(Suppl 6), 1–49. <http://doi.org/10.4269/ajtmh.18-0083>

Jennings, D. E., Duan, J. J., & Follett, P. A. (2017, August 29). Environmental Impacts of Arthropod Biological Control. *Environmental Pest Management*. <http://doi.org/doi:10.1002/9781119255574.ch5>

Jin, S., Zong, Y., Gao, Q., Zhu, Z., Wang, Y., Qin, P., ... Gao, C. (2019). Cytosine, but not adenine, base editors induce genome-wide off-target mutations in rice. *Science*, eaaw7166. <http://doi.org/10.1126/science.aaw7166>

Joint FAO/IAEA Programme. (2012). *Plant Mutation Breeding and Biotechnology*. (Q. Y. Shu, B. P. Forster, & H. Nakagawa, Eds.) (Vol. 53). Vienna, Austria. <http://doi.org/10.1017/CBO9781107415324.004>

Jupe, F., Rivkin, A. C., Michael, T. P., Zander, M., Motley, S. T., Sandoval, J. P., ... Ecker, J. R. (2019). The complex architecture and epigenomic impact of plant T-DNA insertions. *PLOS Genetics*, 15(1), e1007819. <http://doi.org/10.1371/journal.pgen.1007819>

Kohl, P. A., Brossard, D., Scheufele, D. A., & Xenos, M. A. (2019). Public views about gene editing wildlife for conservation. *Conservation Biology*. <http://doi.org/10.1111/cobi.13310>

Kosicki, M., Tomberg, K., & Bradley, A. (2018). Repair of double-strand breaks induced by CRISPR–Cas9 leads to large deletions and complex rearrangements. *Nature Biotechnology*. <http://doi.org/10.1038/nbt.4192>

Kyrou, K., Hammond, A. M., Galizi, R., Kranjc, N., Burt, A., Beaghton, A. K., ... Crisanti, A. (2018). A CRISPR–Cas9 gene drive targeting doublesex causes complete population suppression in caged *Anopheles gambiae* mosquitoes. *Nature Biotechnology*, 36, 1062. Retrieved from <https://doi.org/10.1038/nbt.4245>

Lalonde, S., Stone, O. A., Lessard, S., Lavertu, A., Desjardins, J., Beaudoin, M., ... Lettre, G. (2017). Frameshift indels introduced by genome editing can lead to in-frame exon skipping. *PLOS ONE*, 12(6), e0178700. <http://doi.org/10.1371/journal.pone.0178700>

Lander, E. S., Baylis, F., Zhang, F., Charpentier, E., Berg, P., Bourgain, C., ... Winnacker, E.-L. (2019). Adopt a moratorium on heritable genome editing. *Nature*, 567(7747), 165–168. <http://doi.org/10.1038/d41586-019-00726-5>

Lees, R. S., Gilles, J. R. L., Hendrichs, J., Vreysen, M. J. B., & Bourtzis, K. (2015). Back to the future: the sterile insect technique against mosquito disease vectors. *Current Opinion in Insect Science*, 10, 156–162. <http://doi.org/https://doi.org/10.1016/j.cois.2015.05.011>

Lemmon, Z. H., Reem, N. T., Dalrymple, J., Soyk, S., Swartwood, K. E., Rodriguez-Leal, D., ... Lippman, Z. B. (2018). Rapid improvement of domestication traits in an orphan crop by genome editing. *Nature Plants*, 4(10), 766–770. <http://doi.org/10.1038/s41477-018-0259-x>

Li, T., Yang, X., Yu, Y., Si, X., Zhai, X., Zhang, H., ... Xu, C. (2018). Domestication of wild tomato is accelerated by genome editing. *Nature Biotechnology*, 36, 1160. Retrieved from <https://doi.org/10.1038/nbt.4273>

Lynch, J., & Pierrehumbert, R. (2019). Climate Impacts of Cultured Meat and Beef Cattle. *Frontiers in Sustainable Food Systems*, 3. <http://doi.org/10.3389/fsufs.2019.00005>

- Manova, V., & Gruszka, D. (2015). DNA damage and repair in plants – from models to crops. *Frontiers in Plant Science*, 6. <http://doi.org/10.3389/fpls.2015.00885>
- Marshall, J. M., & Akbari, O. S. (2018). Can CRISPR-Based Gene Drive Be Confined in the Wild? A Question for Molecular and Population Biology. *ACS Chemical Biology*, 13(2), 424–430. <http://doi.org/10.1021/acscchembio.7b00923>
- Min, J., Noble, C., Najjar, D., & Esvelt, K. M. (2017). Daisy quorum drives for the genetic restoration of wild populations.
- Morínigo Villalba, A. (2017). *Evaluación de Fin de Proyecto: Incorporación de la agricultura familiar al mercado de la Stevia en Paraguay Evaluación de Fin de Proyecto Incorporación de la agricultura familiar al mercado de la Stevia en Paraguay*. Asunción, Paraguay.
- Mou, H., Smith, J. L., Peng, L., Yin, H., Moore, J., Zhang, X.-O., ... Xue, W. (2017). CRISPR/Cas9-mediated genome editing induces exon skipping by alternative splicing or exon deletion. *Genome Biology*, 18(1), 108. <http://doi.org/10.1186/s13059-017-1237-8>
- Niiler, E. (2018). How Crispr Could Transform Our Food Supply. Retrieved April 1, 2019, from <https://www.nationalgeographic.com/environment/future-of-food/food-technology-gene-editing/>
- Noble, C., Adlam, B., Church, G. M., Esvelt, K. M., & Nowak, M. A. (2018). Current CRISPR gene drive systems are likely to be highly invasive in wild populations. *Elife*, 7, e33423. <http://doi.org/10.7554/eLife.33423>
- Oberhofer, G., Ivy, T., & Hay, B. A. (2019). Cleave and Rescue, a novel selfish genetic element and general strategy for gene drive. *Proceedings of the National Academy of Sciences*, 116(13), 6250–6259. <http://doi.org/10.1073/pnas.1816928116>
- OECD, & Royal Society. (2010). *Symposium on Opportunities and Challenges in the Emerging Field of Synthetic Biology. Symposium on Opportunities and Challenges in the Emerging Field of Synthetic Biology*. Retrieved from royalsociety.org
- Ono, R., Yasuhiko, Y., Aisaki, K., Kitajima, S., Kanno, J., & Hirabayashi, Y. (2019). Exosome-mediated horizontal gene transfer occurs in double-strand break repair during genome editing. *Communications Biology*, 2(1), 57. <http://doi.org/10.1038/s42003-019-0300-2>
- Piaggio, A. J., Segelbacher, G., Seddon, P. J., Alphey, L., Bennett, E. L., Carlson, R. H., ... Wheeler, K. (2017). Is It Time for Synthetic Biodiversity Conservation? *Trends in Ecology & Evolution*, 32(2), 97–107. <http://doi.org/10.1016/j.tree.2016.10.016>
- Reeves, R. G., Bryk, J., Altrock, P. M., Denton, J. A., & Reed, F. A. (2014). First Steps towards Underdominant Genetic Transformation of Insect Populations. *PloS ONE*, 9(5), e97557. <http://doi.org/10.1371/journal.pone.0097557>
- Rogers, C., & Oldroyd, G. E. D. (2014). Synthetic biology approaches to engineering the nitrogen symbiosis in cereals. *Journal of Experimental Botany*, 65(8), 1939–1946. <http://doi.org/10.1093/jxb/eru098>

Salverda, M. L. M., Dellus, E., Gorter, F. A., Debets, A. J. M., van der Oost, J., Hoekstra, R. F., ... de Visser, J. A. G. M. (2011). Initial Mutations Direct Alternative Pathways of Protein Evolution. *PLOS Genetics*, 7(3), e1001321. Retrieved from <https://doi.org/10.1371/journal.pgen.1001321>

SCENIR, SCHER, & SCCS. (2016). *Final opinion on synthetic biology III – Risks to the environment and biodiversity related to synthetic biology and research priorities in the field of synthetic biology*. EU Publications.

Silva, D.-A., Yu, S., Ulge, U. Y., Spangler, J. B., Jude, K. M., Labão-Almeida, C., ... Baker, D. (2019). De novo design of potent and selective mimics of IL-2 and IL-15. *Nature*, 565(7738), 186–191. <http://doi.org/10.1038/s41586-018-0830-7>

Simon, S., Otto, M., & Engelhard, M. (2018). Synthetic gene drive: between continuity and novelty. *EMBO Reports*, 19(5), e45760. <http://doi.org/10.15252/embr.201845760>

The Royal Society. (2018). Gene drive research: why it matters. Pp.24. <https://royalsociety.org/topics-policy/publications/2018/gene-drive-statement/>

U.S. Department of Health and Human Services. (2014). CDC Media Statement on Newly Discovered Smallpox Specimens | CDC Online Newsroom | CDC. Retrieved April 1, 2019, from <https://www.cdc.gov/media/releases/2014/s0708-nih.html>

Vella, M. R., Gunning, C. E., Lloyd, A. L., & Gould, F. (2017). Evaluating strategies for reversing CRISPR-Cas9 gene drives. *Scientific Reports*, 7(1), 11038. <http://doi.org/10.1038/s41598-017-10633-2>

Wiek, A., Guston, D., Frow, E., & Calvert, J. (2012). Sustainability and Anticipatory Governance in Synthetic Biology. *International Journal of Social Ecology and Sustainable Development*, 3(2), 25–38. <http://doi.org/10.4018/jesed.2012040103>

World Health Organization. (2018). *Eighth meeting of the WHO Vector Control Advisory Group*. Geneva, Switzerland. Retrieved from www.who.int

World Health Organization. (2016). *Fifth Meeting of the Vector Control Advisory Group*. Geneva, Switzerland.

World Health Organization. (2018). *World Malaria Report 2018*. Geneva, Switzerland. Retrieved from www.who.int/malaria

Zsögön, A., Čermák, T., Naves, E. R., Notini, M. M., Edel, K. H., Weigl, S., ... Peres, L. E. P. (2018). De novo domestication of wild tomato using genome editing. *Nature Biotechnology*, 36, 1211. Retrieved from <https://doi.org/10.1038/nbt.4272>

Zuo, E., Sun, Y., Wei, W., Yuan, T., Ying, W., Sun, H., ... Yang, H. (2019). Cytosine base editor generates substantial off-target single-nucleotide variants in mouse embryos. *Science*, eaav9973. <http://doi.org/10.1126/science.aav9973>

Websites

-Genetic Literacy Project <https://geneticliteracyproject.org/category/synthetic-biology>

-Target Malaria www.targetmalaria.org

Topic 5: Consider whether any living organism developed thus far through new developments in synthetic biology fall outside the definition of living modified organisms as per the Cartagena Protocol

Articles

Acevedo-Rocha, C. G., & Budisa, N. (2011). On the Road towards Chemically Modified Organisms Endowed with a Genetic Firewall. *Angewandte Chemie International Edition*, 50(31), 6960–6962. <http://doi.org/10.1002/anie.201103010>

Australian Government Department of Health. (2018). *Technical Review of the Gene Technology Regulations 2001*. Australian Government Department of Health. Retrieved from <http://www.ogtr.gov.au/internet/ogtr/publishing.nsf/Content/reviewregulations-1>

Beales, P. A., Ciani, B., & Mann, S. (2018). The artificial cell: biology-inspired compartmentalization of chemical function. *Interface Focus*, 8(5), 20180046. <http://doi.org/10.1098/rsfs.2018.0046>

Bortesi, L., & Fischer, R. (2015). The CRISPR/Cas9 system for plant genome editing and beyond. *Biotechnology Advances*, 33(1), 41–52. <http://doi.org/10.1016/j.biotechadv.2014.12.006>

Butterfield, G. L., Lajoie, M. J., Gustafson, H. H., Sellers, D. L., Nattermann, U., Ellis, D., ... Baker, D. (2017). Evolution of a designed protein assembly encapsulating its own RNA genome. *Nature*, 552, 415. Retrieved from <https://doi.org/10.1038/nature25157>

Chilcoat, D., Liu, Z.-B., & Sander, J. (2017). Use of CRISPR/Cas9 for Crop Improvement in Maize and Soybean (pp. 27–46). <http://doi.org/10.1016/bs.pmbts.2017.04.005>

Food and Agriculture Organization. (2006). *ISPM No. 11: Pest risk analysis for quarantine pests including analysis of Environmental risks and living modified organisms*.

Fuentes, I., Stegemann, S., Golczyk, H., Karcher, D., & Bock, R. (2014). Horizontal genome transfer as an asexual path to the formation of new species. *Nature*, 511, 232. Retrieved from <https://doi.org/10.1038/nature13291>

Gray, P., Meek, S., Griffiths, P., Trapani, J., Small, I., Vickers, C., ... Wood, R. (2018). *Synthetic Biology in Australia: An Outlook to 2030*. Melbourne, Australia: Australian Council of Learned Academies. Retrieved from www.acola.org.au

Hutchison, C. A., Chuang, R.-Y., Noskov, V. N., Assad-Garcia, N., Deerinck, T. J., Ellisman, M. H., ... Venter, J. C. (2016). Design and synthesis of a minimal bacterial genome. *Science*, 351(6280), aad6253–aad6253. <http://doi.org/10.1126/science.aad6253>

Hwang, W. Y., Fu, Y., Reyon, D., Maeder, M. L., Tsai, S. Q., Sander, J. D., ... Joung, J. K. (2013). Efficient genome editing in zebrafish using a CRISPR-Cas system. *Nature Biotechnology*, 31, 227. Retrieved from <https://doi.org/10.1038/nbt.2501>

Ledford, H. (2017). Geneticists enlist engineered virus and CRISPR to battle citrus disease. *Nature*, 545(7654), 277–278. <http://doi.org/10.1038/545277a>

- Leslie, M. (2018). Biologists create the most lifelike artificial cells yet. *Science*. <http://doi.org/10.1126/science.aaw1173>
- Liang, Z., Chen, K., Li, T., Zhang, Y., Wang, Y., Zhao, Q., ... Gao, C. (2017). Efficient DNA-free genome editing of bread wheat using CRISPR/Cas9 ribonucleoprotein complexes. *Nature Communications*, 8, 14261. Retrieved from <https://doi.org/10.1038/ncomms14261>
- Liu, J., Stace-Naughton, A., Jiang, X., & Brinker, C. J. (2009). Porous Nanoparticle Supported Lipid Bilayers (Protocells) as Delivery Vehicles. *Journal of the American Chemical Society*, 131(4), 1354–1355. <http://doi.org/10.1021/ja808018y>
- Metje-Sprink, J., Menz, J., Modrzejewski, D., & Sprink, T. (2019). DNA-Free Genome Editing: Past, Present and Future. *Frontiers in Plant Science*, 9. <http://doi.org/10.3389/fpls.2018.01957>
- Molteni, M. (2017). To Save Florida's Famous Oranges, Scientists Race to Weaponize a Virus | WIRED. Retrieved April 1, 2019, from <https://www.wired.com/2017/04/save-floridas-famous-oranges-scientists-race-weaponize-virus/>
- Nickling, J. H., Baumann, T., Schmitt, F.-J., Bartholomae, M., Kuipers, O. P., Friedrich, T., & Budisa, N. (2018). Antimicrobial Peptides Produced by Selective Pressure Incorporation of Non-canonical Amino Acids. *Journal of Visualized Experiments*, (135). <http://doi.org/10.3791/57551>
- Olzscha, H., Schermann, S. M., Woerner, A. C., Pinkert, S., Hecht, M. H., Tartaglia, G. G., ... Vabulas, R. M. (2011). Amyloid-like Aggregates Sequester Numerous Metastable Proteins with Essential Cellular Functions. *Cell*, 144(1), 67–78. <http://doi.org/10.1016/j.cell.2010.11.050>
- Reeves, R. G., Voeneky, S., Caetano-Anollés, D., Beck, F., & Boëte, C. (2018). Agricultural research, or a new bioweapon system? *Science*, 362(6410), 35–37. <http://doi.org/10.1126/science.aat7664>
- Richardson, S. M., Mitchell, L. A., Stracquadanio, G., Yang, K., Dymond, J. S., DiCarlo, J. E., ... Bader, J. S. (2017). Design of a synthetic yeast genome. *Science*, 355(6329), 1040–1044. <http://doi.org/10.1126/science.aaf4557>
- SCHER, SCENIHR, & SCCS. (2014). *Opinion on Synthetic Biology I: Definition*. Luxembourg.
- Secretariat of the International Plant Protection Convention. (2006). *International Standards for Phytosanitary Measures ISPM 12* (Vol. 24). Rome, Italy.
- Stegemann, S., Keuthe, M., Greiner, S., & Bock, R. (2012). Horizontal transfer of chloroplast genomes between plant species. *Proceedings of the National Academy of Sciences*, 109(7), 2434–2438. <http://doi.org/10.1073/pnas.1114076109>
- Tang, X., Liu, G., Zhou, J., Ren, Q., You, Q., Tian, L., ... Zhang, Y. (2018). A large-scale whole-genome sequencing analysis reveals highly specific genome editing by both Cas9 and Cpf1 (Cas12a) nucleases in rice. *Genome Biology*, 19(1), 84. <http://doi.org/10.1186/s13059-018-1458-5>
- Tycko, J., Hess, G. T., Jeng, E. E., Dubreuil, M., & Bassik, M. C. (2017). CRISPR_poster-WEB, 2017. <http://doi.org/ISSN 1548-7105>

Welch, E., Bagley, M. A., Kuiken, T., & Louafi, S. (2018). Potential Implications of New Synthetic Biology and Genomic Research Trajectories on the International Treaty for Plant Genetic Resources for Food and Agriculture. *SSRN Electronic Journal*. <http://doi.org/10.2139/ssrn.3173781>

West, M. W., Wang, W., Patterson, J., Mancias, J. D., Beasley, J. R., & Hecht, M. H. (1999). De novo amyloid proteins from designed combinatorial libraries. *Proceedings of the National Academy of Sciences*, 96(20), 11211–11216. <http://doi.org/10.1073/pnas.96.20.11211>

World Health Organization/Special Programme for Research and Training in Tropical Diseases. (2014). *Guidance Framework for Testing of Genetically Modified Mosquitoes*. Geneva, Switzerland. Retrieved from http://www.who.int/tdr/news/2012/GMM_Guidance_2012.pdf

Zhang, Y., Lamb, B. M., Feldman, A. W., Zhou, A. X., Lavergne, T., Li, L., & Romesberg, F. E. (2017). A semisynthetic organism engineered for the stable expansion of the genetic alphabet. *Proceedings of the National Academy of Sciences*, 114(6), 1317–1322. <http://doi.org/10.1073/pnas.1616443114>

Conferences

-Fenner conference on the environment: The use of gene drive technology in conservation <https://vickithomson.wixsite.com/fennergenedrives>

Websites

-Australian Academy of Science <https://www.science.org.au>

-FAO IPPC Training material on pest risk analysis based on IPPC standards <https://www.ippc.int/en/core-activities/capacity-development/training-material-pest-risk-analysis-based-ippc-standards/>

-OECD Safety of novel foods and feeds and on the harmonisation of regulatory oversight in biotechnology <http://www.oecd.org/chemicalsafety/biotrack/oecdandriskassessmentinmodernbiotechnology.htm>

-United States EPA Risk Assessment Guidance <https://www.epa.gov/risk/risk-assessment-guidelines>

-World organization for animal health Invasive Animal Species <http://www.oie.int/en/our-scientific-expertise/specific-information-and-recommendations/invasive-alien-animal-species/>

Topic 7: Relationship between synthetic biology and the criteria set out in decision IX/29

Articles

Artner, C., Holtkamp, H. U., Hartinger, C. G., & Meier-Menches, S. M. (2017). Characterizing activation mechanisms and binding preferences of ruthenium metallo-prodrugs by a competitive binding assay. *Journal of Inorganic Biochemistry*, 177, 322–327. <http://doi.org/10.1016/j.jinorgbio.2017.07.010>

Bober, J. R., Beisel, C. L., & Nair, N. U. (2018). Synthetic Biology Approaches to Engineer Probiotics and Members of the Human Microbiota for Biomedical Applications. *Annual Review of Biomedical Engineering*, 20(1), 277–300. <http://doi.org/10.1146/annurev-bioeng-062117-121019>

Douglas, T., & Savulescu, J. (2010). Synthetic biology and the ethics of knowledge. *Journal of Medical Ethics*, 36(11), 687–693. <http://doi.org/10.1136/jme.2010.038232>

- European Food Safety Authority. (2015). *Principles and process for dealing with data and evidence in scientific assessments*. *EFSA Journal* (Vol. 13). Retrieved from <http://doi.wiley.com/10.2903/j.efsa.2015.4121>
- Falk, J., Bronstein, L., Hanst, M., Drossel, B., & Koepl, H. (2019). Context in synthetic biology: Memory effects of environments with mono-molecular reactions. *The Journal of Chemical Physics*, *150*(2), 024106. <http://doi.org/10.1063/1.5053816>
- Finnan, S., Morrissey, J. P., O’Gara, F., & Boyd, E. F. (2004). Genome Diversity of *Pseudomonas aeruginosa* Isolates from Cystic Fibrosis Patients and the Hospital Environment. *Journal of Clinical Microbiology*, *42*(12), 5783–5792. <http://doi.org/10.1128/JCM.42.12.5783-5792.2004>
- Jupe, F., Rivkin, A. C., Michael, T. P., Zander, M., Motley, S. T., Sandoval, J. P., ... Ecker, J. R. (2019). The complex architecture and epigenomic impact of plant T-DNA insertions. *PLOS Genetics*, *15*(1), e1007819. <http://doi.org/10.1371/journal.pgen.1007819>
- Mainz, E. R., Wang, Q., Lawrence, D. S., & Allbritton, N. L. (2016). An Integrated Chemical Cytometry Method: Shining a Light on Akt Activity in Single Cells. *Angewandte Chemie International Edition*, *55*(42), 13095–13098. <http://doi.org/10.1002/anie.201606914>
- OECD. (2014). *Emerging Policy Issues in Synthetic Biology*. OECD. <http://doi.org/10.1787/9789264208421-en>
- Oye, K. A., Esvelt, K., Appleton, E., Catteruccia, F., Church, G., Kuiken, T., ... Collins, J. P. (2014). Regulating gene drives. *Science*, *345*(6197), 626–628. <http://doi.org/10.1126/science.1254287>
- Pandolfo, C. E., Presotto, A., Carbonell, F. T., Ureta, S., Poverene, M., & Cantamutto, M. (2018). Transgene escape and persistence in an agroecosystem: the case of glyphosate-resistant *Brassica rapa* L. in central Argentina. *Environmental Science and Pollution Research*, *25*(7), 6251–6264. <http://doi.org/10.1007/s11356-017-0726-3>
- Phelps, M. P., Seeb, L. W., & Seeb, J. E. (2019). Transforming ecology and conservation biology through genome editing. *Conservation Biology*. <http://doi.org/10.1111/cobi.13292>
- Simon, S., Otto, M., & Engelhard, M. (2018). Synthetic gene drive: between continuity and novelty. *EMBO Reports*, *19*(5), e45760. <http://doi.org/10.15252/embr.201845760>
- Vogel, J. H., Angerer, K., Muller, M. R., & Oduardo-Sierra, O. (2017). Bounded openness as the modality for the global multilateral benefit-sharing mechanism of the Nagoya Protocol. In *Routledge Handbook of Biodiversity and the Law* (pp. 377–394). Routledge. <http://doi.org/10.4324/9781315530857-26>
- Wahl, D. C. (2018). Sustainability is not Enough: We Need Regenerative Cultures – Resilience. Retrieved April 1, 2019, from <https://www.resilience.org/stories/2018-05-23/sustainability-is-not-enough-we-need-regenerative-cultures/>
- Wang, J., Zhang, Y., Xiang, F., Zhang, Z., & Li, L. (2010). Combining capillary electrophoresis matrix-assisted laser desorption/ionization mass spectrometry and stable isotopic labeling techniques for comparative crustacean peptidomics. *Journal of Chromatography A*, *1217*(26), 4463–4470. <http://doi.org/10.1016/j.chroma.2010.02.084>

Webber, B. L., Raghu, S., & Edwards, O. R. (2015). Opinion: Is CRISPR-based gene drive a biocontrol silver bullet or global conservation threat?: Fig. 1. *Proceedings of the National Academy of Sciences*, 112(34), 10565–10567. <http://doi.org/10.1073/pnas.1514258112>

Whitford, C. M., Lübke, N.-C., & Rückert, C. (2018). Synthetic Biology Ethics at iGEM: iGEMer Perspectives. *Trends in Biotechnology*, 36(10), 985–987. <http://doi.org/10.1016/j.tibtech.2018.06.004>

Website

-Science Across Virtual Institutes Synthetic Yeast Project <http://syntheticyeast.org/>

-Stanford University HIV Drug Resistance Database <https://hivdb.stanford.edu/>

-University of Maryland Antibiotic Resistance <https://arab.cbc.umd.edu/>

IV. ADDITIONAL REFERENCES ON SYNTEHTIC BIOLOGY FOR THE SUBSIDIARY BODY ON SCIENTIFIC, TECHNICAL AND TECHNOLOGICAL ADVICE

Bioelectronics and DNA data storage

Anavy, L., Vaknin, I., Atar, O., Amit, R., & Yakhini, Z. (2019). Data storage in DNA with fewer synthesis cycles using composite DNA letters. *Nature Biotechnology*, 37(10), 1229–1236. <https://doi.org/10.1038/s41587-019-0240-x>

Lee, H. H., Kalhor, R., Goela, N., Bolot, J., & Church, G. M. (2019). Terminator-free template-independent enzymatic DNA synthesis for digital information storage. *Nature Communications*, 10(1), 2383. <https://doi.org/10.1038/s41467-019-10258-1>

Logan, B. E., Rossi, R., Ragab, A., & Saikaly, P. E. (2019). Electroactive microorganisms in bioelectrochemical systems. *Nature Reviews Microbiology*, 17(5), 307–319. <https://doi.org/10.1038/s41579-019-0173-x>

Selberg, J., Gomez, M., & Rolandi, M. (2018). The Potential for Convergence between Synthetic Biology and Bioelectronics. *Cell Systems*, 7(3), 231–244. <https://doi.org/10.1016/j.cels.2018.08.007>

Service, R. (2018). New way to write DNA could turbocharge synthetic biology and data storage. *Science*. <https://doi.org/10.1126/science.aav6033>

Wu, S., Kim, E., Li, J., Bentley, W. E., Shi, X.-W., & Payne, G. F. (2019). Catechol-Based Capacitor for Redox-Linked Bioelectronics. *ACS Applied Electronic Materials*, 1(8), 1337–1347. <https://doi.org/10.1021/acsaelm.9b00272>

Zeng, J., Banerjee, A., Kim, J., Deng, Y., Chapman, T. W., Daniel, R., & Sarpeshkar, R. (2019). A Novel Bioelectronic Reporter System in Living Cells Tested with a Synthetic Biological Comparator. *Scientific Reports*, 9(1), 7275. <https://doi.org/10.1038/s41598-019-43771-w>

Biofoundries and automation

Carbonell, P., Radivojevic, T., & García Martín, H. (2019). Opportunities at the Intersection of Synthetic Biology, Machine Learning, and Automation. *ACS Synthetic Biology*, 8(7), 1474–1477. <https://doi.org/10.1021/acssynbio.8b00540>

Freemont, P. S. (2019). Synthetic biology industry: data-driven design is creating new opportunities in biotechnology. *Emerging Topics in Life Sciences*, 3(5), 651–657. <https://doi.org/10.1042/ETLS20190040>

Hillson, N., Caddick, M., Cai, Y., Carrasco, J. A., Chang, M. W., Curach, N. C., Bell, D. J., Le Feuvre, R., Friedman, D. C., Fu, X., Gold, N. D., Herrgård, M. J., Holowko, M. B., Johnson, J. R., Johnson, R. A., Keasling, J. D., Kitney, R. I., Kondo, A., Liu, C., ... Freemont, P. S. (2019). Building a global alliance of biofoundries. *Nature Communications*, 10(1), 2040. <https://doi.org/10.1038/s41467-019-10079-2>

Kim, H. (2019). AI, big data, and robots for the evolution of biotechnology. *Genomics & Informatics*, 17(4), e44. <https://doi.org/10.5808/GI.2019.17.4.e44>

Biomaterials and biocomposites

Bila, H., Kurisinkal, E. E., & Bastings, M. M. C. (2019). Engineering a stable future for DNA-origami as a biomaterial. *Biomaterials Science*, 7(2), 532–541. <https://doi.org/10.1039/C8BM01249K>

Cao, Y., Feng, Y., Ryser, M. D., Zhu, K., Herschlag, G., Cao, C., Marusak, K., Zauscher, S., & You, L. (2017). Programmable assembly of pressure sensors using pattern-forming bacteria. *Nature Biotechnology*, 35(11), 1087–1093. <https://doi.org/10.1038/nbt.3978>

Echavarri-Bravo, V., Eggington, I., & Horsfall, L. E. (2019). Synthetic biology for the development of bio-based binders for greener construction materials. *MRS Communications*, 9(02), 474–485. <https://doi.org/10.1557/mrc.2019.39>

González, L. M., Mukhitov, N., & Voigt, C. A. (2019). Resilient living materials built by printing bacterial spores. *Nature Chemical Biology*. <https://doi.org/10.1038/s41589-019-0412-5>

Heveran, C. M., Williams, S. L., Qiu, J., Artier, J., Hubler, M. H., Cook, S. M., Cameron, J. C., & Srubar, W. V. (2020). Biomineralization and Successive Regeneration of Engineered Living Building Materials. *Matter*. <https://doi.org/10.1016/j.matt.2019.11.016>

Koch, J., Gantenbein, S., Masania, K., Stark, W. J., Erlich, Y., & Grass, R. N. (2020). A DNA-of-things storage architecture to create materials with embedded memory. *Nature Biotechnology*, 38(1), 39–43. <https://doi.org/10.1038/s41587-019-0356-z>

Moser, F., Tham, E., González, L. M., Lu, T. K., & Voigt, C. A. (2019). Light- Controlled, High-Resolution Patterning of Living Engineered Bacteria Onto Textiles, Ceramics, and Plastic. *Advanced Functional Materials*, 29(30), 1901788. <https://doi.org/10.1002/adfm.201901788>

Rivera-Tarazona, L. K., Bhat, V. D., Kim, H., Campbell, Z. T., & Ware, T. H. (2020). Shape-morphing living composites. *Science Advances*, 6(3), eaax8582. <https://doi.org/10.1126/sciadv.aax8582>

Bioproduction and “cell factories”

Carbonell, P., Jervis, A. J., Robinson, C. J., Yan, C., Dunstan, M., Swainston, N., Vinaixa, M., Hollywood, K. A., Currin, A., Rattray, N. J. W., Taylor, S., Spiess, R., Sung, R., Williams, A. R., Fellows, D., Stanford, N. J., Mulherin, P., Le Feuvre, R., Barran, P., ... Scrutton, N. S. (2018). An

automated Design-Build-Test-Learn pipeline for enhanced microbial production of fine chemicals.

Communications Biology, 1(1), 66. <https://doi.org/10.1038/s42003-018-0076-9>

Diamos, A. G., Hunter, J. G. L., Pardhe, M. D., Rosenthal, S. H., Sun, H., Foster, B. C., DiPalma, M. P., Chen, Q., & Mason, H. S. (2020). High Level Production of Monoclonal Antibodies Using an Optimized Plant Expression System. *Frontiers in Bioengineering and Biotechnology*, 7.

<https://doi.org/10.3389/fbioe.2019.00472>

Gohil, N., Bhattacharjee, G., Khambhati, K., Braddick, D., & Singh, V. (2019). Engineering Strategies in Microorganisms for the Enhanced Production of Squalene: Advances, Challenges and Opportunities.

Frontiers in Bioengineering and Biotechnology, 7. <https://doi.org/10.3389/fbioe.2019.00050>

Guo, J., Suástegui, M., Sakimoto, K. K., Moody, V. M., Xiao, G., Nocera, D. G., & Joshi, N. S. (2018). Light-driven fine chemical production in yeast biohybrids. *Science*, 362(6416), 813–816.

<https://doi.org/10.1126/science.aat9777>

Julve Parreño, J. M., Huet, E., Fernández-del-Carmen, A., Segura, A., Venturi, M., Gandía, A., Pan, W., Albaladejo, I., Forment, J., Pla, D., Wigdorovitz, A., Calvete, J. J., Gutiérrez, C., Gutiérrez, J. M., Granell, A., & Orzáez, D. (2018). A synthetic biology approach for consistent production of plant-made recombinant polyclonal antibodies against snake venom toxins. *Plant Biotechnology Journal*, 16(3), 727–736.

<https://doi.org/10.1111/pbi.12823>

Kallscheuer, N., Classen, T., Drepper, T., & Marienhagen, J. (2019). Production of plant metabolites with applications in the food industry using engineered microorganisms. *Current Opinion in Biotechnology*, 56, 7–17.

<https://doi.org/10.1016/j.copbio.2018.07.008>

Kitaoka, N., Nomura, T., Ogita, S., & Kato, Y. (2020). Bioproduction of glucose conjugates of 4-hydroxybenzoic and vanillic acids using bamboo cells transformed to express bacterial 4-hydroxycinnamoyl-CoA hydratase/lyase. *Journal of Bioscience and Bioengineering*.

<https://doi.org/10.1016/j.jbiosc.2020.02.010>

Luo, X., Reiter, M. A., D’Espaux, L., Wong, J., Denby, C. M., Lechner, A., Zhang, Y., Grzybowski, A. T., Harth, S., Lin, W., Lee, H., Yu, C., Shin, J., Deng, K., Benites, V. T., Wang, G., Baidoo, E. E. K., Chen, Y., Dev, I., ... Keasling, J. D. (2019). Complete biosynthesis of cannabinoids and their unnatural analogues in yeast. *Nature*, 567(7746), 123–126. <https://doi.org/10.1038/s41586-019-0978-9>

Martins-Santana, L., Nora, L. C., Sanches-Medeiros, A., Lovate, G. L., Cassiano, M. H. A., & Silva-Rocha, R. (2018). Systems and Synthetic Biology Approaches to Engineer Fungi for Fine Chemical Production.

Frontiers in Bioengineering and Biotechnology, 6. <https://doi.org/10.3389/fbioe.2018.00117>

Massa, S., Paolini, F., Marino, C., Franconi, R., & Venuti, A. (2019). Bioproduction of a Therapeutic Vaccine Against Human Papillomavirus in Tomato Hairy Root Cultures. *Frontiers in Plant Science*, 10.

<https://doi.org/10.3389/fpls.2019.00452>

Napier, J. A., Olsen, R., & Tocher, D. R. (2019). Update on GM canola crops as novel sources of omega-3 fish oils. *Plant Biotechnology Journal*, 17(4), 703–705. <https://doi.org/10.1111/pbi.13045>

Nieto-Gómez, R., Angulo, C., Monreal-Escalante, E., Govea-Alonso, D. O., De Groot, A. S., & Rosales-Mendoza, S. (2019). Design of a multiepitopic Zaire ebolavirus protein and its expression in plant cells.

Journal of Biotechnology, 295, 41–48. <https://doi.org/10.1016/j.jbiotec.2019.02.003>

Wang, C., Liwei, M., Park, J.-B., Jeong, S.-H., Wei, G., Wang, Y., & Kim, S.-W. (2018). Microbial Platform for Terpenoid Production: *Escherichia coli* and Yeast. *Frontiers in Microbiology*, 9. <https://doi.org/10.3389/fmicb.2018.02460>

Yamamoto, T., Hoshikawa, K., Ezura, K., Okazawa, R., Fujita, S., Takaoka, M., Mason, H. S., Ezura, H., & Miura, K. (2018). Improvement of the transient expression system for production of recombinant proteins in plants. *Scientific Reports*, 8(1), 4755. <https://doi.org/10.1038/s41598-018-23024-y>

Cellular, metabolic and physiological engineering

Banerjee, S., & Mitra, D. (2020). Structural Basis of Design and Engineering for Advanced Plant Optogenetics. *Trends in Plant Science*, 25(1), 35–65. <https://doi.org/10.1016/j.tplants.2019.10.002>

Berhanu, S., Ueda, T., & Kuruma, Y. (2019). Artificial photosynthetic cell producing energy for protein synthesis. *Nature Communications*, 10(1), 1325. <https://doi.org/10.1038/s41467-019-09147-4>

Buchman, A., Gamez, S., Li, M., Antoshechkin, I., Li, H.-H., Wang, H.-W., Chen, C.-H., Klein, M. J., Duchemin, J.-B., Crowe, J. E., Paradkar, P. N., & Akbari, O. S. (2020). Broad dengue neutralization in mosquitoes expressing an engineered antibody. *PLOS Pathogens*, 16(1), e1008103. <https://doi.org/10.1371/journal.ppat.1008103>

Eseverri, Á., López- Torrejón, G., Jiang, X., Burén, S., Rubio, L. M., & Caro, E. (2020). Use of synthetic biology tools to optimize the production of active nitrogenase Fe protein in chloroplasts of tobacco leaf cells. *Plant Biotechnology Journal*, pbi.13347. <https://doi.org/10.1111/pbi.13347>

Fang, Y., Huang, F., Faulkner, M., Jiang, Q., Dykes, G. F., Yang, M., & Liu, L.-N. (2018). Engineering and Modulating Functional Cyanobacterial CO₂-Fixing Organelles. *Frontiers in Plant Science*, 9. <https://doi.org/10.3389/fpls.2018.00739>

García-Granados, R., Lerma-Escalera, J. A., & Morones-Ramírez, J. R. (2019). Metabolic Engineering and Synthetic Biology: Synergies, Future, and Challenges. *Frontiers in Bioengineering and Biotechnology*, 7. <https://doi.org/10.3389/fbioe.2019.00036>

Gleizer, S., Ben-Nissan, R., Bar-On, Y. M., Antonovsky, N., Noor, E., Zohar, Y., Jona, G., Krieger, E., Shamshoum, M., Bar-Even, A., & Milo, R. (2019). Conversion of *Escherichia coli* to Generate All Biomass Carbon from CO₂. *Cell*, 179(6), 1255-1263.e12. <https://doi.org/10.1016/j.cell.2019.11.009>

Goñi-Moreno, A., & Nikel, P. I. (2019). High-Performance Biocomputing in Synthetic Biology–Integrated Transcriptional and Metabolic Circuits. *Frontiers in Bioengineering and Biotechnology*, 7. <https://doi.org/10.3389/fbioe.2019.00040>

Lachaux, C., Frazao, C. J. R., Krauß, F., Morin, N., Walther, T., & François, J. M. (2019). A New Synthetic Pathway for the Bioproduction of Glycolic Acid From Lignocellulosic Sugars Aimed at Maximal Carbon Conservation. *Frontiers in Bioengineering and Biotechnology*, 7. <https://doi.org/10.3389/fbioe.2019.00359>

Liu, G., Gilding, E. K., Kerr, E. D., Schulz, B. L., Tabet, B., Hamaker, B. R., & Godwin, I. D. (2019). Increasing protein content and digestibility in sorghum grain with a synthetic biology approach. *Journal of Cereal Science*, 85, 27–34. <https://doi.org/10.1016/j.jcs.2018.11.001>

- Liu, Z., Zhang, J., Jin, J., Geng, Z., Qi, Q., & Liang, Q. (2018). Programming Bacteria With Light—Sensors and Applications in Synthetic Biology. *Frontiers in Microbiology*, 9. <https://doi.org/10.3389/fmicb.2018.02692>
- Lovett, B., Bilgo, E., Millogo, S. A., Ouattarra, A. K., Sare, I., Gnambani, E. J., Dabire, R. K., Diabate, A., & St. Leger, R. J. (2019). Transgenic *Metarhizium* rapidly kills mosquitoes in a malaria-endemic region of Burkina Faso. *Science*, 364(6443), 894–897. <https://doi.org/10.1126/science.aaw8737>
- Papanatsiou, M., Petersen, J., Henderson, L., Wang, Y., Christie, J. M., & Blatt, M. R. (2019). Optogenetic manipulation of stomatal kinetics improves carbon assimilation, water use, and growth. *Science*, 363(6434), 1456–1459. <https://doi.org/10.1126/science.aaw0046>
- Park, D. M., & Taffet, M. J. (2019). Combinatorial Sensor Design in *Caulobacter crescentus* for Selective Environmental Uranium Detection. *ACS Synthetic Biology*, acssynbio.8b00484. <https://doi.org/10.1021/acssynbio.8b00484>
- Santos-Merino, M., Singh, A. K., & Ducat, D. C. (2019). New Applications of Synthetic Biology Tools for Cyanobacterial Metabolic Engineering. *Frontiers in Bioengineering and Biotechnology*, 7. <https://doi.org/10.3389/fbioe.2019.00033>
- Shen, B.-R., Wang, L.-M., Lin, X.-L., Yao, Z., Xu, H.-W., Zhu, C.-H., Teng, H.-Y., Cui, L.-L., Liu, E.-E., Zhang, J.-J., He, Z.-H., & Peng, X.-X. (2019). Engineering a New Chloroplastic Photorespiratory Bypass to Increase Photosynthetic Efficiency and Productivity in Rice. *Molecular Plant*, 12(2), 199–214. <https://doi.org/10.1016/j.molp.2018.11.013>
- South, P. F., Cavanagh, A. P., Liu, H. W., & Ort, D. R. (2019). Synthetic glycolate metabolism pathways stimulate crop growth and productivity in the field. *Science*, 363(6422), eaat9077. <https://doi.org/10.1126/science.aat9077>
- VanArsdale, E., Tsao, C., Liu, Y., Chen, C., Payne, G. F., & Bentley, W. E. (2019). Redox-Based Synthetic Biology Enables Electrochemical Detection of the Herbicides Dicamba and Roundup via Rewired *Escherichia coli*. *ACS Sensors*, 4(5), 1180–1184. <https://doi.org/10.1021/acssensors.9b00085>
- Yang, J., Xie, X., Xiang, N., Tian, Z.-X., Dixon, R., & Wang, Y.-P. (2018). Polyprotein strategy for stoichiometric assembly of nitrogen fixation components for synthetic biology. *Proceedings of the National Academy of Sciences*, 115(36), E8509–E8517. <https://doi.org/10.1073/pnas.1804992115>

Engineered gene drives

- Backus, G. A., & Delborne, J. A. (2019). Threshold-Dependent Gene Drives in the Wild: Spread, Controllability, and Ecological Uncertainty. *BioScience*. <https://doi.org/10.1093/biosci/biz098>
- Baltzegar, J., Cavin Barnes, J., Elsensohn, J. E., Gutzmann, N., Jones, M. S., King, S., & Sudweeks, J. (2018). Anticipating complexity in the deployment of gene drive insects in agriculture. *Journal of Responsible Innovation*, 5(sup1), S81–S97. <https://doi.org/10.1080/23299460.2017.1407910>
- Barrett, L. G., Legros, M., Kumaran, N., Glassop, D., Raghu, S., & Gardiner, D. M. (2019). Gene drives in plants: opportunities and challenges for weed control and engineered resilience. *Proceedings of the Royal Society B: Biological Sciences*, 286(1911), 20191515. <https://doi.org/10.1098/rspb.2019.1515>

- Buchman, A. B., Ivy, T., Marshall, J. M., Akbari, O. S., & Hay, B. A. (2018). Engineered Reciprocal Chromosome Translocations Drive High Threshold, Reversible Population Replacement in *Drosophila*. *ACS Synthetic Biology*, 7(5), 1359–1370. <https://doi.org/10.1021/acssynbio.7b00451>
- Buchman, A., Marshall, J. M., Ostrovski, D., Yang, T., & Akbari, O. S. (2018). Synthetically engineered Medea gene drive system in the worldwide crop pest *Drosophila suzukii*. *Proceedings of the National Academy of Sciences*, 115(18), 4725–4730. <https://doi.org/10.1073/pnas.1713139115>
- Bull, J. J., Remien, C. H., & Krone, S. M. (2019). Gene-drive-mediated extinction is thwarted by population structure and evolution of sib mating. *Evolution, Medicine, and Public Health*, 2019(1), 66–81. <https://doi.org/10.1093/emph/eoz014>
- Bull, J. J., Remien, C. H., Gomulkiewicz, R., & Krone, S. M. (2019). Spatial structure undermines parasite suppression by gene drive cargo. *PeerJ*, 7, e7921. <https://doi.org/10.7717/peerj.7921>
- Champer, J., Chung, J., Lee, Y. L., Liu, C., Yang, E., Wen, Z., ... Messer, P. W. (2019). Molecular safeguarding of CRISPR gene drive experiments. *Elife*, 8. <https://doi.org/10.7554/eLife.41439>
- Champer, J., Lee, E., Yang, E., Liu, C., Clark, A. G., & Messer, P. W. (2020). A toxin-antidote CRISPR gene drive system for regional population modification. *Nature Communications*, 11(1), 1082. <https://doi.org/10.1038/s41467-020-14960-3>
- Champer, J., Liu, J., Oh, S. Y., Reeves, R., Luthra, A., Oakes, N., ... Messer, P. W. (2018). Reducing resistance allele formation in CRISPR gene drive. *Proceedings of the National Academy of Sciences*, 115(21), 5522–5527. <https://doi.org/10.1073/pnas.1720354115>
- Champer, J., Wen, Z., Luthra, A., Reeves, R., Chung, J., Liu, C., ... Clark, A. G. (2019). CRISPR Gene Drive Efficiency and Resistance Rate Is Highly Heritable with No Common Genetic Loci of Large Effect. *Genetics*, genetics.302037.2019. <https://doi.org/10.1534/genetics.119.302037>
- Champer, S. E., Oh, S. Y., Liu, C., Wen, Z., Clark, A. G., Messer, P. W., & Champer, J. (2020). Computational and experimental performance of CRISPR homing gene drive strategies with multiplexed gRNAs. *Science Advances*, 6(10), eaaz0525. <https://doi.org/10.1126/sciadv.aaz0525>
- Dhole, S., Vella, M. R., Lloyd, A. L., & Gould, F. (2018). Invasion and migration of spatially self-limiting gene drives: A comparative analysis. *Evolutionary Applications*, 11(5), 794–808. <https://doi.org/10.1111/eva.12583>
- Edgington, M. P., & Alphey, L. S. (2019). Modeling the mutation and reversal of engineered underdominance gene drives. *Journal of Theoretical Biology*, 479, 14–21. <https://doi.org/10.1016/j.jtbi.2019.06.024>
- Famakinde, D. O. (2020). Public health concerns over gene-drive mosquitoes: will future use of gene-drive snails for schistosomiasis control gain increased level of community acceptance? *Pathogens and Global Health*, 114(2), 55–63. <https://doi.org/10.1080/20477724.2020.1731667>
- Frieß, J. L., von Gleich, A., & Giese, B. (2019). Gene drives as a new quality in GMO releases—a comparative technology characterization. *PeerJ*, 7, e6793. <https://doi.org/10.7717/peerj.6793>

- Grunwald, H. A., Gantz, V. M., Poplawski, G., Xu, X.-R. S., Bier, E., & Cooper, K. L. (2019). Super-Mendelian inheritance mediated by CRISPR–Cas9 in the female mouse germline. *Nature*, *566*(7742), 105–109. <https://doi.org/10.1038/s41586-019-0875-2>
- Hammond, A. M., Kyrou, K., Bruttini, M., North, A., Galizi, R., Karlsson, X., ... Nolan, T. (2017). The creation and selection of mutations resistant to a gene drive over multiple generations in the malaria mosquito. *PLoS Genetics*, *13*(10), e1007039. <https://doi.org/10.1371/journal.pgen.1007039>
- Hayes, K. R., Hosack, G. R., Dana, G. V., Foster, S. D., Ford, J. H., Thresher, R., ... Dambacher, J. M. (2018). Identifying and detecting potentially adverse ecological outcomes associated with the release of gene-drive modified organisms. *Journal of Responsible Innovation*, *5*(sup1), S139–S158. <https://doi.org/10.1080/23299460.2017.1415585>
- Heffel, M. G., & Finnigan, G. C. (2019). Mathematical modeling of self-contained CRISPR gene drive reversal systems. *Scientific Reports*, *9*(1), 20050. <https://doi.org/10.1038/s41598-019-54805-8>
- Holman, L. (2019). Evolutionary simulations of Z-linked suppression gene drives. *Proceedings of the Royal Society B: Biological Sciences*, *286*(1912), 20191070. <https://doi.org/10.1098/rspb.2019.1070>
- James, S., Collins, F. H., Welkhoff, P. A., Emerson, C., J Godfray, H. C., Gottlieb, M., ... Toure, Y. T. (2018). Pathway to deployment of gene drive mosquitoes as a potential biocontrol tool for elimination of malaria in sub-Saharan Africa: Recommendations of a scientific working group. *American Journal of Tropical Medicine and Hygiene*, *98*(Suppl 6), 1–49. <https://doi.org/10.4269/ajtmh.18-0083>
- KaramiNejadRanjbar, M., Eckermann, K. N., Ahmed, H. M. M., Sánchez C., H. M., Dippel, S., Marshall, J. M., & Wimmer, E. A. (2018). Consequences of resistance evolution in a Cas9-based sex conversion-suppression gene drive for insect pest management. *Proceedings of the National Academy of Sciences*, *115*(24), 6189–6194. <https://doi.org/10.1073/pnas.1713825115>
- Kyrou, K., Hammond, A. M., Galizi, R., Kranjc, N., Burt, A., Beaghton, A. K., ... Crisanti, A. (2018). A CRISPR–Cas9 gene drive targeting doublesex causes complete population suppression in caged *Anopheles gambiae* mosquitoes. *Nature Biotechnology*, *36*(11), 1062–1066. <https://doi.org/10.1038/nbt.4245>
- Leftwich, P. T., Edgington, M. P., Harvey-Samuel, T., Carabajal Paladino, L. Z., Norman, V. C., & Alphey, L. (2018). Recent advances in threshold-dependent gene drives for mosquitoes. *Biochemical Society Transactions*, *46*(5), 1203–1212. <https://doi.org/10.1042/BST20180076>
- Leitschuh, C. M., Kanavy, D., Backus, G. A., Valdez, R. X., Serr, M., Pitts, E. A., ... Godwin, J. (2018). Developing gene drive technologies to eradicate invasive rodents from islands. *Journal of Responsible Innovation*, *5*(sup1), S121–S138. <https://doi.org/10.1080/23299460.2017.1365232>
- Li, M., Yang, T., Kandul, N. P., Bui, M., Gamez, S., Raban, R., ... Akbari, O. S. (2020). Development of a confinable gene drive system in the human disease vector *Aedes aegypti*. *Elife*, *9*. <https://doi.org/10.7554/eLife.51701>
- López Del Amo, V., Bishop, A. L., Sánchez C., H. M., Bennett, J. B., Feng, X., Marshall, J. M., ... Gantz, V. M. (2020). A transcomplementing gene drive provides a flexible platform for laboratory investigation and potential field deployment. *Nature Communications*, *11*(1), 352. <https://doi.org/10.1038/s41467-019-13977-7>

- Maier, T., Wheeler, N. J., Namigai, E. K. O., Tycko, J., Grewelle, R. E., Woldeamanuel, Y., ... Reinhard-Rupp, J. (2019). Gene drives for schistosomiasis transmission control. *PLOS Neglected Tropical Diseases*, 13(12), e0007833. <https://doi.org/10.1371/journal.pntd.0007833>
- Manser, A., Cornell, S. J., Sutter, A., Blondel, D. V., Serr, M., Godwin, J., & Price, T. A. R. (2019). Controlling invasive rodents via synthetic gene drive and the role of polyandry. *Proceedings of the Royal Society B: Biological Sciences*, 286(1909), 20190852. <https://doi.org/10.1098/rspb.2019.0852>
- Marshall, J. M., & Akbari, O. S. (2018). Can CRISPR-Based Gene Drive Be Confined in the Wild? A Question for Molecular and Population Biology. *ACS Chemical Biology*, 13(2), 424–430. <https://doi.org/10.1021/acscchembio.7b00923>
- Moro, D., Byrne, M., Kennedy, M., Campbell, S., & Tizard, M. (2018). Identifying knowledge gaps for gene drive research to control invasive animal species: The next CRISPR step. *Global Ecology and Conservation*, 13, e00363. <https://doi.org/10.1016/j.gecco.2017.e00363>
- Nash, A., Urdaneta, G. M., Beaghton, A. K., Hoermann, A., Papathanos, P. A., Christophides, G. K., & Windbichler, N. (2019). Integral gene drives for population replacement. *Biology Open*, 8(1), bio037762. <https://doi.org/10.1242/bio.037762>
- Neve, P. (2018). Gene drive systems: do they have a place in agricultural weed management? *Pest Management Science*, 74(12), 2671–2679. <https://doi.org/10.1002/ps.5137>
- Noble, C., Adlam, B., Church, G. M., Esvelt, K. M., & Nowak, M. A. (2018). Current CRISPR gene drive systems are likely to be highly invasive in wild populations. *Elife*, 7. <https://doi.org/10.7554/eLife.33423>
- Noble, C., Min, J., Olejarz, J., Buchthal, J., Chavez, A., Smidler, A. L., ... Esvelt, K. M. (2019). Daisy-chain gene drives for the alteration of local populations. *Proceedings of the National Academy of Sciences*, 201716358. <https://doi.org/10.1073/pnas.1716358116>
- Oberhofer, G., Ivy, T., & Hay, B. A. (2019). Cleave and Rescue, a novel selfish genetic element and general strategy for gene drive. *Proceedings of the National Academy of Sciences*, 116(13), 6250–6259. <https://doi.org/10.1073/pnas.1816928116>
- Oberhofer, G., Ivy, T., & Hay, B. A. (2018). Behavior of homing endonuclease gene drives targeting genes required for viability or female fertility with multiplexed guide RNAs. *Proceedings of the National Academy of Sciences*, 115(40), E9343–E9352. <https://doi.org/10.1073/pnas.1805278115>
- Prowse, T. A., Adikusuma, F., Cassey, P., Thomas, P., & Ross, J. V. (2019). A Y-chromosome shredding gene drive for controlling pest vertebrate populations. *Elife*, 8. <https://doi.org/10.7554/eLife.41873>
- Rode, N. O., Estoup, A., Bourguet, D., Courtier-Orgogozo, V., & Débarre, F. (2019). Population management using gene drive: molecular design, models of spread dynamics and assessment of ecological risks. *Conservation Genetics*, 20(4), 671–690. <https://doi.org/10.1007/s10592-019-01165-5>
- Schmidt, H., Collier, T. C., Hanemaaijer, M. J., Houston, P. D., Lee, Y., & Lanzaro, G. C. (2020). Abundance of conserved CRISPR-Cas9 target sites within the highly polymorphic genomes of *Anopheles* and *Aedes* mosquitoes. *Nature Communications*, 11(1), 1425. <https://doi.org/10.1038/s41467-020-15204-0>

Simon, S., Otto, M., & Engelhard, M. (2018). Synthetic gene drive: between continuity and novelty. *EMBO Reports*, 19(5), e45760. <https://doi.org/10.15252/embr.201845760>

Snow, A. A. (2019). Genetically Engineering Wild Mice to Combat Lyme Disease: An Ecological Perspective. *BioScience*, 69(9), 746–756. <https://doi.org/10.1093/biosci/biz080>

Then, C., Kawall, K., & Valenzuela, N. (2020). Spatio-temporal controllability and environmental risk assessment of genetically engineered gene drive organisms from the perspective of EU GMO Regulation. *Integrated Environmental Assessment and Management*. <https://doi.org/10.1002/ieam.4278>

Yan, Y., & Finnigan, G. C. (2018). Development of a multi-locus CRISPR gene drive system in budding yeast. *Scientific Reports*, 8(1), 17277. <https://doi.org/10.1038/s41598-018-34909-3>

Gene editing and new breeding techniques

Adikusuma, F., Piltz, S., Corbett, M. A., Turvey, M., McColl, S. R., Helbig, K. J., ... Thomas, P. Q. (2018). Large deletions induced by Cas9 cleavage. *Nature*, 560(7717), E8–E9. <https://doi.org/10.1038/s41586-018-0380-z>

Adli, M. (2018). The CRISPR tool kit for genome editing and beyond. *Nature Communications*, 9(1), 1911. <https://doi.org/10.1038/s41467-018-04252-2>

Akcakaya, P., Bobbin, M. L., Guo, J. A., Malagon-Lopez, J., Clement, K., Garcia, S. P., ... Joung, J. K. (2018). In vivo CRISPR editing with no detectable genome-wide off-target mutations. *Nature*, 561(7723), 416–419. <https://doi.org/10.1038/s41586-018-0500-9>

Anderson, K. R., Haeussler, M., Watanabe, C., Janakiraman, V., Lund, J., Modrusan, Z., ... Warming, S. (2018). CRISPR off-target analysis in genetically engineered rats and mice. *Nature Methods*, 15(7), 512–514. <https://doi.org/10.1038/s41592-018-0011-5>

Anzalone, A. V., Randolph, P. B., Davis, J. R., Sousa, A. A., Koblan, L. W., Levy, J. M., ... Liu, D. R. (2019). Search-and-replace genome editing without double-strand breaks or donor DNA. *Nature*, 576(7785), 149–157. <https://doi.org/10.1038/s41586-019-1711-4>

Barrangou, R., & Notebaart, R. A. (2019). CRISPR-Directed Microbiome Manipulation across the Food Supply Chain. *Trends in Microbiology*. <https://doi.org/10.1016/j.tim.2019.03.006>

Bewg, W. P., Ci, D., & Tsai, C.-J. (2018). Genome Editing in Trees: From Multiple Repair Pathways to Long-Term Stability. *Frontiers in Plant Science*, 9. <https://doi.org/10.3389/fpls.2018.01732>

Brackett, N., Riedy, J., Adli, M., Pomes, A., & Chapman, M. (2020). Gene Editing the Major Cat Allergen, Fel d 1, Using CRISPR-Cas9. *Journal of Allergy and Clinical Immunology*, 145(2), AB156. <https://doi.org/10.1016/j.jaci.2019.12.405>

Chen, J., Wang, W., Tian, Z., Dong, Y., Dong, T., Zhu, H., ... Hu, W. (2018). Efficient Gene Transfer and Gene Editing in Sterlet (*Acipenser ruthenus*). *Frontiers in Genetics*, 9. <https://doi.org/10.3389/fgene.2018.00117>

- Cleves, P. A., Strader, M. E., Bay, L. K., Pringle, J. R., & Matz, M. V. (2018). CRISPR/Cas9-mediated genome editing in a reef-building coral. *Proceedings of the National Academy of Sciences*, *115*(20), 5235–5240. <https://doi.org/10.1073/pnas.1722151115>
- Dolgin, E. (2020). The kill-switch for CRISPR that could make gene-editing safer. *Nature*, *577*(7790), 308–310. <https://doi.org/10.1038/d41586-020-00053-0>
- Enciso-Rodriguez, F., Manrique-Carpintero, N. C., Nadakuduti, S. S., Buell, C. R., Zarka, D., & Douches, D. (2019). Overcoming Self-Incompatibility in Diploid Potato Using CRISPR-Cas9. *Frontiers in Plant Science*, *10*. <https://doi.org/10.3389/fpls.2019.00376>
- Fister, A. S., Landherr, L., Maximova, S. N., & Guiltinan, M. J. (2018). Transient Expression of CRISPR/Cas9 Machinery Targeting TcNPR3 Enhances Defense Response in *Theobroma cacao*. *Frontiers in Plant Science*, *9*. <https://doi.org/10.3389/fpls.2018.00268>
- Greppi, C., Laursen, W. J., Budelli, G., Chang, E. C., Daniels, A. M., van Giesen, L., ... Garrity, P. A. (2020). Mosquito heat seeking is driven by an ancestral cooling receptor. *Science*, *367*(6478), 681–684. <https://doi.org/10.1126/science.aay9847>
- Grohmann, L., Keilwagen, J., Duensing, N., Dagand, E., Hartung, F., Wilhelm, R., ... Sprink, T. (2019). Detection and Identification of Genome Editing in Plants: Challenges and Opportunities. *Frontiers in Plant Science*, *10*. <https://doi.org/10.3389/fpls.2019.00236>
- Grünewald, J., Zhou, R., Garcia, S. P., Iyer, S., Lareau, C. A., Aryee, M. J., & Joung, J. K. (2019). Transcriptome-wide off-target RNA editing induced by CRISPR-guided DNA base editors. *Nature*. <https://doi.org/10.1038/s41586-019-1161-z>
- Grünewald, J., Zhou, R., Iyer, S., Lareau, C. A., Garcia, S. P., Aryee, M. J., & Joung, J. K. (2019). CRISPR DNA base editors with reduced RNA off-target and self-editing activities. *Nature Biotechnology*, *37*(9), 1041–1048. <https://doi.org/10.1038/s41587-019-0236-6>
- He, Y., Zhu, M., Wang, L., Wu, J., Wang, Q., Wang, R., & Zhao, Y. (2018). Programmed Self-Elimination of the CRISPR/Cas9 Construct Greatly Accelerates the Isolation of Edited and Transgene-Free Rice Plants. *Molecular Plant*, *11*(9), 1210–1213. <https://doi.org/10.1016/j.molp.2018.05.005>
- Hoffmann, M. D., Aschenbrenner, S., Grosse, S., Rapti, K., Domenger, C., Fakhiri, J., ... Niopek, D. (2019). Cell-specific CRISPR–Cas9 activation by microRNA-dependent expression of anti-CRISPR proteins. *Nucleic Acids Research*, *47*(13), e75–e75. <https://doi.org/10.1093/nar/gkz271>
- Iyer, V., Boroviak, K., Thomas, M., Doe, B., Riva, L., Ryder, E., & Adams, D. J. (2018). No unexpected CRISPR-Cas9 off-target activity revealed by trio sequencing of gene-edited mice. *PLOS Genetics*, *14*(7), e1007503. <https://doi.org/10.1371/journal.pgen.1007503>
- Jin, S., Zong, Y., Gao, Q., Zhu, Z., Wang, Y., Qin, P., ... Gao, C. (2019). Cytosine, but not adenine, base editors induce genome-wide off-target mutations in rice. *Science*, eaaw7166. <https://doi.org/10.1126/science.aaw7166>
- Kandul, N. P., Liu, J., Sanchez C., H. M., Wu, S. L., Marshall, J. M., & Akbari, O. S. (2019). Transforming insect population control with precision guided sterile males with demonstration in flies. *Nature Communications*, *10*(1), 84. <https://doi.org/10.1038/s41467-018-07964-7>

- Kannan, B., Jung, J. H., Moxley, G. W., Lee, S.-M., & Altpeter, F. (2018). TALEN-mediated targeted mutagenesis of more than 100 COMT copies/alleles in highly polyploid sugarcane improves saccharification efficiency without compromising biomass yield. *Plant Biotechnology Journal*, *16*(4), 856–866. <https://doi.org/10.1111/pbi.12833>
- Kazama, T., Okuno, M., Watari, Y., Yanase, S., Koizuka, C., Tsuruta, Y., ... Arimura, S. (2019). Curing cytoplasmic male sterility via TALEN-mediated mitochondrial genome editing. *Nature Plants*, *5*(7), 722–730. <https://doi.org/10.1038/s41477-019-0459-z>
- Kelliher, T., Starr, D., Su, X., Tang, G., Chen, Z., Carter, J., ... Que, Q. (2019). One-step genome editing of elite crop germplasm during haploid induction. *Nature Biotechnology*, *37*(3), 287–292. <https://doi.org/10.1038/s41587-019-0038-x>
- Kleinstiver, B. P., Sousa, A. A., Walton, R. T., Tak, Y. E., Hsu, J. Y., Clement, K., ... Joung, J. K. (2019). Engineered CRISPR–Cas12a variants with increased activities and improved targeting ranges for gene, epigenetic and base editing. *Nature Biotechnology*, *37*(3), 276–282. <https://doi.org/10.1038/s41587-018-0011-0>
- Kocak, D. D., Josephs, E. A., Bhandarkar, V., Adkar, S. S., Kwon, J. B., & Gersbach, C. A. (2019). Increasing the specificity of CRISPR systems with engineered RNA secondary structures. *Nature Biotechnology*. <https://doi.org/10.1038/s41587-019-0095-1>
- Konermann, S., Lotfy, P., Brideau, N. J., Oki, J., Shokhirev, M. N., & Hsu, P. D. (2018). Transcriptome Engineering with RNA-Targeting Type VI-D CRISPR Effectors. *Cell*, *173*(3), 665–676.e14. <https://doi.org/10.1016/j.cell.2018.02.033>
- Kosicki, M., Tomberg, K., & Bradley, A. (2018). Repair of double-strand breaks induced by CRISPR–Cas9 leads to large deletions and complex rearrangements. *Nature Biotechnology*. <https://doi.org/10.1038/nbt.4192>
- Lee, H., & Kim, J.-S. (2018). Unexpected CRISPR on-target effects. *Nature Biotechnology*. <https://doi.org/10.1038/nbt.4207>
- Lemmon, Z. H., Reem, N. T., Dalrymple, J., Soyk, S., Swartwood, K. E., Rodriguez-Leal, D., ... Lippman, Z. B. (2018). Rapid improvement of domestication traits in an orphan crop by genome editing. *Nature Plants*, *4*(10), 766–770. <https://doi.org/10.1038/s41477-018-0259-x>
- Li, C., Zhou, S., Li, Y., Li, G., Ding, Y., Li, L., ... Wang, X. (2018). Trio-Based Deep Sequencing Reveals a Low Incidence of Off-Target Mutations in the Offspring of Genetically Edited Goats. *Frontiers in Genetics*, *9*. <https://doi.org/10.3389/fgene.2018.00449>
- Li, S., Song, Z., Liu, C., Chen, X.-L., & Han, H. (2019). Biomimetic Mineralization-Based CRISPR/Cas9 Ribonucleoprotein Nanoparticles for Gene Editing. *ACS Applied Materials & Interfaces*, *11*(51), 47762–47770. <https://doi.org/10.1021/acsami.9b17598>
- Liang, Y., Jiao, S., Wang, M., Yu, H., & Shen, Z. (2020). A CRISPR/Cas9-based genome editing system for *Rhodococcus ruber* TH. *Metabolic Engineering*, *57*, 13–22. <https://doi.org/10.1016/j.ymben.2019.10.003>

- Liu, Z., Cai, Y., Liao, Z., Xu, Y., Wang, Y., Wang, Z., ... Sun, Q. (2019). Cloning of a gene-edited macaque monkey by somatic cell nuclear transfer. *National Science Review*, 6(1), 101–108. <https://doi.org/10.1093/nsr/nwz003>
- Ma, C., Zhu, C., Zheng, M., Liu, M., Zhang, D., Liu, B., ... Song, H. (2019). CRISPR/Cas9-mediated multiple gene editing in *Brassica oleracea* var. 64gricult using the endogenous tRNA-processing system. *Horticulture Research*, 6(1), 20. <https://doi.org/10.1038/s41438-018-0107-1>
- Macias, V. M., McKeand, S., Chaverra-Rodriguez, D., Hughes, G. L., Fazekas, A., Pujhari, S., ... Rasgon, J. L. (2020). Cas9-Mediated Gene-Editing in the Malaria Mosquito *Anopheles stephensi* by ReMOT Control. *G3: Genes/Genomes/Genetics*, g3.401133.2020. <https://doi.org/10.1534/g3.120.401133>
- Maher, M. F., Nasti, R. A., Vollbrecht, M., Starker, C. G., Clark, M. D., & Voytas, D. F. (2020). Plant gene editing through *de novo* induction of meristems. *Nature Biotechnology*, 38(1), 84–89. <https://doi.org/10.1038/s41587-019-0337-2>
- McFarlane, G. R., Salvesen, H. A., Sternberg, A., & Lillico, S. G. (2019). On-Farm Livestock Genome Editing Using Cutting Edge Reproductive Technologies. *Frontiers in Sustainable Food Systems*, 3. <https://doi.org/10.3389/fsufs.2019.00106>
- Mehta, D., Stürchler, A., Anjanappa, R. B., Zaidi, S. S.-A., Hirsch-Hoffmann, M., Gruissem, W., & Vanderschuren, H. (2019). Linking CRISPR-Cas9 interference in cassava to the evolution of editing-resistant geminiviruses. *Genome Biology*, 20(1), 80. <https://doi.org/10.1186/s13059-019-1678-3>
- Menchaca, A., dos Santos-Neto, P. C., Souza-Neves, M., Cuadro, F., Mulet, A. P., Tesson, L., ... Crispo, M. (2020). Otoferrin gene editing in sheep via CRISPR-assisted ssODN-mediated Homology Directed Repair. *Scientific Reports*, 10(1), 5995. <https://doi.org/10.1038/s41598-020-62879-y>
- Metje-Sprink, J., Menz, J., Modrzejewski, D., & Sprink, T. (2019). DNA-Free Genome Editing: Past, Present and Future. *Frontiers in Plant Science*, 9. <https://doi.org/10.3389/fpls.2018.01957>
- Mishra, R., Joshi, R. K., & Zhao, K. (2018). Genome Editing in Rice: Recent Advances, Challenges, and Future Implications. *Frontiers in Plant Science*, 9. <https://doi.org/10.3389/fpls.2018.01361>
- Nakamura, M., Srinivasan, P., Chavez, M., Carter, M. A., Dominguez, A. A., La Russa, M., ... Qi, L. S. (2019). Anti-CRISPR-mediated control of gene editing and synthetic circuits in eukaryotic cells. *Nature Communications*, 10(1), 194. <https://doi.org/10.1038/s41467-018-08158-x>
- Oliva, R., Ji, C., Atienza-Grande, G., Huguet-Tapia, J. C., Perez-Quintero, A., Li, T., ... Yang, B. (2019). Broad-spectrum resistance to bacterial blight in rice using genome editing. *Nature Biotechnology*, 37(11), 1344–1350. <https://doi.org/10.1038/s41587-019-0267-z>
- Phelps, M. P., Seeb, L. W., & Seeb, J. E. (2019). Transforming ecology and conservation biology through genome editing. *Conservation Biology*, cob1.13292. <https://doi.org/10.1111/cobi.13292>
- Raji, J. I., Melo, N., Castillo, J., Gonzalez, S., Saldana, V., Stensmyr, M., & DeGennaro, M. (2019). *Aedes Aegypti* Mosquitoes Detect Acidic Volatiles in Human Odor Using the IR8a Pathway. *Current Biology*, (29), 1–10. <https://doi.org/10.2139/ssrn.3280246>

- Sánchez-León, S., Gil-Humanes, J., Ozuna, C. V., Giménez, M. J., Sousa, C., Voytas, D. F., & Barro, F. (2018). Low-gluten, nontransgenic wheat engineered with CRISPR/Cas9. *Plant Biotechnology Journal*, 16(4), 902–910. <https://doi.org/10.1111/pbi.12837>
- Sharma, A. K., Nymark, M., Sparstad, T., Bones, A. M., & Winge, P. (2018). Transgene-free genome editing in marine algae by bacterial conjugation – comparison with biolistic CRISPR/Cas9 transformation. *Scientific Reports*, 8(1), 14401. <https://doi.org/10.1038/s41598-018-32342-0>
- Shen, M. W., Arbab, M., Hsu, J. Y., Worstell, D., Culbertson, S. J., Krabbe, O., ... Sherwood, R. I. (2018). Predictable and precise template-free CRISPR editing of pathogenic variants. *Nature*, 563(7733), 646–651. <https://doi.org/10.1038/s41586-018-0686-x>
- Si, X., Zhang, H., Wang, Y., Chen, K., & Gao, C. (2020). Manipulating gene translation in plants by CRISPR–Cas9-mediated genome editing of upstream open reading frames. *Nature Protocols*. <https://doi.org/10.1038/s41596-019-0238-3>
- Skryabin, B. V., Kummerfeld, D.-M., Gubar, L., Seeger, B., Kaiser, H., Stegemann, A., ... Rozhdestvensky, T. S. (2020). Pervasive head-to-tail insertions of DNA templates mask desired CRISPR–Cas9-mediated genome editing events. *Science Advances*, 6(7), eaax2941. <https://doi.org/10.1126/sciadv.aax2941>
- Straume, A. H., Kjærner-Semb, E., Ove Skaftnesmo, K., Güralp, H., Kleppe, L., Wargelius, A., & Edvardsen, R. B. (2020). Indel locations are determined by template polarity in highly efficient in vivo CRISPR/Cas9-mediated HDR in Atlantic salmon. *Scientific Reports*, 10(1), 409. <https://doi.org/10.1038/s41598-019-57295-w>
- Tang, J., Chen, L., & Liu, Y.-G. (2019). Off-target effects and the solution. *Nature Plants*, 5(4), 341–342. <https://doi.org/10.1038/s41477-019-0406-z>
- Thuronyi, B. W., Koblan, L. W., Levy, J. M., Yeh, W.-H., Zheng, C., Newby, G. A., ... Liu, D. R. (2019). Continuous evolution of base editors with expanded target compatibility and improved activity. *Nature Biotechnology*, 37(9), 1070–1079. <https://doi.org/10.1038/s41587-019-0193-0>
- Toda, E., Koiso, N., Takebayashi, A., Ichikawa, M., Kiba, T., Osakabe, K., ... Okamoto, T. (2019). An efficient DNA- and selectable-marker-free genome-editing system using zygotes in rice. *Nature Plants*, 5(4), 363–368. <https://doi.org/10.1038/s41477-019-0386-z>
- Vilarino, M., Suchy, F. P., Rashid, S. T., Lindsay, H., Reyes, J., McNabb, B. R., ... Ross, P. J. (2018). Mosaicism diminishes the value of pre-implantation embryo biopsies for detecting CRISPR/Cas9 induced mutations in sheep. *Transgenic Research*, 27(6), 525–537. <https://doi.org/10.1007/s11248-018-0094-x>
- Wang, G., Du, M., Wang, J., & Zhu, T. F. (2018). Genetic variation may confound analysis of CRISPR–Cas9 off-target mutations. *Cell Discovery*, 4(1), 18. <https://doi.org/10.1038/s41421-018-0025-2>
- Wang, S.-R., Wu, L.-Y., Huang, H.-Y., Xiong, W., Liu, J., Wei, L., ... Zhou, X. (2020). Conditional control of RNA-guided nucleic acid cleavage and gene editing. *Nature Communications*, 11(1), 91. <https://doi.org/10.1038/s41467-019-13765-3>
- Wang, X., Liu, J., Niu, Y., Li, Y., Zhou, S., Li, C., ... Chen, Y. (2018). Low incidence of SNVs and indels in trio genomes of Cas9-mediated multiplex edited sheep. *BMC Genomics*, 19(1), 397. <https://doi.org/10.1186/s12864-018-4712-z>

Xiao, B., Yin, S., Hu, Y., Sun, M., Wei, J., Huang, Z., ... Jiang, L. (2019). Epigenetic editing by CRISPR/dCas9 in *Plasmodium falciparum*. *Proceedings of the National Academy of Sciences*, 116(1), 255–260. <https://doi.org/10.1073/pnas.1813542116>

Young, A. E., Mansour, T. A., McNabb, B. R., Owen, J. R., Trott, J. F., Brown, C. T., & Van Eenennaam, A. L. (2019). Genomic and phenotypic analyses of six offspring of a genome-edited hornless bull. *Nature Biotechnology*. <https://doi.org/10.1038/s41587-019-0266-0>

Yu, H., Li, H., Li, Q., Xu, R., Yue, C., & Du, S. (2019). Targeted Gene Disruption in Pacific Oyster Based on CRISPR/Cas9 Ribonucleoprotein Complexes. *Marine Biotechnology*, 21(3), 301–309. <https://doi.org/10.1007/s10126-019-09885-y>

Zaidi, S. S.-A., Vanderschuren, H., Qaim, M., Mahfouz, M. M., Kohli, A., Mansoor, S., & Tester, M. (2019). New plant breeding technologies for food security. *Science*, 363(6434), 1390–1391. <https://doi.org/10.1126/science.aav6316>

Zhang, H., Si, X., Ji, X., Fan, R., Liu, J., Chen, K., ... Gao, C. (2018). Genome editing of upstream open reading frames enables translational control in plants. *Nature Biotechnology*, 36(9), 894–898. <https://doi.org/10.1038/nbt.4202>

Zhang, R., Liu, J., Chai, Z., Chen, S., Bai, Y., Zong, Y., ... Gao, C. (2019). Generation of herbicide tolerance traits and a new selectable marker in wheat using base editing. *Nature Plants*. <https://doi.org/10.1038/s41477-019-0405-0>

Zhang, Y., Wang, J., Wang, Z., Zhang, Y., Shi, S., Nielsen, J., & Liu, Z. (2019). A gRNA-tRNA array for CRISPR-Cas9 based rapid multiplexed genome editing in *Saccharomyces cerevisiae*. *Nature Communications*, 10(1), 1053. <https://doi.org/10.1038/s41467-019-09005-3>

Zsögön, A., Čermák, T., Naves, E. R., Notini, M. M., Edel, K. H., Weinl, S., ... Peres, L. E. P. (2018). De novo domestication of wild tomato using genome editing. *Nature Biotechnology*, 36(12), 1211–1216. <https://doi.org/10.1038/nbt.4272>

Zuo, E., Sun, Y., Wei, W., Yuan, T., Ying, W., Sun, H., ... Yang, H. (2019). Cytosine base editor generates substantial off-target single-nucleotide variants in mouse embryos. *Science*, eaav9973. <https://doi.org/10.1126/science.aav9973>

Genetic circuits and cell-free systems

Andres, J., Blomeier, T., & Zurbriggen, M. D. (2019). Synthetic Switches and Regulatory Circuits in Plants. *Plant Physiology*, 179(3), 862–884. <https://doi.org/10.1104/pp.18.01362>

Gao, X. J., Chong, L. S., Kim, M. S., & Elowitz, M. B. (2018). Programmable protein circuits in living cells. *Science*, 361(6408), 1252–1258. <https://doi.org/10.1126/science.aat5062>

Garenne, D., & Noireaux, V. (2019). Cell-free transcription–translation: engineering biology from the nanometer to the millimeter scale. *Current Opinion in Biotechnology*, 58, 19–27. <https://doi.org/10.1016/j.copbio.2018.10.007>

- Hasenjäger, S., Trauth, J., Hepp, S., Goenrich, J., Essen, L.-O., & Taxis, C. (2019). Optogenetic Downregulation of Protein Levels with an Ultrasensitive Switch. *ACS Synthetic Biology*, *acssynbio.8b00471*. <https://doi.org/10.1021/acssynbio.8b00471>
- Jiang, L., Zhao, J., Lian, J., & Xu, Z. (2018). Cell-free protein synthesis enabled rapid prototyping for metabolic engineering and synthetic biology. *Synthetic and Systems Biotechnology*, *3*(2), 90–96. <https://doi.org/10.1016/j.synbio.2018.02.003>
- Koch, M., Faulon, J.-L., & Borkowski, O. (2018). Models for Cell-Free Synthetic Biology: Make Prototyping Easier, Better, and Faster. *Frontiers in Bioengineering and Biotechnology*, *6*. <https://doi.org/10.3389/fbioe.2018.00182>
- Kopniczky, M. B., Canavan, C., McClymont, D. W., Crone, M. A., Suckling, L., Goetzmann, B., Siciliano, V., MacDonald, J. T., Jensen, K., & Freemont, P. S. (2020). Cell-Free Protein Synthesis as a Prototyping Platform for Mammalian Synthetic Biology. *ACS Synthetic Biology*, *9*(1), 144–156. <https://doi.org/10.1021/acssynbio.9b00437>
- Li, N., Cao, L., Miu, W., Cao, R., Peng, M., Wan, W., & Huang, L.-J. (2020). Molecular Rewiring of the Jasmonate Signaling Pathway to Control Auxin-Responsive Gene Expression. *Cells*, *9*(3), 641. <https://doi.org/10.3390/cells9030641>
- Libicher, K., Hornberger, R., Heymann, M., & Mutschler, H. (2020). In vitro self-replication and multicistronic expression of large synthetic genomes. *Nature Communications*, *11*(1), 904. <https://doi.org/10.1038/s41467-020-14694-2>
- Lv, Y., Qian, S., Du, G., Chen, J., Zhou, J., & Xu, P. (2019). Coupling feedback genetic circuits with growth phenotype for dynamic population control and intelligent bioproduction. *Metabolic Engineering*, *54*, 109–116. <https://doi.org/10.1016/j.ymben.2019.03.009>
- Marshall, R., Maxwell, C. S., Collins, S. P., Jacobsen, T., Luo, M. L., Begemann, M. B., Gray, B. N., January, E., Singer, A., He, Y., Beisel, C. L., & Noireaux, V. (2018). Rapid and Scalable Characterization of CRISPR Technologies Using an *E. coli* Cell-Free Transcription-Translation System. *Molecular Cell*, *69*(1), 146-157.e3. <https://doi.org/10.1016/j.molcel.2017.12.007>
- Martin, R. W., Des Soye, B. J., Kwon, Y.-C., Kay, J., Davis, R. G., Thomas, P. M., Majewska, N. I., Chen, C. X., Marcum, R. D., Weiss, M. G., Stoddart, A. E., Amiram, M., Ranji Charna, A. K., Patel, J. R., Isaacs, F. J., Kelleher, N. L., Hong, S. H., & Jewett, M. C. (2018). Cell-free protein synthesis from genomically recoded bacteria enables multisite incorporation of noncanonical amino acids. *Nature Communications*, *9*(1), 1203. <https://doi.org/10.1038/s41467-018-03469-5>
- Menon, G., & Krishnan, J. (2019). Design Principles for Compartmentalization and Spatial Organization of Synthetic Genetic Circuits. *ACS Synthetic Biology*, *8*(7), 1601–1619. <https://doi.org/10.1021/acssynbio.8b00522>
- Nakanishi, H., & Saito, H. (2020). Caliciviral protein-based artificial translational activator for mammalian gene circuits with RNA-only delivery. *Nature Communications*, *11*(1), 1297. <https://doi.org/10.1038/s41467-020-15061-x>
- Pandi, A., Grigoras, I., Borkowski, O., & Faulon, J.-L. (2019). Optimizing Cell-Free Biosensors to Monitor Enzymatic Production. *ACS Synthetic Biology*, *8*(8), 1952–1957. <https://doi.org/10.1021/acssynbio.9b00160>

- Soltani, M., Davis, B. R., Ford, H., Nelson, J. A. D., & Bundy, B. C. (2018). Reengineering cell-free protein synthesis as a biosensor: Biosensing with transcription, translation, and protein-folding. *Biochemical Engineering Journal*, 138, 165–171. <https://doi.org/10.1016/j.bej.2018.06.014>
- Swank, Z., Laohakunakorn, N., & Maerkl, S. J. (2019). Cell-free gene-regulatory network engineering with synthetic transcription factors. *Proceedings of the National Academy of Sciences*, 116(13), 5892–5901. <https://doi.org/10.1073/pnas.1816591116>
- Takahashi, M. K., Tan, X., Dy, A. J., Braff, D., Akana, R. T., Furuta, Y., Donghia, N., Ananthakrishnan, A., & Collins, J. J. (2018). A low-cost paper-based synthetic biology platform for analyzing gut microbiota and host biomarkers. *Nature Communications*, 9(1), 3347. <https://doi.org/10.1038/s41467-018-05864-4>
- Taketani, M., Zhang, J., Zhang, S., Triassi, A. J., Huang, Y.-J., Griffith, L. G., & Voigt, C. A. (2020). Genetic circuit design automation for the gut resident species *Bacteroides thetaiotaomicron*. *Nature Biotechnology*. <https://doi.org/10.1038/s41587-020-0468-5>
- Voyvodic, P. L., Pandi, A., Koch, M., Conejero, I., Valjent, E., Courtet, P., Renard, E., Faulon, J.-L., & Bonnet, J. (2019). Plug-and-play metabolic transducers expand the chemical detection space of cell-free biosensors. *Nature Communications*, 10(1), 1697. <https://doi.org/10.1038/s41467-019-09722-9>
- Wilding, K. M., Schinn, S.-M., Long, E. A., & Bundy, B. C. (2018). The emerging impact of cell-free chemical biosynthesis. *Current Opinion in Biotechnology*, 53, 115–121. <https://doi.org/10.1016/j.copbio.2017.12.019>
- Xie, M., & Fussenegger, M. (2018). Designing cell function: assembly of synthetic gene circuits for cell biology applications. *Nature Reviews Molecular Cell Biology*, 19(8), 507–525. <https://doi.org/10.1038/s41580-018-0024-z>
- Yousefi, H., Ali, M. M., Su, H.-M., Filipe, C. D. M., & Didar, T. F. (2018). Sentinel Wraps: Real-Time Monitoring of Food Contamination by Printing DNzyme Probes on Food Packaging. *ACS Nano*, 12(4), 3287–3294. <https://doi.org/10.1021/acs.nano.7b08010>

Genomic re-coding and engineering

- Blazejewski, T., Ho, H.-I., & Wang, H. H. (2019). Synthetic sequence entanglement augments stability and containment of genetic information in cells. *Science*, 365(6453), 595–598. <https://doi.org/10.1126/science.aav5477>
- Diwo, C., & Budisa, N. (2018). Alternative Biochemistries for Alien Life: Basic Concepts and Requirements for the Design of a Robust Biocontainment System in Genetic Isolation. *Genes*, 10(1), 17. <https://doi.org/10.3390/genes10010017>
- Fischer, E. C., Hashimoto, K., Zhang, Y., Feldman, A. W., Dien, V. T., Karadeema, R. J., ... Romesberg, F. E. (2020). New codons for efficient production of unnatural proteins in a semisynthetic organism. *Nature Chemical Biology*. <https://doi.org/10.1038/s41589-020-0507-z>
- Hoshika, S., Leal, N. A., Kim, M.-J., Kim, M.-S., Karalkar, N. B., Kim, H.-J., Bates, A. M., Watkins, N. E., SantaLucia, H. A., Meyer, A. J., DasGupta, S., Piccirilli, J. A., Ellington, A. D., SantaLucia, J.,

- Georgiadis, M. M., & Benner, S. A. (2019). Hachimoji DNA and RNA: A genetic system with eight building blocks. *Science*, 363(6429), 884–887. <https://doi.org/10.1126/science.aat0971>
- Lee, J. W., Chan, C. T. Y., Slomovic, S., & Collins, J. J. (2018). Next-generation biocontainment systems for engineered organisms. *Nature Chemical Biology*, 14(6), 530–537. <https://doi.org/10.1038/s41589-018-0056-x>
- Lee, J., Schwieter, K. E., Watkins, A. M., Kim, D. S., Yu, H., Schwarz, K. J., Lim, J., Coronado, J., Byrom, M., Anslyn, E. V., Ellington, A. D., Moore, J. S., & Jewett, M. C. (2019). Expanding the limits of the second genetic code with ribozymes. *Nature Communications*, 10(1), 5097. <https://doi.org/10.1038/s41467-019-12916-w>
- Nieto-Dominguez, M., & Nikel, P. I. (2020). Intersecting xenobiology and neo-metabolism to bring novel chemistries to life. *ChemBioChem*. <https://doi.org/10.1002/cbic.202000091>
- Shao, Y., Lu, N., Wu, Z., Cai, C., Wang, S., Zhang, L.-L., Zhou, F., Xiao, S., Liu, L., Zeng, X., Zheng, H., Yang, C., Zhao, Z., Zhao, G., Zhou, J.-Q., Xue, X., & Qin, Z. (2018). Creating a functional single-chromosome yeast. *Nature*, 560(7718), 331–335. <https://doi.org/10.1038/s41586-018-0382-x>
- Tang, W., & Liu, D. R. (2018). Rewritable multi-event analog recording in bacterial and mammalian cells. *Science*, 360(6385), eaap8992. <https://doi.org/10.1126/science.aap8992>
- Venez, J. E., Del Medico, L., Wölflle, A., Schächle, P., Bucher, Y., Appert, D., Tschan, F., Flores-Tinoco, C. E., van Kooten, M., Guennoun, R., Deutsch, S., Christen, M., & Christen, B. (2019). Chemical synthesis rewriting of a bacterial genome to achieve design flexibility and biological functionality. *Proceedings of the National Academy of Sciences*, 116(16), 8070–8079. <https://doi.org/10.1073/pnas.1818259116>
- Wang, C., Liu, Q., Shen, Y., Hua, Y., Wang, J., Lin, J., Wu, M., Sun, T., Cheng, Z., Mercier, R., & Wang, K. (2019). Clonal seeds from hybrid rice by simultaneous genome engineering of meiosis and fertilization genes. *Nature Biotechnology*, 37(3), 283–286. <https://doi.org/10.1038/s41587-018-0003-0>
- Wang, K., de la Torre, D., Robertson, W. E., & Chin, J. W. (2019). Programmed chromosome fission and fusion enable precise large-scale genome rearrangement and assembly. *Science*, 365(6456), 922–926. <https://doi.org/10.1126/science.aay0737>
- Wannier, T. M., Kunjapur, A. M., Rice, D. P., McDonald, M. J., Desai, M. M., & Church, G. M. (2018). Adaptive evolution of genomically recoded *Escherichia coli*. *Proceedings of the National Academy of Sciences*, 115(12), 3090–3095. <https://doi.org/10.1073/pnas.1715530115>
- Zhou, Y., Sun, T., Chen, Z., Song, X., Chen, L., & Zhang, W. (2019). Development of a New Biocontainment Strategy in Model Cyanobacterium *Synechococcus* Strains. *ACS Synthetic Biology*, 8(11), 2576–2584. <https://doi.org/10.1021/acssynbio.9b00282>

Minimal cells, molecular chassis and artificial cells

- Bhattacharya, A., Brea, R. J., Niederholtmeyer, H., & Devaraj, N. K. (2019). A minimal biochemical route towards *de novo* formation of synthetic phospholipid membranes. *Nature Communications*, 10(1), 300. <https://doi.org/10.1038/s41467-018-08174-x>

Bhattacharya, A., Brea, R. J., Song, J.-J., Bhattacharya, R., Sinha, S. K., & Devaraj, N. K. (2019). Single-Chain β -d-Glycopyranosylamides of Unsaturated Fatty Acids: Self-Assembly Properties and Applications to Artificial Cell Development. *The Journal of Physical Chemistry B*, 123(17), 3711–3720.

<https://doi.org/10.1021/acs.jpccb.9b01055>

Breuer, M., Earnest, T. M., Merryman, C., Wise, K. S., Sun, L., Lynott, M. R., Hutchison, C. A., Smith, H. O., Lapek, J. D., Gonzalez, D. J., de Crécy-Lagard, V., Haas, D., Hanson, A. D., Labhsetwar, P., Glass, J. I., & Luthey-Schulten, Z. (2019). Essential metabolism for a minimal cell. *Elife*, 8.

<https://doi.org/10.7554/eLife.36842>

Butterfield, G. L., Lajoie, M. J., Gustafson, H. H., Sellers, D. L., Nattermann, U., Ellis, D., Bale, J. B., Ke, S., Lenz, G. H., Yehdego, A., Ravichandran, R., Pun, S. H., King, N. P., & Baker, D. (2017). Evolution of a designed protein assembly encapsulating its own RNA genome. *Nature*, 552(7685), 415–420. <https://doi.org/10.1038/nature25157>

Choe, D., Lee, J. H., Yoo, M., Hwang, S., Sung, B. H., Cho, S., Palsson, B., Kim, S. C., & Cho, B.-K. (2019). Adaptive laboratory evolution of a genome-reduced *Escherichia coli*. *Nature Communications*, 10(1), 935. <https://doi.org/10.1038/s41467-019-08888-6>

Crozet, P., Navarro, F. J., Willmund, F., Mehrshahi, P., Bakowski, K., Lauersen, K. J., Pérez-Pérez, M.-E., Auroy, P., Gorchs Rovira, A., Sauret-Gueto, S., Niemeyer, J., Spaniol, B., Theis, J., Trösch, R., Westrich, L.-D., Vavitsas, K., Baier, T., Hübner, W., de Carpentier, F., ... Lemaire, S. D. (2018). Birth of a Photosynthetic Chassis: A MoClo Toolkit Enabling Synthetic Biology in the Microalga *Chlamydomonas reinhardtii*. *ACS Synthetic Biology*, 7(9), 2074–2086.

<https://doi.org/10.1021/acssynbio.8b00251>

Fan, C., Davison, P. A., Habgood, R., Zeng, H., Decker, C. M., Gesell Salazar, M., ... Huang, W. E. (2020). Chromosome-free bacterial cells are safe and programmable platforms for synthetic biology. *Proceedings of the National Academy of Sciences*, 117(12), 6752–6761.

<https://doi.org/10.1073/pnas.1918859117>

Garenne, D., Libchaber, A., & Noireaux, V. (2020). Membrane molecular crowding enhances MreB polymerization to shape synthetic cells from spheres to rods. *Proceedings of the National Academy of Sciences*, 201914656. <https://doi.org/10.1073/pnas.1914656117>

Godino, E., López, J. N., Foschepoth, D., Cleij, C., Doerr, A., Castellà, C. F., & Danelon, C. (2019). *De novo* synthesized Min proteins drive oscillatory liposome deformation and regulate FtsA-FtsZ cytoskeletal patterns. *Nature Communications*, 10(1), 4969. <https://doi.org/10.1038/s41467-019-12932-w>

Kim, H. J., Jeong, H., & Lee, S. J. (2018). Synthetic biology for microbial heavy metal biosensors. *Analytical and Bioanalytical Chemistry*, 410(4), 1191–1203. <https://doi.org/10.1007/s00216-017-0751-6>

Kong, Z., Hart, M., & Liu, H. (2018). Paving the Way From the Lab to the Field: Using Synthetic Microbial Consortia to Produce High-Quality Crops. *Frontiers in Plant Science*, 9. <https://doi.org/10.3389/fpls.2018.01467>

Kriegman, S., Blackiston, D., Levin, M., & Bongard, J. (2020). A scalable pipeline for designing reconfigurable organisms. *Proceedings of the National Academy of Sciences*, 201910837. <https://doi.org/10.1073/pnas.1910837117>

- McCarty, N. S., & Ledesma-Amaro, R. (2019). Synthetic Biology Tools to Engineer Microbial Communities for Biotechnology. *Trends in Biotechnology*, 37(2), 181–197. <https://doi.org/10.1016/j.tibtech.2018.11.002>
- Niederholtmeyer, H., Chaggan, C., & Devaraj, N. K. (2018). Communication and quorum sensing in non-living mimics of eukaryotic cells. *Nature Communications*, 9(1), 5027. <https://doi.org/10.1038/s41467-018-07473-7>
- Pols, T., Sikkema, H. R., Gaastra, B. F., Frallicciardi, J., Śmigiel, W. M., Singh, S., & Poolman, B. (2019). A synthetic metabolic network for physicochemical homeostasis. *Nature Communications*, 10(1), 4239. <https://doi.org/10.1038/s41467-019-12287-2>
- Rampioni, G., D'Angelo, F., Leoni, L., & Stano, P. (2019). Gene-Expressing Liposomes as Synthetic Cells for Molecular Communication Studies. *Frontiers in Bioengineering and Biotechnology*, 7. <https://doi.org/10.3389/fbioe.2019.00001>
- Szymanski, E., & Calvert, J. (2018). Designing with living systems in the synthetic yeast project. *Nature Communications*, 9(1), 2950. <https://doi.org/10.1038/s41467-018-05332-z>
- Tang, Q., Lu, T., & Liu, S.-J. (2018). Developing a Synthetic Biology Toolkit for *Comamonas* 71griculture71, an Emerging Cellular Chassis for Bioremediation. *ACS Synthetic Biology*, 7(7), 1753–1762. <https://doi.org/10.1021/acssynbio.7b00430>
- van Nies, P., Westerlaken, I., Blanken, D., Salas, M., Mencía, M., & Danelon, C. (2018). Self-replication of DNA by its encoded proteins in liposome-based synthetic cells. *Nature Communications*, 9(1), 1583. <https://doi.org/10.1038/s41467-018-03926-1>
- van Nies, P., Westerlaken, I., Blanken, D., Salas, M., Mencía, M., & Danelon, C. (2018). Self-replication of DNA by its encoded proteins in liposome-based synthetic cells. *Nature Communications*, 9(1), 1583. <https://doi.org/10.1038/s41467-018-03926-1>
- Wang, X., Tian, L., Du, H., Li, M., Mu, W., Drinkwater, B. W., Han, X., & Mann, S. (2019). Chemical communication in spatially organized protocell colonies and protocell/living cell micro-arrays. *Chemical Science*, 10(41), 9446–9453. <https://doi.org/10.1039/C9SC04522H>
- Yue, K., Zhu, Y., & Kai, L. (2019). Cell-Free Protein Synthesis: Chassis toward the Minimal Cell. *Cells*, 8(4), 315. <https://doi.org/10.3390/cells8040315>
- Zhang, Y., Ptacin, J. L., Fischer, E. C., Aerni, H. R., Caffaro, C. E., San Jose, K., Feldman, A. W., Turner, C. R., & Romesberg, F. E. (2017). A semi-synthetic organism that stores and retrieves increased genetic information. *Nature*, 551(7682), 644–647. <https://doi.org/10.1038/nature24659>
- Nanotechnology**
- Demirer, G., Zhang, H., Goh, N., Chang, R., & Landry, M. (2019). Nanotubes Effectively Deliver siRNA to Intact Plant Cells and Protect siRNA Against Nuclease Degradation. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3352632>
- Kim, J., & Franco, E. (2020). RNA nanotechnology in synthetic biology. *Current Opinion in Biotechnology*, 63, 135–141. <https://doi.org/10.1016/j.copbio.2019.12.016>

- Landry, M. P., & Mitter, N. (2019). How nanocarriers delivering cargos in plants can change the GMO landscape. *Nature Nanotechnology*, *14*(6), 512–514. <https://doi.org/10.1038/s41565-019-0463-5>
- Li, S., Song, Z., Liu, C., Chen, X.-L., & Han, H. (2019). Biomimetic Mineralization-Based CRISPR/Cas9 Ribonucleoprotein Nanoparticles for Gene Editing. *ACS Applied Materials & Interfaces*, *11*(51), 47762–47770. <https://doi.org/10.1021/acsami.9b17598>
- Liu, C., Wan, T., Wang, H., Zhang, S., Ping, Y., & Cheng, Y. (2019). A boronic acid-rich dendrimer with robust and unprecedented efficiency for cytosolic protein delivery and CRISPR-Cas9 gene editing. *Science Advances*, *5*(6), eaaw8922. <https://doi.org/10.1126/sciadv.aaw8922>
- Lombi, E., Donner, E., Dusinska, M., & Wickson, F. (2019). A One Health approach to managing the applications and implications of nanotechnologies in agriculture. *Nature Nanotechnology*, *14*(6), 523–531. <https://doi.org/10.1038/s41565-019-0460-8>
- Mohamed, M. A., & Abd-Elsalam, K. A. (2019). Magnetic Nanoparticles: A Unique Gene Delivery System in Plant Science. In K. A. Abd-Elsalam, M. A. Mohamed, & R. Prasad (Eds.), *Nanotechnology in Life Sciences* (pp. 95–108). Springer, Cham. https://doi.org/10.1007/978-3-030-16439-3_6
- Rui, Y., Wilson, D. R., & Green, J. J. (2019). Non-Viral Delivery To Enable Genome Editing. *Trends in Biotechnology*, *37*(3), 281–293. <https://doi.org/10.1016/j.tibtech.2018.08.010>

RNA interference

- Buchman, A., Gamez, S., Li, M., Antoshechkin, I., Li, H.-H., Wang, H.-W., ... Akbari, O. S. (2019). Engineered resistance to Zika virus in transgenic *Aedes aegypti* expressing a polycistronic cluster of synthetic small RNAs. *Proceedings of the National Academy of Sciences*, *116*(9), 3656–3661. <https://doi.org/10.1073/pnas.1810771116>
- Cai, Q., He, B., Kogel, K.-H., & Jin, H. (2018). Cross-kingdom RNA trafficking and environmental RNAi — nature's blueprint for modern crop protection strategies. *Current Opinion in Microbiology*, *46*, 58–64. <https://doi.org/10.1016/j.mib.2018.02.003>
- Callahan, A. M., Dardick, C. D., & Scorza, R. (2019). Multilocation comparison of fruit composition for 'HoneySweet', an RNAi based plum pox virus resistant plum. *PLOS ONE*, *14*(3), e0213993. <https://doi.org/10.1371/journal.pone.0213993>
- Christiaens, O., Dzhambazova, T., Kostov, K., Arpaia, S., Joga, M. R., Urru, I., ... Smagghe, G. (2018). Literature review of baseline information on RNAi to support the environmental risk assessment of RNAi- based GM plants. *EFSA Supporting Publications*, *15*(5). <https://doi.org/10.2903/sp.efsa.2018.EN-1424>
- Dalakouras, A., Jarausch, W., Buchholz, G., Bassler, A., Braun, M., Manthey, T., ... Wassenegger, M. (2018). Delivery of Hairpin RNAs and Small RNAs Into Woody and Herbaceous Plants by Trunk Injection and Petiole Absorption. *Frontiers in Plant Science*, *9*. <https://doi.org/10.3389/fpls.2018.01253>
- Dalakouras, A., Wassenegger, M., Dadami, E., Ganopoulos, I., Pappas, M. L., & Papadopoulou, K. (2020). Genetically Modified Organism-Free RNA Interference: Exogenous Application of RNA Molecules in Plants. *Plant Physiology*, *182*(1), 38–50. <https://doi.org/10.1104/pp.19.00570>

- Ding, B., Niu, J., Shang, F., Yang, L., Zhang, W., Smagghe, G., & Wang, J. (2020). Parental silencing of a horizontally transferred carotenoid desaturase gene causes a reduction of red pigment and fitness in the pea aphid. *Pest Management Science*, ps.5783. <https://doi.org/10.1002/ps.5783>
- Dubrovina, A., Aleynova, O., Kalachev, A., Suprun, A., Ogneva, Z., & Kiselev, K. (2019). Induction of Transgene Suppression in Plants via External Application of Synthetic dsRNA. *International Journal of Molecular Sciences*, 20(7), 1585. <https://doi.org/10.3390/ijms20071585>
- Goodfellow, S., Zhang, D., Wang, M.-B., & Zhang, R. (2019). Bacterium-Mediated RNA Interference: Potential Application in Plant Protection. *Plants*, 8(12), 572. <https://doi.org/10.3390/plants8120572>
- Haller, S., Widmer, F., Siegfried, B. D., Zhuo, X., & Romeis, J. (2019). Responses of two ladybird beetle species (Coleoptera: Coccinellidae) to dietary RNAi. *Pest Management Science*, ps.5370. <https://doi.org/10.1002/ps.5370>
- Heinemann, J. A. (2019). Should dsRNA treatments applied in outdoor environments be regulated? *Environment International*, 132, 104856. <https://doi.org/10.1016/j.envint.2019.05.050>
- Hu, J., Li, S., Li, Z., Li, H., Song, W., Zhao, H., ... Zhang, Y. (2019). A barley stripe mosaic virus- based guide RNA delivery system for targeted mutagenesis in wheat and maize. *Molecular Plant Pathology*, 20(10), 1463–1474. <https://doi.org/10.1111/mpp.12849>
- Koch, A., Höfle, L., Werner, B. T., Imani, J., Schmidt, A., Jelonek, L., & Kogel, K. (2019). SIGS vs HIGS: a study on the efficacy of two dsRNA delivery strategies to silence Fusarium FgCYP51 genes in infected host and non- host plants. *Molecular Plant Pathology*, 20(12), 1636–1644. <https://doi.org/10.1111/mpp.12866>
- Leonard, S. P., Powell, J. E., Perutka, J., Geng, P., Heckmann, L. C., Horak, R. D., ... Moran, N. A. (2020). Engineered symbionts activate honey bee immunity and limit pathogens. *Science*, 367(6477), 573–576. <https://doi.org/10.1126/science.aax9039>
- Niehl, A., Soininen, M., Poranen, M. M., & Heinlein, M. (2018). Synthetic biology approach for plant protection using dsRNA. *Plant Biotechnology Journal*, 16(9), 1679–1687. <https://doi.org/10.1111/pbi.12904>
- Parker, K. M., Barragán Borrero, V., Van Leeuwen, D. M., Lever, M. A., Mateescu, B., & Sander, M. (2019). Environmental Fate of RNA Interference Pesticides: Adsorption and Degradation of Double-Stranded RNA Molecules in Agricultural Soils. *Environmental Science and Technology*, 53(6), 3027–3036. <https://doi.org/10.1021/acs.est.8b05576>
- Worrall, E. A., Bravo-Cazar, A., Nilon, A. T., Fletcher, S. J., Robinson, K. E., Carr, J. P., & Mitter, N. (2019). Exogenous Application of RNAi-Inducing Double-Stranded RNA Inhibits Aphid-Mediated Transmission of a Plant Virus. *Frontiers in Plant Science*, 10. <https://doi.org/10.3389/fpls.2019.00265>
- Yang, D., Xu, X., Zhao, H., Yang, S., Wang, X., Zhao, D., ... Hou, C. (2018). Diverse Factors Affecting Efficiency of RNAi in Honey Bee Viruses. *Frontiers in Genetics*, 9. <https://doi.org/10.3389/fgene.2018.00384>
- Zheng, Y., Hu, Y., Yan, S., Zhou, H., Song, D., Yin, M., & Shen, J. (2019). A polymer/detergent formulation improves dsRNA penetration through the body wall and RNAi- induced mortality in the

soybean aphid *Aphis glycines*. *Pest Management Science*, 75(7), 1993–1999.
<https://doi.org/10.1002/ps.5313>

Safety and Security

Ahteensuu, M. (2017). Synthetic Biology, Genome Editing, and the Risk of Bioterrorism. *Science and Engineering Ethics*, 23(6), 1541–1561. <https://doi.org/10.1007/s11948-016-9868-9>

Diggans, J., & Leproust, E. (2019). Next Steps for Access to Safe, Secure DNA Synthesis. *Frontiers in Bioengineering and Biotechnology*. <https://doi.org/10.3389/fbioe.2019.00086>

Edwards, B. (2019). Synthetic Biology as a Techno-Scientific Field of Security Concern. In *Insecurity and Emerging Biotechnology* (pp. 35–50). Springer International Publishing. https://doi.org/10.1007/978-3-030-02188-7_3

Edwards, B. (2019). Synthetic Biology and the Dilemmas of Innovation Governance. In *Insecurity and Emerging Biotechnology* (pp. 65–77). Springer International Publishing. https://doi.org/10.1007/978-3-030-02188-7_5

Gronvall, G. K. (2019). Synthetic Biology: Biosecurity and Biosafety Implications. In *Defense Against Biological Attacks* (pp. 225–232). Springer International Publishing. https://doi.org/10.1007/978-3-030-03053-7_11

Kupferschmidt, K. (2018). Crop-protecting insects could be turned into bioweapons, critics warn. *Science*. <https://doi.org/10.1126/science.aav6274>

Lowe, C. (2019). Biotechnological innovation, non-obvious warfare and challenges to international law. In *Routledge Handbook of War, Law and Technology* (pp. 201–214). Routledge.

Mueller, S. (2019). Are Market GM Plants an Unrecognized Platform for Bioterrorism and Biocrime? *Frontiers in Bioengineering and Biotechnology*, 7. <https://doi.org/10.3389/fbioe.2019.00121>

Murashov, V., Howard, J., & Schulte, P. (2020). *Synthetic Biology Industry: Biosafety Risks to Workers* (pp. 165–182). https://doi.org/10.1007/978-3-030-27264-7_8

Reeves, R. G., Voeneky, S., Caetano-Anollés, D., Beck, F., & Boëte, C. (2018). Agricultural research, or a new bioweapon system? *Science*, 362(6410), 35–37. <https://doi.org/10.1126/science.aat7664>

Schabacker, D. S., Levy, L.-A., Evans, N. J., Fowler, J. M., & Dickey, E. A. (2019). Assessing Cyberbiosecurity Vulnerabilities and Infrastructure Resilience. *Frontiers in Bioengineering and Biotechnology*, 7. <https://doi.org/10.3389/fbioe.2019.00061>

Wang, F., & Zhang, W. (2019). Synthetic biology: Recent progress, biosafety and biosecurity concerns, and possible solutions. *Journal of Biosafety and Biosecurity*, 1(1), 22–30.
<https://doi.org/10.1016/j.jobbb.2018.12.003>

Social, economic, ethical and legal considerations

Agapito-Tenfen, S. Z., Okoli, A. S., Bernstein, M. J., Wikmark, O.-G., & Myhr, A. I. (2018). Revisiting Risk Governance of GM Plants: The Need to Consider New and Emerging Gene-Editing Techniques. *Frontiers in Plant Science*, 9. <https://doi.org/10.3389/fpls.2018.01874>

Alam, A., Jiang, L., Kittleson, G. A., Steadman, K. D., Nandi, S., Fuqua, J. L., Palmer, K. E., Tusé, D., & McDonald, K. A. (2018). Technoeconomic Modeling of Plant-Based Griffithsin Manufacturing. *Frontiers in Bioengineering and Biotechnology*, 6. <https://doi.org/10.3389/fbioe.2018.00102>

Bailey, J. (2019). CRISPR-Mediated Gene Editing: Scientific and Ethical Issues. *Trends in Biotechnology*, 37(9), 920–921. <https://doi.org/10.1016/j.tibtech.2019.05.002>

Bartkowski, B., & Baum, C. M. (2019). Dealing With Rejection: An Application of the Exit–Voice Framework to Genome-Edited Food. *Frontiers in Bioengineering and Biotechnology*, 7. <https://doi.org/10.3389/fbioe.2019.00057>

Bauer, A., & Bogner, A. (2020). Let's (not) talk about synthetic biology: Framing an emerging technology in public and stakeholder dialogues. *Public Understanding of Science*, 096366252090725. <https://doi.org/10.1177/0963662520907255>

Brossard, D., Belluck, P., Gould, F., & Wirz, C. D. (2019). Promises and perils of gene drives: Navigating the communication of complex, post-normal science. *Proceedings of the National Academy of Sciences*, 116(16), 7692–7697. <https://doi.org/10.1073/pnas.1805874115>

Callies, D. E. (2019). The ethical landscape of gene drive research. *Bioethics*, 33(9), 1091–1097. <https://doi.org/10.1111/bioe.12640>

Clarke, L. J. (2019). Synthetic biology – pathways to commercialisation. *Engineering Biology*, 3(1), 2–5. <https://doi.org/10.1049/enb.2018.5009>

Delborne, J. A., Kokotovich, A. E., & Lunshof, J. E. (2020). Social license and synthetic biology: the trouble with mining terms. *Journal of Responsible Innovation*, 1–18. <https://doi.org/10.1080/23299460.2020.1738023>

Dixon, T. (2019). Mapping the potential impact of synthetic biology on Australian foreign policy. *Australian Journal of International Affairs*, 73(3), 270–288. <https://doi.org/10.1080/10357718.2019.1584154>

Eckerstorfer, M. F., Heissenberger, A., Reichenbecher, W., Steinbrecher, R. A., & Waßmann, F. (2019). An EU Perspective on Biosafety Considerations for Plants Developed by Genome Editing and Other New Genetic Modification Techniques (nGMs). *Frontiers in Bioengineering and Biotechnology*, 7. <https://doi.org/10.3389/fbioe.2019.00031>

Edlund, A. M., Jones, J., Lewis, R., & Quinn, J. C. (2018). Economic feasibility and environmental impact of synthetic spider silk production from *Escherichia coli*. *New Biotechnology*, 42, 12–18. <https://doi.org/10.1016/j.nbt.2017.12.006>

Esvelt, K. M., & Gemmell, N. J. (2017). Conservation demands safe gene drive. *PLOS Biology*, 15(11), e2003850. <https://doi.org/10.1371/journal.pbio.2003850>

- Ferretti, F. (2019). Mapping do-it-yourself science. *Life Sciences, Society and Policy*, 15(1), 1. <https://doi.org/10.1186/s40504-018-0090-1>
- George, D. R., Kuiken, T., & Delborne, J. A. (2019). Articulating ‘free, prior and informed consent’ (FPIC) for engineered gene drives. *Proceedings of the Royal Society B: Biological Sciences*, 286(1917), 20191484. <https://doi.org/10.1098/rspb.2019.1484>
- Hudson, M., Mead, A. T. P., Chagné, D., Roskrige, N., Morrison, S., Wilcox, P. L., & Allan, A. C. (2019). Indigenous Perspectives and Gene Editing in Aotearoa New Zealand. *Frontiers in Bioengineering and Biotechnology*, 7. <https://doi.org/10.3389/fbioe.2019.00070>
- Jouanin, A., Boyd, L., Visser, R. G. F., & Smulders, M. J. M. (2018). Development of Wheat With Hypoimmunogenic Gluten Obstructed by the Gene Editing Policy in Europe. *Frontiers in Plant Science*, 9. <https://doi.org/10.3389/fpls.2018.01523>
- Kato-Nitta, N., Maeda, T., Inagaki, Y., & Tachikawa, M. (2019). Expert and public perceptions of gene-edited crops: attitude changes in relation to scientific knowledge. *Palgrave Communications*, 5(1), 137. <https://doi.org/10.1057/s41599-019-0328-4>
- Kitney, R., Adeogun, M., Fujishima, Y., Goñi-Moreno, Á., Johnson, R., Maxon, M., Steedman, S., Ward, S., Winickoff, D., & Philp, J. (2019). Enabling the Advanced Bioeconomy through Public Policy Supporting Biofoundries and Engineering Biology. *Trends in Biotechnology*, 37(9), 917–920. <https://doi.org/10.1016/j.tibtech.2019.03.017>
- Kofler, N., Collins, J. P., Kuzma, J., Marris, E., Esvelt, K., Nelson, M. P., Newhouse, A., Rothschild, L. J., Vigliotti, V. S., Semenov, M., Jacobsen, R., Dahlman, J. E., Prince, S., Caccione, A., Brown, T., & Schmitz, O. J. (2018). Editing nature: Local roots of global governance. *Science*, 362(6414), 527–529. <https://doi.org/10.1126/science.aat4612>
- Kohl, P. A., Brossard, D., Scheufele, D. A., & Xenos, M. A. (2019). Public views about editing genes in wildlife for conservation. *Conservation Biology*, 33(6), 1286–1295. <https://doi.org/10.1111/cobi.13310>
- Lucchi, N. (2019). Challenges and Opportunities at the Interface of Synthetic Biology, Microbiology, and Intellectual Property Rights. In *Intellectual Property Issues in Microbiology* (pp. 37–54). Springer Singapore. https://doi.org/10.1007/978-981-13-7466-1_2
- Martin-Laffon, J., Kuntz, M., & Ricroch, A. E. (2019). Worldwide CRISPR patent landscape shows strong geographical biases. *Nature Biotechnology*, 37(6), 613–620. <https://doi.org/10.1038/s41587-019-0138-7>
- Meghani, Z. (2019). Autonomy of Nations and Indigenous Peoples and the Environmental Release of Genetically Engineered Animals with Gene Drives. *Global Policy*, 10(4), 554–568. <https://doi.org/10.1111/1758-5899.12699>
- Mitchell, P. D., Brown, Z., & McRoberts, N. (2018). Economic issues to consider for gene drives. *Journal of Responsible Innovation*, 5(sup1), S180–S202. <https://doi.org/10.1080/23299460.2017.1407914>
- Morris, M. C. (2019). Predator Free New Zealand and the ‘War’ on Pests: Is it a just War? *Journal of Agricultural and Environmental Ethics*. <https://doi.org/10.1007/s10806-019-09815-x>

- Rabitz, F. (2019). Institutional Drift in International Biotechnology Regulation. *Global Policy*, 10(2), 227–237. <https://doi.org/10.1111/1758-5899.12652>
- Rabitz, F. (2019). Gene drives and the international biodiversity regime. *Review of European, Comparative & International Environmental Law*, 28(3), 339–348. <https://doi.org/10.1111/reel.12289>
- Reynolds, J. L. (2019). Governing New Biotechnologies for Biodiversity Conservation: Gene Drives, International Law, and Emerging Politics. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3471735>
- Ribeiro, B., & Shapira, P. (2020). Private and public values of innovation: A patent analysis of synthetic biology. *Research Policy*, 49(1), 103875. <https://doi.org/10.1016/j.respol.2019.103875>
- Ribeiro, B., & Shapira, P. (2019). Anticipating governance challenges in synthetic biology: Insights from biosynthetic menthol. *Technological Forecasting and Social Change*, 139, 311–320. <https://doi.org/10.1016/j.techfore.2018.11.020>
- Sandler, R. (2019). The ethics of genetic engineering and gene drives in conservation. *Conservation Biology*, *cobi.13407*. <https://doi.org/10.1111/cobi.13407>
- Seddon, P. J., & King, M. (2019). Creating proxies of extinct species: the bioethics of de-extinction. *Emerging Topics in Life Sciences*, 3(6), 731–735. <https://doi.org/10.1042/ETLS20190109>
- Small, E. (2019). In defence of the world’s most reviled invertebrate ‘bugs.’ *Biodiversity*, 20(4), 168–221. <https://doi.org/10.1080/14888386.2019.1663636>
- Valdez, R. X., Kuzma, J., Cummings, C. L., & Nils Peterson, M. (2019). Anticipating risks, governance needs, and public perceptions of de-extinction. *Journal of Responsible Innovation*, 6(2), 211–231. <https://doi.org/10.1080/23299460.2019.1591145>
- Whitford, C. M., Lübke, N.-C., & Rückert, C. (2018). Synthetic Biology Ethics at iGEM: iGEMer Perspectives. *Trends in Biotechnology*, 36(10), 985–987. <https://doi.org/10.1016/j.tibtech.2018.06.004>
- Zettler, P. J., Guerrini, C. J., & Sherkow, J. S. (2019). Finding a Regulatory Balance for Genetic Biohacking. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3490006>
- Zhang, D., Hussain, A., Manghwar, H., Xie, K., Xie, S., Zhao, S., ... Ding, F. (2020). Genome editing with the CRISPR-Cas system: an art, ethics and global regulatory perspective. *Plant Biotechnology Journal*. <https://doi.org/10.1111/pbi.13383>

Synthetic viruses and viral delivery methodologies

- Bouton, C., King, R. C., Chen, H., Azhakanandam, K., Bieri, S., Hammond-Kosack, K. E., & Kanyuka, K. (2018). Foxtail mosaic virus: A viral vector for protein expression in cereals. *Plant Physiology*, pp.01679.2017. <https://doi.org/10.1104/pp.17.01679>
- Chariou, P. L., Dogan, A. B., Welsh, A. G., Saidel, G. M., Baskaran, H., & Steinmetz, N. F. (2019). Soil mobility of synthetic and virus-based model nanopesticides. *Nature Nanotechnology*, 14(7), 712–718. <https://doi.org/10.1038/s41565-019-0453-7>

Cody, W. B., & Scholthof, H. B. (2019). Plant Virus Vectors 3.0: Transitioning into Synthetic Genomics. *Annual Review of Phytopathology*, 57(1), 211–230. <https://doi.org/10.1146/annurev-phyto-082718-100301>

Lee, J., Ma, J., & Lee, K. (2019). Direct delivery of adenoviral CRISPR/Cas9 vector into the blastoderm for generation of targeted gene knockout in quail. *Proceedings of the National Academy of Sciences*, 116(27), 13288–13292. <https://doi.org/10.1073/pnas.1903230116>

Noyce, R. S., Lederman, S., & Evans, D. H. (2018). Construction of an infectious horsepox virus vaccine from chemically synthesized DNA fragments. *PLOS ONE*, 13(1), e0188453. <https://doi.org/10.1371/journal.pone.0188453>

Pasin, F., Menzel, W., & Daròs, J.-A. (2019). Harnessed viruses in the age of metagenomics and synthetic biology: an update on infectious clone assembly and biotechnologies of plant viruses. *Plant Biotechnology Journal*. <https://doi.org/10.1111/pbi.13084>

Shi, X., Cordero, T., Garrigues, S., Marcos, J. F., Daròs, J.-A., & Coca, M. (2018). Efficient production of antifungal proteins in plants using a new transient expression vector derived from tobacco mosaic virus. *Plant Biotechnology Journal*. <https://doi.org/10.1111/pbi.13038>

General reference about synthetic biology

Chong, C., & Low, C. (2019). Synthetic antibody: Prospects in aquaculture biosecurity. *Fish & Shellfish Immunology*, 86, 361–367. <https://doi.org/10.1016/j.fsi.2018.11.060>

Coleman, M. A., & Goold, H. D. (2019). Harnessing synthetic biology for kelp forest conservation 1. *Journal of Phycology*, 55(4), 745–751. <https://doi.org/10.1111/jpy.12888>

El Karoui, M., Hoyos-Flight, M., & Fletcher, L. (2019). Future Trends in Synthetic Biology—A Report. *Frontiers in Bioengineering and Biotechnology*, 7. <https://doi.org/10.3389/fbioe.2019.00175>

Freemont, P. S. (2019). Synthetic biology industry: data-driven design is creating new opportunities in biotechnology. *Emerging Topics in Life Sciences*, 3(5), 651–657. <https://doi.org/10.1042/ETLS20190040>

Heinemann, J. A., & Walker, S. (2019). Environmentally applied nucleic acids and proteins for purposes of engineering changes to genes and other genetic material. *Biosafety and Health*. <https://doi.org/10.1016/j.bsheat.2019.09.003>

Jessop-Fabre, M. M., & Sonnenschein, N. (2019). Improving Reproducibility in Synthetic Biology. *Frontiers in Bioengineering and Biotechnology*, 7. <https://doi.org/10.3389/fbioe.2019.00018>

Kuzma, J. (2019). Procedurally Robust Risk Assessment Framework for Novel Genetically Engineered Organisms and Gene Drives. *Regulation & Governance*, rego.12245. <https://doi.org/10.1111/rego.12245>

Lai, H.-E., Canavan, C., Cameron, L., Moore, S., Danchenko, M., Kuiken, T., Sekeyová, Z., & Freemont, P. S. (2019). Synthetic Biology and the United Nations. *Trends in Biotechnology*, 37(11), 1146–1151. <https://doi.org/10.1016/j.tibtech.2019.05.011>

- Myburg, A. A., Hussey, S. G., Wang, J. P., Street, N. R., & Mizrachi, E. (2019). Systems and Synthetic Biology of Forest Trees: A Bioengineering Paradigm for Woody Biomass Feedstocks. *Frontiers in Plant Science*, 10. <https://doi.org/10.3389/fpls.2019.00775>
- Nadra, A. D., Rodríguez, P. E., Grunberg, R., Olalde, L. G., & Sánchez, I. E. (2020). Developing synthetic biology in Argentina: the Latin American TECNOx community as an alternative way for growth of the field. *Critical Reviews in Biotechnology*, 40(3), 357–364. <https://doi.org/10.1080/07388551.2020.1712322>
- Roell, M.-S., & Zurbruggen, M. D. (2020). The impact of synthetic biology for future agriculture and nutrition. *Current Opinion in Biotechnology*, 61, 102–109. <https://doi.org/10.1016/j.copbio.2019.10.004>
- Trump, B. D., Foran, C., Rycroft, T., Wood, M. D., Bandolin, N., Cains, M., Cary, T., Crocker, F., Friedenberg, N. A., Gurian, P., Hamilton, K., Hoover, J. J., Meyer, C., Pokrzywinski, K., Ritterson, R., Schulte, P., Warner, C., Perkins, E., & Linkov, I. (2018). Development of community of practice to support quantitative risk assessment for synthetic biology products: contaminant bioremediation and invasive carp control as cases. *Environment Systems and Decisions*, 38(4), 517–527. <https://doi.org/10.1007/s10669-018-9710-9>
- Warner, C. M., Carter, S. R., Lance, R. F., Crocker, F. H., Meeks, H. N., Adams, B. L., ... Perkins, E. J. (2020). Synthetic Biology: Research Needs for Assessing Environmental Impacts (pp. 19–50). https://doi.org/10.1007/978-3-030-27264-7_2

Governmental, intergovernmental and non-governmental reports

- African Union, & NEPAD. (2018). *Gene drives for malaria control and elimination in Africa*. <https://www.nepad.org/publication/gene-drives-malaria-control-and-elimination-africa>
- Australian Academy of Science. (2017). *Synthetic Gene Drives in Australia: Implications of Emerging Technologies*. <https://www.science.org.au/support/analysis/reports/synthetic-gene-drives-australia-implications-emerging-technologies>
- Cotter, J., Kawall, K., & Then, C. (2020). *New genetic engineering technologies. Report of the results from the RAGES project 2016-2019*. http://www.testbiotech.org/projekt_rages
- Critical Scientists Switzerland, European Network of Scientists for Social and Environmental Responsibility, & Vereinigung Deutscher Wissenschaftler. (2019). *Gene drives: A report on their science, applications, social aspects, ethics and regulations*. <https://genedrives.ch/report>
- Dolezol, M., Simon, S., Otto, M., Engelhard, M., & Züghart, W. (2020). *Gene drive organisms: Implications for the Environment and Nature Conservation*. Vienna, Austria.
- ETC Group. (2018). *Forcing the Farm: How gene drive organisms could entrench industrial agriculture and threaten food sovereignty*. <https://www.etcgroup.org/content/forcing-farm>
- National Academies of Sciences Engineering and Medicine. (2016). *Gene Drives on the Horizon*. National Academies Press. <https://doi.org/10.17226/23405>

Redford, K. H., Brooks, T. M., Macfarlane, N. B. W., & Adams, J. S. (Eds.). (2019). *Genetic frontiers for conservation: an assessment of synthetic biology and biodiversity conservation: technical assessment*. IUCN, International Union for Conservation of Nature. <https://doi.org/10.2305/IUCN.CH.2019.05.en>

Rüdelshheim, P., & Smets, G. (2018). *Gene Drives: Experience with gene drive systems that may inform an environmental risk assessment*. <https://cogem.net/app/uploads/2019/07/CGM-2018-03-Report-Gene-Drives-met-kaft1.pdf>

Sirinathsingji, E. (2020, March). Risk assessment challenges of synthetic gene drive organisms. *Third World Network Biosafety Briefing*. Retrieved from <https://biosafety-info.net/articles/assessment-impacts/risk-assessment/risk-assessment-challenges-of-synthetic-gene-drive-organisms/>

United Nations Conference on Trade and Development. (2019). *Synthetic Biology and its Potential Implications for BioTrade and Access and Benefit-Sharing* (UNCTAD/DIT). <https://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=2554>

van der Vlugt, C., van den Akker, H., Roesink, C., & Westra, J. (2018). *Risk assessment method for activities involving organisms with a gene drive under contained use*. <https://doi.org/10.21945/RIVM-2018-0090>

Warner, C. M., Carter, S. R., Lance, R. F., Crocker, F. H., Meeks, H. N., Adams, B. L., Magnuson, M. L., Perkins, E. J., Rycroft, T. E., & Pokrzywinski, K. L. (2019). *Synthetic Biology: Research Needs for Assessing Environmental Impacts*. <https://apps.dtic.mil/dtic/tr/fulltext/u2/1078268.pdf>

Other related information

Barnhill-Dilling, S. K., Rivers, L., & Delborne, J. A. (2020). Rooted in Recognition: Indigenous Environmental Justice and the Genetically Engineered American Chestnut Tree. *Society & Natural Resources*, 33(1), 83–100. <https://doi.org/10.1080/08941920.2019.1685145>

Jupe, F., Rivkin, A. C., Michael, T. P., Zander, M., Motley, S. T., Sandoval, J. P., Slotkin, R. K., Chen, H., Castanon, R., Nery, J. R., & Ecker, J. R. (2019). The complex architecture and epigenomic impact of plant T-DNA insertions. *PLOS Genetics*, 15(1), e1007819. <https://doi.org/10.1371/journal.pgen.1007819>

King, A. (2019). Bio- art. *EMBO Reports*, 20(7). <https://doi.org/10.15252/embr.201948563>

Shelton, A. M., Long, S. J., Walker, A. S., Bolton, M., Collins, H. L., Revuelta, L., Johnson, L. M., & Morrison, N. I. (2020). First Field Release of a Genetically Engineered, Self-Limiting Agricultural Pest Insect: Evaluating Its Potential for Future Crop Protection. *Frontiers in Bioengineering and Biotechnology*, 7. <https://doi.org/10.3389/fbioe.2019.00482>

Zheng, X., Zhang, D., Li, Y., Yang, C., Wu, Y., Liang, X., Liang, Y., Pan, X., Hu, L., Sun, Q., Wang, X., Wei, Y., Zhu, J., Qian, W., Yan, Z., Parker, A. G., Gilles, J. R. L., Bourtzis, K., Bouyer, J., ... Xi, Z. (2019). Incompatible and sterile insect techniques combined eliminate mosquitoes. *Nature*, 572(7767), 56–61. <https://doi.org/10.1038/s41586-019-1407-9>
