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Genome Editing in the Natural Environment

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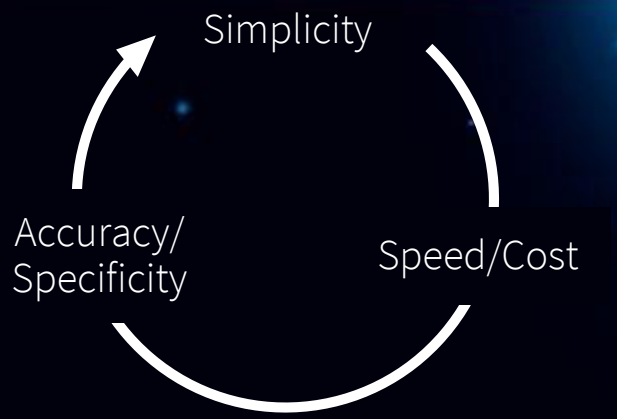
https://www.istockphoto.com/photo/colored-genetic-code-dna-molecule-structure-gm1186615180-334863063?phrase=genome%20

What is CRISPR and why is it better?



<1 month (CRISPR)

~6 months (conventional)

source: https://www.optumhealtheducation.com/sites/default/files/DiPersio%20Presentation.pdf

Genome editing can impact Maine's heritage industries

Forestry
Sustainable Energy

Marine
Plastic and Wastewater Bioremediation

Agriculture
Crop Resilience

https://www.istockphoto.com/photo/log-pile-cross-section-gm688765478-126731901?phrase=Wood%20stacks

Lobster Pots Stacked Up In Rows On The Quayside Crab Fishing Background Stock Photo - Download Image Now - iStock (istockphoto.com)

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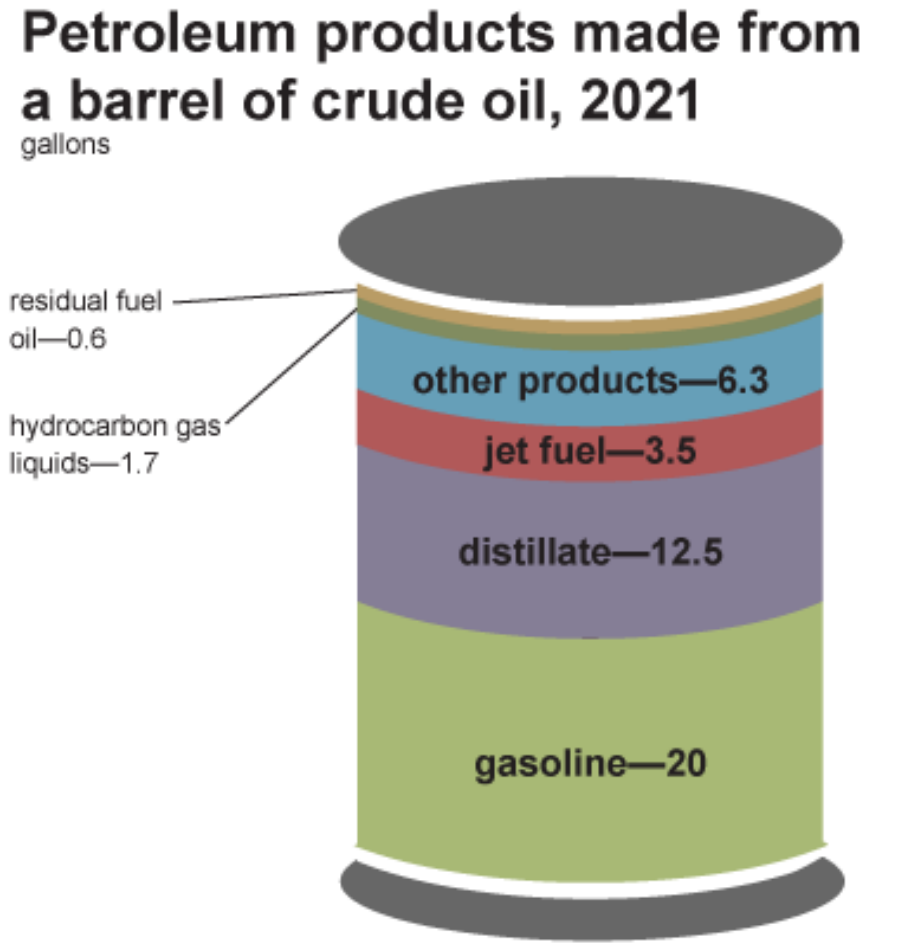
Forestry Sustainable Energy

The Problem

- What will happen when the world runs out of oil?
- How will we replace the over 6,000 products made from petroleum?
- How can we mitigate the impact of fossil energy on climate?
- Are there alternative ways to produce petro-derived products?



Source: U.S. Energy Information Administration, *Petroleum Supply Monthly*, March 2022, preliminary data
Note: A 42-gallon (U.S.) barrel of crude oil yields about 45 gallons of petroleum products because of refinery processing gain. The sum of the product amounts in the image may not equal 45 because of independent rounding.

https://www.eia.gov/energyexplained/oil-and-petroleum-products/#tab1

Forestry Sustainable Energy

The Genome Editing Solution

Exploit forest/agricultural residues as substrates for bioenergy

Edit the genomes of industrial microbial strains for efficient biofuels and biochemicals production

- Bioethanol → transportation fuel
- 2,3-Butanediol → feedstock for synthetic rubber
- 2,5-Furandicarboxylic acid → bioplastics and resins

Edit microbial genomes for carbon dioxide utilization

- Carbon dioxide conversion to bioethanol, biobutanol, etc.
- Reduction in global warming

https://www.istockphoto.com/photo/ecologist-on-fieldwork-forester-examines-trees-in-their-natural-condition-in-the-gm1323675815-409250963?phrase=forestry%20workerc

Marine Plastic Bioremediation

The Problem

- It takes 50 – 450 years for plastics to decompose in the natural world
- Plastics degrade into microplastics, resulting in health consequences

The Genome Editing Solution

- With biotechnology, we can identify microorganisms that have the capacity to remove this waste and then use genome editing to improve the efficiency and capacity of plastic degradation pathways.

https://www.forbes.com/sites/rrapier/2021/09/30/the-plastic-pollution-crisis/?sh=6080985f78a5

Marine Wastewater Bioremediation

The Problem

- The wastewater from anaerobic digestion results in high concentrations of ammonia, phosphorous, and heavy metals, which are environmental pollutants.

The Genome Editing Solution

- Using genomic editing, we can identify microorganisms that can remove these pollutants from the waste and make the waste safer to be released into the environment.

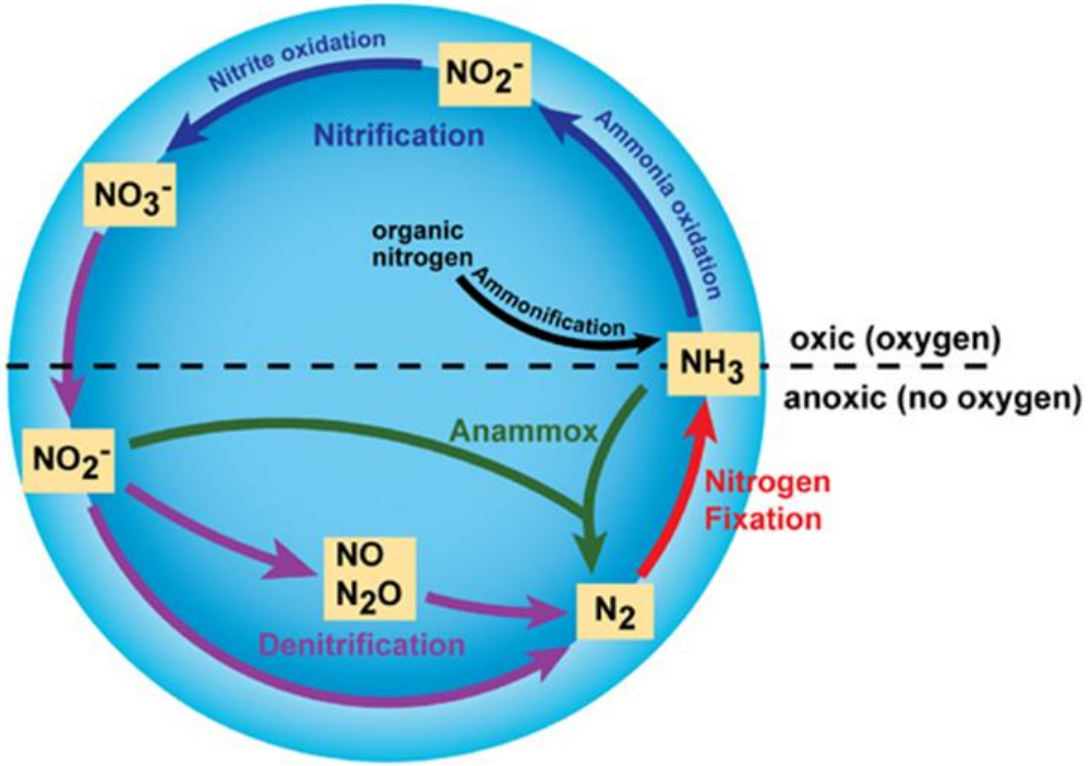
https://www.istockphoto.com/photo/discharge-of-sewage-into-a-river-gm950679732-259495203?utm_source=pixabay&utm_medium=affiliate&utm_campaign=SRP_image_sponsored&utm_content=http%3A%2F%2Fpixabay.com%2Fimages%2Fsearch%2Fwater%2520pollution%2F&utm_term=water+pollution

Ujor, V. C., Okonkwo, C. C., Rush, B. B., McCrea, G. E., & Ezeji, T. C. (2020). Harnessing the residual nutrients in anaerobic digestate for ethanol fermentation and digestate remediation using Saccharomyces cerevisiae. Fermentation, 6(2), 52.

Genome editing as a solution for biological treatment of municipal/industrial wastewater

Anammox Bacteria

- Can convert organic nitrogen to atmospheric nitrogen
- Doubling time takes weeks



https://www.nature.com/scitable/knowledge/library/the-nitrogen-cycle-processes-players-and-human-15644632/

***Saccharomyces cerevisiae* (Baker's yeast)**

- Doubling time is approximately 90 min
- Can remove phosphorus and heavy metals
- Cannot convert organic nitrogen to atmospheric nitrogen

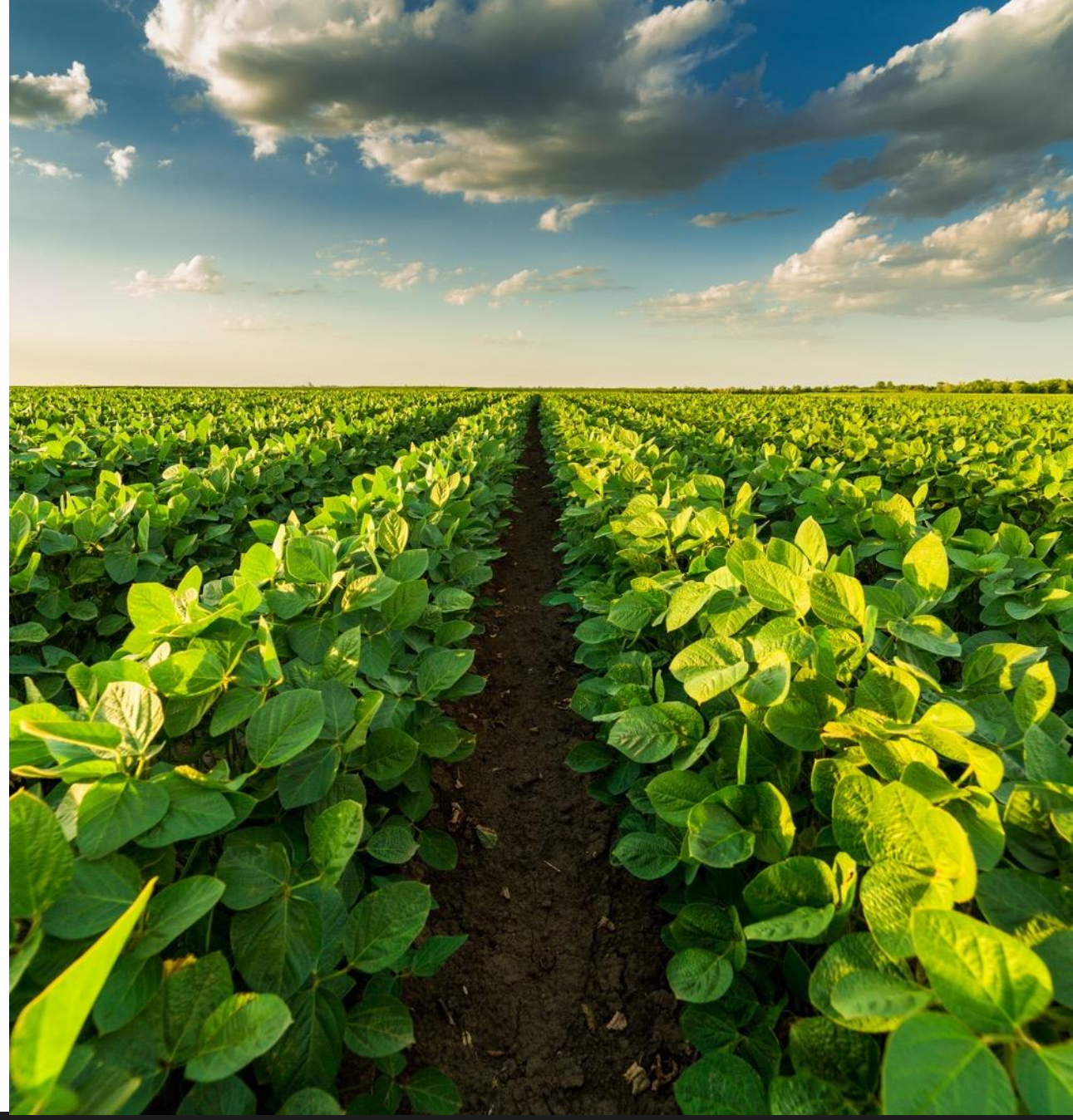
Agriculture Crop Resilience

The Problem

- The impact of climate change on crops, diseases, and pests results in low yield.

The Genome Editing Solution

- With genome editing, it is possible to help plants resist drought, control the impact of pests, and reduce disease, thus, increasing crop yields and productivity.



https://www.the-scientist.com/news-opinion/gene-edited-soybean-oil-makes-restaurant-debut-65590

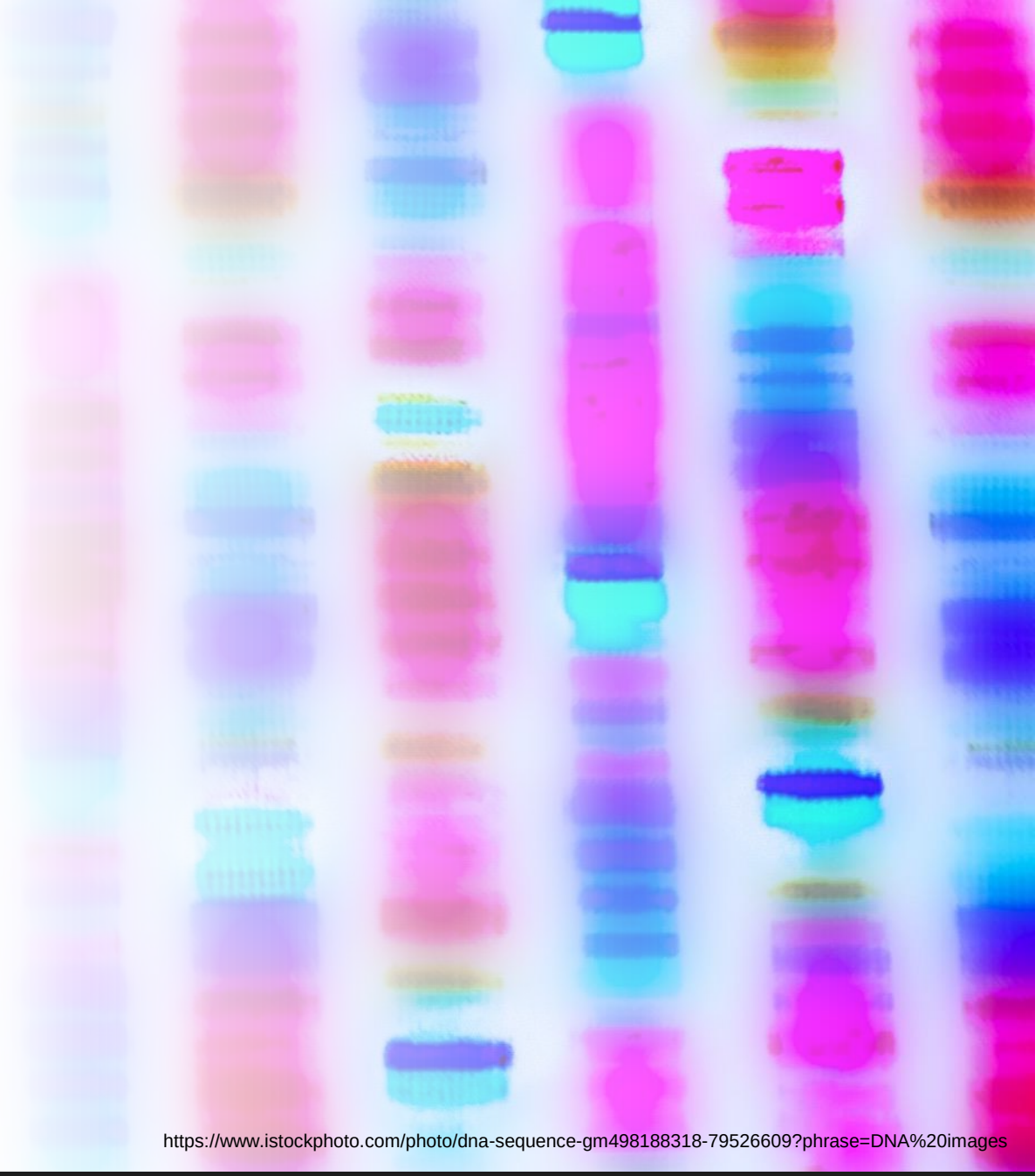
Opportunities

For society, gene editing will:

- Mitigate global warming
- Create value for forest residues in Maine
- Increase food security

For Maine, investing in genome editing will result in:

- Increased collaborations between industry and academia
- Spin-off biotech companies
- A Maine biotech hub
- Multiple future industries
- Workforce opportunities for individuals at all levels (high school diploma, Associates, Bachelors, Masters, and Doctorates)



https://www.istockphoto.com/photo/dna-sequence-gm498188318-79526609?phrase=DNA%20images

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