WORLD ECONOMIC FORUM

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Biotechnology
Dynamic Briefing

Generated 10 February 2021 for Marco Antonio Gonzalez

Biotechnology

Co-curated with **Korea Advanced Institute of Science and Technology (KAIST)**

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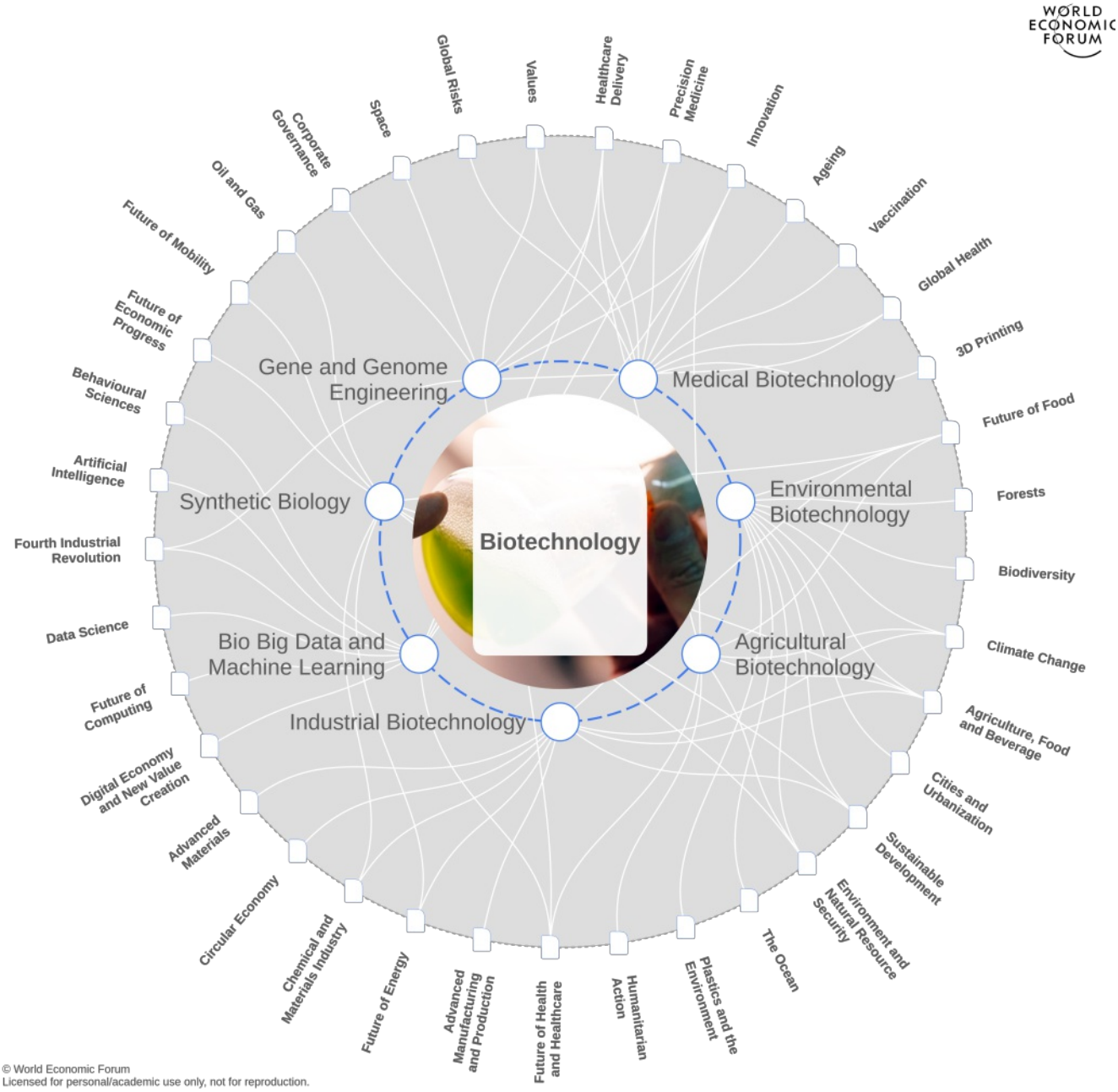
About

This dynamic briefing draws on the collective intelligence of the Forum network to explore the key trends, interconnections and interdependencies between industry, regional and global issues. In the briefing, you will find a visual representation of this topic (Transformation Map – interactive version available online via intelligence.weforum.org), an overview and the key trends affecting it, along with summaries and links to the latest research and analysis on each of the trends. Briefings for countries also include the relevant data from the Forum's benchmarking indices. The content is continuously updated with the latest thinking of leaders and experts from across the Forum network, and with insights from Forum meetings, projects communities and activities.



Executive summary

Medical biotechnology is personalizing medicine by keying on our individual biology, industrial biotechnology is being used to develop more eco-friendly ways of building things, agricultural biotechnology can help feed an expanding global population, and synthetic biology is helping to sustainably produce essential chemicals and materials. Meanwhile environmental biotechnology may yet solve the vexing problem of plastic pollution. However, while recent biotechnology-related advances have opened up incredible new possibilities, they have also created significant ethical issues - as society grapples with concepts like gene-edited babies.

This briefing is based on the views of a wide range of experts from the World Economic Forum's Expert Network and is curated in partnership with Dr. Sang Yup Lee, Distinguished Professor, Department of Chemical and Biomolecular Engineering, Korea Advanced Institute of Science and Technology (KAIST), and colleagues.

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Ageing populations and people with genetically-inherited diseases can benefit from gene editing, but there are ethical concerns.

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DNA can now be picked apart and rearranged like a bouquet of flowers.

Medical Biotechnology

Ageing populations and people with genetically-inherited diseases can benefit from gene editing, but there are ethical concerns

Medical biotechnology is a rapidly developing means to rejuvenate the elderly and regenerate ageing or diseased organs - a potentially helpful development for the many countries with greying populations (nearly 8.7% of the global population was aged 65 or older by 2017, up from 6.7% in 1997, according to World Bank data). The use of “induced pluripotent” stem cells, which do not have to be derived from human embryos, has shown promise for regenerating an injured heart (while avoiding the ethical issues tied to the use of human embryonic stem cells), for example. Biotechnology tools are also being used for the diagnosis and treatment of human disease in a personalized way. We are currently able to modulate each layer of biology, from genes to proteins and cells. When it comes to the immunological treatment of cancer, the clinical development of protein- or antibody-based therapeutics is advancing, and the range of biological targets is expanding. In addition, genetically modified immune cells are being developed as immuno-oncology drugs, including chimeric antigen receptor (CAR)-T cells and T-cell receptor (TCR)-transduced T cells.

Regenerative medicine will be accelerated by gene-editing technology. CRISPR-Cas9, for example, enables the direct modification of genes in the interest of preventing and treating disease - though there are significant ethical issues related to altering the human genome in ways that will be passed from one generation to the next (a Chinese scientist stunned the world in 2018 when it was revealed that he had engineered the world’s first gene-edited babies in a bid to make them resistant to their father’s HIV infection). Tissue engineering has also evolved, thanks to organoid (a miniaturized organ produced in vitro) technology, novel biomaterials, and 3D printing. In general, a more personalized application of medical biotechnology is necessary, to enhance therapeutic efficacy and minimize unwanted side effects. And, the most important personal factor is the genome - in terms of genetic and acquired diseases. Integrating genome information into medical data is an important component of precision medicine, and is being aided by artificial intelligence. Personalized cancer vaccines, and drug tests using surrogates, are also major elements of precision medicine.

Related insight areas: Global Risks, Values, Healthcare Delivery, Precision Medicine, Innovation, Ageing, Vaccination, Global Health, 3D Printing

UN Women

Women in science who are making a difference during the pandemic

09 February 2021

This 11 February, we're celebrating International Day of Women and Girls in Science by highlighting just some of the women and girls around the world who have made tremendous contributions during the ongoing crisis.

World Health Organization

The road to a COVID-19 vaccine

01 February 2021

Developing a vaccine is a long road full of checkpoints. Each phase designed to make sure it is both effective and safe. But with the whole world struggling to contain a pandemic, and unprecedented amounts of funding available, the road to finding the COVID-19 vaccine looks more like this.

RAND Corporation

Wellcome Sanger Institute and Wellcome Genome Campus Landscape Review

19 January 2021

RAND Europe was commissioned by Wellcome to analyse the role and contribution of the Sanger Institute and the Wellcome Genome Campus within the field of genetics and genomics, set within the context of four comparator organisations.

FiveThirtyEight

What Happens When You Get A COVID-19 Vaccine That Uses mRNA

15 January 2021

On this week's episode of PODCAST-19, we talk with Dr. Margaret Liu, one of the pioneers of gene-based vaccines, about vaccines that use mRNA to help us build immunity to COVID-19, including the Pfizer-BioNTech and Moderna vaccines. How is this method different from vaccines in the past, and what does the mRNA do once it gets inside our bodies?.

Scientific American

Should We Change COVID Vaccine Doses to Reach More People? What the Data Say

14 January 2021

The first COVID-19 vaccines have arrived, and the race is on to get them into as many arms as possible as soon as possible. Vaccination rates have fallen frustratingly short of what is needed to turn the tide of this pandemic, which continues to claim thousands of lives every day. The currently authorized vaccines are meant to be given in two doses. To speed things up, some scientists have floated the idea of delaying the second dose, only giving people only a single dose or halving the dose size. U.K. regulators have prioritized giving as many individuals their first dose of the Pfizer and AstraZeneca vaccines as possible—even if that means waiting up to 12 weeks for the second shot.

Project Syndicate

Britain's Vaccine Gamble

14 January 2021

During the pandemic, the UK has led the way in studying pharmaceutical interventions, with well-designed randomized controlled studies enabling vast improvements in patient care globally. Yet, by deciding to increase the gap between vaccine doses, the country's government has effectively abandoned this evidence-based approach.

Project Syndicate

The Big Bounce-Back?

08 January 2021

Following the 2008 financial crisis, many policymakers failed to focus sufficiently on securing robust, inclusive, and sustainable long-term growth. To avoid repeating this mistake in 2021 as the world emerges from the COVID-19 pandemic, governments must act early and decisively in three areas.

Environmental Biotechnology

Plastic pervades our lives while spoiling the environment, and biotechnology may provide a sustainable solution

Metabolic and bioprocess engineering can be used to treat waste water and tackle serious environmental problems - including plastic pollution. The production and incineration of plastic will add more than 850 million metric tons of greenhouse gases to the atmosphere during 2019, equivalent to the pollution caused by 189 coal-fired power plants, according to a report published by the Center for International and Environmental Law. Plastics like polyethylene terephthalate (PET) pervade our daily lives because they are cheap to manufacture and highly durable. This durability causes serious damage; as much as 8.8 million metric tons of plastic waste is estimated to enter the ocean every year, where it will remain indefinitely. Microorganisms, which have mostly been used for the production of chemicals and materials, can also be applied to the biodegradation of plastics in a way that enables a highly-sustainable recycling system. In 2016, a Japanese research team from the Kyoto Institute of Technology and Keio University published a report in the journal Science about a bacterium called Ideonella sakaiensis, which contains an enzyme, PETase, that was found to be able to degrade PET.

A Korean research team from the Korea Advanced Institute of Science & Technology (KAIST) and Kyungpook National University further delved into this PET-degrading enzyme and determined its 3D crystal structure, while predicting a molecular mechanism of the PET degradation. They published their research in the journal Nature Communications in 2018 - and the approaches behind it can now be applied to the study of enzymes that could degrade other types of plastics. Recent research on the biodegradation of plastics has created potential for synergy with the sort of microbial production of biodegradable polymers that have long been studied by microbial engineers. Microorganisms can now be engineered to produce polyhydroxyalkanoates (polyesters that can store carbon), polylactic acid (a biodegradable polyester), and, as of recently, aromatic polyesters that use renewable biomass feedstock as raw material. One lingering challenge has been to find a way to improve microbial production performance at an economically viable scale - which will need to be overcome in order to significantly mitigate plastic pollution and establish sustainable plastic recycling.

Related insight areas: Future of Food, Forests, Biodiversity, Climate Change, Agriculture, Food and Beverage, Cities and Urbanization, Sustainable Development, Environment and Natural Resource Security, The Ocean, Plastics and the Environment

Project Syndicate

Prevent the Next Food Crisis Now

29 January 2021

The number of chronically hungry people increased by an estimated 130 million last year, to more than 800 million – about eight times the number of COVID-19 cases to date. The international community needs to adopt an anticipatory approach to the growing hunger pandemic, by acting before food emergencies turn into full-blown famines.

The Science Breaker

Genes coordinating selfishness and altruism between parents and offspring

11 January 2021

The social bond between parent and offspring balances selfishness and altruism. We investigated how genes control these behaviors in European earwigs, and found 1600 genes associated with parenting, and two genes coordinating selfishness and altruism. Our results suggest that internal reward and communication, encoded by these genes, help maintain parent-offspring interactions.

Project Syndicate

Long Live the Bio-Revolution

30 December 2020

The COVID-19 pandemic has increased threats to food security around the world, underscoring the need for innovation to make agriculture and aquaculture more resilient and efficient. Fortunately, the biological innovations needed to do just that are quickly becoming competitive and scalable.

The Conversation

Singapore approves cell-cultured chicken bites – who will be the first to try them?

03 December 2020

Cultured meat made from animal cells without animal slaughter has been approved for sale for the first time. The approval, granted by the Singapore Food Agency to US food company Eat Just for their cultured “chicken bites”, is a watershed moment for the future of meat. Unlike existing products, which imitate meat with plant-based ingredients, cultured meat will provide us with a new way to make the real thing. As well as avoiding animal slaughter, cultured meat could be key to addressing public health concerns linked to meat from animals and has just a fraction of the environmental impact of conventional meat. Although not quite as green as eating plants only, cultured meat may be a way to satiate our global appetite for animal meat without all the problems animal farming entails.

Frontiers

Turning Up the Temperature on CRISPR: Increased Temperature Can Improve the Editing Efficiency of Wheat Using CRISPR/Cas9

26 November 2020

The application of CRISPR/Cas9 technologies has transformed our ability to target and edit designated regions of a genome. It’s broad adaptability to any organism has led to countless advancements in our understanding of many biological processes. Many current tools are designed for simple plant systems such as diploid species, however, efficient deployment in crop species requires a greater efficiency of editing as these often contain polyploid genomes. Here, we examined the role of temperature to understand if CRISPR/Cas9 editing efficiency can be improved in wheat. The recent finding that plant growth under higher temperatures could increase mutation rates was tested with Cas9 expressed from two different promoters in wheat.

JSTOR Daily

In Phytoremediation, Plants Extract Toxins from Soils

18 November 2020

Researchers have a cheap, easy way for cleaning up oil spills: letting plants do the work. Why isn’t it used more often? .

Agricultural Biotechnology

"Green" biotechnology can help generate more nutritious food for an expanding global population

Agricultural, or "green" biotechnology can be used to help improve crop yields and quality, nutrient usage, disease resistance, environmental stress resistance, and flowering time. Technology has been used to modify the genetic content of plants throughout the history of human civilization - long before the discovery of DNA, Neolithic-era farmers developed domesticated crops by selecting those with desirable traits derived from naturally-occurring mutation. Later, the selection of the most desirable plants from the general population was crystalized into the concept of breeding - which spawned a plethora of modern crops. The pinnacle of breeding technology has been the development of "semi-dwarf" wheat, which is sturdier and higher-yielding, and now accounts for most of the wheat acreage in the world after appearing around the middle of the 20th century. Advances in DNA technology, coupled with the identification of genes essential for desired traits, raised green biotechnology to a new level; scientists became able to not only pinpoint a gene regulating a specific trait, but also to introduce the gene into plant genomes by using methods such as particle bombardment.

This ability to introduce a specific gene as a DNA fragment removed the biggest hurdle for conventional crop breeding: reproductive isolation separating different species. The successful generation of the blue rose using a blue gene from another plant species, for example, is testament to this. The removal of this species barrier has opened up new ways to mass produce valuable products, like edible vaccines and medicinal compounds. Meanwhile genome editing technology enabled by ZFN, TALEN, and more recently CRISPR/Cas9, promises even more precise plant engineering. This technology can knock out a specific gene, change the sequence of a specific gene, and replace one DNA fragment with another. This can occur without leaving a trace of foreign DNA or resulting in antibiotic-resistant genes (a flaw often associated with genetically-modified organisms, or GMO). The recent development of a soybean variety that can produce high levels of heart-healthy oils, and the engineering of wild ground cherries in a way that can make them as domesticated as strawberries, underline the ways green biotechnology may be able to help sustain a rapidly-expanding global population.

Related insight areas: Future of Food, Healthcare Delivery, Agriculture, Food and Beverage, Humanitarian Action, Innovation, Environment and Natural Resource Security, Climate Change, Future of Health and Healthcare

London School of Economics and Political Science

Vaccines and patents: how self-interest and artificial scarcity weaken human solidarity

09 February 2021

We are living through a humanitarian crisis, yet design faults in intellectual property mechanisms and a faith-based approach to patents is steering governments into what the WHO has called ‘a catastrophic moral failing’, writes Siva Thambisetty. To explain patents and vaccines in the context of recent developments we need larger frameworks that are not contingent … Continued.

The Science Breaker

The Trojan mosquito: an in-house parasite defends against malaria

26 January 2021

Malaria is a life-threatening tropical disease globally spreading out, and scientists have been seeking an effective way to control its prevalence. Here, we propose an innovative approach that prevents disease transmission by infecting mosquitoes with a newly found beneficial parasite.

Nature

How COVID unlocked the power of RNA vaccines

12 January 2021

The technology could revolutionize efforts to immunize against HIV, malaria, influenza and more. The technology could revolutionize efforts to immunize against HIV, malaria, influenza and more.

Science

COVID-19 testing: One size does not fit all

08 January 2021

Tests for detecting severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) were developed within days of the release of the virus genome. Multiple countries have been successful at controlling SARS-CoV-2 transmission by investing in large-scale testing capacity ([2][2]). Most testing has focused on quantitative polymerase chain reaction (qPCR) assays, which are capable of detecting minute amounts of viral RNA. Although powerful, these molecular tools cannot be scaled to meet demands for more extensive public health testing. To combat COVID-19, the “one-size-fits-all” approach that has dominated and confused decision-making with regard to testing and the evaluation of tests is unsuitable: Diagnostics, screening, and surveillance serve different purposes, demand distinct strategies, and require separate approval mechanisms.

Big Think

New type of dual-acting antibiotic shows promise

06 January 2021

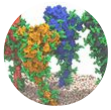
Antibiotic resistance is a big problem, but not many new drugs are currently under development. A recent discovery may give us a new antibiotic that is effective against a wide range of germs, including those resistant to other drugs. The new drug's mechanism also appears to signal the immune system, helping to amplify its response. Antibiotic resistance is a major problem, but one that seems to bother academics and specialists more than it worries members of the general public .

VoxEU

Valuing gene therapies for orphan pediatric disease

23 December 2020

Gene therapy offer patients the promise of improved health, longevity, and hope. However, the infancy of the technology and its sizable impact on budget conscious payers raises fundamental questions regarding gene therapy’s value. This column addresses the challenges associated with its value assessment and suggests initiatives which may help address these issues. Given payers’ reliance on value assessments to decide whether to provide access to these technologies and innovators’ reliance on such assessments to set prices, further analytic research in this direction is essential.



Max Planck Society

High-speed model for the fight against corona

11 December 2020

Researchers have developed genetically modified mice for corona research - Before therapies against Sars-CoV2 can be tested in humans and made available to the general public, their effect must be investigated and optimized in animals. The mouse is a model organism frequently used for testing drugs before they are used in medicine. Because receptor molecules differ so greatly between humans and mice, it has not yet been possible to study the infection in mice because Sars-CoV2 cannot penetrate mouse cells. Together with colleagues from China, Hans Schöler from the Max Planck Institute for Molecular Biomedicine in Münster has genetically modified mice to develop the human ACE2 receptor, to which Sars-CoV2 binds, on the surface of their somatic cells. To do this, the researchers used a method from stem cell research.

Industrial Biotechnology

"White" biotechnology can help feed the undernourished and better protect the environment

Industrial Biotechnology, also known as "white" biotechnology, involves the sustainable production of chemicals, pharmaceuticals, food, fibres, textiles, and energy. White biotechnology is often referred to as the third wave of biotechnology, following "red" biotechnology (medical-related) and "green" biotechnology (agriculture-related), and it has become a powerful means to address climate change, mounting energy demand, the depletion of fossil-fuel resources, and environmental issues including petroleum-based plastics and micro-plastics pollution. The field's underpinning technologies are mainly based on the engineering of microbial hosts, and it has been boosted over the course of the past decade by scientific breakthroughs in metabolic engineering, synthetic and systems biology, and advanced cultivation techniques. In particular, the recent establishment of systems metabolic engineering (combining metabolic engineering with systems biology, synthetic biology, and evolutionary engineering) has led to a dramatic advances. Through the comprehensive optimization of existing methods, and the creation of new methods, the spectrum of possible commercial products has been expanded dramatically - including healthy food products that can be used to combat malnutrition in impoverished parts of the world.

Compared with traditional, fossil fuel-based chemical processes, an industrial biotechnology process completed via a single fermentation can be a way to make relatively affordable products that help protect the environment. As a result, the total industrial biotechnology market is expected to grow at a rate of nearly 9% annually, and reach a total size of $472.3 billion by the end of 2025. According to a study published by the Organisation for Economic Co-operation and Development, The Bioeconomy to 2030: Designing a Policy Agenda, industrial biotechnology will account for 39% of all economic value generated by biotechnology by the year 2030. Bioethylene, for example, is expected to account for as much as 40% of all plastic polyethylene production by 2035 - and production of biodegradable polylactic acid, usable for everything from decomposable packaging material to medical implants, is expected to reach 800,000 tonnes by 2020, according to the International Energy Agency and International Renewable Energy Agency. Ultimately, industrial biotechnology can make a major contribution to achieving United Nations Sustainable Development Goals related to fostering affordable and clean energy, sustainable cities and communities, and responsible consumption and production.

Related insight areas: Climate Change, Advanced Manufacturing and Production, Future of Food, Future of Energy, Agriculture, Food and Beverage, Chemical and Materials Industry, Sustainable Development, Circular Economy, Advanced Materials

The Science Breaker

Naturally occurring enzyme does the unexpected

09 February 2021

Macrocycles are complex molecules with unique three-dimensional shapes, that are difficult to synthesize in the lab. We show that a commercially available enzyme can execute this non-natural reaction, given the right building blocks. This allows us to further explore the use of macrocycles and the boundaries of molecular synthesis.

Project Syndicate

The Promise and Peril of the Bio-Revolution

26 January 2021

Many of today's biological innovations are complex, and we need to understand them fully to gauge their impact on our lives and societies. Only by working together can governments, scientists, businesses, and the public unleash the power of biology for good while effectively managing the risks.

Scientific American

New COVID Vaccines Need Absurd Amounts of Material and Labor

04 January 2021

Barely a year ago few people outside of a small network of scientists and companies had heard of mRNA vaccines. Today millions are pinning their hopes on these genetics-based immunizations, which have taken center stage in the fight against COVID. Deficiencies in needed supplies and materials for making the vaccines could lead to widespread shortages, some scientists say. The first doses of mRNA COVID vaccines began arriving at hospitals in the U.S. and several other countries in December. An overarching question is how fast companies making them can scale up production to meet global demand.

World Economic Forum

3 scenarios for how bioengineering could change our world in 10 years

21 December 2020

Edible vaccines, new approaches to treat disabilities and better carbon sequestration are among the promising innovations. But we also need to manage the risks.

Science Daily

Researchers develop new biomaterial that helps bones heal faster: Material recreates children's superior bone-healing ability in adults' stem cells

30 November 2020

The study, led by researchers from RCSI University of Medicine and Health Sciences and CHI at Temple Street, is published in the current edition of Biomaterials , the highest ranked journal in the field of biomaterials science. The researchers had previously discovered a molecule called JNK3, which is a key driver of children's stem cells being more sensitive to their environment and regenerating better than adults'. This explains, at least partially, why children's bones are able to heal more quickly. Building on this knowledge, they created a biomaterial that mimics the structure of bone tissue and incorporates nanoparticles that activate JNK3. When tested in a pre-clinical model, the biomaterial quickly repaired large bone defects and reduced inflammation after a month of use.

Wired

This Squishy 3D-Printed Human Heart Feels Like the Real Thing

23 November 2020

The researchers call their technique the Freeform Reversible Embedding of Suspended Hydrogels, or FRESH. They begin with a scan of a real heart and translate the data into something a 3D printer can read. Because the device works by depositing layers of material one on top of another, they run the 3D image through a slicer program. "For every layer, it basically defines the path that the material is going to be extruded, and then feeds that to the printer," says Adam Feinberg, a biomedical engineer at Carnegie Mellon University who coauthored the new paper.

Bio Big Data and Machine Learning

The automated analysis of increasingly large sets of genetic data promises to transform health care

Biomedical science is transforming into big-data science. Thanks to next-generation genomic sequencing technology, there has been a dramatic data explosion; as of 2016, more than 100,000 human genomes had been sequenced from normal and diseased tissue, and petabytes of raw sequence data are now being produced and deposited in public genome data repositories such as International Cancer Genome Consortium data portal. This is transforming the scientific landscape, and entire healthcare systems. Currently-archived datasets represent only a small fraction of the genome-related big data yet to be produced, as sequencing capacity will continue to grow. If the current growth rate continues, doubling capacity about every seven months, exabytes-worth of genome data (one exabyte is equivalent to about 250 million DVDs worth of video) will be yielded in the next 5 years. As the global population pushes toward 8 billion within the next decade, it is possible that 15% or more of it will have their genome sequenced. In addition to genomics, high-resolution imaging, medical records, and lifestyle-related datasets will add new dimensions to bio big-data, and provide a foundation for next-generation healthcare.

However, there is a long road ahead before big data can help deliver precision medicine - based on a patient's genetic makeup and environmental circumstances - to the masses. There are immense challenges when it comes to data storage, distribution, and proper interpretation in biomedical contexts. Large-scale machine learning systems need to be integrated with vast computing infrastructure in order for deep learning, one of the most promising branches of artificial intelligence, to help better enable the navigation of big data and detect things that are impossible to catch manually. Machine learning could facilitate the mining of gene-to-gene interaction, the classification of cellular images, and finding links between datasets. Yet, machine-learning algorithms require large-scale, high-quality "ground truth" data for algorithm training - which is difficult to acquire. In addition, machine learning can be biased, and understanding exactly how machine learning algorithms are classifying the features in datasets can be challenging. Still, the analysis of big data will eventually have an enormous impact on disease prevention, on the ability to cure and care, and on the global healthcare system.

Related insight areas: Precision Medicine, Digital Economy and New Value Creation, Innovation, Future of Computing, Data Science, Fourth Industrial Revolution, Artificial Intelligence, Healthcare Delivery, Behavioural Sciences, Future of Health and Healthcare

Ecole Polytechnique Fédérale de Lausanne

Genes that dance to the circadian rhythm

09 February 2021

Scientists at EPFL have made breakthrough discoveries on the circadian clock and how it affects gene expression. Some of the findings suggest a biological underpinning for different behaviors in people, such as morning people, nappers, evening people, night owls etc. In 2017, the Nobel Prize in Physiology or Medicine went to three scientists who uncovered the molecular mechanisms that control the circadian rhythm, otherwise known as the “wake-sleep” cycle. To carry out their work, the scientists used the common fruit fly Drosophila melanogaster , making this the sixth Nobel to be awarded to research involving it. Fruitful fruit flies Life scientists have been using Drosophila for over a century now. First proposed by entomologist Charles W. Woodworth as a model organism, its use in research was pioneered by geneticist Thomas H.

Ecole Polytechnique Fédérale de Lausanne

NAD+ can restore age-related muscle deterioration

20 January 2021

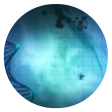
Scientists at EPFL have discovered that Alzheimer’s-like protein aggregates underly the muscle deterioration seen in aging. But the aggregates can be reversed by boosting the levels of nicotinamide adenine dinucleotide (NAD +), which turns on the defense systems of mitochondria in cells and restores muscle function. The older we grow, the weaker our muscles get, riddling old age with frailty and physical disability. But this doesn’t only affect the individual, it also creates a significant burden on public healthcare. And yet, research efforts into the biological processes and biomarkers that define muscle aging have not yet defined the underlying causes.

The Science Breaker

What makes us different - chance in brain development and its consequences for individuality

14 January 2021

Why are we all different? By comparing brain anatomy we uncovered anatomical difference in the brain of individuals, resulting from chance processes during development. We show that these differences are linked to changes in behavioral responses. Therefore, next to nature and nurture, also chance shapes individuality.



The Science Breaker

More than meets the eye: the histones revealed as enzymes

12 January 2021

Histones have been known as proteins that package the DNA of eukaryotes and regulate gene expression. We discovered that histones also function as enzymes that convert copper ions into a usable form for cells. The enzymatic function changes how we think about the roles of histones in health and disease. It may have also been a critical driver for emergence of eukaryotes in the first place.

Brookings

The new urgency of global tech governance

07 January 2021

Landry Signé, Mark Esposito, and Sanjeev Khagram underscore the urgent need for international rules and standards governing data to catch up with the accelerated diffusion of digital technologies during the COVID-19 pandemic.

Imperial College London

Vaccine collaboration could overcome cold chain issues for RNA-based vaccines

07 January 2021

Imperial vaccine researchers are collaborating with industry partners to develop RNA vaccines stable at temperatures up to 40C.

The Science Breaker

Understanding how COVID-19 Patients shed viral particles into their environment

04 January 2021

A study of the surfaces, objects and the air inside and around rooms housing COVID-19 patients helps us to understand how infected people spread the virus. The results of this study can help protect doctors and nurses providing care and can help inform effective protective measures for everyone.

Synthetic Biology

Microbial cell factories can sustainably produce the chemicals needed to fuel an economy

Civilization has largely committed itself to forging a more resource-efficient and sustainable global economy. One of the ultimate goals is to reconcile demand for chemical materials needed to treat human disease, develop sustainable agriculture and fisheries, bolster food security, and power industrial applications with the need to ensure biodiversity and environmental protection. In order to help achieve this, many countries have leveraged advances in synthetic biology and metabolic engineering by using natural biological processes to produce important chemicals - and by making use of standardized, intelligent “cell factories” (collections of microbial cells, often built from bacteria or yeast, that can function like a chemical production facility). The consequences of this could be as significant as the impact of alchemy on chemistry millennia ago, with enormous and as perhaps unimaginable implications for medicine and materials science. The range of potential applications is vast, encompassing, and not limited to: diagnostics, therapeutics, sensors, environmental remediation, energy production, and biomolecular and chemical manufacturing. Studies have shown, for example, the potential to deploy bacteria-based cell factories to sustainably produce ethanol and butanol - which could in turn be used to de-carbonize transportation.

Following the emergence of recombinant DNA technology, which mashes up DNA from different species to produce combinations that have value for medicine or industry, biological systems have become widely used in industries such as chemicals and pharmaceuticals. However, the cell factories underpinning these processes often encounter systemic failure and suffer from instability. Synthetic biology and metabolic engineering can be applied to these problems by developing cells specifically designed for predictable, efficient, and streamlined production. Synthetic biology and metabolic engineering also enable the development of new biological systems capable of efficiently producing industrial chemicals and materials while consuming relatively less time, labour, and money. Some examples of this trend include reported advances in the microbial production of gasoline, terephthalic acid (an organic compound used to make clothing and plastic bottles), 1,4-butanediol (used to make fibres such as Spandex), and aromatic polyesters. In 2016, systems metabolic engineering was selected as one of the Top 10 emerging technologies by the World Economic Forum, for the ways that it can be used to more sustainably and affordably produce chemicals by using plants instead of fossil fuels.

Related insight areas: Sustainable Development, Chemical and Materials Industry, Environment and Natural Resource Security, Agriculture, Food and Beverage, Future of Economic Progress, Future of Energy, Future of Mobility, Future of Food, Oil and Gas

McGill Reporter

LSD may offer viable treatment for certain mental disorders

29 January 2021

McGill study a step in understanding the mechanism of psychedelics' impact on brain and potential for therapeutic use The post LSD may offer viable treatment for certain mental disorders appeared first on McGill Reporter .

University College London

Heat treatment may make chemotherapy more effective

05 January 2021

Heating up cancer cells while targeting them with chemotherapy is a highly effective way of killing them, according to a new study led by UCL researchers.

The Science Breaker

The inanimate building-blocks for a living synthetic cell

22 December 2020

One of the most significant synthetic biology goals is the development of artificial lifelike structures that can reproduce themselves. One aspect of this is the self-replication of genomes that encode the blueprint of the whole system. We have now succeeded in reconstructing critical parts of this process in test tubes.

United Nations Environment

COVID-19 vaccine could revolutionize cold storage around the world

09 December 2020

Vaccine rollout is an opportunity to create a new, sustainable cold chain that will be of use well beyond the current crisis After 11 dark months, the end of the COVID-19 pandemic is tantalizingly in sight. In recent weeks, two coronavirus vaccines – one from Pfizer-BioNTech and another from Moderna – were revealed to be more than 90 per cent effective in clinical trials. .

Scientific American

Metal-Breathing Bacteria Synthesize High-Tech Material

30 November 2020

Scientists have known for more than a century that some bacteria can breathe anaerobically, or without oxygen, but only in recent decades have researchers started exploiting this property to fabricate useful materials. Now electrical engineers have found a way to use such bacteria to manufacture an up-and-coming two-dimensional material called molybdenum disulfide (MoS 2), which can form a sheet just a few atoms thick and holds promise for future electronics. The new finding, published in Biointerphases, could help avoid a daunting synthesis process that requires a harsh environment. " Graphene is the breakout superstar of the two-dimensional materials," says Shayla Sawyer, an electrical engineer at Rensselaer Polytechnic Institute and a senior author of the paper.

The Science Breaker

How a type of expanding thread dictates plant growth

12 November 2020

Until recently, scientists thought that the growth of plant cells is driven by pressure on their rigid cell walls. Using new nanoimaging technology we show that the cell wall polymer pectin can independently expand plant cells. Similar biochemical 'self-expansion' of extracellular polymers in different kingdoms may change our vision of life beyond the plasma membrane.

Gene and Genome Engineering

DNA can now be picked apart and rearranged like a bouquet of flowers

As the 20th century drew to a close, biotechnology's equivalent of Promethean fire appeared: the first detailed sequence of the human genome. Now, the ability to decrypt genetic sequences has empowered us - albeit while creating significant risks. The DNA structure discovered by Watson and Crick in 1953 begat a restriction enzyme that can cleave DNA within seconds, which begat the discovery of biochemical enzymes that process DNA, which begat gene-editing technology that could be used to directly control the expression of intracellular genes within a nucleus. However, it was neither cost-effective nor efficient to manipulate gene expression within the nucleus - a problem solved by the breakthrough discovery of the CRISPR-Cas9 system in the early 21st century. Researchers found that by attaching a specific sequence of guide RNA joined up with a protein called Cas9 to a genome, they could cut and delete (or add) DNA. Soon after its discovery, CRISPR-Cas9 became a global sensation due to its relative ease and compatibility with just about any type of organism.

Genome manipulation techniques were eventually discovered that can eradicate or correct erroneous genes, to create recombinant embryos, treat cancer, or prevent infectious diseases. In the near future, gene therapy drugs could be injected, potentially eliminating the need for surgery to avoid genetic defects - such as the procedure the actress Angelina Jolie underwent to address her predisposition to breast and ovarian cancer. Epigenetics, or the study of genetic expression that doesn't involve changing a DNA sequence, promises future innovation for genome engineering. Epigenetics could eventually enable humans to adapt to, and evolve in, environments such as the atmosphere of Mars. However, genome engineering comes with ethical issues. A Chinese scientist's successful effort in 2018 to create genetically-engineered babies in order to endow them with a resistance to their father's HIV infection shocked the scientific community and points to a need for greater global awareness of the perils of genetic engineering technology as a means of artificial reproduction (Chinese officials have since declared that the scientist's conduct was illegal). Prometheus's gift, after all, had serious repercussions for civilization.

Related insight areas: Future of Health and Healthcare, Healthcare Delivery, Corporate Governance, Values, Precision Medicine, Space, Fourth Industrial Revolution, Innovation, Global Health

The Science Breaker

Diagnosing cancer by microbial signatures

03 February 2021

Cancer tissues are often thought to be sterile entities in the human body, exempt from the influence of our microbial cohabitants. To test this theory, we examined genetic information from patients' tumors and blood and discovered cancer-specific microbial communities among more than 30 cancer types. This study proposes a new class of microbial-based cancer diagnostics.

Imperial College London

Imperial vaccine tech to target COVID mutations and booster doses

26 January 2021

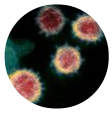
Imperial is focusing its RNA vaccine technology to target SARS-CoV-2 mutations, boosters and thermostability rather than an immediate efficacy trial.

The Conversation

Coronavirus variants: how did they evolve and what do they mean?

19 January 2021

When supplies of oxygen at hospitals in Manaus, Brazil, recently ran out, the airforce was called in for emergency evacuations while healthcare workers frantically tried to save lives with manual ventilation. For those that could not be saved, there was only morphine and a final hand-squeeze. As calamitous as the situation is for those affected, the devastating surge in COVID cases in Manaus over the last few weeks has set alarm bells ringing ever more loudly for governments and agencies around the world struggling to manage the pandemic. Cases continue to surge in the UK and South Africa and, as in Manaus, they appear to be mainly due to the emergence of new variants of the coronavirus.



Imperial College London

Imperial leads new consortium to study threats from new SARS-CoV-2 variants

15 January 2021

Imperial researchers will lead a new consortium of UK virologists to study the effects of emerging mutations in SARS-CoV-2.

Nature

Search for better COVID vaccines confounded by existing rollouts

08 January 2021

As placebo-controlled testing falls out of favour, vaccine developers eye blood markers and challenge trials to assess next-generation candidates.

Science

Viral evolution may herald new pandemic phase

08 January 2021

For COVID-19 researchers, this year brings a strong sense of déjà vu. As in early 2020, the world is anxiously watching a virus spread in one country and trying to parse the risk for everyone else. This time it is not a completely new threat, but a rapidly spreading variant of SARS-CoV-2. In southeastern England, where the B.1.1.7 variant was first detected last month, it has quickly replaced other variants, and it may be the harbinger of a new, particularly perilous phase of the pandemic. The concern has led some countries to speed up vaccine authorizations or discuss dosing regimens that may protect more people rapidly. But as the new variant surfaces in multiple countries, many scientists are calling for governments to strengthen existing control measures as well.

Frontiers

Induction of Trained Immunity by Recombinant Vaccines

07 January 2021

Vaccines represent an important strategy to protect humans against a wide variety of pathogens and have even led to eradicating some diseases. Although every vaccine is developed to induce specific protection for a particular pathogen, some vaccine formulations can also promote trained immunity, which is a non-specific memory-like feature developed by the innate immune system. It is thought that trained immunity can protect against a wide variety of pathogens other than those contained in the vaccine formulation. The non-specific memory of the trained immunity-based vaccines (TIbV) seems beneficial for the immunized individual, as it may represent a powerful strategy that contributes to the control of pathogen outbreaks, reducing morbidity and mortality.

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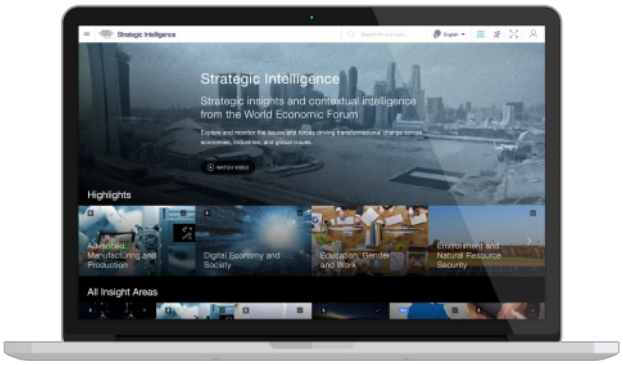

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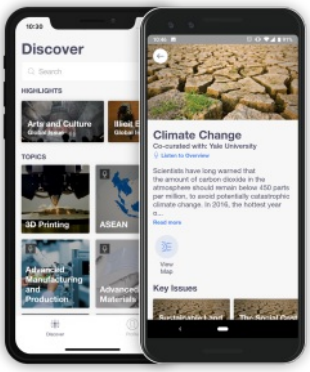

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