

BIOTIC FUTURE IN...

NOTE: The following is a non-exhaustive list of current and future potential applications across all sectors. This list is only for awareness of how biology as a technology may be under development, not an endorsement of any specific project or application.

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Military



1. Biomaterials are lighter compared to traditional vehicle materials, allowing for better fuel efficiency
2. A chemical coating can be used to protect against biological pathogens
3. Hemoglobin has been altered to create artificial blood
4. Engineered materials inspired by animals create improved camouflage gear, often called “biomimicry”
5. Engineered microbes are being used to sense explosives
6. Biodegradable plastics are used to develop compostable bullets
7. Bioluminescent fog has been developed for military and law enforcement
8. DNA can be used to produce highly secure encryption
9. Probiotics can be used to improve cognitive development
10. E. coli is used to produce biofuels to replace jet fuel
11. Portable microbial fuel cells allow the conversion of food and waste into electricity
12. Butanol and acetone are fermented in bacteria to create bio-explosives
13. Microorganisms are engineered to produce enzymes that prevent barnacles and mussels from accumulating on submarines
14. A bio-based coating is used to create a hydrophobic layer on pilot visors
15. Light-sensitive proteins allow for dynamic visors that adjust to changing light conditions
16. Engineered organisms can produce materials that absorb heat to help regulate visor temperature
17. Engineered bacteria are used to make spider silk for body armor

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Computing



1. DNA can be used as a compact storage medium for large datasets
2. Bacteria mixed into dye were used to create fluorescent artwork
3. Computer systems can be based on genetic and metabolic engineering
4. Amino acids can be used to create music
5. Bacteria can be engineered to perform computational tasks
6. Biochemical oscillators from organisms can be used to create clocks
7. Genetic circuits can be used to mimic electronic circuits
8. Artificial neurons are used to create neural networks for computing systems
9. Proteins and cells can be used to create logic gates that process inputs and outputs



Crop Improvement

1. Corn roots can be genetically modified to reduce their dependency on fertilizers (PIVOT bio)
2. Biotechnology creates plants that have more succulent tissue—leading to drought tolerance
3. Bacteria are used to fertilize soil, replacing traditional chemicals
4. Fungi and algae are engineered to be toxic to pests and create safer pesticides
5. CRISPR-modified plants can be designed to enhance carbon capture
6. Basil seeds' coating can be engineered to help seeds grow in drought
7. CRISPR is used to make plants more nutritious
8. CRISPR has been applied to boost plants' resistance to viruses
9. Engineered plants produce less pollen, reducing allergy symptoms
10. Soil bacteria can be utilized to repel mosquitos more effectively than DEET
11. Engineered bioluminescent plants can provide an alternative light source
12. Yeast fermentation can be utilized to make sustainable palm oil
13. Genetically modified soybeans increase soybean oil shelf life
14. Drug metabolism enzymes are engineered to produce insecticides from oranges
15. Cotton was genetically engineered to produce color naturally
16. Marker-assisted breeding can be used for crops and animals
17. Genetically engineered crops can be created to have enhanced photosynthesis
18. Algae has improved photosynthesis and increased carbon capture
19. Bacteria can be engineered to absorb carbon dioxide

Livestock and Food Applications

1. Yeast can be used as an alternative food source for fish farming
2. Plants are used as natural preservatives for meat storage
3. Engineered bacteria are introduced to bee colonies to increase stability and health
4. Cheese can be made from bacteria found on human skin
5. Artificial blood compounds are used to make plant-based meat substitutes taste authentic
6. Engineered enzymes are used to make bread softer
7. Different types of yeast are used to produce more flavorful types of wine
8. Yeast has been used to make flavorful, non-alcoholic wine
9. Engineered tomatoes produce resveratrol—a health-promoting compound in red wine
10. Engineered yeast is used to give beer a hoppy flavor without the flower
11. Engineered yeast can be used to create components for saffron
12. E. coli is engineered to break down sugars to produce honey sustainably and ethically
13. Algae are used to create safe food colorings
14. Yeast can be used to create coffee without coffee beans
15. Yeasts can be used to produce essential nutrients to produce better pet food
16. Genetically engineered animals are used for food to reduce greenhouse gas emissions
17. Atlantic salmon have been genetically engineered to have accelerated growth rates during their early stages

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Industrial



Omics is a field that studies biological molecules to understand how life works at different levels; it suffices for genomics, proteomics, and transcriptomics. Genomics looks at genes, proteomics examines proteins, and transcriptomics studies RNA produced by genes.

1. Engineered vegetable oil is used as an alternative to petroleum-based lubricants
2. Sugars from agricultural products are used to create food packaging materials
3. Cellulose is used to replace foam materials in packaging
4. Cell membrane protein is used to create biological glue
5. Bacteria are used to create dyes for textiles
6. Biological polymers can be used to create self-repairing materials
7. Engineered bacteria are used to make sustainable rubber for tires
8. Mushrooms are used to create artificial leather
9. Proteins, wood, and vegetables can be used to create biodegradable plastic
10. Tissue-engineered skin cells from horses are used to create leather
11. Enzymes from bacteria and yeast are used in detergents to remove stains
12. CRISPR-engineered plants can be used to make eco-friendly paint
13. E. coli can be engineered to create essential oils used in perfumes
14. Omics and molecular technology can be used to create oxygen and food sources in controlled environments

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Biomachine Interface



1. Brain-monitoring headsets can provide basic gaming control
2. Neuroprosthetics can be used to create hearing implants
3. Brain activity monitoring is used to diagnose diseases (EEG)
4. Neuroprosthetics can be used to treat blindness
5. Deep brain stimulation can help treat Alzheimer's, Parkinson's, depression, and anxiety
6. Neuropriming can improve athletic performance
7. Neuroprosthetics can improve motor control
8. Mental state monitoring can be accomplished by measuring brain waves
9. Neuroergonomics can improve workplace design
10. Direct brain-to-device communication can be used to help paralyzed patients
11. Brain waves can be used to interpret a pet's emotions
12. Enhanced sensory perception can be marketed for consumer use
13. Headsets that read brain signals can control consumer electronic actions

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Consumer Products



1. Direct-to-consumer genetic testing for ancestry utilizes genetic engineering (e.g., 23andMe)
2. Direct-to-consumer genetic testing for personal insights about health and lifestyle are being used (e.g., 23andMe, Ancestry DNA)
3. Personalized meal services based on genetics and microbiome are currently available (e.g., myDNA, Gene Food)
4. Personalized probiotics and vitamins based on genetic and microbiome profile can help consumers' health (Seed Health, Ombre)
5. Pet genetic testing is possible using gene therapies
6. Biosensors can be used to monitor personal health, nutrition, and fitness based on omics data
7. Gene therapy can be used to treat hair loss and aging
8. Apples can be modified to stay fresh longer and not brown
9. Fluorescent fish are created for consumer consumption
10. Tomatoes have been modified to have increased antioxidants
11. Embryo screening can be done for nonmedical traits (hair color)
12. Embryo editing for nonmedical traits uses CRISPR engineering

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Pharmaceutical



1. Engineered proteins are used to make Januvia, a diabetes drug
2. Stem cells targeting acute leukemia increase remission rates by 53 percent
3. Gene therapy replaces nonfunctional genes in spinal muscular atrophy, providing a cure
4. CRISPR can be used to validate drug delivery more efficiently
5. B-cell immune cells can be used to treat bone marrow cancer
6. mRNA is used to develop vaccines for RSV and COVID-19
7. Natural killer immune cells are used to target lymphoma
8. Liver stem cells can be used for organ regeneration
9. Drug research and development are enhanced by omics technology
10. Mitochondria transfer can be used to treat neurodegenerative disorders
11. Car T-cell therapies can be used for liquid tumors
12. Gene therapies can be used for single-gene diseases
13. CAR T-cell therapies can treat solid tumors
14. Cell-based therapies can be used to minimize the rejection risk of organ transplants
15. Using plants to produce proteins for the swine flu vaccine reduced production time to one-tenth of the traditional method



Preventative Care

1. Engineered probiotics reduce the risk of intestinal diseases
2. Sensor cells are used for diagnosing diseases
3. Engineered enzymes reduce the risk of heart attack by breaking blood clots
4. Genetically engineered viruses provide safe treatment for mesothelioma
5. Cell signaling engineering can decrease symptoms of aging
6. Single-stranded DNA can be used for cheaper insulin sensors
7. Protein receptors can be engineered to reduce brain cancer
8. Spearmint can be used to reduce chronic pain
9. E. coli can be engineered to convert essential oils to menthol, which is used for pain relief
10. Algae can be used to create anti-inflammatory compounds
11. Carrier screening can be performed to detect genetic disorders
12. Noninvasive prenatal testing has had preliminary efforts and more are on the way
13. Preimplantation genetic testing is performed on embryos for genetic disorders
14. A noninvasive liquid biopsy analyzes DNA from the bloodstream
15. Omics-based screening diagnosis and treatment are used for infectious diseases and some cardiovascular and immune disorders
16. Omics can be used to study and decelerate the molecular aging process
17. Omics-based screening can be used for diagnosis of neurodegenerative diseases
18. CRISPR can be used for embryo editing in medical settings

Disease Treatment

1. 3D bioprinting can create organs and tissues
2. Bioengineered bacterial viruses can treat antibiotic-resistant infections
3. Microbes can be used to create a coating for medical implants
4. Caffeine can be used as a sensor to produce proteins to treat diabetes
5. Dopamine-based receptors are used to produce peptides to reduce blood pressure under high stress
6. A synthetic gene circuit is used to reverse insulin resistance in diabetes
7. CRISPR Cas9 is used to treat muscular dystrophy in dogs
8. Engineered antigen receptors block tumor signaling for leukemia—ensuring that the immune system will not be compromised
9. Bacteria from buttermilk can be used to fight cholera
10. Engineered fungi use a fermentation process to produce pravastatin, a cholesterol-lowering drug
11. Tissue can be repaired using noncellular biomaterials

Biomanufacturing/Biotechnology

1. Mobile bioreactors can be used to create vital drugs anywhere
2. Protein engineering in yeast can be used to create opioids
3. Engineering of enzymes in yeast can be used to produce omega-3-fatty acids
4. Omega-3 fatty acids produced by algae improve asthma and the risk of heart attacks
5. Bacteria are engineered to produce rare cannabinoids for recreational and pharmaceutical use
6. Bacteria can be used for drug discovery screening assays
7. Artificial organs can replace animal testing
8. Using RNA to synthesize proteins outside of cells accelerates traditional chemical manufacturing processes.
9. Yeast serves as a biofactory for producing vital molecules used in drug development.
10. Stem cells can be used to produce transplantable organs
11. New bioroutes are used for drug manufacturing, creating peptides
12. Fermentation processes can be improved for fragrance production
13. Genetic tracing can be used to identify fabric origin and authenticity

Nutritional/Cosmetology

1. Lactase is taken from yeast to make to ease lactose intolerance
2. Microbe engineering allows milk-like protein to be used for non-dairy products
3. Engineered yeast can be used to create low-calorie sugar substitutes
4. Bacterial metabolism can be used to create vanilla flavoring
5. UV-absorbing bacteria are used to develop safer sunscreen
6. Hyaluronic acid and collagen are bioengineered to increase absorption and moisturization for skin care
7. Yeast can be engineered to create vitamin A
8. Yeast can be engineered to make squalene, an essential ingredient in skin care products that are primarily found in sharks
9. Microbes can be used to create skin care and whitening products

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Sustainability



Alternative Fuels

1. Corn and sugarcane are used to create ethanol as an alternative fuel
2. Algae are engineered to produce fatty acids used as biofuels
3. Fuel cells made of bacteria turn wastewater into electricity
4. Algae are used to create solar cells for energy

Biodiversity

1. CRISPR gene drive can be used to control mosquito populations
2. CRISPR was used to bring back endangered chestnut trees
3. Genetic alteration of organisms disrupts the reproduction of invasive species
4. Releases of non-biting male mosquitoes have been decreasing malaria transmissions

Materials

1. Self-repairing concrete is created by using biological systems to increase its lifespan
2. Microbes are used to create fibers for sustainable clothing fabric
3. Wood is engineered to no longer need chemicals to be stripped and to store more carbon
4. Photosynthetic algae is used to develop carbon-absorbing concrete
5. Algae is used to make sustainable surfboards and skis
6. Carbon fiber material is made from algae, identical to the original
7. Bio-based fishing nets are biodegradable
8. Engineered bacteria absorb methane to create plastics
9. Fermentation microbes are used to develop compostable diapers
10. Cellulose is used to create biodegradable glitter
11. Biodegradable tableware is made from seeds and grains
12. Mealworms can eat polystyrene—allowing for faster degradation
13. New bioroutes for food ingredients include stevia sweetener
14. Extraction of raw materials is performed through genetically engineered microbes
15. Novel biopolymer materials such as PLA and PET are developed

Environmental Monitoring

1. Biosensors are used to monitor pollutants in air, water, and soil
2. Microorganisms are used to absorb toxic metals from electronic waste
3. Plant microbiome is used to filter toxic air pollutants in homes
4. Deep sea bacteria are used for oil spill cleanups
5. Bacteria can be engineered into plants to clean up explosive-contaminated lands
6. Fish scales are used to remove heavy metals from water
7. Genetic tracing is used to find food's origin, safety, and authenticity
8. Crop microbiome diagnostics can be used for probiotic treatments
9. Soil microbiome diagnostic and microbial seed treatments are used to improve agriculture
10. Plants are used as sensors to monitor dangerous chemicals
11. Nanotechnology senses microbial contamination in produce