

THE BIOECONOMY AT GENOPOLE

COLLECTION "SECTORS AT GENOPOLE"

GREENING HUMAN ACTIVITIES



GENOPOLE
INNOVATION TODAY, EVERY DAY

THE BIOECONOMY: NATIONAL AND SOCIETAL ISSUES



REDUCE THE ENVIRONMENTAL
IMPACT OF HUMAN ACTIVITIES



CHANGE MANUFACTURING
AND CONSUMPTION PRACTICES



GENERATE GROWTH FOR
THE FRENCH ECONOMY

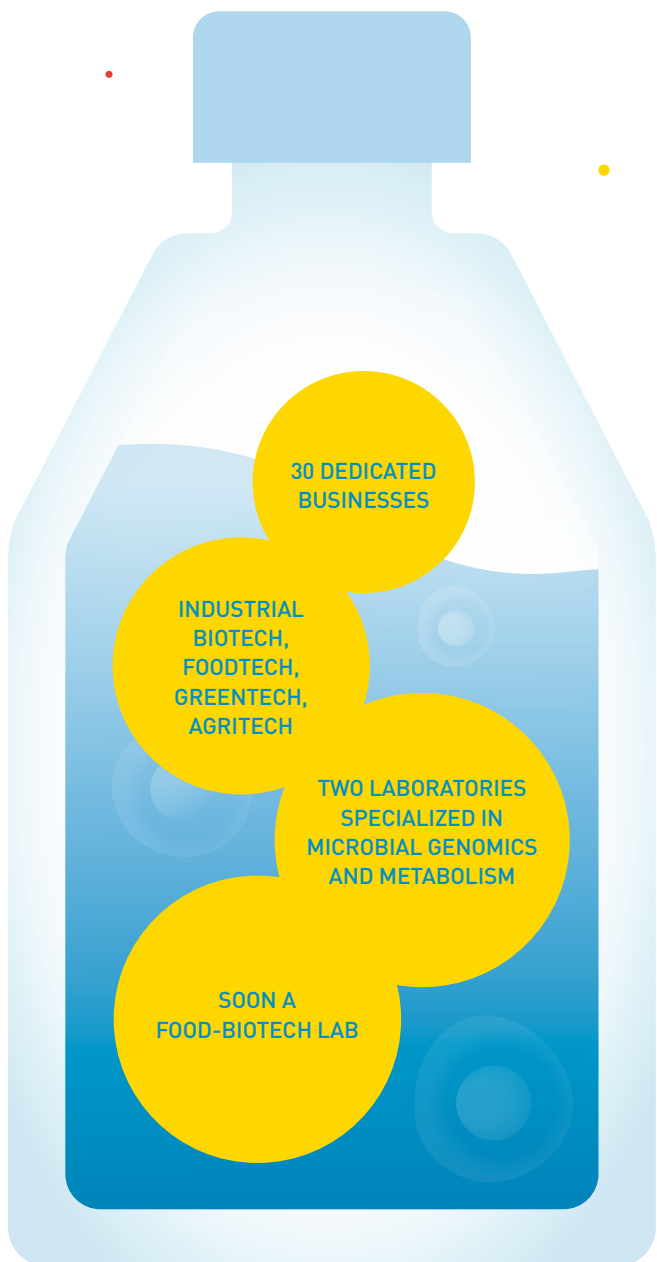


DEVELOP SUSTAINABLE EMPLOYMENT
FOR GREEN ECONOMIES AND ENERGIES



SUPPORT R&D AND INNOVATION


The bioeconomy aims to valorize biomass for the production of materials, nutrition, energy and molecules of industrial interest. At Genopole, a growing number of actors are energizing the development of a sustainable bioeconomy.





GENOPOLE: A LEADER FOR BIOTECHNOLOGIES IN FRANCE

Located in Évry-Courcouronnes, within the greater Paris area, Genopole unites academic research laboratories, innovative businesses and university-level training programs, all focused on biotechnologies for health, the environment and industry. Particularly, the biocluster's actors seek to develop fossil fuel alternatives, greener manufacturing processes and pathways to sustainable nutrition for all.



SUSTAINABLE AGRICULTURE



THE ISSUES

- Reduce agricultural loss, optimize pesticide use, limit chemical fertilizers

USES

- Plant disease diagnostics
- Alternative disease prevention solutions
- Novel natural fertilizers
- Valorization of by-products

WORKING FOR SUSTAINABLE AGRICULTURE

A key resource for the bioeconomy, plant biomass is a particular focal point for biotech innovation. At Genopole, both **Agdia EMEA** and **Anova-Plus** propose on-site molecular diagnostic tools for agriculture to optimize the use of pesticides and reduce crop loss. The start-up **Cearitis** aims to provide an alternative to conventional insecticides by using natural chemical signals to control agricultural pests (photo). **Ynsect** is valorizing the excreted residues (frass) of its insects as fertilizers for use in organic agriculture. To limit the use of antibiotics in livestock, **Phagos** is studying the bacteriophage, a bacteria-specific virus, as an alternative means for controlling bacterial infectious diseases.



A PIONEER IN SYNTHETIC BIOLOGY

In 2008, Genopole founded France's first laboratory dedicated to synthetic biology and participated in the creation of the first university degree for the discipline: the European Master 2 in Systems & Synthetic Biology (mSSB) at the University of Évry-Paris Saclay. Thereafter, Genopole drew and continues to draw researchers and industrials in that field. Since 2012, a team from Évry has participated every year in iGEM, the renowned international competition for synthetic biology.



BIOTECHNOLOGIES: A VITAL LEVER FOR THE BIOECONOMY

The impetus provided by synthetic biology has, today, found its place as a part of the larger development of industrial and environmental biotechnologies at Genopole. Activities at the biocluster include biomanufacturing (biofuels, biomaterials, biodrugs, etc.), nutrition (alternative proteins, synthetic flavorings, etc.), environmental monitoring and remediation, and sustainable agriculture. The innovations born of these biotechnologies are all keystones for a bioeconomy under construction.

SYNTHETIC BIOLOGY

Synthetic biology involves the *in-silico* conception and laboratory creation of complex biological systems with novel functions. The discipline took form in the 2000s and builds upon biotechnological breakthroughs, notably DNA sequencing and synthesis, and engineering sciences.

For the bioeconomy, it holds great promise in such fields as:

- the biomanufacturing of therapeutics, vaccines, materials, fuels, nutritional ingredients and cosmetics
- the conception of biosensors for environmental monitoring
- and many more

AN ADVANCING BIOECONOMY AT GENOPOLE

Beyond bringing good to the environment, advancing a bioeconomy sector also contributes to the nation's independence for resources and the development of high added value, job-creating industries. The emergence of this new economic model is empowered by the innovation, growth and industrialization capacities of biotech start-ups, in other words, Genopole's *raison d'être*. Dedicated to R&D in genomics and biotechnologies, Genopole offers structures and services to accompany the creation and growth of biotech businesses. The growing number of non-healthcare-sector businesses over the last ten years illustrates a dynamic underway at the biocluster. Today, the emerging bioeconomy sector at Genopole comprises two academic laboratories, three shared-use technological platforms, and 30 businesses. The biocluster aims to increase its attractiveness for bioeconomy researchers and industrials.

THE VALUE CHAIN

GENOPOLE'S ACTORS CONTRIBUTE TO THE GROWTH OF A NATIONAL BIOECONOMY SECTOR

INITIAL AND CONTINUOUS TRAINING

UNIVERSITY OF ÉVRY-PARIS SACLAY

- European Master 2, Systems & Synthetic Biology "mSSB"
- Master 2, Health and Biotechnologies Law "One Health – Une Seule Santé" Legal Clinic: training, through practical experience and research, on legal and ethical issues in human, animal and environmental health

IMT GROUP

Professional training in biomanufacturing for the cosmetics and pharmaceutical industries

SUPPLIERS / SERVICES

HYBRIGENICS SERVICES

Research services for the discovery of novel protein interactions

NEW ENGLAND BIOLABS

Reagent discovery, production and supply

SYNHELIX

Enzymatic production of DNA



R&D / OPTIMIZATION

GENOSCOPE

Large-scale sequencing, biodiversity genomics, environmental metagenomics

GENOMICS METABOLICS UNIT

Genomic and chemical diversity of organisms, metabolic engineering, synthetic biology (a Genoscope basic research unit)

BIOMANUFACTURING BY FERMENTATION

Equipment and expertise for the upscalable biomanufacturing of compounds of interest by yeasts or bacteria

MICROSCOPE

Microbial genome annotation, bacterial metagenome and metabolism analyses

MASS SPECTROMETRY

Molecular assays and analyses, proteomics

PROTOPIA

Food-Biotech Lab: culinary laboratory, BSL-1 and BSL-2 labs and equipment for molecular, cellular and microbiology





R&D / OPTIMIZATION

BIOMANUFACTURING – INDUSTRIAL BIOTECH

ABOLIS

Conception of microorganisms for fermentation-based biomanufacturing

ALGENTECH

Development of synthetic biology technologies in plant cells

ALTAR

Development via directed evolution of bacteria, yeasts and microalgae for industry

EVER DYE

Innovative dyeing process associated with a new biologically-produced pigment

FAIRCRAFT

Cell-culture-based process for the production of a leather substitute

PYMABS

R&D services in the field of transient expression of recombinant proteins in plants

STH BIOTECH

Cannabis-based bioprocess for the production of therapeutic, cosmetic or nutraceutical compounds

SYNOVANCE

Fermentation-based biomanufacturing of pigments for the textile and cosmetics industries



R&D / OPTIMIZATION

NUTRITION

GOURMEY

Sustainable meat production from cultivated poultry cells

NUTROPY

Production of animal proteins via precision fermentation

STANDING OVATION

Production of cheeses via plant fermentation

YEASTY

Revalorization of spent brewer's yeast to produce proteinaceous ingredients and foods

ENVIRONMENT

SAFEINSIGHT

Detection of endocrine disruptors for industry (cosmetics, nutrition, textiles, toys, etc.)

SUSTAINABLE AGRICULTURE

CEARITIS

Chemical-ecology-based solution to control olive fruit flies

PHAGOS

Bacteriophages as alternatives to antibiotics for infectious diseases in livestock

PLANTIK BIOSCIENCES

Novel technology to accelerate plant breeding for the creation of new varieties



- Laboratory
- Business
- Technological platform
- ⋯ Technological platform being set-up
- Training

INDUSTRIAL PILOTS / INDUSTRIALIZATION

BIOMANUFACTURING

GLOBAL BIOENERGIES

Bioconversion of plant resources into a family of key ingredients, notably for the cosmetics and biofuels sectors

GLOWEE

Bioluminescent raw material derived from marine bacteria for urban lighting

PHARMING

Production of recombinant proteins in rabbit milk

BIOFOUNDRY

Automated infrastructure to create optimized biological tools for synthetic biology

NUTRITION

ALGAMA

Conception of foods derived from microalgae

NEXTPROTEIN

Conversion of food & agriculture by-products into animal nutrients using black soldier fly larvae

YNSECT

Large-scale insect farming and transformation for nutritional needs in domestic animals, farmed fish, plants, and soon humans

INDUSTRIAL PILOTS / INDUSTRIALIZATION

ENVIRONMENT

BIOMEDE

Remediation of soils polluted by heavy metals using hyperaccumulator plants (phytoremediation)

EVALDÉPOL

Expertise and software for soil and industrial-site pollution diagnostics and remediation

WATCHFROG

Measurement of endocrine disruptor effects, tests on APIs and other ingredients, finished products, packaging, biomonitoring of water and aquatic habitats

SUSTAINABLE AGRICULTURE

AGDIA EMEA

GMO and plant pathogen immunological and molecular diagnostics

ANOVA-PLUS

On-site DNA/RNA tests for decision making in agriculture (treatment management, variety selection, etc.)



- Laboratory
- Business
- Technological platform
- Technological platform being set-up
- Training



BIOMANUFACTURING



NUTRITION



ENVIRONMENT



AGRICULTURE

AN IMPORTANT SECTOR FOR GENOPOLE



BUSINESSES



EMPLOYEES



FIELDS OF APPLICATION ADDRESSING IMPORTANT SOCIETAL CHALLENGES

Genopole brings its strengths to numerous partnerships, particularly those with the 450-member Bioeconomy For Change hub (formerly IAR), the industrial biotechnology demonstrator Toulouse White Biotechnology (TWB), and the Center for Biotechnology and Bioeconomy (CEBB). It also has close ties with EIT Food, a European innovation network in the nutrition sector.

LIFE SCIENCES AND TECHNOLOGIES: A KEY TO TOMORROW'S INDUSTRY

Life sciences and progressing biotechnologies can transform the industrial world. Chemistry, materials, foods and many other sectors will benefit from innovations made possible by biological technologies.

GENOPOLE IS CONTRIBUTING TO SUSTAINABLE INDUSTRIAL PRODUCTION

In coherency with the government's plans for the deployment of biomanufacturing and a bioeconomy in France, the businesses and laboratories at Genopole are conceiving innovative biomass-based products, or developing alternatives to conventional chemistry, notably by finding natural catalysts for synthesis reactions, or engineering biological pathways in bacteria or plants. In the **Genomics Metabolics Laboratory**, biologists and chemists are exploring the diversity of bacterial genomes for novel enzymatic functions capable of making energy-efficient, green manufacturing a reality. Several biocluster actors are looking to leverage microorganisms for the conversion of renewable carbon resources into compounds of industrial interest. For example, since 2008, **Global Bioenergies** has been advancing the biomanufacturing of isobutylene, formerly a petrochemical compound, for use today in the cosmetics industry and tomorrow in biofuels and bioplastics. **Abolis**, under the direction of a doctor in synthetic biology at the University of Évry, uses bioinformatics to conceive biochemical pathways for novel molecules, then synthetic biology to create the microorganisms able to produce them. The company **Altar** builds upon natural selection itself, using algorithms to control the culturing conditions of microorganisms, so that these latter evolve to produce the desired molecule. **Algentech** harnesses synthetic biology to make factories out of plants. The company has patented a high-yield technology for the expression of molecules in chloroplasts, which have the advantage of running on only sunlight and atmospheric CO₂. These companies benefit from the **shared-use Fermentation Bioproduction platform** for the upscaling of their biomanufacturing systems, from small, 350-milliliter volumes all the way up to larger, 20-liter pilot volumes. As bioprocesses and biological resources diversify, the biocluster welcomes new start-ups, like **Glowee** and **Faircraft** for example. The former draws upon marine bacteria to produce a soft lighting with low environmental impact for use in urban and event settings, and the latter is betting on the technological potential of cell culturing to make a high-quality substitute for leather while lowering carbon emissions.

INDUSTRIAL PRODUCTION



THE ISSUES

- Develop biosourced production and increase the share of biomanufacturing notably in the fine chemicals sector

USES

- **Metabolic engineering and biological production in:**
 - microorganisms (bacteria, yeasts, unicellular microalgae, etc.)
 - plants
 - insects
- **Green chemistry and biocatalysis:** natural catalyzing enzymes as alternatives to conventional chemistry
- **Biosourced chemistry:** from agricultural, forest, and other biomasses, including by-products and waste

NUTRITION, ALTERNATIVE PROTEINS



THE ISSUES

- Meet rapidly-growing needs for human nutrition, notably as concerns proteins
- Increase national and European autonomy for protein needs in animal nutrition

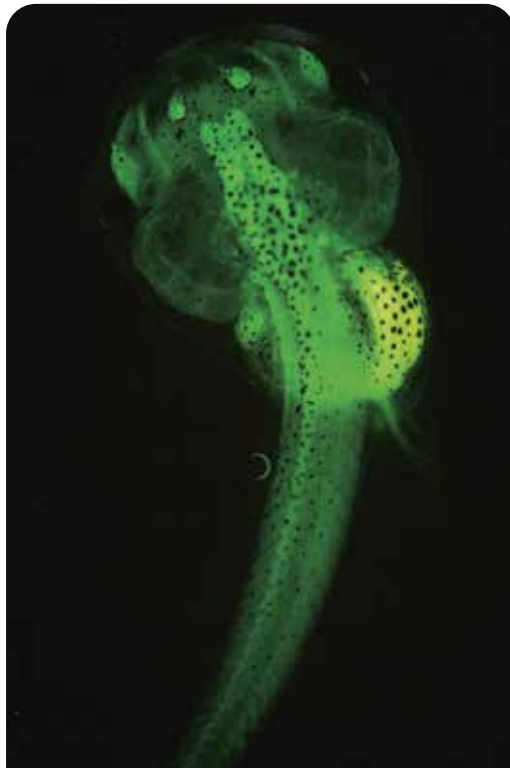
USES

- **Alternative proteins, new resources for human nutrition** (Novel Food regulation):
 - insect farming and transformation
 - algae/microalgae culture and transformation
 - protein production via yeast fermentation
 - cellular agriculture
- **Novel sources of proteins and other nutriment for animal nutrition:**
 - insect farming and transformation, algae culturing, wood fermentation, etc.

INNOVATING AT GENOPOLE TO FEED THE WORLD

Close to 10 billion people will inhabit the earth by year 2050. To meet their nutritional needs, especially in proteins, food resources for both humans and animals must diversify. Several companies at Genopole are exploring novel, environmentally-friendly nutrition sources and bringing life to a new agro-industry era. **Algama** is studying algae as an alternative to animal proteins. Laureate of the Île-de-France Administrative Region's Pm'up Relaunch Industry program in late 2020, the company is planning a large-scale facility for the production of ingredients meant to replace eggs, milk, meat and fish, or serve as emulsifiers. Already at the industrial stage, **Ynsect** is building the world's largest insect farming center. This latter will provide high-quality proteins and oils for use in foods for pets and fish currently, and for humans in the future. The company's laboratory at Genopole is one of the world's largest private entities for insect research. Other innovations are taking form, for example, meats created via cell culturing (**Gourmey**), or proteins through yeast or bacteria fermentation (**Nutropy**, **Yeasty**, **Standing Ovation**). A shared space called **Protopia** will soon provide these companies with a culinary laboratory and shared-use equipment for microbiological studies and analyses.





HEALTHIER ENVIRONMENTS AND INDUSTRIAL PRODUCTS

Genopole's actors are inventing technological solutions to clean up air, water and soils and ensure the fitness of consumer products. The start-up **EvalDépol**, a specialist in environmental remediation, has patented software for industrial site diagnostics and rehabilitation. The program processes and compiles data in the form of 3D interactive maps of concerned sites. The **laboratory WatchFrog** calls upon the natural susceptibility of aquatic larvae (photo) to endocrine disruptors to measure the effects of these latter not only in water but also in specific ingredients, finished products and packaging. Its tests are internationally validated by the OECD. The national center **Genoscope** is pursuing its analyses and remediation projects in the wake of its demonstration of the degradability of the insecticide chlordecone, which remains to this day as a massive pollutant of West Indies soils despite its ban in 1993.

ENVIRONMENTAL MONITORING AND REMEDIATION



THE ISSUES

- Monitor the environment, manage and diminish pollution

USES

- Pollution-detecting biosensors
- Biologicals systems for pollutant capture
- Bioremediation: biological breakdown of pollutants

COLLECTION "SECTORS AT GENOPOLE"



- 1 INNOVATIVE BIOTHERAPIES
- 2 COMPUTATIONAL GENOMICS
- 3 THE BIOECONOMY

By combining the worlds of business, academic research and professional training, Genopole is helping to build three of tomorrow's industrial sectors.

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