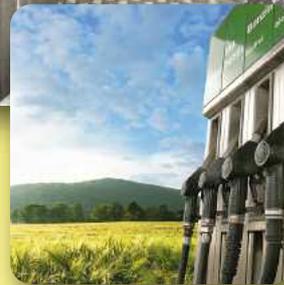


Industrial Biotechnology in Hessen

A Guided Tour through the User Sectors



Hessen – there's no way around us.

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A Guided Tour through the
User Sectors

Volume 11 of the Publication Series
of the Aktionslinie Hessen-Biotech

Imprint

Industrial Biotechnology in Hessen A Guided Tour through the User Sectors

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Content

Preamble	2
Industrial Biotechnology is the link Interdisciplinary Research for Practical Application	3
CIB Frankfurt - the Competence Network for Industrial Biotechnology in Hessen	4
Hessen - Innovation Centre for Industrial Biotechnology	5
Industrial Biotechnology is beauty care More effective cosmetics	6
Industrial Biotechnology is energy Regenerative fuels	9
Industrial Biotechnology is clothing Enzymes in the textile and leather industries	12
Industrial Biotechnology puts the flavour in Food production with Industrial Biotechnology	14
Industrial Biotechnology protects the environment Microorganisms and enzymes remove pollution	17
Industrial Biotechnology has a future A world without chimneys	19
Publication Series of the Aktionslinie Hessen-Biotech	21



Dear Readers,



Dieter Posch
Hessian Minister of
Economy, Transport, Urban
and Regional Development

Industrial Biotechnology - or White Biotechnology, as it is also called - has an important potential contribution to make to the further development of our industrial society. It will help to put sustainability on a sure footing in industry and safeguard the competitiveness of the German and European economy. Industrial Biotechnology has already successfully captured key market positions in a number of segments. In the food, cosmetics and textile industries, in drug production and in fine chemicals, biotechnological processes by now account for about 5 percent of the total turnover of the chemical industry. However, in view of the increasing scarcity of resources and rising energy prices, experts believe that this share will grow yet further in the years to come. Hessen, with its long tradition in chemistry and its effective research, is well qualified to play a pioneer role not only now but also well into the future.

Greater sustainability in industrial production

"Agenda 21" gave the starting signal for international initiatives in favour of a sustainable way of life. Since then, a great number of countries have committed themselves to achieving a balance between economy, ecology and social aspects of economic activity. This goal is becoming of ever greater public and political importance. With the aid of biotechnological processes it will be possible ultimately to reduce costs and environmental pollution, while at the same time creating more jobs.

One of the pioneers of Industrial Biotechnology came from Hessen

Ten years or so ago, Industrial Biotechnology was put back into the centre of attention with a study by the Organization for Economic Cooperation and Development (OECD) - after all, the principle is in itself not new. As early as 1907, the pharmacist Otto Röhm in Darmstadt extracted enzymes from the pancreas of animals with a view to making leather tanning more environmentally friendly. Hessen can thus count itself as a pioneer of a global development.

This guided tour through Industrial Biotechnology in Hessen's universities, research institutes and companies will give you an idea of the situation as it is at present - though without neglecting current laboratory developments and visions for tomorrow. We in Hessen, situated at the very centre of Europe, see ourselves in an excellent position to make a sustainable contribution for our future, in cooperation with others at both national and international level. The achievements of Industrial Biotechnology will help to shape our everyday lives - ecologically, economically and in a socially acceptable way - to ensure sustainability now and over the generations to come.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Dieter Posch'.

Dieter Posch
Hessian Minister of Economy, Transport,
Urban and Regional Development

Industrial Biotechnology is the link

Interdisciplinary Research for Practical Application

Industrial - or White - Biotechnology is a genuine interdisciplinary technology: located at the interfaces of chemistry, biology and the engineering sciences, it takes advantage of nature's own tools. It uses microorganisms and enzymes to create new substances and processes for the purpose of producing innovations for many very different user sectors. For example, amino acids, vitamins

and aromas for the food and feed industries, new active ingredients for the cosmetics industry, special technical enzymes for the textile and paper industries, and a wide range of innovative processes for generating energy and protecting the environment. Innovations of this kind call for many different competences along the value chain in Industrial Biotechnology.

Everything comes together in Hessen

Hessen is one of Europe's key locations for Industrial Biotechnology. The pace here is set mainly by small and medium-sized companies. With companies such as BRAIN, BioSpring, nadicom, N-Zyme BioTec and AB Enzymes, a solid core of enzyme and biocatalysis specialist has come into being. Only Hessen can show such a concentration of small and medium-sized companies with a powerful R&D base. With its long tradition as a location for chemistry, Hessen also has many production sites belonging to large concerns - Sandoz (Frankfurt), Evonik (Hanau), Merck and Evonik Röhm (Darmstadt), to name just a few. In addition to these key companies in the sector, Hessen also has a number of excellent research facilities in this field. The highcompetence in this region was one of the decisive reasons why Hessen's cluster concept "Integrated Bioindustry" was chosen as winner of the countrywide Industrial Biotechnology cluster contest.

The research facilities and companies in Hessen cover the entire value chain in Industrial Biotechnology:

- Development of cost-efficient substrates
- Provision of suitable enzymes and expression systems
- Optimization of metabolic pathways (metabolic design)
- Development of novel and more effective recovery and purification methods (downstream processing)

Hessen's Competences in Industrial Biotechnology

Research facilities	Special feature
Universities of Applied Sciences in Darmstadt, Giessen, Frankfurt am Main	Main focus biotechnology and process engineering
Technical University Darmstadt Goethe University Frankfurt	Joint Master's course Molecular Biotechnology
Justus Liebig University Giessen	Hessen's only food chemistry course
Justus Liebig University Giessen	LOEWE Focal Point* Fraunhofer Bioresources Project Group
Philipps University Marburg MPI for Terrestrial Microbiology	Joint LOEWE Project* "Synthetic Microbiology"
Karl Winnacker Institute of DECHEMA in Frankfurt	Bioprocess engineering, interface between research and industry

* LOEWE: State Offensive for the Development of Scientific and Economic Excellence

Company	Town	Competence Areas													
		Agriculture	Aromas	Biomedicine	Soil remediation	Chemistry	Energy	Animal feeds	Health	Cosmetics	Plastics	Food	Leather	Textiles	Env. protection
Major concerns															
Evonik Degussa GmbH	Hanau					X	X	X							X
Merck KGaA	Darmstadt								X	X					
Sandoz Industrial Products GmbH	Frankfurt a. M.					X			X						
Sanofi-Aventis Deutschland GmbH	Frankfurt a. M.								X						
Small and medium-sized companies															
AB Enzymes GmbH	Darmstadt	X				X		X				X			
B.R.A.I.N AG	Zwingenberg		X			X				X		X		X	
BioSpring GmbH	Frankfurt a. M.					X			X						
nadicom GmbH	Marburg				X							X			X
N-Zyme BioTec GmbH	Darmstadt			X				X	X	X	X	X	X		

CIB Frankfurt - the Competence Network for Industrial Biotechnology in Hessen



CIB Frankfurt

Cluster Integrated Bioindustry Frankfurt

The Cluster Initiative Integrated Biotechnology (CIB) Frankfurt, with its focus on fine and specialty chemistry, was among the winners of the "BioIndustry 2021" contest held by the Federal Ministry of Research. Nineteen competitors from throughout Germany originally took part. Five winners were selected by an international jury. As a first step, funds to a total of five million euros were awarded to Industrial Biotechnology projects in Hessen. The Cluster Management of the CIB Frankfurt organizes an annual congress for the actors in Industrial Biotechnology as the main get together for the sector. This is an occasion for presenting new ideas for projects, discussing research results with a view to their industrial application potential, and identifying new partners - thus creating the basis for new joint projects.

To get new processes and innovative products ready for the market, the Frankfurt Cluster now has the support of about 80 partners from science and industry with their competences in the key technologies of enzyme catalysis, fermentation and downstream processing. Seven projects with a total volume of more than 11 million euros have already grown out of CIB's partnering activities. In a variety of fields such as pharmaceutical precursors, cosmetic active ingredients, fine chemicals and nutrients, well-known representatives of the various user industries from throughout Germany, including Sanofi-Aventis, Merck, DSM, BASF and Symrise, are active in the funding projects of CIB Frankfurt.

Capital for Industrial Biotechnology

Further developments in Industrial Biotechnology will depend, among other things, on whether the combined efforts of all parties concerned can successfully promote good ideas and provide help for innovative companies during the start-up phase. To this end, Hessen's government set up a State Offensive for the Development of Scientific and Economic Excellence (LOEWE) in 2008 with a view to providing long-term support for the research landscape. This especially includes new ideas in Industrial Biotechnology. Insect biotechnology - a major new research line of the Justus Liebig University in Giessen and the Fraunhofer Gesellschaft - is being promoted in its work of discovering new active ingredients for the chemical and pharmaceutical industry in the metabolism of insects. Another key element of the Frankfurt Cluster concept is the financing of Industrial Biotechnology companies. For this purpose "CIB invest" was set up. Companies are brought together with investors at conferences and workshops on the subject of financing. The entrepreneurs are given coaching before these decisive discussions are held. One result of the exchanges between experts from

the technical and financial spheres is that an increasing number of bankers and venture capital investors are coming to realize the investment opportunities opened up by Industrial Biotechnology.

The results of research cannot be planned. But the close cooperation between public and private funding can enhance the probability of success. Nearness to the financial centre Frankfurt and the subsequent networking with wider circles are of inestimable value for this type of public-private partnership.



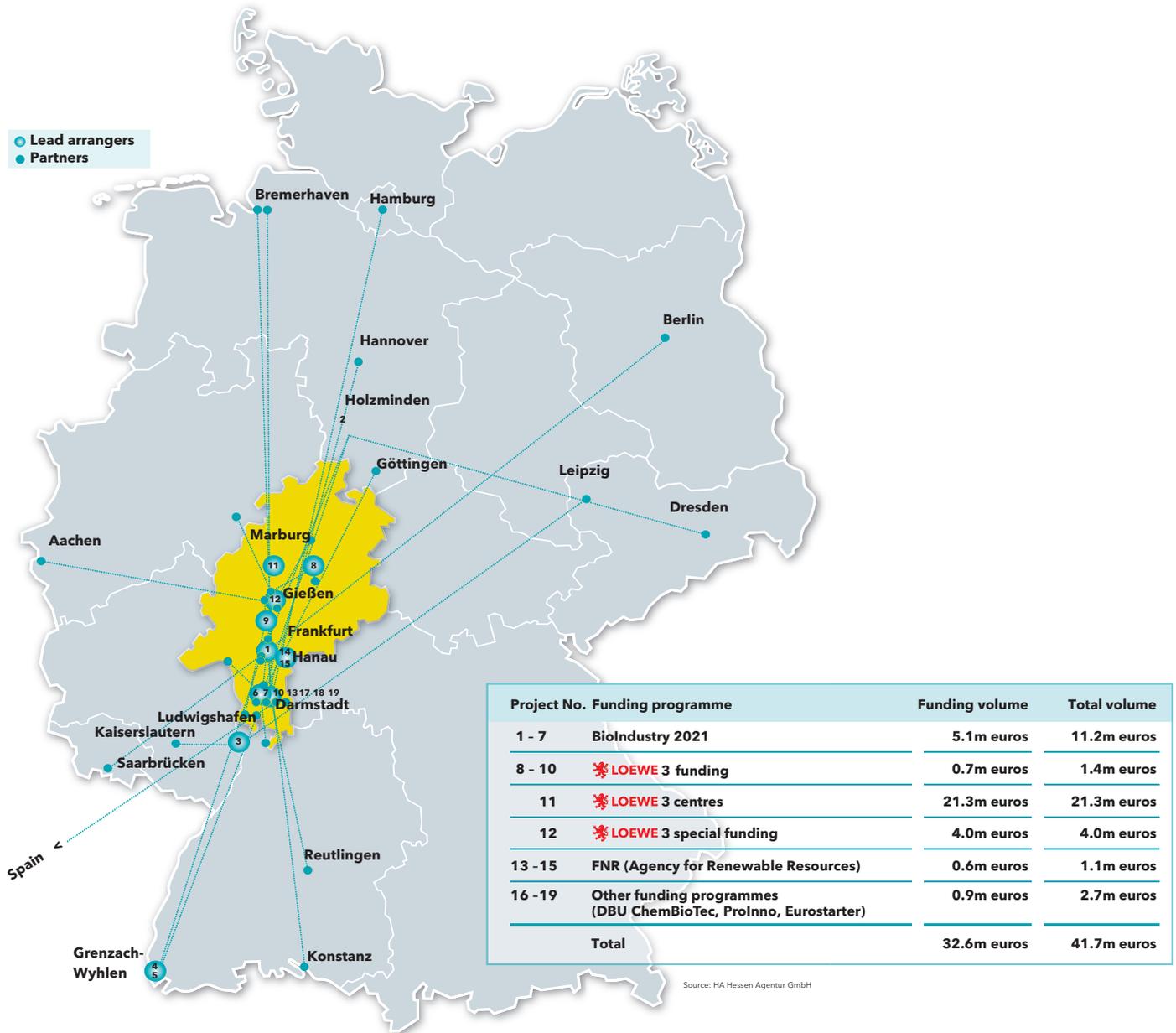
"At a rough estimate, the amount of capital which will be required by existing start-ups or small and medium-sized companies, and potential start-ups over the next few years will amount to about 500 million euros."

Dr. Gunter Festel, Festel Capital



Hessen

Innovation Centre for Industrial Biotechnology



In Hessen, funds of more than 32 million euros are made available for Industrial Biotechnology. Funding of this future technology is an integral part of Hessen’s government programmes. Approximately 26 million euros are being invested through Hessen’s funding programme LOEWE (State Offensive for the Development of Scientific and Economic Excellence) in projects, centres and focal points of Industrial Biotechnology.

“The BioIndustry 2021 initiative of the BMBF [Federal Ministry of Education and Research] helps to ensure that ideas and research results in the field of “White Biotechnology” can be brought on the market more quickly in the form of products. To this end, regional and cross-regional partners from science, economy and finance should come together from the beginning.”

Dr. Christian Müller, BMBF Berlin

Industrial Biotechnology is beauty care

More effective cosmetics



Germans spend 150 euros per head every year for body care products such as deodorants, shower gels or skin creams. Since body care products are expected to be natural, effective and well tolerated, cosmetics manufacturers are focusing increasingly on biotechnological processes. "Natural beauty is from within." In the era of Industrial Biotechnology this slogan of the Frankfurt company Merz becomes more relevant than ever before. The new cosmetics act directly in the cells, which are ultimately decisive for good outward appearance. Scientists decode the cell processes which lead to skin aging and use this knowledge to develop new additives for the prevention of lines and wrinkles. They turn their attention to odour producing bacteria and discover new active principles for deodorants. In Hessen, ingredients for cosmetics are not only explored, they are also produced in bioreactors.

Biotechnology against wrinkles

Our largest organ, the skin, has a wide range of protective mechanisms against harmful environmental influences. Among these are certain lipids in the surface layer of the skin, the ceramides, which effectively prevent the skin from drying out and slow down the skin aging process. For some years it has already been possible to produce skin-identical ceramides by biotechnological methods. A special yeast species is used to produce a ceramide component which occurs in the same form in our skin. Cosmetics producers are now incorporating this in creams.

Better still would be to prevent the formation of wrinkles in the first place. Scientists have already found out why our skin ages: under UV stress the skin cells release a collagen degrading enzyme which causes the skin to lose its elasticity. Fortunately, our cells also produce a substance which blocks the collagen degrading enzyme, thus slowing down the aging process. The human gene containing the blueprint for this inhibitor has been isolated at BRAIN and implanted in E-coli bacteria. The bacteria now produce the natural anti-wrinkle factor in a bioreactor. The substance is carefully purified and mixed in with a cream. The result is a test product which has aroused great interest in the cosmetics sector.

“

"We are currently carrying out in-house discussions to identify areas where we can make use of White Biotechnology to replace or support chemical processes."

*Professor Thomas Herget
Senior Director Research and
Development at Merck in Darmstadt*

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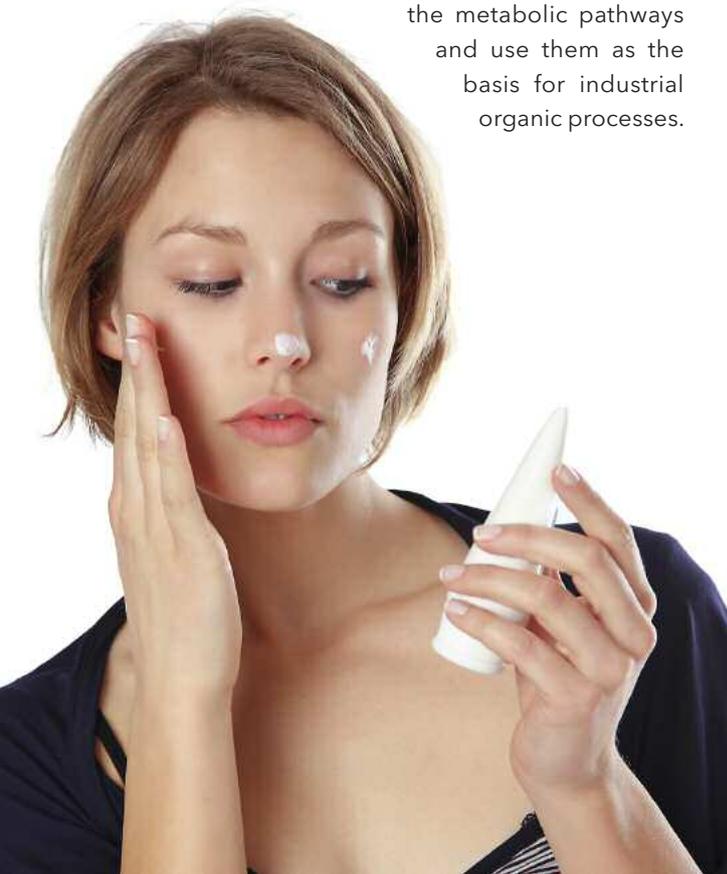
Self-tanning products and musk fragrance from the bioreactor

For almost 40 years, Merck KGaA has been producing one of the basic materials for the cosmetics industry in the bioreactor: the sunless tanning agent dihydroxyacetone. The substance was discovered in 1960 in *Gluconobacter oxydans* bacteria, which have been used for hundreds of years in the production of vinegar. These microorganisms are also used in the cosmetics industry, since the biotechnological process is cheap and simple - the starting material is glycerine, which occurs abundantly as a by-product of soap manufacture and, more recently, of biodiesel production. Scientists are continually widening the range of substances which can be produced by fermentation. For this reason, Merck is now aiming to find out what other products can be produced in bioreactors instead of traditional chemical apparatus.

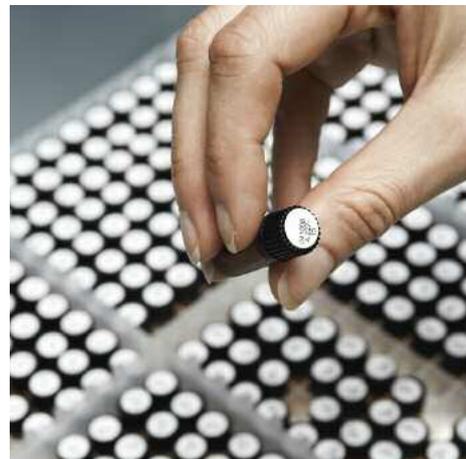
Another company planning to make greater use of biotechnological processes is Symrise AG in Holzminden (Lower Saxony), one of the world's major suppliers of aromas and fragrances. For this purpose Symrise is engaging in strategic cooperations with partners in Hessen, and is working together with Darmstadt Technical University and the Karl Winacker Institute of DECHEMA (Society for Chemical Engineering and Biotechnology) on the biotechnological production of valuable musk fragrances. For cost reasons these fragrances are still being produced on a petrochemical basis. They originate naturally from an abdominal gland of the musk deer, but knowledge about their biosynthesis is still incomplete. It is now proposed to clarify the metabolic pathways and use them as the basis for industrial organic processes.

New active principles for deodorants and creams

Cooperation with partners from Hessen has proved useful for Symrise AG in the past. The company has already developed two novel cosmetic active ingredients together with BRAIN AG in Zwingenberg. One of these soothes irritated skin by blocking a receptor responsible for reddening, itching and other dermal irritations. The other prevents body odour - and to better effect than conventional products.



patriciaphotography © www.foto.de



Source: BRAIN AG



Source: BRAIN AG

The new deodorant active ingredient is designed to inhibit a particular bacterium which makes sweat smell unpleasant (sweat in itself has a neutral odour). Bacteria of this kind form a wafer-thin organic film in which they communicate through highly specific signals. If this bacterial communication can be specifically blocked, the organic film will not be formed and the sweat will not smell disagreeable. The first thing the scientists at BRAIN did was to identify the bacteria concerned. In close cooperation with AnalytiCon Discovery GmbH, a specialist in the screening and optimization of natural substances, they discovered an active ingredient and modified it in such a way that it was able to inhibit the bacterial communication for 24 hours. As a result, there is no need for any other deodorant additives such as alcohol or broad-spectrum antibiotics which disturb the entire skin microflora.

The interdisciplinary cooperation between Symrise, BRAIN and AnalytiCon Discovery led to an extraordinary shortening of the development period. The whole project, from initiation to the launching of the new deodorant active ingredient, took only two years - an impressive example of the value creation made possible by the networking of different experts, which is a characteristic of Industrial Biotechnology.

Preservatives from citrus fruits

A permanent challenge for cosmetics manufacturers is the restricted shelf life of their products. Some of the substances often used for preserving them contain halogen or formaldehyde, which can irritate the skin. However, nature has antimicrobial substances of its own which increase shelf life in a gentle way. One example is perillic acid. The technique for producing this natural preservative in the bioreactor has been explored by scientists at the Karl Winnacker Institute of DECHEMA in Frankfurt. The special feature of their fermentation process is that the precursor used by the bacteria in question is limonene, which occurs in large quantities as a waste product in the citrus fruit industry. The researchers at DECHEMA are at present trying to find out what other substances the bacterium can produce from limonene and similar residual material.

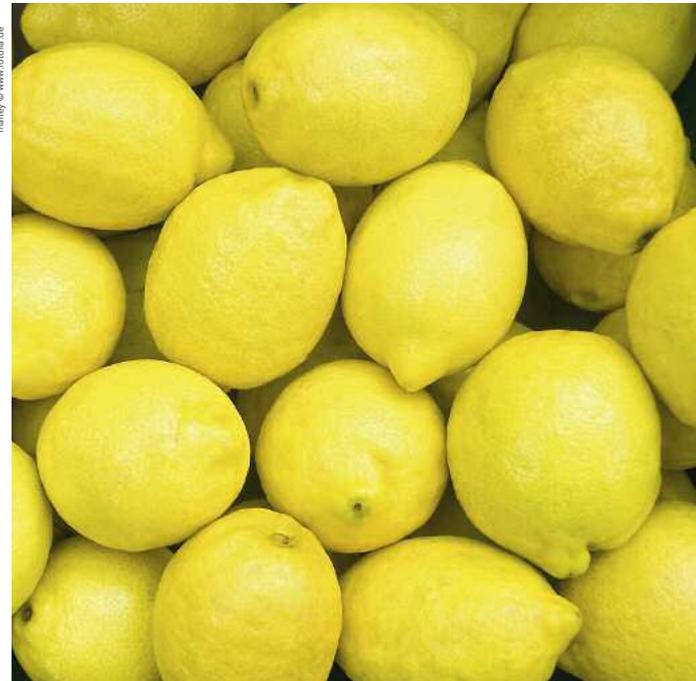
The use of cheap organic wastes as raw materials, the production of more readily tolerable additives and, more particularly, of better active ingredients - Industrial Biotechnology offers the cosmetics industry several advantages at the same time. And quite apart from this, it enables the sector to meet consumer wishes for natural ingredients.

“

“We will continue to develop this successful strategy and are glad that we have formed such a powerful consortium in the field of natural substances.”

Achim Daub, President of Scent & Care at Symrise in Holzminden

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Industrial Biotechnology is energy

Regenerative fuels

Global energy consumption is continually rising, while fossil energy resources such as oil and coal are being depleted more rapidly day by day. It is not for this reason alone that renewable energy is becoming increasingly important. One of the major sources of renewable energy in Germany is biomass. The utilization of whole plants or residual materials of plant and animal origin is already making a noticeable contribution to Germany's energy supplies. However, the use of biofuels from renewables such as rapeseed oil or vegetable starch has fallen recently into disrepute because energy crops enter into competition with food crops. Industrial Biotechnology points the way out of this dilemma - researchers in Hessen are developing second generation biofuels, to be produced from straw, wood and other residual materials.



klick © www.fotolia.de

Biogas from organic waste

The “fuel or food” debate does not arise for biogas production. Waste materials of plant and animal origin are fermented by special bacteria to methane and carbon dioxide in large tanks. The bacteria feed on residual and waste matter of biological origin such as old or scrap wood, organic wastes, sewage sludge, liquid manure or cereal straw. Hessen already has 94 biogas plants with a total capacity of 33,600 kilowatts (as at October 2009). Readily degradable organic matter such as manure or silage are fermented in them - and they can also be fermented together with so-called co-substrates such as lawn clippings, food leftovers and other residual matter. The methane is finally burnt and used for generating electricity and heat.

A biogas plant unique of its kind has been in operation since 2007 at the Höchst Industrial Park in Frankfurt. Here organic wastes and industrial sludge are converted daily to 30,000 cubic metres of biogas. It is planned to condition some of it in future and feed it into the public gas network in an amount equivalent to that needed by about 4,000 one-family houses. The first biogas plant in Hessen to feed gas into the supply network was inaugurated in 2008 in Darmstadt-Wixhausen. The materials fermented here are mainly maize silage and rye husks.

However, the bacteria used for biogas production are unable to use woody plant waste, but new enzymes are already being developed for the pre-treatment of tree waste and other organic material similarly difficult to break down.



Source: OKOBI GmbH

Conditioning plant in Darmstadt-Wixhausen



Mobile in Hessen with fuel from the field

Given the increasing mobility of people and goods, bio-energy will play an important role particularly in transport. Hessen – a major traffic hub between north and south, east and west – is devoting itself to this issue with all due responsibility. Germany's first bioethanol filling station was opened in Hessen in December 2005 on the premises of a car dealer in Bad Homburg. The proprietor had already been selling so-called flexible fuel vehicles which can run on both gasoline and ethanol. It was only logical, therefore, to supply the necessary biofuel. In the meantime, ethanol – or more correctly E85, i.e. gasoline with 85 percent ethanol by volume – is being sold countrywide at approximately 270 filling stations, of which 30 are in Hessen. And flexible fuel vehicles are becoming increasingly popular – as part of Hessen's pilot project "Mobile with Bioethanol" the Regional Council in Giessen concluded a leasing contract for flexible fuel vehicles.

Bioethanol is produced in Germany predominantly from cereals and sugar beets, in Brazil from sugar cane, and in the USA mainly from maize. However, these first generation biofuels can be nothing more than an interim solution on the way to an exit from fossil energy fuels. Since valuable foodstuffs should not end up in fuel tanks in future, there is a clear need for new methods of biofuel production.

Ethanol and butanol from plant waste

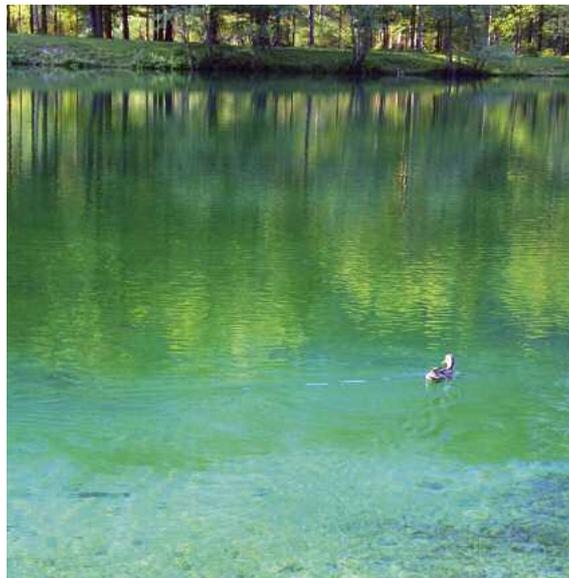
A low-cost alternative is provided by the second generation biofuels, which are obtained from plant waste and food industry by-products, e.g. straw, wood scraps, or energy plants such as miscanthus and switchgrass. Professor Eckhard Boles, a microbiologist at Frankfurt's Goethe University, is working on the use of plant biomass for the production of alcohol fuels. Together with his own company, Butalco GmbH, Professor Boles is developing special yeasts which convert straw and other organic wastes to alcohol fuels. As a fuel, however, ethanol has a serious drawback – it absorbs water and has a corrosive action. The aim of Professor Boles, therefore, is the biotechnological production of biobutanol, which causes no damage to conventional internal combustion engines. In addition, butanol has a higher energy density, which means a greater maximum distance per tankful. Butanol, unlike ethanol, does not occur in natural yeast metabolism, but genetically modified yeasts are already producing the future fuel on a laboratory scale, even if only in very small amounts. Their metabolism is now being further optimized for commercial use.

Biohydrogen – learning from the termites

Experts are also setting great hopes in hydrogen as an energy source for fuel cell vehicles. But the hydrogen will also have to be produced by a sustainable method if it is to become established in the energy mix of the future. Researchers in Giessen and Marburg are pursuing the vision of getting hydrogen from woody plant waste, and have taken termites as their model. The termite intestine houses a community of highly specialized symbiotic microorganisms which digest wood enzymatically. The amount of cellulose needed by termites to produce two litres of hydrogen is equivalent to not more than that contained in a DIN A4 sheet of paper.

Enzymatic digestion of wood and the composition of the microorganisms in the termite intestine are being investigated in detail by Professor Andreas Brune at the Max Planck Institute for Terrestrial Microbiology in Marburg. At the Justus Liebig University in Giessen Professor Andreas Vilcinskis is investigating insects in a search for enzymes which convert woody plant waste to hydrogen. His particular interest is focused on the digestion of wood by indigenous insects such as the common wood wasp.

What biofuels our vehicles will run on in future – whether ethanol, butanol or hydrogen – is something which no-one can predict at the moment. But one thing is certain: ideas from Hessen will contribute to the sustainable provision of tomorrow's fuels.



romy mitterlechner © www.fotolia.de

Cyanobacteria as fuel producers

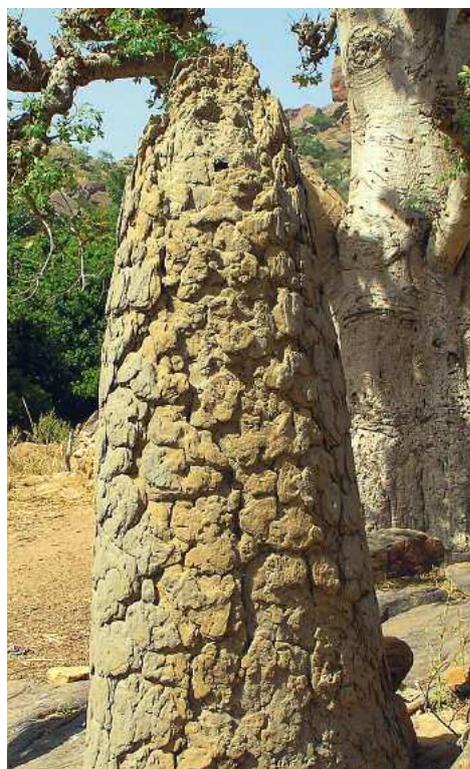
Another initiator in the search for regenerative fuels which do not compete with food crops for their production is the Justus Liebig University in Giessen, where the metabolism of cyanobacteria (also known as "blue-green algae") is being studied by Annegret Wilde, a professor of microbiology. Cyanobacteria, like algae and higher plants, also obtain their energy from photosynthesis. From sunlight and carbon dioxide they produce very small amounts of ethanol as a natural metabolite. It is hoped that analysis of the metabolism of cyanobacteria with the aid of molecular biology will provide starting points for stepping up ethanol production.

“

“In theory, termites can produce about two litres of hydrogen from the cellulose contained in a DIN A4 sheet of paper by breaking them down with symbionts which inhabit their intestines. With this a fuel cell vehicle can travel almost ten kilometres.”

*Professor Andreas Vilcinskis,
Entomologist at the Justus Liebig
University in Giessen and Head of the
Fraunhofer Bioresources Project Group*

”



Jan Renke © www.fotolia.de

Industrial Biotechnology is clothing

Enzymes in the textile and leather industries



Charly © www.fotolia.de

Chemicals are indispensable for the production of artificial fibres and for the processing of cotton, leather and other natural materials. Chromium salts are used for tanning leather, formaldehyde serves to prevent wrinkling. Thanks to modern textile chemistry, our clothes keep their colours longer and do not become matted so quickly. However, some of the substances used are considered to be harmful to health and the environment. Industrial Biotechnology can provide more gentle means, for example enzymes for the bleaching of jeans. The leather and textile industries are on the search for natural alternatives for many other chemical processes. Biotechnology companies in Hessen are greatly in demand by global concerns engaged in the production of textile chemicals.

Many processes are optimized by enzymes

Biotechnological processes have long become established in the textile industry. Special enzymes, the xylanases, remove woody tissues from raw cotton, while amylases remove the starch used to coat and stabilize the fibres during weaving. However, since the European textile industry cannot compete with firms in Asia as regards the costs either for labour or for compliance with environmental regulations, it will have to establish more environmentally friendly production processes and more sustainable new products.

The latest trend: clothes with a function

A wide range of potential uses is expected from what are known as technical or functional textiles, e.g. textiles for allergy sufferers, textiles with an antimicrobial effect, textiles for hospital hygiene, and textiles in which cosmetic or pharmaceutical products have been incorporated. Natural coatings against rain and wind are already being developed. Research into biotechnological solutions for textile manufacturers is also being done by companies in Hessen. For example, BRAIN AG in Zwingenberg is cooperating with the specialty chemical producer Clariant AG on the development of new enzymes for textile finishing and the optimization of processes in the textile industry.

Otto Röhm, pioneer of Industrial Biotechnology in Hessen

Over 100 years ago, the pharmacist and chemist Otto Röhm isolated enzymes from the animal pancreas for leather production. In 1907, together with the merchant Otto Haas, he founded the company Röhm & Haas, out of which grew Röhm Enzyme, now AB Enzymes. In 1909 the company moved to Darmstadt in the vicinity of the then leather factories. Otto Röhm, who filed a patent for the first enzymatic detergent in 1914 and introduced the first biotechnological method of clarifying fruit juice in the mid-1930s, was among those who originally helped to establish Hessen's powerful position in Industrial Biotechnology.

Olive leaves for fine leather

The leather industry, too, is interested in new and environmentally more friendly processes. At the present time it is still using worldwide more than 480,000 tonnes of chromium-containing tanning agents which, when improperly handled, can be hazardous to both human health and the environment. Biotechnology is working on a sustainable alternative on the basis of plant substances.

N Zyme BioTec GmbH in Darmstadt is developing a new tanning agent from olive leaves and has already applied for a patent. The company specializes in natural cross-linking molecules, and these are exactly the substances needed for tanning, since they link the collagen of the animal skins to form leather. The plant-derived tanning agent is extracted with water from olive leaves – without organic solvents – and biotechnologically activated. In cooperation with the Reutlingen Leather Institute, an internationally renowned research centre and tanner's school, N Zyme BioTec has already used it for tanning leather on a pilot plant scale. Thanks to Industrial Biotechnology it is not only ecologically compatible but also highly resistant and at the same time just as soft as conventionally tanned leather.



Sven Hoppe © www.foto12.de

Jeans – stonewashed without stones

Environmentally friendlier techniques, improved products – the advantages of biotechnology have also been recognized by the manufacturers of stonewashed jeans. Up to now jeans were washed with pumice stones to give them a worn and faded look. However, the process is problematic – each pair of jeans involves more than half a kilogram of worn pumice stones which damage the industrial washing machines, and which also have to be disposed of. Enzymes, on the other hand, produce the pumice effect in a gentle way, while at the same time saving water, energy and waste. Among the enzymes supplied by AB Enzymes GmbH in Darmstadt – one of the earliest enzyme suppliers worldwide – are cellulases and laccases for the treatment of jeans. Cellulases get to work on the cellulose in the cotton fibres, breaking down the dyed outer layers of the fibres. Laccases oxidize the indigo dye and decolourize it without damaging the fabric. Faded look, fibres intact – only enzymes can manage that.

“

“Tanning is dependent on cross-linking molecules – and this is exactly where our know-how lies.”

*Dr. Stefan Marx,
CEO of N Zyme BioTec, Darmstadt*

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Jacques Ribault © www.foto12.de

Industrial Biotechnology puts the flavour in

Food production with Industrial Biotechnology



The food sector, like other areas of German industry, is under increasing competitive pressure internationally. In view of the saturated food market in Germany, experts consider that there will be no significant growth potential for German producers over the long term. For this reason, innovation will be needed for the development of new processes and products. Major potential is seen largely in what is known as "functional food". Experts estimates of the opportunities for growth in this area are optimistic - annual growth rates on the world market of over 20 percent are expected. The new generation of better foods - from classical food processing to novel beverages, sweeteners and aromas - will come from Hessen.

Pure yeast enzymes ensure good quality for wines

Biotechnological methods have a long tradition in food production. For thousands of years use has been made of microorganisms and their metabolic products for processing milk or producing beverages, and for baking. And for a long time this was all done unknowingly. Among our oldest drinks is wine. The yeasts necessary for fermentation already form colonies on the skin of ripe grapes. Until the 1970s wines were the outcome of what is known as spontaneous fermentation. Since this process was scarcely controllable, wine growers always had to live with the risk of economic loss. To guarantee the quality and taste of their wines, winegrowers nowadays use selected yeasts. Erbslöh Geisenheim AG, one of the world's largest yeast producers, provides microorganisms as starter cultures for all varieties of grapes. A selected yeast on a biological basis has been available for Europe's organic winegrowers since 2008. The company delivers the cultures from the production site in Geisenheim to customers both in Germany and abroad.



The latest trend: fermented drinks

Through the great success of Bionade, the popular fermented soft drink from Germany, Industrial Biotechnology has also found its way into the production of non-alcoholic drinks. Another company banking on this trend is Döhler GmbH which, together with N Zyme BioTec GmbH as development partner, has produced Georgia - the fermented drink from Coca Cola. The positive and healthy image of this class of drinks has given rise to a dynamic growth on the market. Non-alcoholic products based on malt do not merely taste good - they are actually healthy. The natural raw material furnishes a number of B vitamins together with important minerals and trace elements. Döhler offers a wide range of fermentation bases which can be obtained alternatively by fermentations of malt, tea or fruit juices tuned to individual tastes.



Birgit Reitz-Holmann © www.fotoh.de

Functional foods

Food products with health-promoting characteristics are becoming increasingly popular. Examples of functional foods are foods containing special minerals, vitamins, amino acids, fatty acids or dietary fibres which should not be left out of a balanced diet. The market potential over the medium term in Germany alone will amount to several billion euros. Most of the nutritional ingredients in these functional foods have long been produced by biotechnological processes. The most familiar functional food products are yoghurts with bacterial cultures described as "probiotic". Fruit juices, for example, are enriched with vitamins A-C-E, bread with omega-3-fatty acids and iodine, margarine with vegetable sterines.

The new sweetness comes from Hessen

The trend towards low-calorie foods is important in view of diseases of civilization such as diabetes and adiposity. A company devoting itself to this trend is Nutrinova, an internationally leading food additive supplier forming part of the Celanese group. Nutrinova operates production plants in the Frankfurt Höchst Industrial Park, and since 2004 it has been developing new sweeteners originating from microorganisms, edible fungi or plants. The researchers in Hessen are following entirely new paths in their search for innovative low-calorie sweeteners. They have developed novel molecular taste buds with the ability to recognize sweetness, and initial successes have already been reported. These molecular probes are able to detect not only new sweeteners but also sweetness enhancers. The most promising candidates for new sweeteners and sweetness enhancers are currently being submitted by Nutrinova to intensive testing lasting several years. They must not only show that are safe for human beings but also whether they really qualify to meet the high standards imposed by the food industry.



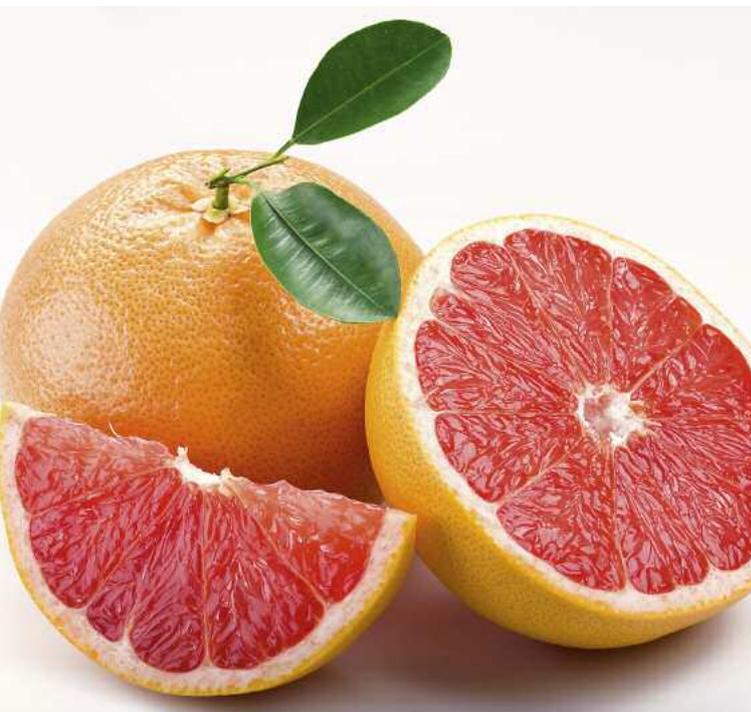
Source: BRANN AG

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“Germany can offer many examples of success as a centre of biotechnological production. Small and medium-sized firms are playing an increasingly important role here.”

Professor Dieter Sell
DECHEMA e.V., Frankfurt

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vdiff © www.foto123.de

Natural fruit aromas from fungi

Industrial Biotechnology is also focusing attention on aromatic ingredients. Natural aromas from fruits or plants are expensive, and synthetic aromas are not fully accepted by consumers. For example, a popular and frequently used aroma is nootkaton, which is contained in grapefruits. To produce it, Industrial Biotechnology makes use of nature's own tools. Professor Holger Zorn of the Institute of Food Chemistry and Food Biotechnology at the University of Giessen is working on the biotechnological production of this key aroma from natural substrates with the aid of fungi. The process has been set up on a laboratory scale. The natural aroma can already be got from a 300-litre bioreactor. Further development is in the hands of the industrial cooperation partner, N Zyme BioTec. Since the production costs of natural nootkaton correspond to those for the synthetic aroma, the rating as "natural" will doubtless open up a considerable marketing advantage for a process which was developed in Hessen.

Functional beer: can be drunk even by people suffering from gluten allergy

Up to one percent of the population in Central Europe suffers from gluten allergy, a hereditary disease of the small intestine, as a result of which gluten damages the intestinal mucus. The persons affected must keep off all the traditional cereal products. Even beer brewed in compliance with the German beer purity law does not agree with them. However, gluten-free beer has been part of the product range of many health food stores since April 2008. The enzyme which extracts the gluten from the beer was developed by N Zyme BioTec GmbH in Darmstadt. The beer, which is brewed by the Neumarkter Lammsbräu organic brewery in Nürnberg, is drunk throughout Germany. Production is already 150 hectolitres per month.

Industrial Biotechnology protects the environment

Microorganisms and enzymes remove pollution

Biotechnological processes have been put to use in environmental protection for almost a hundred years, long before the term "biotechnology" came into existence. Municipal sewage purification plants and gas filters were developed at the turn of the nineteenth century. They were already highly effective at the time, even though little was known about the biological principles on which they were based. Nowadays, Industrial Biotechnology is also making a major contribution to environmental protection in industrial production. With its various possibilities, including use of renewable raw materials or the specific use of enzymes, Industrial Biotechnology helps to reduce pollutant emissions and to economize on resources.



Bohanka © www.foto12.de

Biologically clean at low temperatures

Enzymes play an important role in environmental protection. For about 50 years they have been included as ingredients in detergents, with the result that laundry comes out just as clean at 40 degrees as it did before at 60 degrees. Another advantage is that these enzymes not only remove protein stains like blood, lipstick and other grease spots but also help to reduce the amount of active washing substances. If the washing temperature is reduced by 20 degrees Celsius energy consumption per wash can be cut by 50 percent. This has the effect of cutting carbon dioxide emissions by 1.3 million tonnes a year in Germany alone.

At the same time, the saving of 18,000 tonnes of detergents contributes towards a further reduction of the harmful greenhouse gas. At present, scientists at BRAIN are cooperating with Henkel KGaA, the globally operating consumer goods manufacturer, on the development of detergent enzymes which remain highly active even in cold water. In 2008 Dr. Holger Zinke, the founder and CEO of the company, received the German Environmental Award of the Federal Foundation for the Environment for his achievements in Industrial Biotechnology.

Biological treatment of effluents with the Biomar process

The avoidance and treatment of effluents have an important part to play not only in households but also particularly in industry. EnviroChemie GmbH in Rossdorf, near Darmstadt, has been engaged for over 30 years in the development of plants and processes for the treatment of industrial effluents with high organic contamination levels, such as occur especially in the food and beverage industry. Microorganisms inhabiting the biosludge in these plants break down the hydrocarbon compounds such as fats in the absence of air to methane and carbon



Source: EnviroChemie GmbH



dioxide. The biogas thus formed can then be exploited as a source of energy. A plant generating biogas in this way is in use, for example, at the Trautwein winery in Rhine Hessen. EnviroChemie has constructed 30 plants in Eastern Europe over the last three years, and the company also sees good sales prospects in Scandinavia and Southern Europe.



“We need a revolution in energy and resource productivity.”

Former German President Dr. Horst Köhler in October 2008 at the presentation of the German Environmental Award to Dr. Holger Zinke, BRAIN AG, Zwingenberg



One of Germany's leading Industrial Biotechnology companies, Evonik Degussa GmbH in Hanau, is also working on effluent treatment. The company has developed a flocculant which speeds up the sedimentation of undissolved substances in purification plants. The only chemical auxiliary available up to now for speeding up sedimentation was synthetic polyacrylate, a substance based on mineral oil, but this was not biologically degradable and hence could not be used in purification plants. Production plants for the new biologically degradable auxiliary are already at the planning stage.

Environmentally friendly cell factories

The chemical industry is increasingly converting to biotechnological processes for its traditional operations. The steps are carried out in aqueous environments, and it is possible to dispense with organic solvents. Further advantages are lower raw material consumption and reductions in waste and climate-damaging emissions. However, as long as the choice of available raw materials is confined to starch, sugar and vegetable oils, not all processes are competitive with conventional petrochemical production. The ongoing research projects at Hessen's universities into cellulose digestion can make further synthetic steps economically attractive. At the present time, products of biotechnological origin (including enzymes, precursors for medicaments and amino acids) make up five percent of the global chemical market. This share will grow considerably in the next few years.

- In 2008 there were 195 chemical firms in Hessen.
- The chemical industry in Hessen achieved a total turnover of 21.4 billion euros in 2008, the turnover for pharmaceuticals being 10.9 billion euros.
- The major potentials for Industrial Biotechnology in chemistry are in the production of fine and special chemicals, with a turnover in 2008 of around 32.4 billion euros.
- In Industrial Biotechnology, Germany is serving a market estimated at 80 billion US dollars for 2009 and with double-digit growth rates.

Industrial Biotechnology has a future

A world without chimneys

Fuels from wood, tanning agents from olive leaves, laundry washed at room temperature - the chemical industry, with its impact on every aspect of our lives and on our society, is now about to undergo a splendid, value-enhancing transformation. Ten years ago the deciphering of the genome - the building blocks of life - laid the foundation for the incipient structural change. Today, the accumulation of new knowledge, the clarification of the interactions of proteins in the cells and the analysis of metabolic processes - proteomics and metabolomics - are moving ahead in seven-league boots. Energy efficient manufacturing, healthier ingredients and sustainable materials are becoming part of our everyday lives. New knowledge opens the way to major innovative leaps and a rethinking process is setting in, with the focus on greater sustainability for the sake of later generations. Chemical factories without a chimney? This is not just a dream - it is a vision well within reach.

Source: Evonik Degussa GmbH



Scientists on the search for alternative raw materials

The chemical industry, with all its creativity, has been one of the most powerful drivers of our global economy ever since it first came into being. And this will continue to be the case for a long time to come. However, now that chemical substances are starting to be made from olive leaves, citrus peel and wood waste, the familiar picture of the chemical industry will undergo a change. And in view of dwindling oil resources, scientists are searching for new sources of energy. Over the long term algae could be one of the alternatives. But for the moment these are in demand as producers of high-grade additives for foodstuffs and cosmetics. With the increasing number of successful processes and products based on enzymes or microorganisms, chemistry is being biologized at an ever increasing rate. Even now, many different microorganisms are being put into service in hundreds of industrial processes, where they create new products, safeguard jobs and maintain our standard of living. Just imagine what will be possible tomorrow with the aid of nature and its bioresources

if, at the present time, not more one percent of the estimated millions and millions of microbes are being cultivated and used as raw materials. With the aid of metagenomics scientists are already finding ways to get round this bottleneck and are creating a diversity which had never before been thought possible, under the motto "Nature - the source of all things new".



Oliver © www.foto12.de



Interdisciplinary teams with competence in problem solving

Visions have a firm basis in existing knowledge and experience, and in the networking of different disciplines, characters and approaches. This is a basis which can be found everywhere in Germany, though Hessen, with its particular advantages, has an especially prominent position for Industrial Biotechnology. It is already an established centre of production, thanks to its nearness to many different user industries, its tightly knit logistics network and its close links with the financial sector. Capital is indispensable for speeding up developments, particularly when innovative leaders among small and medium-sized companies in Hessen have to be geared in with major industrial concerns. If our vision is to come true in a globalized environment, it is vital that new discoveries should be brought as soon as possible from laboratory to market. In future, therefore, not only regional and federal funding, but also investment funds with private enterprises and banks will become a substantial driving force behind the development of Industrial Biotechnology.

Insects also offer a wide range of raw materials which have not been exploited hitherto and which extend far beyond medical applications. Researchers in Hessen are leading in this field. And with SYNMIKRO, the Hessian Government has taken on a leading position in the visionary research field of synthetic microbiology. Within the framework of the State Offensive for the Development of Scientific and Economic Excellence (LOEWE), more than 21 million euros are being devoted to the design of biological structures and cells. This research could culminate in biohydrogen production, or equally well in more readily tolerable crop protection products or in medicaments free of side effects. In this excellent research landscape, the focus is set firmly on future energy sources, the control of climate change, and the sustainability of production for the sake of generations to come.

Hessen, with its central position in Germany and Europe, is at all events well set up for a Revolution in White together with all its partners.



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