Applied Evolution

Company management,
The company and Corporate Stories
(from the Annual Report 2016/17)

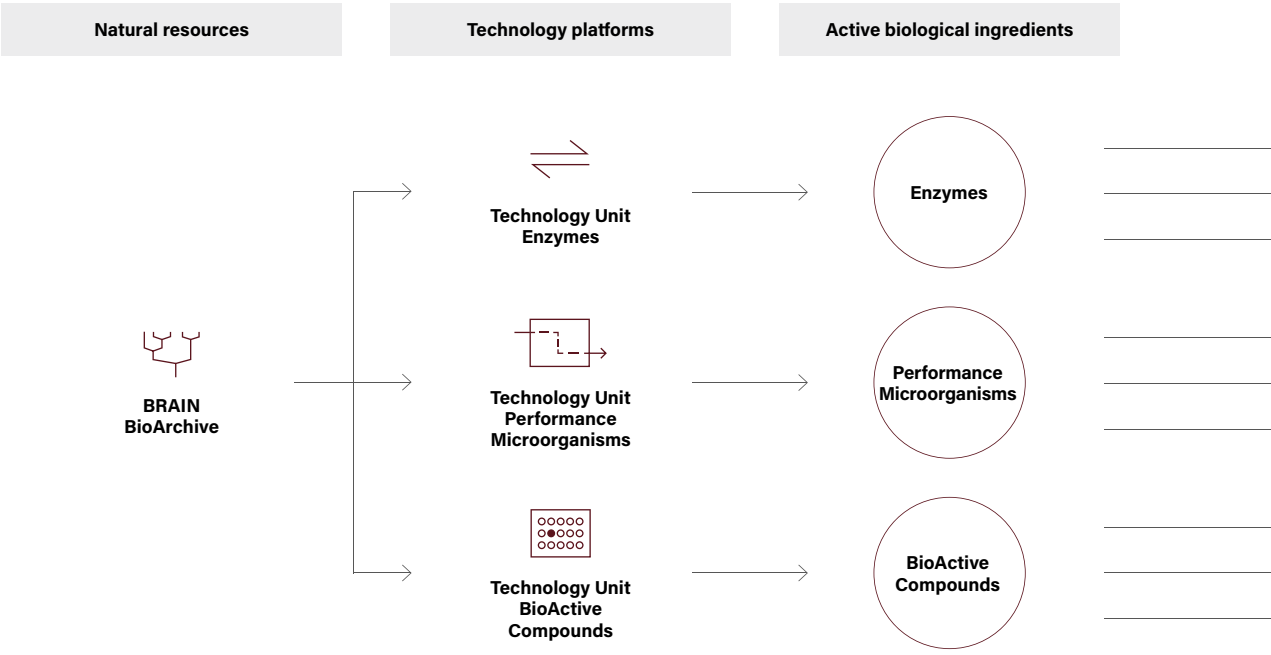
B·R·A·I·N

BRAIN Group financial highlights

in € million	2016/17	2015/16	2014/15
Consolidated income statement data:			
Revenue	24.1	22.8	21.1
Total operating performance[1]	**26.9**	**26.1**	**25.7**
Operating result (EBIT)	–9.4	–13.8	– 4.6
Adjusted operating result (adjusted EBIT)[2]	**–6.4**	**– 7.6**	**– 4.4**
Net loss for the reporting period	–9.7	–14.9	– 5.9
Consolidated balance sheet data:			
Total equity	47.2	26.9	5.7
Equity ratio (in %)	**69 %**	**57 %**	**19 %**
Total assets	68.5	47.5	30.4
Consolidated cash flow data:			
Cash flows from operating activities	**–5.8**	**– 8.7**	**– 4.1**
Cash flows from investing activities[3]	8.8	–11.2	– 0.5
Cash flows from financing activities	27.7	25.0	3.4

1 Defined as the sum of revenue, other income and changes in inventories of finished goods and work in progress
2 Adjusted for a non-cash share-based payment by shareholders of BRAIN AG and a subsidiary's employee share scheme, as well as in 2015/16 the IPO costs.
3 In 2015/16, € 10 million of this amount was invested in short-term deposit accounts with an original term of three months, which cannot be reported as cash or cash equivalents due to the accounting principles applied.

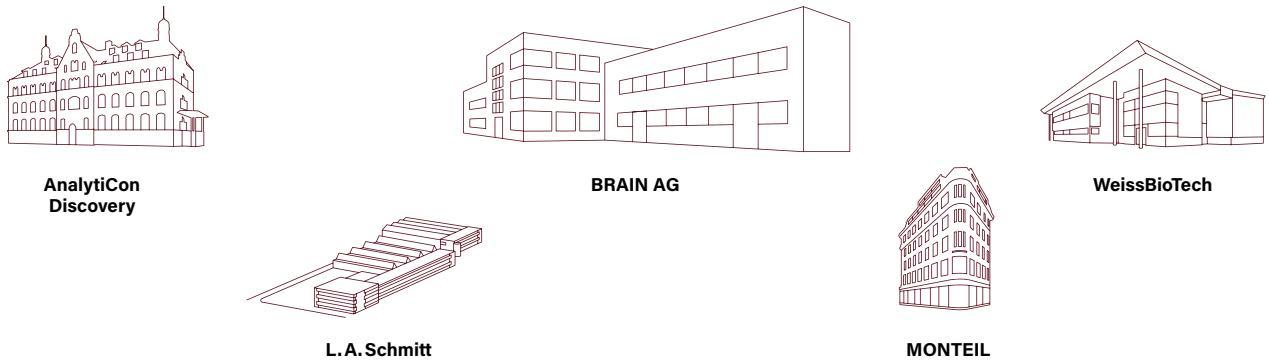
FROM THE BIOARCHIVE TO THE B2B MARKET



Mission Statement

BRAIN is a pacemaker of the bioeconomy and a high-tech pioneer of sustainable, applied biotechnology. BRAIN stands for the biologisation of both industry and the consumer world. The Group develops and markets product and process innovations based on species diversity and its own BioArchive. Its work focuses on bioactive natural compounds, nature-based enzymes and customised high-performance microorganisms for sustainable applications in the consumer goods and chemicals industries.

THE BRAIN GROUP



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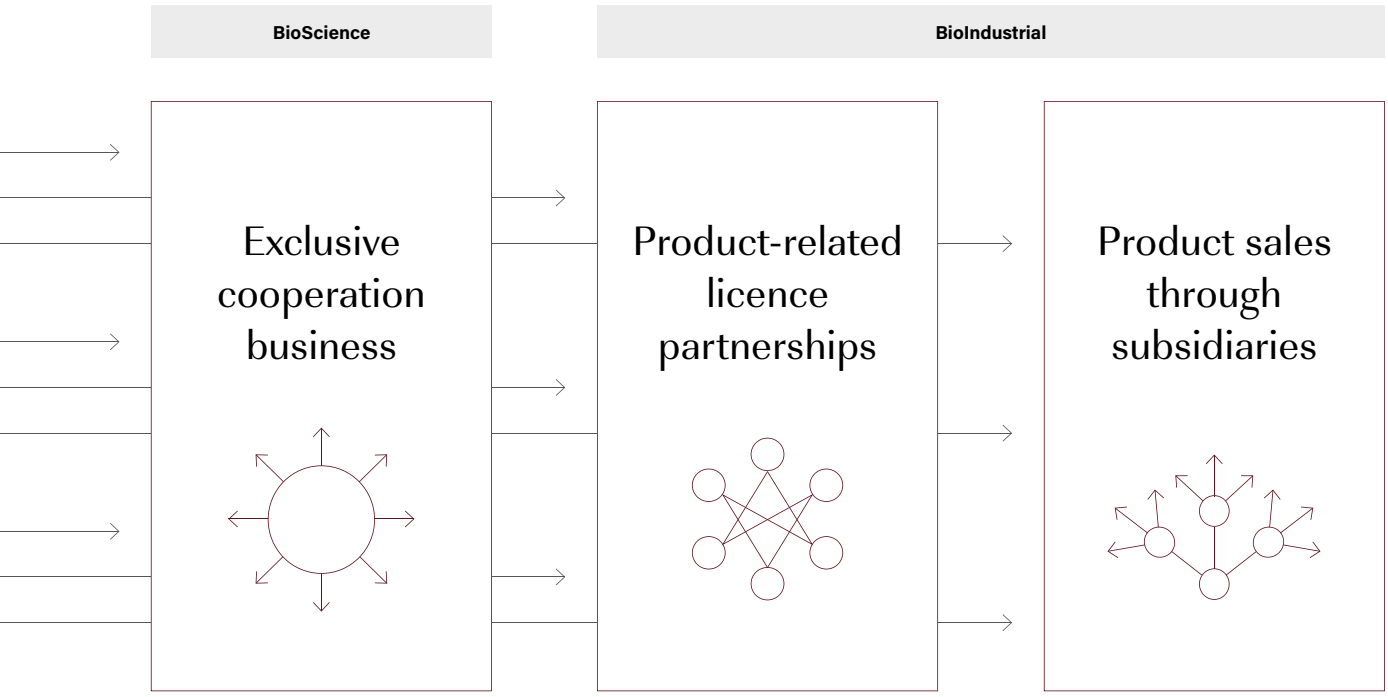
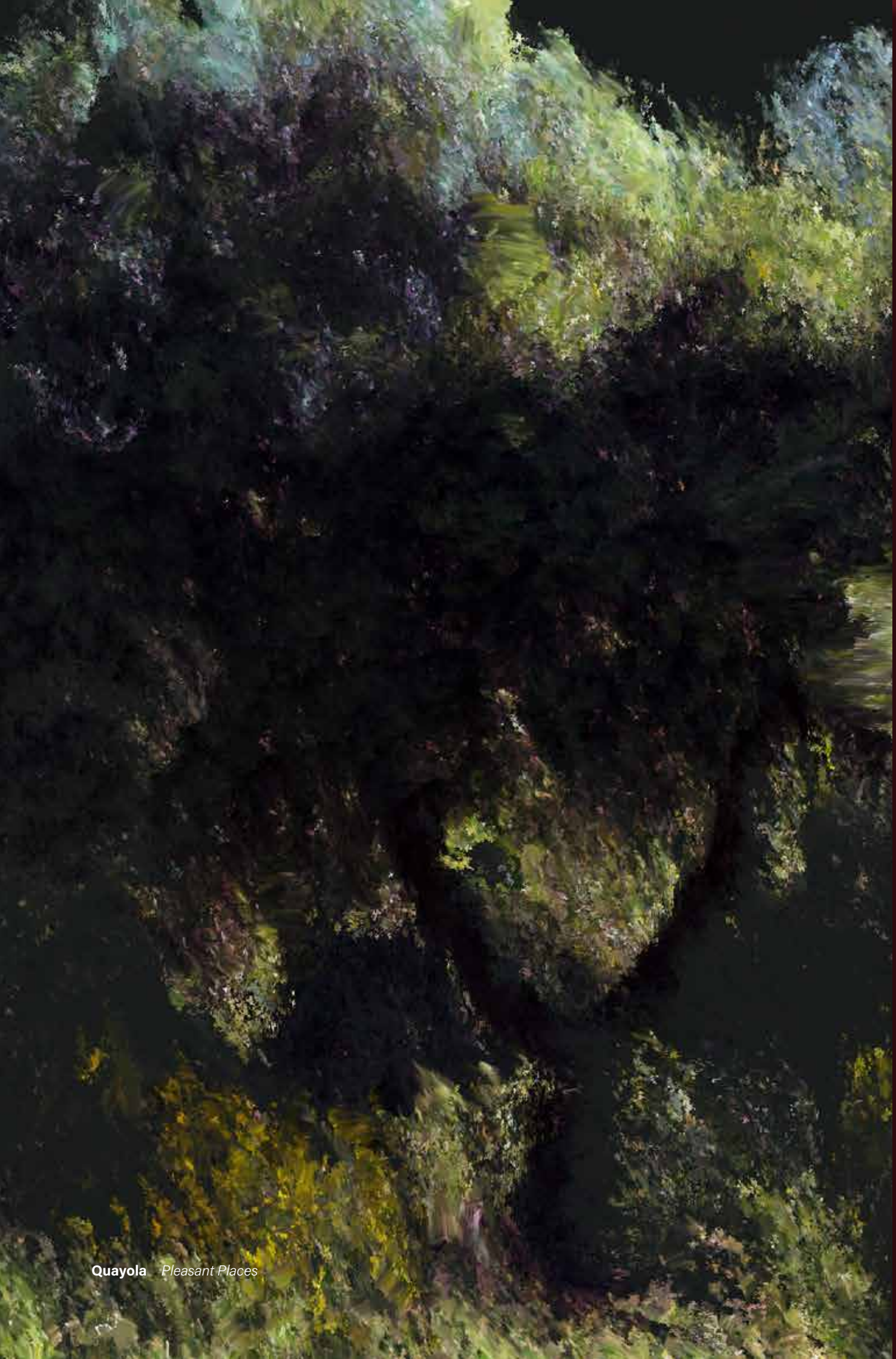


Competences and solutions, page 59

"BRAIN remains on its growth track. Trends in our 2016/17 financial year confirm our expectation that BRAIN is increasingly benefiting from the advancing biologisation of various industries."

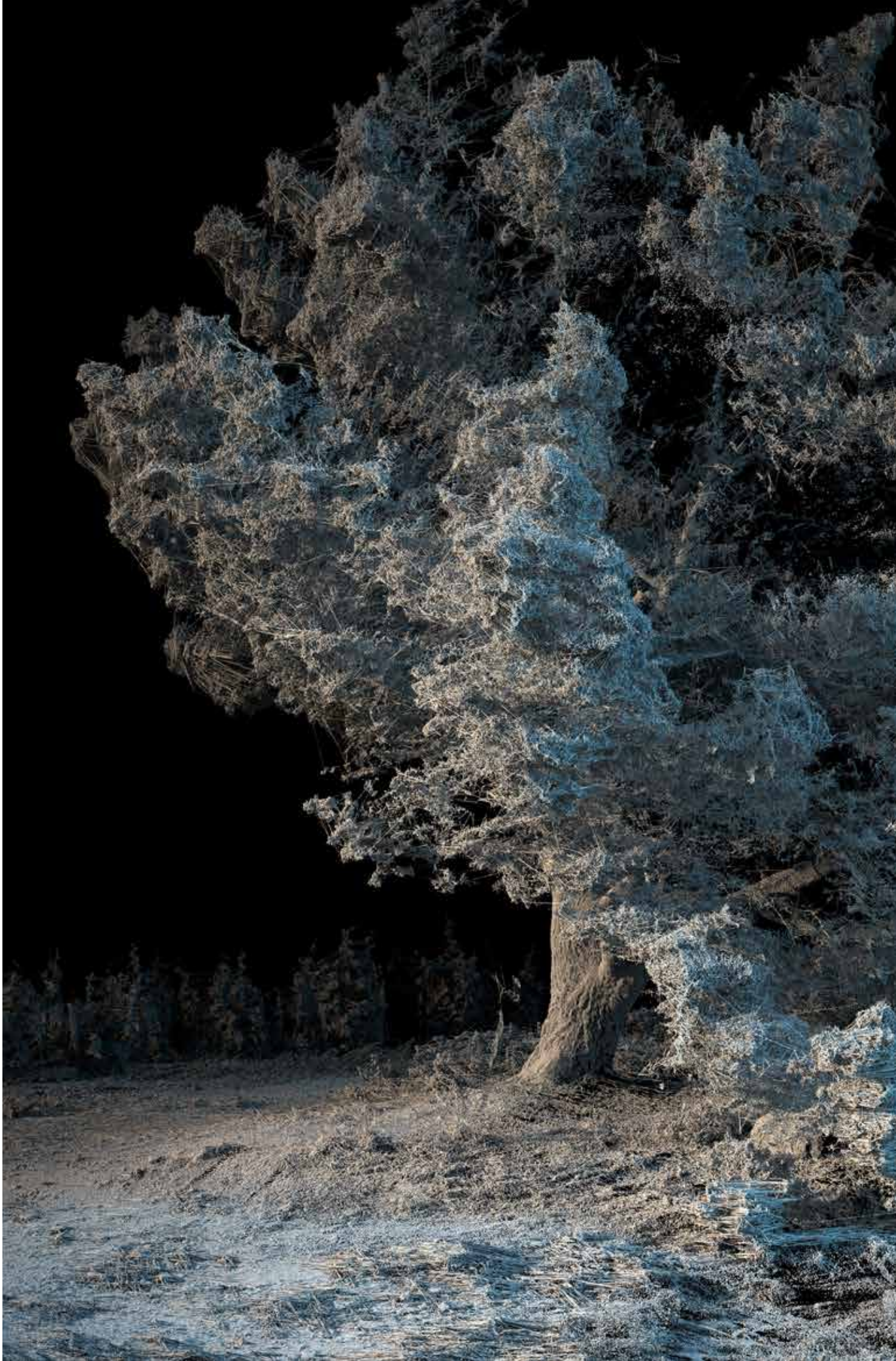
Dr Jürgen Eck — member of the founding team and CEO of BRAIN AG

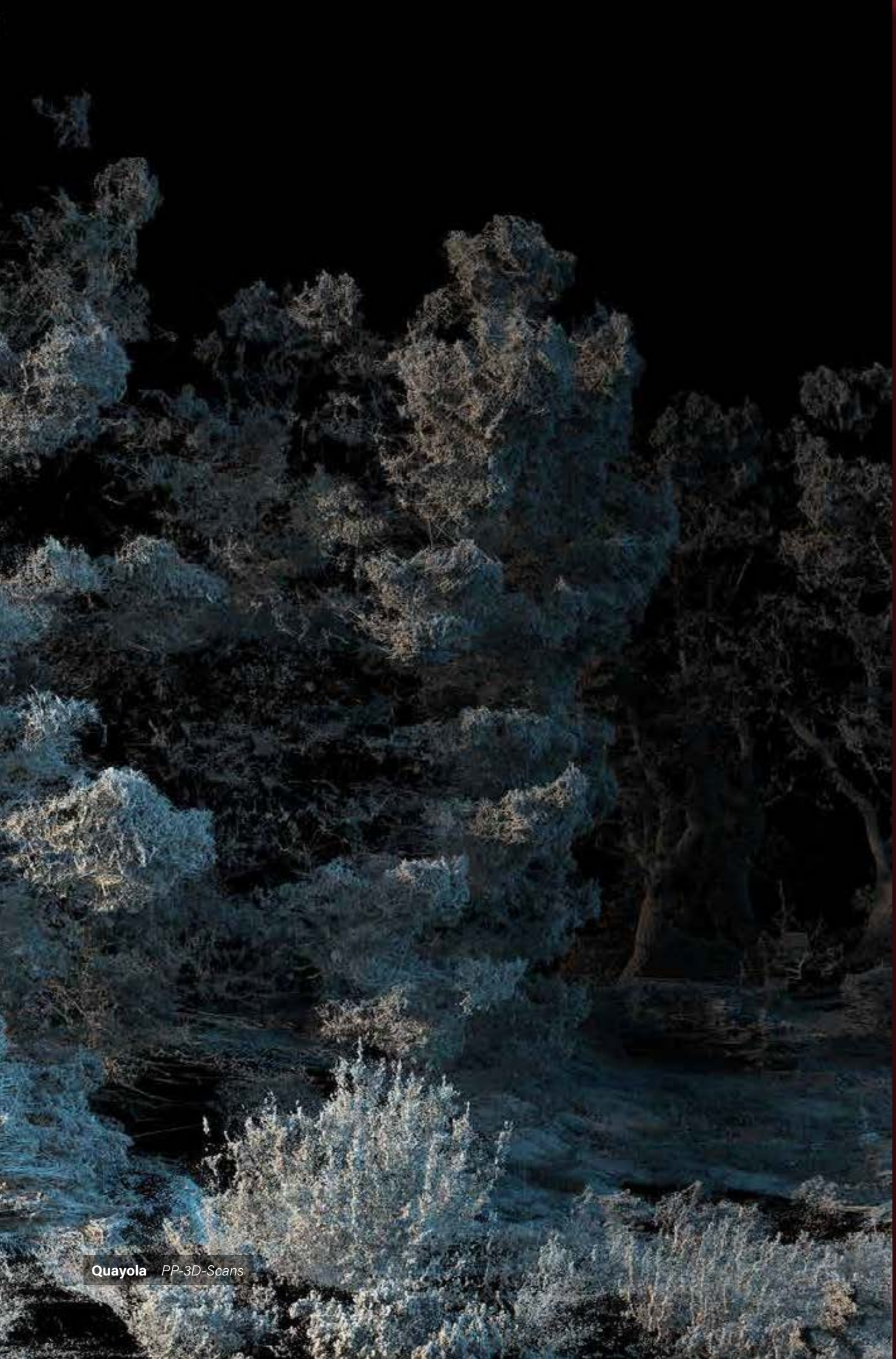
Quayola *PP-3D-Scans*



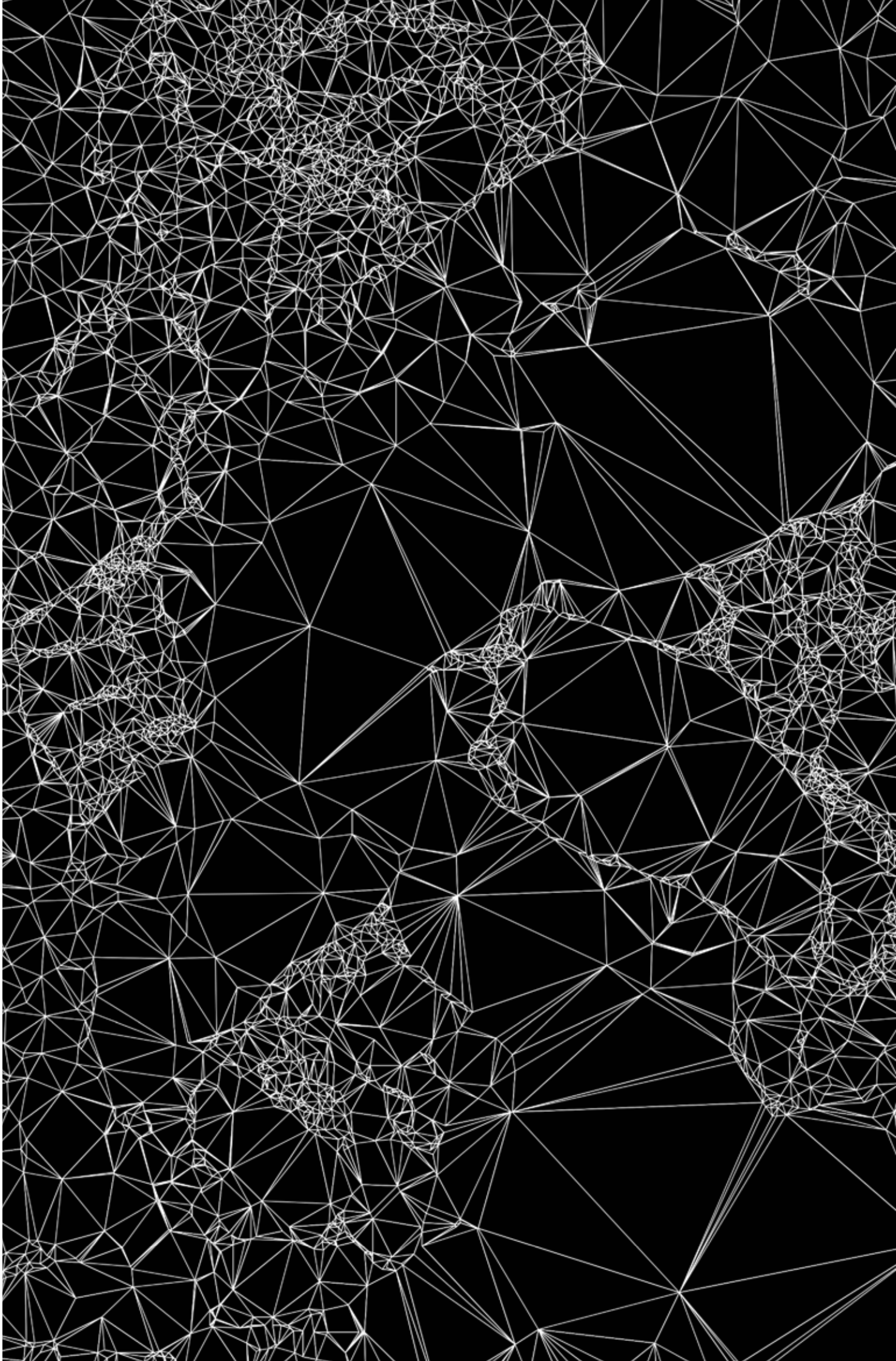
Quayola *Pleasant Places*

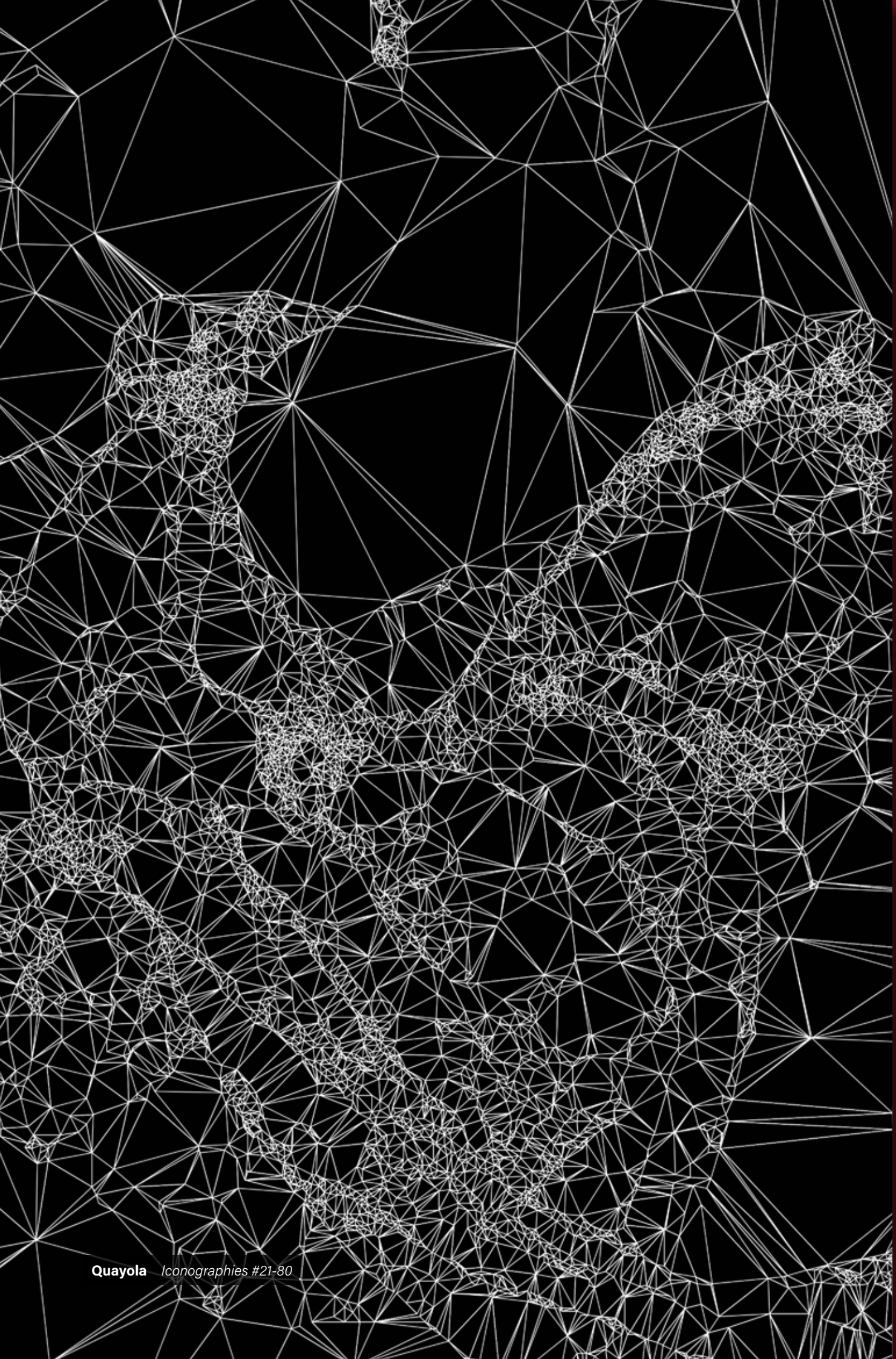
Quayola *Jardins d'Été*





Quayola *PP-3D-Scans*





Quayola *Iconographies #21-80*

Quayola *Sculpture Factory*

Quayola *Sculpture Factory*

BETWEEN REAL AND ARTIFICIAL

Quayola is a visual artist based in London whose work explores the borderlines between art and reality, and examines how technology changes the way we see the world.

The starting point for his works are high-resolution reproductions of the real world — detailed scans of old paintings and 3D scans of landscapes or sculptures. This digital reproduction dissolves reality into data sets that Quayola analyses, deconstructs and artistically alienates to create entirely new artworks.

His *PP-3D-Scans* are a combination of 3D scans and computer simulations of natural landscapes. They result in hyper-realistic images that have been artistically reinterpreted and explore the limits of photography, transforming our habitual view of nature.

Nature also served as the starting point for the *Pleasant Places* and *Jardins d'Été* series. Using a 3D scanner, the artist captured landscapes in Provence that once inspired the paintings of Vincent Van Gogh. With the help of customised software, Quayola makes these landscapes dissolve into abstract images that examine the relationship between nature, art and technology, and in so doing he creates a form of 'animated digital painting.' The images shown here are stills taken from the artist's animated videos.

In the *Iconographies* series, he deconstructs Baroque and Renaissance paintings charged with iconography by translating their data into new forms. The works are removed from their historical context, enabling them to be seen from new perspectives.

But Quayola does not limit himself to virtual space. In artworks like *Sculpture Factory* or the *Laocoön #D20-Q1* series, which are also based on real-life works such as sculptures by Michelangelo, he brings his oeuvre back to solid ground. The artist uses algorithms specially developed for his work, which he plays with like instruments. The algorithms steer industrial robots that carve the shapes of new sculptures out of foam blocks. Far from being random, the result is controlled by the artist and his powers of imagination. While technology is the vehicle, the value of these works lies in the creativity that the artist brings to the process.

www.quayola.com

(The works shown here were not created on behalf of BRAIN.)

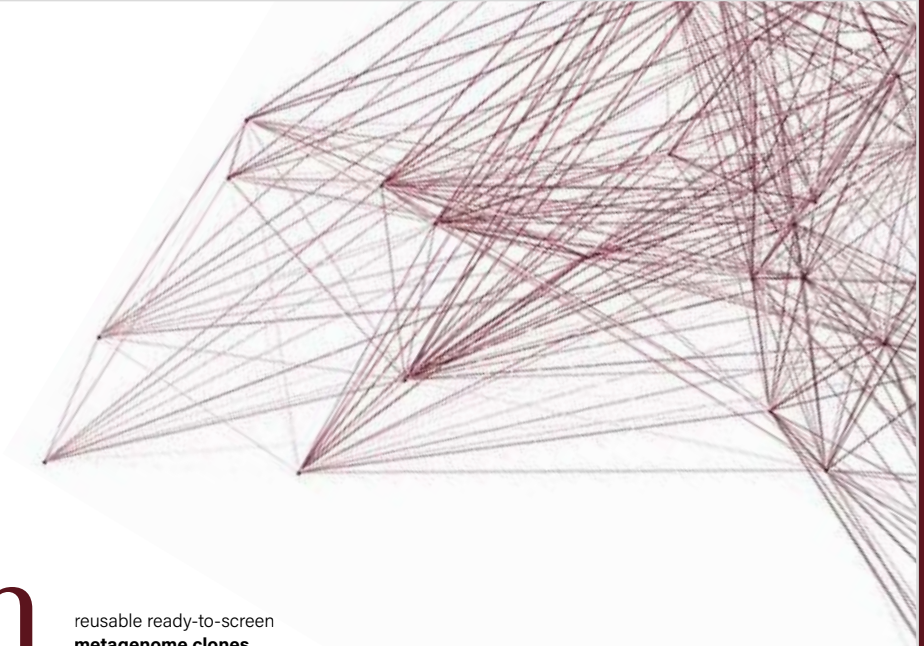
Quayola *Laocoön #D20-Q1*

Biotechnology translates nature into new values

BRAIN's BioArchive is one of the world's most comprehensive collections of biological substances. Together with the company's technology portfolio, the archive enables the transposition of biological diversity into sustainable products and processes.

BRAIN's key competence is its understanding of biological and evolutionary processes and its ability to learn from nature. The creativity of the research team transforms the BioArchive into **"nature's toolbox"**, whose treasures are harnessed using a blend of patience, experience and high-tech equipment. This gives rise to unprecedented products and processes.

The natural model and the ensuing biotechnological transformation steps are continuously compared with each other so as to preserve the properties that need to be transferred. This involves analytics, genome editing and protein engineering. Computer-based 3D modelling, and data visualisation in the CLANS analyses used to identify enzymes, provide 'snapshots' of the process, at the end of which nature is transformed into real products and processes. This is what we call **"Applied Evolution"**.



The BRAIN BioArchive comprises ...

300 m reusable ready-to-screen **metagenome clones**

53,000 **characterised microorganisms** for strain development

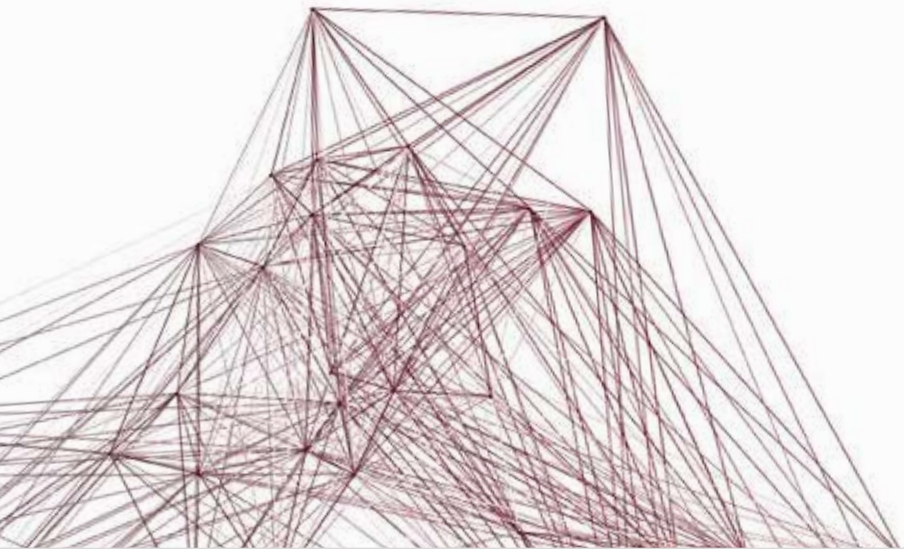
49,500 natural and naturally inspired **compounds**

13,000 **plant fractions** available for isolation campaigns

464 **enzyme libraries** available for screening

450 **habitat collections** and environmental samples

43 **metagenome libraries** isolated from various habitats



CLANS analyses compare pairs of amino acid sequences with the aim of finding new enzymes.

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CONTENTS — REPORT

Dr Jürgen Eck — Chief Executive Officer

Dear shareholders,

The past 2016/17 financial year was the first full BRAIN annual cycle with Prime Standard trading of our share on the Frankfurt Stock Exchange. We can look back on successful months during which we have focussed on further developing our industrialisation strategy.

Along with strengthening our research cooperation business with industrial partners – reflected in our BioScience business segment – we are pursuing the objective of further expanding our BioIndustrial segment to market our own product candidates through the BRAIN Group or through licence agreements with globally operating companies. Accordingly, for some years we have been investing at a high rate in our research and development capacities as well as the bolstering of our networks.

We are well positioned with our development pipeline, and during the past financial year we have further advanced our current 15 development programmes, which are in different stages of realisation. In all three of our product categories – bioactive natural compounds, natural-source enzymes and high-performance micro-organisms – we are sufficiently advanced in some projects that we now stand on the threshold of market entry and licence agreements. For this reason, we have decided to present to you this product aspect of BRAIN in greater detail in this 2016/17 annual report.

"As an innovator of biological solutions, our goal remains to participate in a leading position in the bioeconomy's growth. The prospects for this are still good."

In the previous report on the 2015/16 financial year – which garnered several renowned awards for content and design – we presented our DOLCE programme. Together with our subsidiary AnalytiCon Discovery, and since August 2016 with our production and marketing partner the French company Roquette, we are focusing on a new generation of natural sweeteners and biological sweetness enhancers. In November 2016, we gained our first consumer goods giant for the licence partnership for the "breakfast cereals" and "snacks" product categories. In July 2017, a globally operating US company from the beverages industry joined forces and signed the partnership for our innovations in the categories "non-alcoholic beverages", "milk and yoghurt beverages" and "ginger ales and tonics". (see page 120) We see the fact that consumer goods companies are already joining DOLCE in the development phase as a major success and validation of the significance of our innovative approach for the global food manufacturing industry.

We have also recently reached important milestones in our mining programme, entailing the bio-based extraction of precious metals from waste flows and ores with the help of specialised microorganisms. In August 2017, the BRAIN BioXtractor was completed as a demonstration plant for our groundbreaking approach to meet growing demand for precious metals (see also page 40). Our mining programme as well as development work on the biotechnology conversion of the greenhouse gas CO_2 in preliminary steps of bioplastic are delivering disruptive solutions to meet the growing demand and requirements of a modern bioeconomy and a closed-loop materials system.

As an innovator of biological solutions, our goal remains to participate in a leading position in the bioeconomy's growth. The prospects for this are still good. In the chemicals industry, sales generated with biotechnology solutions continue to grow at a considerably faster rate than in other areas. Business experts expect that sales generated with bio-based chemicals alone will increase from around $ 200 billion in 2015 to more than $ 610 billion by 2025.

Subsidiaries of BRAIN AG are central success factors in our activities (see also page 62). Here we combine first-class research, development, and production know-how with access to markets worldwide. AnalytiCon Discovery is a market leader in natural substance libraries and a core team member of our DOLCE programme. WeissBioTech GmbH is a globally operating supplier, including special enzymes, and offers us access to attractive enzyme markets. We serve markets for active substance cosmetics and biological ingredients through the companies L.A.Schmitt and Monteil.

Our growth strategy includes the targeted expansion of the BRAIN Group to create direct market access for BRAIN's products business. For this reason, we are very pleased to have acquired a major new shareholder in September 2017, with DAH Beteiligungs-GmbH. Gross issue proceeds of around € 28 million accrued to

BRAIN as part of a capital increase in this connection. Entirely in keeping with our strategy, this capital will serve mainly to finance small and medium-sized acquisitions. As potential candidates, we are examining new partners that have good sales networks, established access to markets and profitable product businesses, to which BRAIN innovations as well as the research and development work within the BRAIN Group can be connected.

The possibility to increase the share capital was created with the resolutions relating to "Approved Capital" as part of the first Annual General Meeting of BRAIN in March 2017. This event formed a further highpoint of the financial year. Both lively and constructive shareholder participation in the event at the company's headquarters in Zwingenberg showed, not least, the strength of the connections of BRAIN with the Rhine-Main-Neckar metropolitan region, as well as our firm anchoring among private investors. All agenda items, including the new elections of Supervisory Board members, were accepted with large majorities.

At the time of the IPO in February 2016, we floated with an opening share price of € 9.15. We ended the 2015/16 financial year with a price of € 11.70. As of the end of the 2016/17 financial year, the price amounted to € 19.70. This performance is even more remarkable insofar as – after the expiry of the one-year blocking period following the IPO – two early-phase investors exited their BRAIN shares, partly driven by their funds' durations. Despite these share placings and subsequent completion of the issuance of new shares as part of the capital increase, our share price reported a gain of more than 68 percent for the year. The free float doubled to almost 50 percent and the trading volume of the BRAIN share increased constantly. The milestones that we have successfully reached in both business segments strengthen us in our conviction that we are on the right path. Accordingly, we are continuing to consistently pursue our industrialisation strategy in the new financial year.

On behalf of my Management Board colleague Frank Goebel and myself, I would like to thank our staff in the BRAIN Group. The success of BRAIN – which in 2018 already celebrates its 25th anniversary – is based on the curiosity, spirit of invention, and creative commitment of these bioeconomy pioneers. Our thanks are also due to our numerous cooperation partners and companions of our company's development and – of course – to you our shareholders for your unwavering trust and confidence in our enterprise – the sustainable biologisation of industries and the consumer world. We wish you and ourselves a successful 2017/18 business year, and stimulating reading of this annual report.

Dr Jürgen Eck — Chief Executive Officer

Dear shareholders,

In the 2016/17 financial year, BRAIN AG successfully advanced its defined growth strategy, reaching further milestones on its way to becoming a leading bioeconomy company.

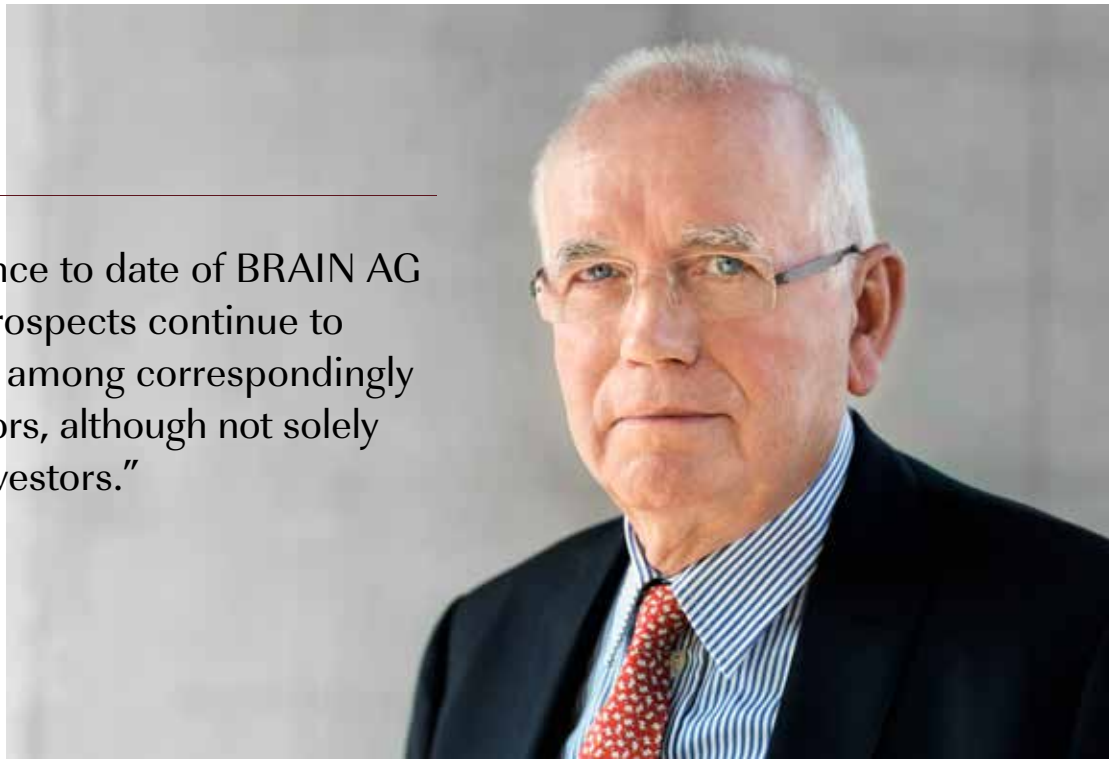
Along with continuous progress in the operating business, such milestones especially include our strategic DOLCE partnership expanding as international food manufacturers join. Our industrialisation process was also successfully advanced further in the "Green and Urban Mining" environment, with a mobile pilot plant being commissioned with the BioXtractor during the year under review. The performance to date of BRAIN AG as well as its prospects continue to arouse interest among correspondingly oriented investors, although not solely among such investors. In September 2017, the company not only raised € 28 million as part of a capital increase to finance planned small and medium-sized acquisitions but also acquired a further investor with a long-term and sustainable orientation. The Supervisory Board continued to play a consultative role in these developments in the financial year elapsed.

The following report provides information about the Supervisory Board's work in the 2016/17 financial year, in other words, from 1 October 2016 until 30 September 2017. During this period, we completely fulfilled the tasks and duties incumbent upon us pursuant to the law, the company's bylaws and the rules of business procedure for the Supervisory Board.

We continuously supervised the Management Board in its management of the business, and consulted on all matters of importance for the company. In this context, the Supervisory Board was always convinced of the legality, propriety, appropriate nature and economic efficiency of the management of the company.

Collaboration between the Supervisory and Management boards

The Management Board informed the Supervisory Board regularly, promptly and comprehensively in the form of detailed written and verbal reports on all questions relating to strategy, planning, business development, the risk position, risk trends and compliance that are of importance for the company and the Group, and consequently fully met its reporting duties to the Supervisory Board in the relevant period. The Supervisory Board and its committees were involved in all important business transactions and decisions of fundamental significance for the company in this context. Collaboration with the Management Board was characterised in all aspects by responsible and purposeful action.



"The performance to date of BRAIN AG as well as its prospects continue to arouse interest among correspondingly oriented investors, although not solely among such investors."

Dr Ludger Müller — Chairman of the Supervisory Board

Personnel matters

The following changes occurred to the composition of the Management and Supervisory boards in the reporting period:

With effect as of 31 October 2016, COO Eric Marks stepped down from the Management Board for personal reasons and at his own wish. No new appointment was made to this position.

With effect as of 1 November 2016, Frank Goebel (48) moved up from the Management Board of BRAIN Capital GmbH to the Management Board of BRAIN AG. This step anchors directly within the company's Management Board M&A activities that are important for the company's forward integration. Along with M&A activities, Frank Goebel also assumes responsibility for managing the company's portfolio of investments, and consequently the steering of the subsidiaries of BRAIN AG, to further expand the interlinking of the respective company management teams and even more intensively exploit synergies within the portfolio of BRAIN AG. As of the end of the AGM on 9 March 2017, Mr Goebel succeeded Dr Georg Kellinghusen as the company's Chief Financial Officer (CFO), as planned.

With the end of the AGM on 9 March 2017, the period of appointment of Dr Georg Kellinghusen as CFO of BRAIN AG ended. This appointment was originally to conclude as of 31 December 2016, and had been extended accordingly. The AGM appointed Dr Georg Kellinghusen to the Supervisory Board of BRAIN AG at the proposal of shareholder MP Beteiligungs-GmbH.

Moreover, the period of office of Supervisory Board members Prof Dr Klaus-Peter Koller and Dr Holger Zinke concluded as of the end of the AGM, as planned. While Prof Dr Klaus-Peter Koller stood for re-election, Dr Holger Zinke stood down. Supervisory Board members Siegfried Drueker and Dr Matthias Kromayer made their posts available.

Along with Dr Georg Kellinghusen, the AGM of BRAIN AG on 9 March 2017 newly issued two further Supervisory Board mandates to Dr Anna C. Eichhorn and Dr Martin B. Jager. The AGM re-elected Prof Dr Klaus-Peter Koller to the Supervisory Board. Taking into consideration the requirements from the German Corporate Governance Code relating to the length of period of office on supervisory boards, Prof Dr Klaus-Peter Koller had himself elected to the Supervisory Board for a further year, instead of for the regular period.

Supervisory Board meetings

In the 2016/17 financial year, a total of six Supervisory Board meetings were held on an attended basis, six attended meetings of the committees, as well as eleven telephone conferences of the Supervisory Board and the committees, and two resolutions were passed by way of written circular. The Supervisory Board members always had sufficient time in this context to critically engage with the information submitted by the Management Board and contribute its own views. As part of the meetings, the information was discussed in detail with the Management Board and examined as to its plausibility. The Supervisory Board issued its approval of specific business transactions as required by law, the company's bylaws or the rules of business procedure for the Supervisory or Management boards.

Both Supervisory Board members who stepped down as of 9 March 2017, Dr Matthias Kromayer and Dr Holger Zinke, participated until that date in at most half of the Supervisory Board and committee meetings of relevance for them. All the meetings that were missed were excused. The individualised listing of participation in meetings below provides more detail.

TABLE 01.1

OVERVIEW OF SUPERVISORY BOARD MEETINGS IN THE 2016/17 FINANCIAL YEAR

Name	Meetings attended (including committee meetings)	Remarks
Dr Ludger Müller	12/12	
Dr Martin B. Jager (since 9 March 2017)	7/7	
Dr Holger Zinke (until 9 March 2017)	1/3	Unattended meetings excused
Siegfried L. Drueker (until 9 March 2017)	3/3	
Dr Anna C. Eichhorn (since 9 March 2017)	4/4	
Prof Dr Klaus-Peter Koller	6/6	
Christian Körfgen	7/7	
Dr Matthias Kromayer (until 9 March 2017)	2/4	Unattended meetings excused
Dr Georg Kellinghusen (until 9 March 2017)	6/6	Replacement member for Siegfried L. Drueker

Outside the scope of meetings, too, the Supervisory Board members, especially myself as Supervisory Board Chairman and Committee Chairman as well as the respective Chairs of the Audit Committee, were in regular communication both with each other as well as with the Management Board. This entailed, in particular, consultations about questions relating to the company's strategy, planning, business development, the risk position, risk management, corporate governance and compliance. The Supervisory Board members were informed about important information at the latest at the next plenary or committee meetings.

No conflicts of interest occurred in the Supervisory Board in the reporting period.

Focus consultation areas in the plenary Supervisory Board

During the 2016/17 financial year, we in the plenary Supervisory Board concerned ourselves especially with the following topics:

- Annual financial statements for the 2015/16 financial year
- Results of the tender of the audit of the annual financial statements for the 2016/17 financial year, selection and proposal to the AGM
- Planning and implementation of the AGM on 9 March 2017,
- Modifications to the Management Board,
- Business allocation plan for the Management Board,
- Current and future research projects,
- Strategic alliances and planned partnerships,
- Acquisition strategy of BRAIN AG
- Capital measures, especially the capital increase on 7 September 2017 and related exclusion of subscription rights,

- Attainment of the corporate targets for the 2016/17 financial year relating to developing the BioIndustrial and BioSciences divisions,
- Risk management and internal controlling systems,
- Composition and competency profile of the Supervisory Board and the ratio of women on the Management and Supervisory boards,
- Corporate governance report and the corporate governance statement of conformity,
- Budget for the 2017/18 financial year,
- Employee stock option programme (ESOP).

The Supervisory Board in all cases passed specific resolutions following intensive review and discussion.

The following topics and resolutions are presented by way of supplement.

On 15 January 2017, the Supervisory Board approved the financial statements documents for the 2015/16 financial year and concurred with the Management Board's proposal relating to the application of unappropriated profit, after having previously clarified and discussed in depth the financial statements at its attended meetings.

The first public Annual General Meeting (AGM) of shareholders was discussed in advance, especially including the proposed elections for the Supervisory Board posts that would become free, and their presentation to the AGM. In addition, the proposal to elect a new auditor and related change of auditor after conducting a tender procedure was prepared for submission to the AGM.

The realisation of the intended Post-IPO Framework Agreement (PSOP), which was implemented in full in the financial year under review, formed one of the discussion points at several meetings. The Board also discussed establishing an employee stock option programme (ESOP). The intended launch of the ESOP was postponed to the 2017/18 financial year in agreement with the company's Management Board.

Following the AGM on 9 March 2017, the constituting meeting of the Supervisory Board with its newly elected members was held on the same day. Dr Martin B. Jager was elected Deputy Chairman at this constituting meeting.

After the changes to the Supervisory Board composition, the committee members were re-elected at the 28 March 2017 meeting. At the same meeting, the allocation of the business within the Management Board was updated and approved as part of changing the number of Management Board members.

The efficiency audit was continued, and the Supervisory Board decided to conduct a supplementary workshop at the end of 2017 to further improve Supervisory Board work.

Committees

The Supervisory Board has currently formed a total of three committees to efficiently perform its work: an Audit Committee, a Nomination Committee and a Personnel Committee. Based on their respective rules of business procedure for the committees, these prepare resolutions for the Supervisory Board, as well as topics to be handled by the plenary board. The Supervisory Board's decision-making powers are also transferred to committees where legally permissible. In all cases, the committees' chairs report on the committees' work at the subsequent plenary meeting.

Audit Committee

The Audit Committee concerns itself especially with supervising the financial accounting, the financial accounting process, the efficacy of the internal control system, the risk management system, the internal audit system, the audit of the financial statements, as well as compliance. The Audit Committee submits a substantiated recommendation for the election of the auditor to the Supervisory Board, which comprises at least two candidates if the audit mandate is to be put out to tender. The Audit Committee supervises the auditor's independence and concerns itself with services to be rendered additionally by the auditor, the award of the audit mandate to the auditor, the setting of focus audit areas, as well as arranging the auditor's fee.

Pursuant to the German Stock Corporation Act (Sections 107 (4), 100 (5) AktG), the audit committee must include at least one supervisory board member with expertise in the financial accounting or financial auditing areas. The Audit Committee Chairman (until 9 March 2017), Siegfried L. Drueker, met these statutory conditions and possessed special knowledge in the areas of mergers & acquisitions, corporate finance and investment banking. Along with its Chairman, the Audit Committee also included further Supervisory Board members Dr Matthias Kromayer and Dr Ludger Müller. The current Audit Committee Chairman Dr Georg Kellinghusen meets the statutory conditions pursuant to the German Stock Corporation Act (Sections 107 (4), 100 (5) AktG) and possesses special knowledge as a CFO of more than 30 years' standing, including at four listed companies. His activities focus on controlling, financial questions and financial accounting, among other areas. He also possesses broad knowledge in compliance topics as well as in the area of investor relations.

Along with its Chairman, the Audit Committee currently also includes further Supervisory Board members Dr Martin B. Jager and Dr Ludger Müller.

The proposal to the AGM to elect a new auditor (Ernst & Young GmbH) was preceded by a tender procedure with a total of six candidates. After supplementary discussions with the candidates, the Audit Committee focused its selection on two offers, with the offer of Ernst & Young GmbH finally given preference by the Supervisory Board and being submitted for election to the AGM, which accepted this proposal by a clear majority.

Furthermore, the Audit Committee approved Ernst & Young GmbH, as well as consulting companies forming part of the Ernst & Young Group of companies, to render due diligence services for the company.

The Audit Committee held four attended meetings and five telephone conferences in the 2016/17 financial year.

Nomination Committee

The Nomination Committee met in the 2016/2017 financial year especially to select appropriate candidates for the Supervisory Board's election proposals to the AGM on 9 March 2017, and conferred by telephone. Along with Chairman Dr Ludger Müller, the committee comprised the Supervisory Board members Dr Matthias Kromayer and Dr Holger Zinke until the AGM on 9 March 2017 and after the AGM, Dr Anna C. Eichhorn and Prof Dr Klaus-Peter Koller.

Personnel Committee

The Personnel Committee prepares personnel decisions for the Supervisory Board, especially including the selection, appointment and dismissal of Management Board members, the conclusion and amendment of service contracts and pension arrangements, the compensation scheme including its implementation as part of the service contracts, target setting for variable compensation, setting and reviewing appropriate total compensation for each Management Board member, and approving the annual compensation report. The Personnel Committee also passes resolutions concerning the representation of the company in relation to Management Board members pursuant to Section 112 AktG, the approval of Management Board members' other business activities pursuant to Section 88 AktG (prohibition of competition), and other ancillary activities, especially assuming supervisory board posts or positions on comparable controlling bodies outside the BRAIN Group. Dr Ludger Müller is the Chairman of the Personnel Committee. Along with Chairman Dr Ludger Müller, the committee comprised the Supervisory Board member Dr Matthias Kromayer until the AGM on 9 March 2017, and after the AGM, Dr Martin B. Jager and Mr Christian Körfgen.

The Personnel Committee held one meeting and one telephone conference in the 2016/17 financial year. With effect as of 1 November 2016, Frank Goebel was appointed to the Management Board, and with effect as of 9 March 2017 he was appointed CFO of BRAIN AG.

The Personnel Committee also concerned itself with the short-term extension of Dr Kellinghusen's Management Board contract.

Corporate governance and the statement of conformity

As part of its meeting, the Supervisory Board consulted on several occasions concerning the company's corporate governance, including requirements deriving from the German Corporate Governance Code.

For the Audit Committee, an update of the rules of business procedure was approved on 28 March 2017, and the rules of business procedure for the Nomination Committee were approved on 29 May 2017.

The Supervisory Board approved the current statement of conformity in December 2017, after the 2016/17 financial year elapsed. The Code's recommendations were, and are, complied with, apart from the exceptions explained in the statement of conformity. The full wording of the statement of conformity as well as the Corporate Governance Report prepared by the Management and Supervisory boards of BRAIN AG, and the corporate governance statement, are published on the company's website at www.brain-biotech.de/investor-relations/corporate-governance.

Regarding the provisions of Section 111 (5) of the German Stock Corporation Act (AktG), the Supervisory Board has set itself the target of taking women into appropriate account in its future composition. Accordingly, resolutions passed at the 23 September 2016 meeting of the Supervisory Board of BRAIN AG included a resolution that the Supervisory Board should include one woman, corresponding to a 17 % ratio. The implementation period for this ran until 30 June 2017. This objective was implemented when the AGM on 9 March 2017 elected Dr Anna C. Eichhorn to the Supervisory Board of BRAIN AG. The retention of this objective was confirmed at the meeting on 28 September 2017. Also on 28 September 2017, the Supervisory Board passed a resolution to provisionally leave unchanged the ratio of women for the Management Board of BRAIN AG.

→ Corporate governance report page 93

Audit of the separate and consolidated annual financial statements

Auditor

The Annual General Meeting on 9 March 2017 determined that Ernst & Young GmbH Wirtschaftsprüfungsgesellschaft (EY), Stuttgart, should be the auditor for the financial year ending 30 September 2017. This appointment also includes appointing the auditor for the consolidated financial statements for the financial year ending 30 September 2017. Helge-Thomas Grathwol, Diplom-Kaufmann, Wirtschaftsprüfer, Certified Public Accountant (CPA) signs as auditor responsible for the audit since this financial year, and Michael Hällmeyer, Diplom-Kaufmann, Wirtschaftsprüfer, as auditor since this financial year. EY audited the separate annual financial statements for the financial year from 1 October 2016 to 30 September 2017 prepared according to the financial accounting regulations of the German Commercial Code (HGB), as well as the management report for BRAIN AG. The auditor EY awarded an unqualified audit certificate. Pursuant to Section 315a of the German Commercial Code (HGB), the consolidated financial statements of BRAIN AG for the financial year from 1 October 2016 to 30 September 2017 and the Group management report were prepared based on International Financial Reporting Standards (IFRS), as applicable in the European Union. Both the consolidated financial statements and the Group management report were also awarded an unqualified audit certificate. The auditor also found that the Management Board has set up an appropriate information and supervision system that is suitable in its design and use to identify developments at an early juncture that jeopardise the company as a going concern.

Review by the Supervisory Board

The documents for the financial statements and the audit reports were discussed extensively at the meeting of the Audit Committee on 12 December 2017, as well as at the Supervisory Board meeting on 13 December 2017. The auditor EY reported on the main results of its audit. It also provided information about its findings on internal control and risk management in relation to the financial accounting process, and was available for additional queries and information. The review of the separate and consolidated financial statements by the Audit Committee was reported upon in detail by its Chairman at the plenary meeting. Following in-depth review and discussion of the separate financial statements, the consolidated financial statements and the management report, the Supervisory Board raised no objections against the documents presented. The Supervisory Board consequently concurred with the Audit Committee's recommendation and approved the result of the audit by the auditor. By way of resolution on 13 December 2017, the Supervisory Board then approved the separate and consolidated annual financial statements of BRAIN AG for the 2016/17 financial year. The separate annual financial statements of BRAIN AG have been adopted as a consequence.

Report on the review of the dependent companies report pursuant to Section 314 of the German Stock Corporation Act (AktG)

Moreover, the Supervisory Board reviewed the report prepared by the Management Board on relationships with affiliates pursuant to Section 312 (1) of the German Stock Corporation Act (AktG) for the period of dependency between 9 March 2017 and 30 September 2017 ("dependent companies report") and discussed it extensively with the Management Board and with the auditor that also audits the dependent companies report.

The auditor reported in detail on the main points of its audit. In this context, the Supervisory Board concerned itself in depth with the report on the audit of the dependent companies report by the auditor. The discussion resulted in no grounds for reservations.

The auditor issued the following audit opinion relating to the dependent companies report:

"In accordance with the audit and appraisal incumbent upon us, we confirm that

1. the actual disclosures presented in the report are correct,
2. for the legal transactions listed in the report the consideration rendered by the company was not inappropriately high."

Following the conclusive results of the extensive review of the dependent companies report by the Supervisory Board, the Supervisory Board states that no reservations are to be expressed (Section 314 (3) AktG) against the Management Board statement that follows the report concerning relationships with affiliates (concluding statement pursuant to Section 312 (3) Clause 1 AktG).

Thank you from the Supervisory Board

The Supervisory Board would like to thank the members of the Management Board as well as all employees of the BRAIN Group for their commitment and outstanding personal contribution during the 2016/17 financial year. We look forward to continuing the past years' growth and success story together with you.

Zwingenberg, 13 December 2017

BRAIN AG, The Supervisory Board
Dr Ludger Müller — Supervisory Board Chairman

Members of the Supervisory Board and Supervisory Board committees

Dr Ludger Müller, Chairman

Member since 17 March 2011.
Appointed until the AGM 2018/19.

Further board mandates in 2016/17:
- Managing Director of KEIPER Brasilien Beteiligungs-GmbH and KEIPER Lateinamerika Beteiligungs-GmbH
- until 30 June 2017, Managing Director of MP Beteiligungs-GmbH, BSN GmbH, BRL GmbH and PUTSCH Immobilien GmbH
- TU Kaiserslautern, University Council Chairman

Dr Martin B. Jager, Deputy Chairman

Member since 09 March 2017.
Appointed until the AGM 2020/21.

Further board mandates in 2016/17:
- since May 2017, member of the Management Board of Herbstreith & Fox Gruppe, Neuenbürg
- until April 2017, member of the Management Board of Doehler Group SE in Darmstadt
- until June 2017, member of the Supervisory Board of the Frankfurter Innovationszentrum Biotechnologie GmbH (FiZ), Frankfurt am Main

Dr Anna C. Eichhorn

Member since 09 March 2017.
Appointed until the AGM 2020/21.

Further board mandates in 2016/17:
- CEO of humatrix AG, Pfungstadt
- Management Board member (Deputy Chairwoman) of the Initiative gesundheitswirtschaft-rhein-main e. V.
- Member of the Supervisory Board of the Frankfurter Innovationszentrums Biotechnologie (FIZ)
- Member of the Management Board of House of Pharma & Healthcare e. V.

Dr Georg Kellinghusen

Member since 09 March 2017.
Appointed until the AGM 2019/20.

Further board mandates in 2016/17:
- Member of the Supervisory Board of WIV Wein International AG, Burg Layen
- Member of the Bavaria Advisory Board of Deutsche Bank AG, Frankfurt am Main
- Member of the Advisory Board of NWB Verlag GmbH & Co. KG, Herne

Prof Dr Klaus-Peter Koller

Member since 21 May 2001.
Appointed until the AGM 2017/18.

Further board mandates in 2016/17:
- Member of the Advisory Council and Honorary Member of the German Association for General and Applied Microbiology (VAAM)
- Member of the Consultant Board for the Subsidy Program of the German Federal Ministry of Education and Research (BMBF) "Validating the Technological and Social Innovation Potential of Scientific Research" (VIP+)
- Member of the Joint Board of Trustees of the Max Planck Institute for Biophysical Chemistry/Dynamics and Self-Organisation, Göttingen

Christian Körfgen

Member since 01 January 2016.
Appointed until the AGM 2018/198.

Further board mandates in 2016/17:
- Putsch GmbH & Co. KG, Advisory Board member, and member of the advisory boards of affiliates of Putsch GmbH & Co. KG

Audit Committee

Dr Georg Kellinghusen, Chairman, independent
Dr Ludger Müller, Member, not independent
Dr Martin B. Jager, Member, independent

Nomination Committee

Dr Ludger Müller, Chairman
Dr Anna C. Eichhorn, Member
Prof Dr Klaus-Peter Koller, Member

Personnel Committee

Dr Ludger Müller, Chairman
Dr Martin B. Jager, Member
Christian Körfgen, Member

→ see also: Statement of conformity page 102

Senior Management

BRAIN is managed by an experienced team, of which some have been with the company for over 15 years.

BioScience

Dr Martin Langer Member of the Management Board, authorised signatory, Unit Head Corporate Development, with the company since: March 1995

Corporate

Dr-Ing. Ute Dechert Unit Head Organisation & Processes, authorised signatory, with the company since: April 1996

Lukas Linnig Unit Head Finance & Controlling, with the company since: April 2017

Dr Michael Krohn Member of the Management Board, authorised signatory, Unit Head BioActives & Performance Biologicals, with the company since: September 1997

Dr Guido Meurer Member of the Management Board, authorised signatory, Unit Head Producer Strain Development, with the company since: April 2000

BioIndustrial

Dr Bela Kelety Unit Head New Business Development, with the company since: October 2010

Dr Wolfgang Aehle Corporate Development, New Business Development Enzymes, with the company since: September 2008

BRAIN Management Board interview

Dr Jürgen Eck
Chief Executive Officer
(CEO)

Frank Goebel
Chief Financial Officer
(CFO)

> "We're succeeding in addressing more and more markets in the classic chemicals and consumer goods areas. The bioeconomy is a megatrend and we're optimally positioned."
>
> **Dr Jürgen Eck** — CEO

As of the first Annual General Meeting of BRAIN since its IPO, Frank Goebel assumed the role of Chief Financial Officer in March 2017, as planned. Dr Jürgen Eck (CEO) and Frank Goebel (CFO) have since formed the two-member Management Board of BRAIN AG.

Mr Eck, the bioeconomy is on an uptrend. How can BRAIN participate in this growth?

JÜRGEN ECK

Our unique BioArchive and technology portfolio in combination with the strong innovation culture within our company make us a globally recognised bioeconomy pioneer. We're facing the challenges our times pose, we're committed to resource efficiency and other sustainability topics, and we're developing natural ingredients for nutrition, cosmetics and animal feed, for example. In this context, we're focusing on three product categories: natural substances, enzymes and high-performance microorganisms. As a result, we're succeeding in addressing more and more markets in the classic chemicals and consumer goods areas. We're making foods healthier, cosmetics more effective, and we're closing material cycles through harnessing CO_2 as a raw material, or through insulating precious metals with the help of specialised microorganisms. The bioeconomy is a megatrend, and we're optimally positioned for it.

To what extent are industrial sectors changing in the era of the bioeconomy?

JÜRGEN ECK

Biologisation refers to the shift to new products and processes that are economically beneficial and at the same time efficient in terms of resources and energy, and are based on biological solutions instead of fossil resources. We see ourselves playing an active role in shaping such change. Here we note that innovations are no longer moving along linear value chains to reach markets – instead, there's increasingly a networked interplay between different technology approaches and the ingredients and consumer goods industries. Value creation networks are developing around BRAIN as an important hub.

FRANK GOEBEL

This trend is evident in our BioIndustrial segment, where we focus on our own product candidates to market them to multinational companies through our Group companies or licence arrangements. Here, too, we're playing a pioneering role by including all players from laboratory work through to the consumer goods group in our development programmes. For example, the DOLCE programme bridges the gap between the development of new sweeteners by the BRAIN Group, and formulation and production by our partner Roquette, before marketing by the food manufacturing groups. Short paths enable rapid development times.

Mr Goebel, you've been CFO of BRAIN since March 2017. What are your main areas of activity?

FRANK GOEBEL

One area of my work concentrates on implementing our growth strategy in the BioIndustrial segment. We have attractive product candidates, some of which are on the threshold of market entry. It's also important to further establish and expand the value chains that are important to us through acquiring companies

> "We have attractive product candidates, some of which are already on the threshold of market entry. Expanding access to markets and establishing global partnerships form important pillars of our growth strategy."
>
> **Frank Goebel** — CFO

with market access to growth segments, thereby increasingly combining research and development with our own marketing and sales expertise.

What can you tell us about the exits of two previous shareholders and the approximately 10 percent increase in the share capital?

JÜRGEN ECK

Given their funds' duration and following the expiry of the one-year lock-up period after the IPO, the MIG funds sold their entire position of around 2.5 million shares to institutional investors in February 2017. As early-phase financiers, they make risk capital available to founders and innovative technology companies, and in this way they have also provided first-class support for the development of BRAIN over many years. Very high demand for our shares was registered in the placing, which was repeated in August 2017 with the disposal of the 1.2 million shares of Green Industries Group GmbH & Co. KG to institutional investors. These placings didn't at all detract from the positive price performance of the BRAIN share, which speaks volumes about the confidence invested in us and in the bioeconomy.

FRANK GOEBEL

Our growth strategy includes acquisitions. The proceeds from the capital increase in September 2017 are earmarked to finance small and medium-sized acquisitions to gradually improve our access to markets. We presented this option at the AGM in March 2017, where a very large majority of the shareholders present supported it.

Are you satisfied with developments during the last business year?

JÜRGEN ECK

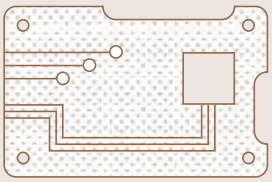
We have made good progress during the financial year that has just elapsed. In particular, the successful arrangement of contracts with further partners for our biological sweetener programme and the completion of our BioXtractor to isolate gold from various sources signified major progress for us in our own product development programmes. Accordingly, we're retaining our business targets and continuing in line with our growth strategy. Over the past business year, we also learned that arranging new contracts with globally operating companies can sometimes become a protracted process – but in some cases they also involve great global marketing potential. I sense we're at the inception of a new era of a modern bioeconomy, and I can see where we can contribute with our expertise. The potential is huge. We can be proud of the milestones and developments that BRAIN has achieved to date.

Precious metals from the circular economy

It is high time we made use of bio-based technologies in order to utilise secondary resources, and not just increasingly scarce primary resources, for creating sustainable added value. Microorganisms can help us in this respect.

There is a growing demand for metals, especially precious metals such as gold, silver, platinum and palladium, resources that play a key role in many high-tech applications. But precious metals are rare and increasingly difficult to come by. The modern circular economy aims to make them available from waste streams as well.

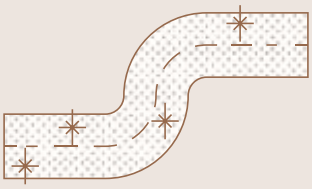
BRAIN is a pioneer in the bioeconomy sector, and has developed solutions for this purpose based on modern biotechnology processes. In the green mining sector, the company offers enrichment and extraction processes for a more environmentally friendly treatment of metal ores from mining operations. For urban mining, BRAIN has developed bio-based processes for extracting precious metals from secondary and waste streams.



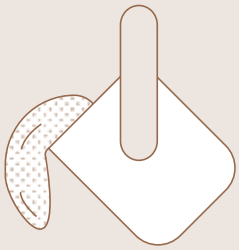
40 m

Every year, we produce over **40 million tonnes of electronic waste**. One tonne of computer boards alone may contain up to 250 grams of gold and one kilogram of silver.

3 t

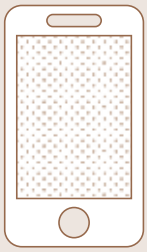


Bottom ashes from waste incineration are added to asphalt for building roads. That means **up to three tonnes of gold** and incredibly large quantities of other metals **are incorporated into German road surfaces every year.**



20 kg

Each year, the steel and metallurgical industry produces hundreds of tonnes of dust, sludge and ash that contain precious metals. **Metal slags**, for instance, can contain up to 20 kg of gold per tonne, as well as many other metals.



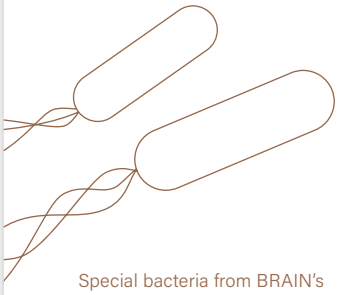
40

It takes about **one gram of gold to manufacture 40 mobile phones,** which have an average service life of only two and a half years. To extract this quantity of gold, about a tonne of ore has to be mined and processed.

4 km

Eight of the **ten deepest mines** are located in South Africa and reach depths of up to four kilometres. The ore content of newly mined deposits is steadily declining.

The first BRAIN BioXtractor pilot plant is located at BRAIN's head office.



Special bacteria from BRAIN's BioArchive are capable of extracting precious metals from primary and secondary resources.

The natural protagonists in these processes are microorganisms that were identified in BRAIN's BioArchive and further developed in the laboratory. These bacteria, for which BRAIN holds property rights, process primary and secondary resources and extract precious metals with a significant yield that sometimes exceeds 90 per cent, depending on the starting material and metal concerned.

This technology has been successfully transferred from laboratory to pilot plant scale in the 2016/17 business year. In August 2017, the first BRAIN BioXtractor was set up at the company's head office in Zwingenberg. This demonstration plant will make it possible to process up to six metric tons of raw material per year.

The BRAIN BioXtractor ...

... is a **pioneering technology** used in the bioeconomy for next-generation metal extraction. It is based on biotechnological processes and microorganisms identified in BRAIN's BioArchive.

... offers **innovative, efficient and safe biological process solutions** for extracting metals from various secondary and waste streams as well as primary resources.

... can **extract further substances from residual material streams** in order to use biologically purified, valuable material in the construction industry, for example.

... is a **mobile, fully equipped, closed-circuit plant on a pilot scale** that is suitable for on-site process demonstrations and can be adapted to specific requirements.

... is a **sustainable answer** to declining ore yields, better environmental protection and volatile markets, as well as a promising option for covering future demand for precious metals.

The objective is to partner the technology for the treatment of various resource streams in green and urban mining.

The innovation lies in the high yield our processes offer

An interview with Dr Guido Meurer, Member of BRAIN's Management Board and Unit Head Producer Strain Development, and Dr Esther Gabor, Programme Manager Green & Urban Mining.

You have developed microorganisms and the corresponding processes for recovering metals from waste streams and electronic waste. What makes these streams so interesting?

GUIDO MEURER

Processing secondary and waste streams offers advantages in terms of a sustainable circular economy. In the final analysis, this also offers huge business potential because precious and high-tech metals are extremely coveted and costly, and mining yield rates are declining. That is especially significant for resource-poor countries like Germany. For these streams, our bio-based processes enable a yield of up to 95 % for gold, and almost 100% for other metals. That puts us in a good position as compared with traditional chemical processes.

How did you identify the right bacteria for these processes?

ESTHER GABOR

BRAIN has a large BioArchive with comprehensively characterised microorganisms. We can use our sophisticated screening processes to search through this archive based on specific requirements. But this archive, which we term "nature's toolbox", represents only a fraction of natural biodiversity. Sometimes we specifically set out to identify new product candidates. We don't have to travel far to find them, either. But we do look out for local habitats where we presume these candidates may live.

If you are looking for microorganisms that are supposed to extract silver at a later stage, you choose locations where silver can probably be found in the soil, and collect soil material there. In recent years, we have therefore made trips to closed-down mines and collected innumerable microorganisms that we subsequently analysed, selected and optimised.

What makes biological "gold digging" so attractive, apart from the price of gold?

GUIDO MEURER

For centuries, gold has held high cultural importance, and is also an important currency reserve and investment. But gold, as a precious metal, is also used for many technical applications.
Of all the raw materials obtained by mining, gold is one of the most versatile. So it would be a shame for it to land on the scrap heap, or to be more accurate: it shouldn't be allowed to remain there. We can well imagine that 'BioX gold' from our BioXtractor will be incorporated into high-tech applications in the foreseeable future.

About five per cent of gold is currently being mined using biotechnological processes, is that correct? What's special about the BRAIN process?

GUIDO MEURER

At present, biological processes are only a preparatory step in extracting gold from ore, where they make subsequent leaching with chemicals more effective. In our processes, which focus on biology, there is no need for the addition of chemicals.

There are a number of processes for obtaining metals from primary or secondary resources. Which are you working on?

GUIDO MEURER

BRAIN has developed a variety of biological processes that can be used for specific starting materials and scaled up to different volumes. Here, we are speaking of bioadhesion, one technical variant of which is also termed bioflotation. Other processes are biosorption and bioleaching. Basically, all three processes are suitable for extracting precious metals, and they can be intelligently combined with each other.

Have you applied for patents, and are research partnerships in place?

ESTHER GABOR

Yes, we have applied for international patents both for the technological process and for the microorganisms used in this process. The first patent specification in this field of research was submitted in 2008. Since 2013, our research work has been embedded in the ZeroCarbFP innovation alliance supported by the German Federal Ministry of Education and Research (BMBF).

“We can well imagine that ‘BioX gold’ from our BioXtractor will be incorporated into high-tech applications in the foreseeable future.”

Dr Guido Meurer

How much starting material can you utilise in the BioXtractor, and how much precious metal do you expect to obtain?
ESTHER GABOR
We expect to be able to process several tonnes of starting material per year in our pilot plant. Of course, it depends on the material itself how much gold or silver we obtain from it. We reckon we will be able to extract precious metals up to kilogram scale each year with such a plant.

Do your processes call for special safety precautions?
ESTHER GABOR
We developed the bacteria for our applications by means of classical biological processes, and work with commercially available materials as well as natural biological materials and processes that pose no risk to human health or the environment. So no special safety precautions are required in general.

Is it conceivable that your technology could be used in further fields of application?
ESTHER GABOR
In principle, the processes can also be applied to highly valuable rare earth metals or basic metals such as copper. In fact, we have already done this successfully. But biological processes may also make sense for recovering heavy metals or other undesirable substances from ash, besides metal extraction as such. The purified residual mineral streams can then be used in the construction industry.

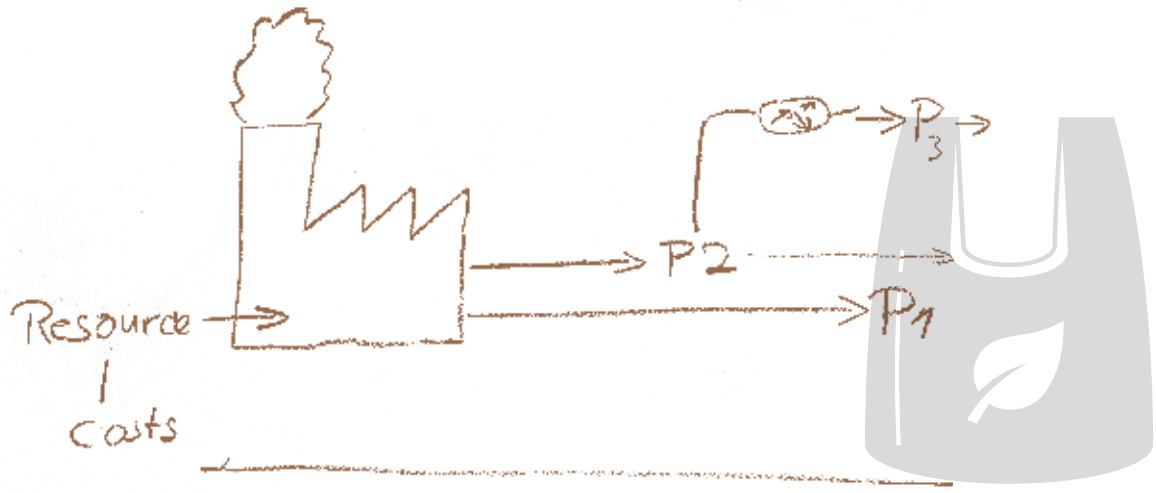
How could the mining programme make contributions to BRAIN’s turnover?
GUIDO MEURER
By entering into partnerships, BRAIN benefits from payments that depend on its personal research contributions and milestone payments. We will also generate licencing fees when the findings and products are marketed. But those are all matters to be negotiated with our future partners.

Have you already signed partnership agreements?
GUIDO MEURER
One research partnership has already been in place for several years in the field of green mining. With regard to urban mining, i.e. the utilisation of secondary and waste streams, we are in touch with several companies from various sectors of industry that are interested in our technology and want to take a closer look at our BioXtractor. I can’t give you any further details at the present time (end of business year 2016/17).

In August 2017, the first BRAIN BioXtractor was set up at the company's head office in Zwingenberg. This demonstration plant will make it possible to process up to six metric tons of raw material per year.

Microorganisms in sustainable use

Microorganisms are capable of converting all manner of raw materials into valuable industrial substances. At the same time, they serve as microbial production strains in a wide variety of bio-based processes.

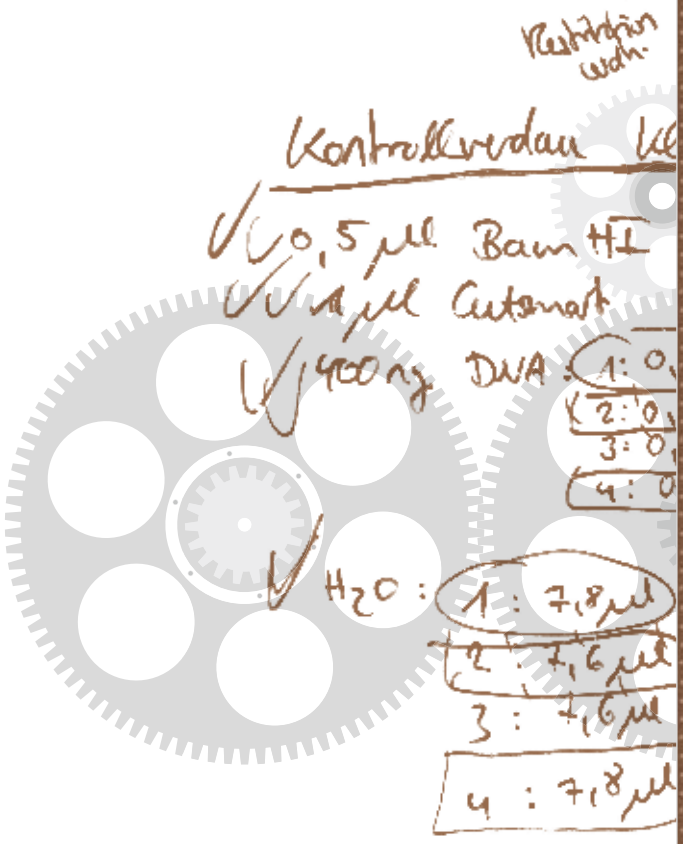


Bioplastic based on CO_2

Carbon dioxide (CO_2) is the most widely discussed resource of our age. Nature points to ways of putting CO_2 to technical use. Nature too uses carbon dioxide as a nutrient and a building block for biomass. So there are several microorganisms that feed on CO_2. BRAIN identifies such bacteria and optimises them using biotechnological processes to bind gaseous CO_2 from secondary and waste streams and then make it available for industrial added value. The specific aim in an existing cooperation partnership is to convert the CO_2 generated in bioethanol plants into intermediates for manufacturing bioplastics.

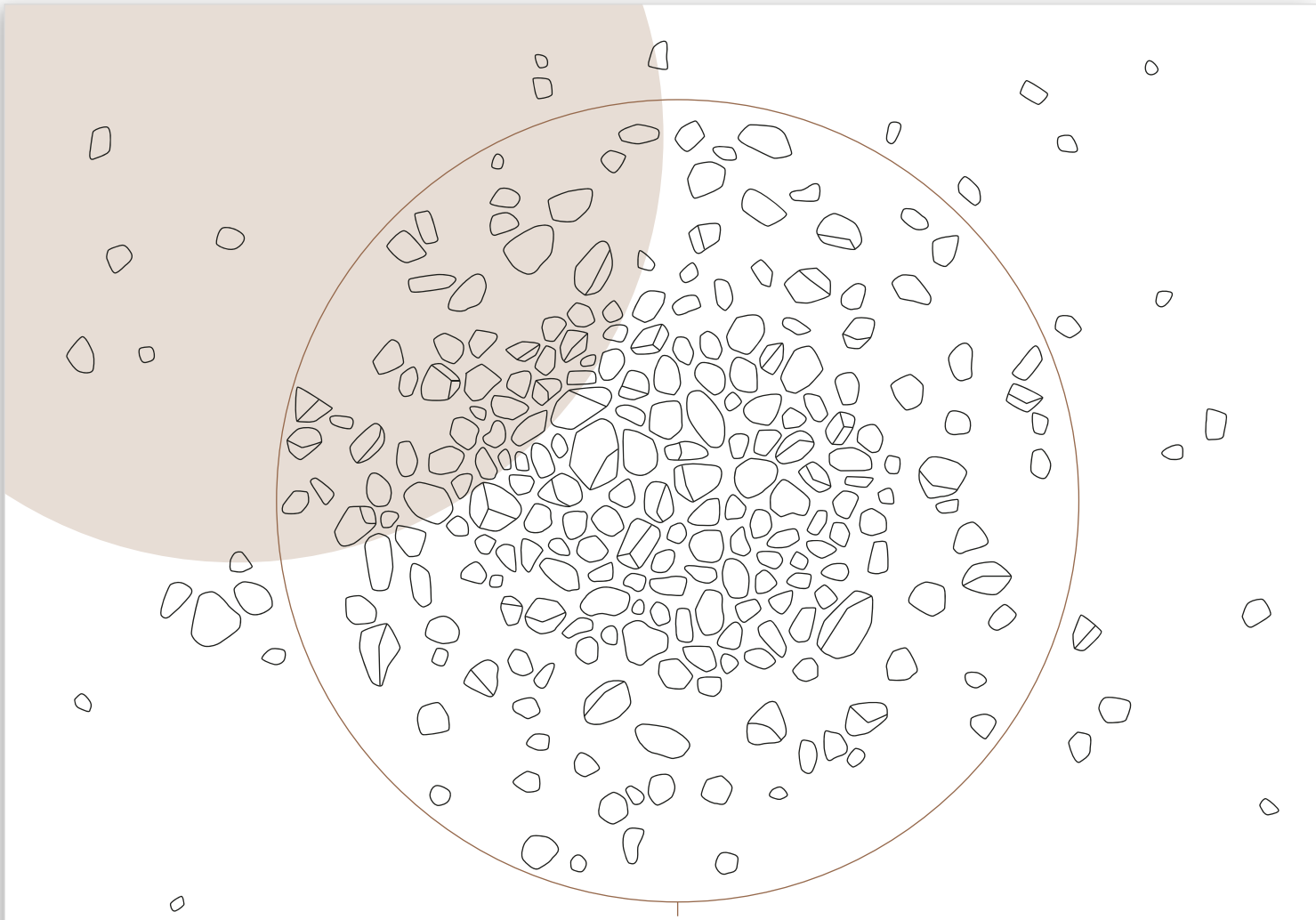
Lubricants from biogenic waste

What should we do with waste from biodiesel production? BRAIN is addressing this question within the ZeroCarbFP innovation alliance. A research partnership with FUCHS Schmierstoffe GmbH and other partners is focusing on enzymatic synthesis processes for producing high-quality lubricants based on carbon-rich secondary and waste streams. Used cooking fats and oils, animal fats, residues from biodiesel production and the cell walls of woody plants are all conceivable types of starting material. The waste streams are used on the one hand as nutrients for enzyme production, and on the other as starting materials for synthesising the target products. Research activities have the key task of identifying and optimising microbial production strains that reliably produce the enzymes while providing high yields.

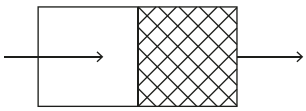


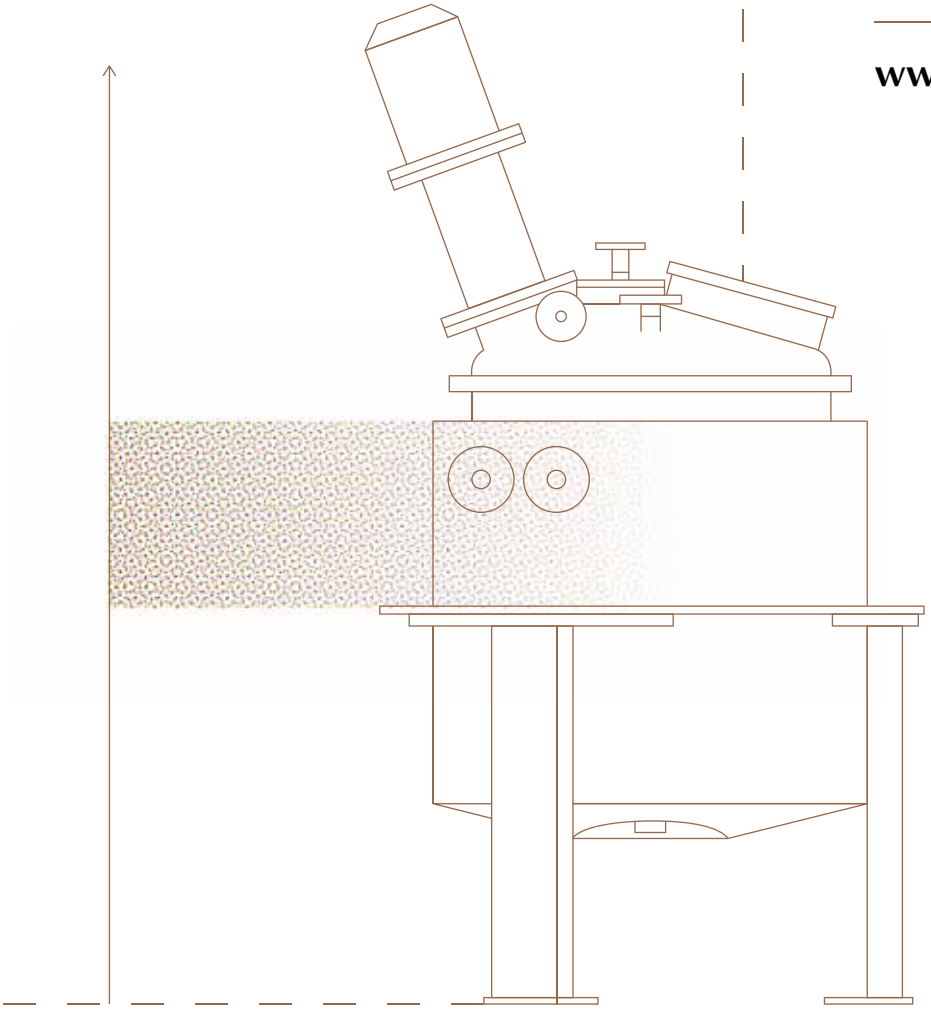
Bio-based copper slate treatment

A Franco-German research team in which BRAIN is involved has succeeded in extracting almost all of the copper from domestic slate deposits in the EcoMetals research project. This is bilaterally supported by the German Federal Ministry of Education and Research (BMBF) and the French Agence Nationale de la Recherche (ANR). The bacteria, which are used in the bioleaching process, start by converting insoluble ore minerals into water-soluble salts. This is followed by biochemical precipitation, which makes it possible to recover up to 97 per cent of the dissolved copper.



Learn more:
www.brain-biotech.de/en





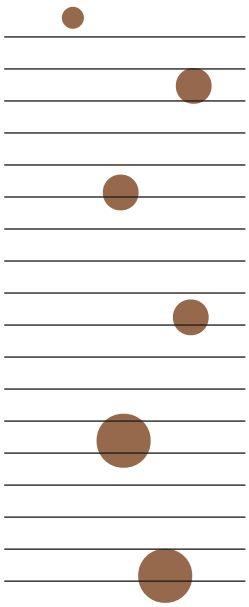


Illustration: David Lemm

02

The company

02 The company 51

The bioeconomy – the biologisation of industry

Modern biosciences and biotechnology have arrived, and the shift to the bioeconomy is underway, with the aim of handling natural resources more efficiently and on a more sustainable basis, and establishing improved industrial manufacturing processes and products to tackle the challenges our times present. The biologisation of entire economic sectors constitutes a megatrend, and is the driver and engine of a sustainable transformation process in industry and society.

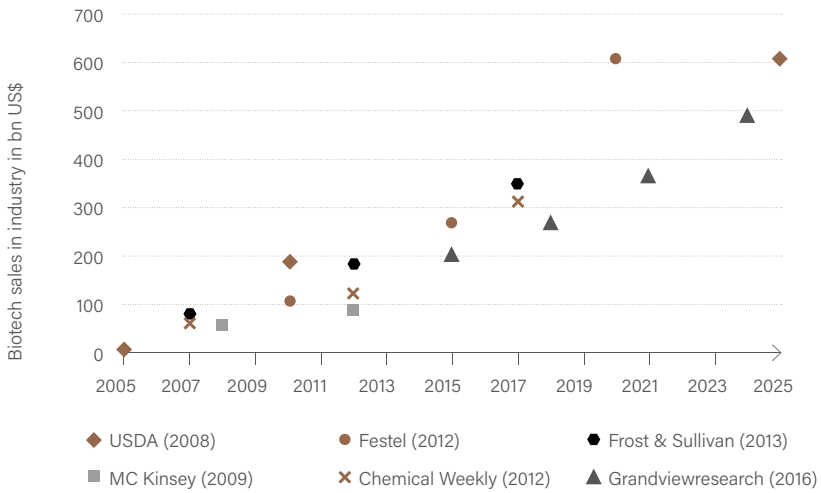
The bioeconomy megatrend

Global challenges such as world population growth, resource bottlenecks and climate change are increasingly prompting society, policymakers and business to rethink in terms of the bioeconomy – the biologisation of processes, products and industrial sectors. With this approach, natural or nature-based production processes and goods replace the deployment of fossil oil resources or solutions that are finite in supply or disadvantageous in other ways. Many current bioeconomy innovations focus on raw materials efficiency, environmental protection and health aspects.

Industrial biotechnology is the driving force and innovation motor, enabling novel solutions that seemed inconceivable even just a few years ago, and new product ideas and ways of creating value. As a cross-sector technology, it integrates highly differing disciplines from natural and engineering sciences, including cell, micro and molecular biology, genetics, immunology, biochemistry, bioprocess engineering and bioinformatics, as well as medicine and areas of machine engineering and materials sciences.

Industrial biotechnology addresses multifaceted target markets in the consumer goods, chemicals, energy and commodity industries. It plays an important role in the implementation of sustainable problem solutions worldwide and is regarded as a pioneer of a sustainable evolutionary transformation of economic systems and society, a fact reflected in numerous national and transnational programmes. The EU Commission launched its European Bioeconomy Strategy in 2012. Germany has pursued its own "National Bioeconomy Research Strategy 2030" since 2010, having established several state-supported innovation alliances since 2011 to accelerate structural change towards bio-based industry. BRAIN coordinates two such alliances – "ZeroCarbon Footprint" (ZeroCarbFP) aimed at converting carbon residue from residual and waste materials flows into industrial materials, and the "Natural Life Excellence Network 2020" (NatLifE 2020) for bioactive substances for foodstuffs and cosmetics.

FIGURE 02.1 **BIOECONOMY — OUTGROWING CHEMICAL INDUSTRIES**[1]



- Experts expect the revenues of biotech-based chemicals to grow from some 140 bn US $ in 2010 to around 610 bn US $ in 2025.
- In 2015 global industrial biotechnology sales were 203 bn US $.
- This revenue increase over the 15 year period represents a CAGR of approx. 11%.
- Industrial biotech sales are expected to outgrow the overall chemical markets – which are expected to grow at 4.1% (CAGR 2015–20)

All values in bn US $;
Exchange rate € to US $:
End of September 2017

The approval of the UN 2030 Agenda for Sustainable Development (Agenda 2030), the G7 commitment to decarbonisation and the elimination of hunger, as well as the signing of the climate agreement in Paris (COP21) gave the bioeconomy further tailwind in 2015. The first "Global Bioeconomy Summit" held in November 2015 in Berlin showed that more than 40 states have already launched research and development initiatives for the bioeconomy. In large parts of America and Asia, too, the bioeconomy is now regarded as one of the most important areas of growth for the 21st century.

Along with digitalisation, the bioeconomy represents a megatrend for the coming decades. The biotechnology-based tapping of naturally available resources forms the foundation for a new cycle entailing groundbreaking innovations, stronger economic growth and a comprehensive improvement of many people's quality of life.

Transformation of industries

In presenting its bioeconomy strategy, the EU Commission showed in its "Innovating for Sustainable Growth" study that nine percent of the European workforce (22 million individuals) were already directly or indirectly allocable to the bioeconomy in 2012, generating EUR 2 trillion of value. Around 2.2 percent of the entire manufacturing output of the USA, and consequently value creation of around USD 353 billion, was already attributable to bio-based products as of this date, too, according to a US National Academy of Sciences survey.

These figures have since continued to rise. Sales generated with biotechnology solutions are growing at double-digit rates in the globally positioned chemicals industry, according to Ernst & Young biotech reports. The US biotechnology sector alone, which has been ranked as one of the USA's top performing economic sectors over the last 15-year period, employed 1.6 million individuals in more than 40,000 companies in 2016, according to a Biotechnology Innovation Organisation (BIO) survey.

1 German Bioeconomy-Council, December 2016; Roland Berger, Grandviewresearch (2016), adapted

Expectations for future market opportunities for industrial biotechnology and bioeconomy are correspondingly high worldwide. Business experts predict that sales from bio-based "green" chemicals will expand from around USD 140 billion to USD 610 billion over the 2010–2025 period, reflecting a compound annual growth rate (CAGR) of around 11 percent, well above the level expected for other chemical product markets. Sector specialists anticipate that one in every five euros generated in sales in the chemical industry in 2020 will derive from biotechnology processes and products. This trend is currently accompanied by brisk M&A activity, with established companies endeavouring to reposition or better position themselves within the growing bioeconomy environment.

Figure 02.1

Sustainability as an investment factor

Global financial markets also regard the bioeconomy as a megatrend, leading to corresponding capital reallocations. Private individuals, asset managers and institutional investors have been placing a greater focus on socially responsible asset types for years, otherwise termed SRIs (Sustainable and Responsible Investments), or "Impact Investing", referring to their sustainable impacts. An increasing aim is to integrate aspects such as environmental protection, social compatibility and human well-being into investment strategies. Conversely, securities issued by companies that fail to make evident efforts (such as to protect the climate) are frequently subject to restrictions, if not outright rejection. Given this, sustainability reports and rankings have become standard in almost all industrial sectors.

SRIs and impact investments exhibit continuous growth. Sustainable investments in the USA amounted to a total of USD 8.7 trillion at the start of 2016, according to the Forum for Sustainable and Responsible Investment (US SIF), already corresponding to almost one fifth of all investments managed in the USA, having grown by 30 % since 2014 to amount to more than USD 2 trillion.

Europe can also offer examples of this trend. Norway's parliament decided in mid–2015 to withdraw its sovereign fund – one of the largest funds of its type with a volume of currently around USD 1 trillion – from investing in companies where climate-damaging carbon business comprises more than 30 percent of business. The biggest disinvestment to date from this segment then commenced, affecting more than 120 companies worldwide. In Germany, for example, insurance and investment giant Allianz took the opportunity ahead of the COP 21 UN Climate Conference to announce that it, too, would no longer invest in companies that procure more than 30 percent of their revenue or energy consumption from coalmining. Securities worth EUR 225 million were put up for sale, and EUR 3.9 billion of bonds were earmarked for expiry.

Such moves strengthen the trend to the bioeconomy, in alignment with all three sustainability pillars. Along with ecological and social advantages, economic benefits also exert a positive impact. Norway's sovereign wealth fund generated a record return of 6.5 percent in the first half of 2017, and its asset volumes reached a new all-time high. After appraising 190 high-quality economic studies, a research team from Oxford University arrived at the conclusion in 2014 that 90 percent of such publications show that companies reduced their cost of capital after introducing sustainability standards, while a directly positive share price performance was reported by 80 percent. Improved business performance as a consequence of applying sustainability standards was ascertained in almost 90 percent of the studies.

FIGURE 02.2 **OUR OBJECTIVE: PARTICIPATING IN THE BIOECONOMY'S SUCCESS**

BRAIN sees itself as playing an active role in helping shape the change to more sustainable ways of living and doing business. The Group stands for the ongoing biologisation of industries and the consumer world, and aims to participate in the bioeconomy's growing success.

Based on its proprietary BioArchive, BRAIN develops and markets product and process innovations for different B2B markets focused on bioactive natural compounds, natural-source enzymes and customised high-performance microorganisms.

Unique selling points

Comprehensive in-house BioArchive combined with widely protected high-tech portfolio for the discovery, decoding, further development and supply of natural resources.

More than 20 years' experience in the sustainability and biotechnology area, pronounced innovation culture, and networks with scientists and research institutions worldwide.

Rapid and reliable results in research and development cooperations and strategic partnerships. More than 100 successfully completed joint projects with industrial partners.

Industrialisation and growth strategy

Ongoing strengthening of the BioScience segment for exclusive research and development partnerships with industrial companies.

Strategic expansion of the BioIndustrial segment to develop and market the company's own product candidates, as well as mergers & acquisitions to tap technologies and markets.

Access to global markets through product-related licence partnerships with industrial companies.

Access to selected speciality markets thanks to product sales through the BRAIN Group.

BRAIN and the bioeconomy

BRAIN is the first bioeconomy company to IPO in Germany. BRAIN AG floated in the Prime Standard of the Frankfurt Stock Exchange on 9 February 2016, to advance the company's own growth and the biologisation of value chains.

Figure 02.2

BRAIN's USPs include access to the extensive "Toolbox of Nature" in the form of the company's proprietary BioArchive, and a unique and comprehensively patented technology portfolio. Based on this, BRAIN offers solutions to produce processed food and cosmetics on a more compatible basis, and to manufacture highly varied consumer products on a natural basis. BRAIN technologies based on microorganisms also serve to extract precious metals and rare earth metals from waste and byproduct flows such as carbon dioxide, electronic scrap and waste incineration ash, and to provide new product components for industrial utilisation. The BRAIN portfolio equally aims to deploy biological solutions to replace problematic chemicals and manufacturing processes.

Strategy and business model

Since it was founded in 1993, BRAIN has been a pacemaker and high-tech pioneer in the areas of industrial biotechnology and sustainable bioeconomy. During the first 15 years of its operations, BRAIN developed itself into a preferred research and development cooperation partner for established industrial companies in the chemicals, nutrition and animal feed, as well as cosmetics industries. The company continuously expanded its BioArchive as part of these partnership programs, and developed its first propriety technologies to locate new product candidates. BRAIN has pursued an industrialisation strategy along the value chain since 2008 to establish itself as a fully integrated company with its own production, marketing and sales. Accordingly, the company has two operating segments today: BioScience and BioIndustrial.

Figure 02.3

BRAIN's industrialisation and growth strategy

The BioScience segment, which is mostly based on exclusive research and development partnerships with industrial companies, comprises a key anchor of BRAIN operating activities. The cooperation business within the BioScience segment is profitable and, not least, also essential for the further development of in-house expertise aligned to market and customer requirements. Segmental revenues report constant growth. Cooperation programs with industrial partners can only be scaled on a linear basis because of the requirement for more personnel, however, and possibilities to participate in the innovation successes in the market are limited.

Given this, BRAIN started to create a second business pillar in 2008, which was established in 2010 and has since attracted a greater scope of its own investments: the BioIndustrial segment. Targets in this segment include developing product candidates in-house and commercialising them through direct market access and licence partnerships. BioIndustrial licence partnerships address global markets that are tapped together with partners along the value chain through to the end-consumer. BioIndustrial transactions through the BRAIN Group entail mainly product sales in speciality markets.

With this strategy and a comprehensive BioIndustrial product pipeline (see page 64), BRAIN anticipates faster future sales revenue growth in its BioIndustrial segment than in its BioScience segment, and consequently also an increase in its EBIT margin.

Acquisitions of companies with attractive market access form part of the industrialisation and growth strategy.

Licence partnerships with industrial partners in global markets

To address big global markets, BRAIN enables the licensing of its own innovations and partnership models for established market participants. The DOLCE programme, which was launched in August 2016, forms one example of such an approach. Together with the BRAIN Group's natural substances specialist, AnalytiCon Discovery GmbH, and Roquette from France, the market leader for substances for special foodstuffs derived from plant-based raw materials, DOLCE is engaged in developing the next generation of natural sweeteners and sweetness enhancers. All three partners of the core team have different tasks in the alliance. The BRAIN

companies are responsible for identifying and developing the natural substances. Globally operating Roquette assumes production and marketing tasks. Roquette is a reliable and preferred manufacturing business partner for many consumer goods manufacturers.

Addressing speciality markets through the BRAIN Group

BRAIN achieves market access to selected specialty markets through its BRAIN Group companies. The joint development and marketing of enzymes by BRAIN AG and WeissBioTech GmbH represents one example. The company has established a close meshed global sales network for enzyme products over the course of many years. WeissBioTech's special enzymes division is currently being bolstered. The innovations of BRAIN in the area of bioactive substances for cosmetic products are realised through its subsidiaries Monteil and L. A. Schmitt.

FIGURE 02.3 **THE SEGMENTS**

BioScience	BioIndustrial
Description • Exclusive collaboration partnerships with large industrial players • BRAIN is a trusted partner due to its unique IP and know-how • IP transfer to the customer, BRAIN retains rights **Focus** • Technology driven, joint developments **Remuneration & benefits** • Upfront, milestone, success payments • Exclusivity fees • Royalties **Rationale** • Continuation of a trusted business model • Stable and profitable growth • Technology development and retained rights	**Description** • Developing and marketing our own product innovations through licence partnerships with established industrial partners in global markets, or through addressing speciality markets through subsidiaries **Focus** • Value accretive growth strategy **Remuneration & benefits** • Licence fees from established industrial partners • Product-related cash flows • Realising product/technology synergies **Rationale** • Leverage BRAIN's proprietary IP and know-how • Optimise the way to market • Scalability

Competences and solutions

The BRAIN Group focuses on the identification, research, utilisation and marketing of natural biological substances and processes for industrial use. The group combines various industrial technology competencies to replace unfavourable industrial constituents and production processes. BRAIN also stands for groundbreaking product and process innovations. BRAIN pursues the biologisation of industry and supports the bioeconomy's more resource-conserving business activities. All research and development activities focus on sustainability, efficiency and economic viability, as well as efficacy and added quality.

Outstanding USPs

Key success factors for product and process innovations from the BRAIN house include more than 20 years' experience with the topics of sustainability and biodiversity and a pronounced innovation culture within the Group. BRAIN started to establish its competences and resources long before the bioeconomy became a prominent economic and social idea. Researchers and developers at BRAIN have subsequently established a series of USPs supplemented by special competencies within the BRAIN Group (see page 62).

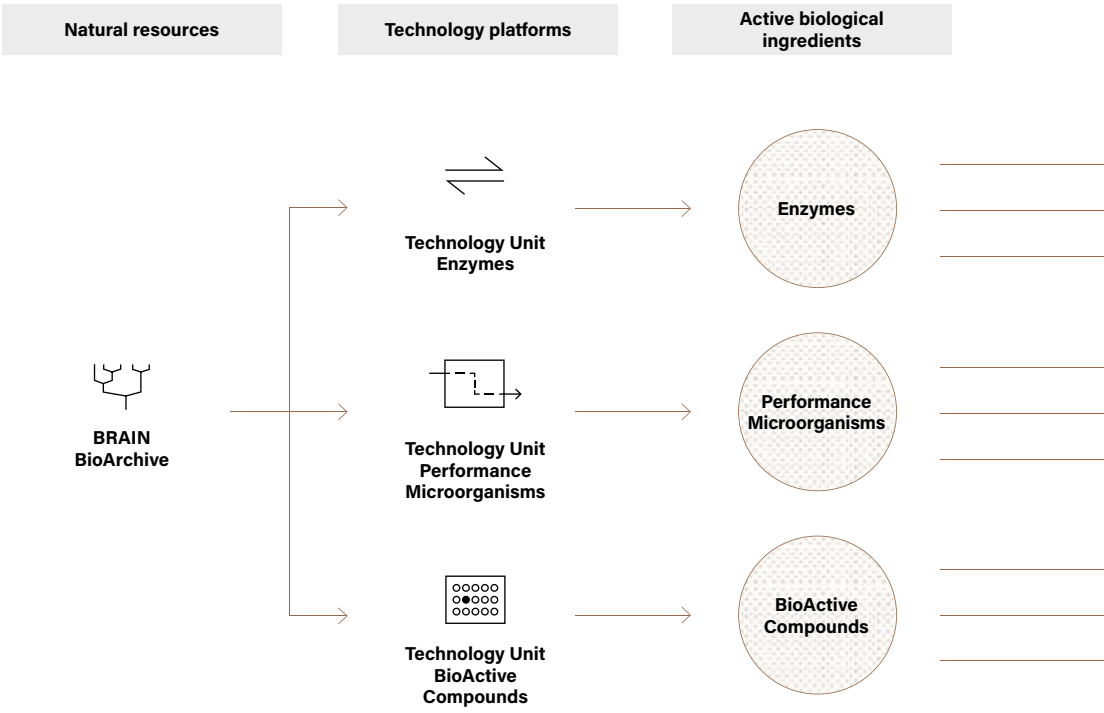
BRAIN BioArchive

The company's own BioArchive offers access to an immense variety of new biological solutions for sustainable industrial processes and contents. The BioArchive encompasses more than 53,000 comprehensively characterised cultivable microorganisms, more than 50,000 characterised natural substances and fractions consisting of edible plant material, more than 40 metagenome libraries as well as many new enzymes and metabolic paths comprising previously uncultivable organisms. This unique "Toolbox of Nature" is being expanded continuously.

BRAIN technologies

BRAIN possesses a high-tech portfolio that ensures the targeted discovery, decoding and further development of natural resources and their long-term and qualitatively reliable availability. State-of-the-art technologies for high throughput sequencing, digital 3D modelling and test simulations, as well as protein engineering and big data analyses are deployed. The high-tech portfolio is broadly secured with more than 350 patents and patent applications to materials and technologies in around 50 patent families. The patent protection encompasses technology and product innovations in all BRAIN product categories.

FIGURE 02.5 **FROM THE BIOARCHIVE TO THE B2B MARKET**

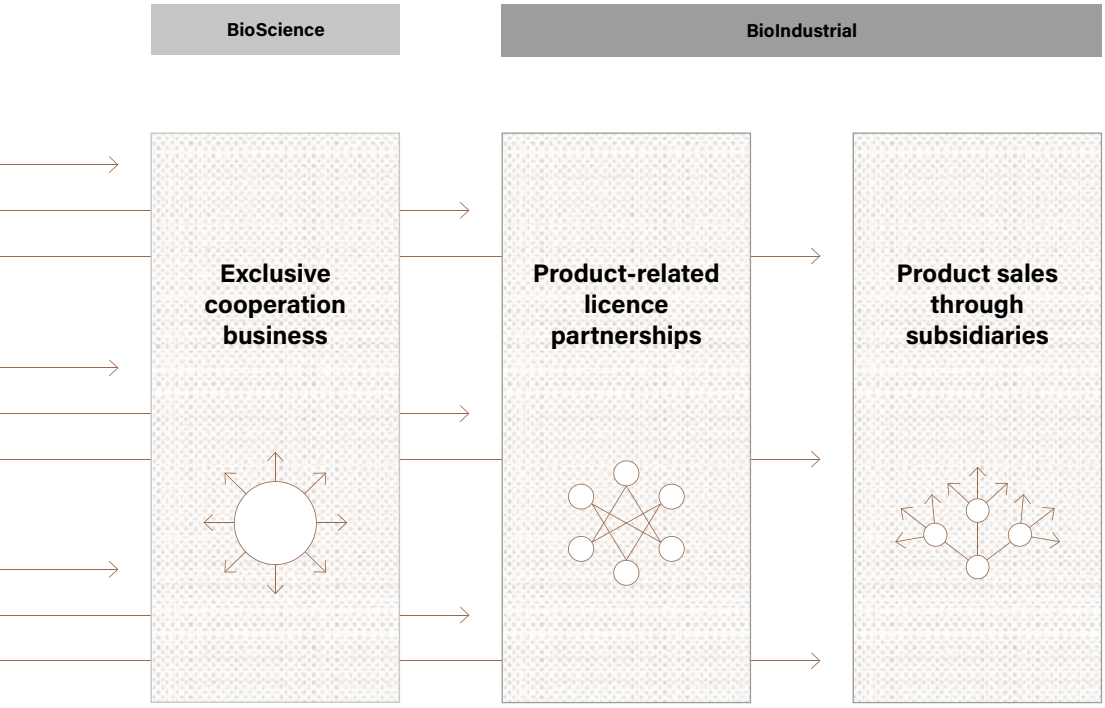


BRAIN product categories

Based on natural biodiversity and the company's own BioArchive, BRAIN focuses on three biotechnology product categories for highly differing applications in the consumer goods and chemical industries: bioactive natural compounds, natural-source enzymes and customised high-performance microorganisms.

Bioactive natural compounds

BRAIN identifies and develops bioactive natural compounds (BioActives) for product development in the food manufacturing and animal feed industry, cosmetics and chemical industries, focussing on the optimised biological effect of natural substances and improved formulations for customised applications. The product range includes sugar substitutes and taste modulators for healthy nutrition as well as natural-source substances for cosmetics.



Natural-source enzymes

BRAIN identifies and develops new or optimised enzymes and biocatalysts that fulfil complex process and application requirements for highly differing product classes, and enable innovative technical production processes to be established. These include enzymes to produce foodstuffs, detergents, wound care preparations and lubricants. The focus is on servicing markets for special enzymes.

High-performance microorganisms

BRAIN identifies and develops customised high-performance microorganisms as functional biomass for optimised industrial production processes or to establish bioprocesses in chemical procedures (BioSubstitutes), as well as to manufacture bioactive natural compounds and enzymes for speciality markets. Application areas include recycling climate gas carbon dioxide as a new industrial raw material for bioplastics, as well as urban and green mining – the extraction of precious metals from byproduct and waste flows and ores.

The BRAIN Group

The BRAIN Group combines first-class research and development work, special production expertise and access to attractive markets. All BRAIN Group companies operate as independent entities in the areas of research and development, process development, production/manufacturing or as suppliers in specific markets.

BRAIN AG

Chief Executive Officer (CEO): Dr Jürgen Eck

Zwingenberg. BRAIN AG is the parent company of the BRAIN Group.

BRAIN AG in Zwingenberg in the metropolitan Rhine-Main-Neckar region is the corporate headquarters of the BRAIN Group, focusing on research and development based on the company's own BioArchive. Since it was founded in 1993, BRAIN has been a pacesetter and high-tech pioneer in the areas of industrial biotechnology and bioeconomy. Its work focuses on bioactive substances, natural-source enzymes and customised high-performance microorganisms. BRAIN AG delivers rapid and reliable results in research and development cooperations and strategic partnerships for customers worldwide. Since 2010, BRAIN AG has been investing to a greater extent in developing its own product candidates, and commercialising them. As part of a growth-oriented and industrialisation strategy, BRAIN AG has been listed in the Prime Standard of the Frankfurt Stock Exchange since February 2016. **www.brain-biotech.de**

AnalytiCon Discovery GmbH

Managing Director: Dr Lutz Müller-Kuhrt

Potsdam. BRAIN AG holds a 59 % interest.

AnalytiCon Discovery GmbH, which was founded in 2000, is a global market leader in the area of compound libraries containing fully analysed structures. Situated on the Potsdam Biotech Campus, the company offers services for every stage of the supply chain for natural product-based (NP-based) substance discoveries and developments. Innovative technology concepts enable high-grade partnerships with globally operating companies from the pharmaceutical, food manufacturing and cosmetics industries. AnalytiCon Discovery enjoys access to around 15 percent of all natural compounds known worldwide, as well as to thousands of structures that have not yet been published. The company established technologies to develop and produce focused combinatorial compound libraries based on rare core structures that contain bioactive structural elements. AnalytiCon Discovery has been a member of the BRAIN Group since 2013. **www.ac-discovery.com**

WeissBioTech GmbH

Ascheberg. BRAIN AG holds a 50.6 % interest.

WeissBioTech GmbH was founded in 2002, and today is a leading supplier in the area of special enzymes, yeasts, natural conservation agents and other fermentation-based products for the food manufacturing industry. The company also serves the starch processing and bioethanol industries as well as producers of drinking water, fruit juices, beer and wine. The company's highly developed technical service, well-grounded expertise in enzyme technology, application know-how and a worldwide network to supply the food manufacturing and starch processing industries, as well as knowledge about enzyme developers, producers and suppliers, form the basis for its growing enzyme business. To strengthen its market position, in 2010 WeissBioTech established a downstream plant for separation and cleaning as well as mixing and packaging in France at its branch operation WeissBioTech France SARL. Combined with strong quality assurance and controlling (QA/QC), further added value is tapped through utilising concentrates of specific enzymes. The enzymes are customised to client requirements and marketed under the WeissBioTech trademarks NATUZYM® and DELTAZYM®. WeissBioTech has been a member of the BRAIN Group since 2014. **www.weissbiotech.com**

Managing Director: Hans de Bie

L. A. Schmitt GmbH

Ludwigsstadt. BRAIN AG holds a 100 % interest.

L. A. Schmitt GmbH, which was founded in Leipzig in 1925, develops and produces cosmetics and wellness products to the highest level. Many years of experience and a passion for cosmetics led to the creation of products that meet customers' high demands and requirements. L. A. Schmitt manufactures its own product lines, as well as products for wholesale and retail companies, and for wellness and cosmetic brands. Regular innovations integrate the latest scientific knowledge into products. The company focuses on individual service, well-founded knowledge and a high level of flexibility for partners and customers. L. A. Schmitt has been a member of the BRAIN Group since 2009. **www.schmitt-cosmetics.com**

Managing Director: Manfred Stöver

MONTEIL Cosmetics International GmbH

Düsseldorf. BRAIN AG holds a 68.3 % interest.

MONTEIL, a brand company founded in 1936, is highly regarded as an experienced partner to beauty institutes and perfumery stores, and is represented in more than 20 countries worldwide. MONTEIL is one of the technologically leading anti-ageing specialists in the face care area. MONTEIL cosmetics are developed at the highest scientific level, and boast a track record of setting innovative skincare trends in the international cosmetics market. MONTEIL focuses on bioactive natural substances offered in high-quality and also optimally coordinated concentrations. The company sees itself as an expert partner for customers for which – and with which – it develops treatment concepts for almost all skin types, based on a broad product range. The product spectrum comprises 86 products and 11 product lines. MONTEIL Cosmetics International GmbH has been a member of the BRAIN Group since 2011. Wilde Group, a specialist in hand and nail care, is a minority shareholder. **www.monteil.com**

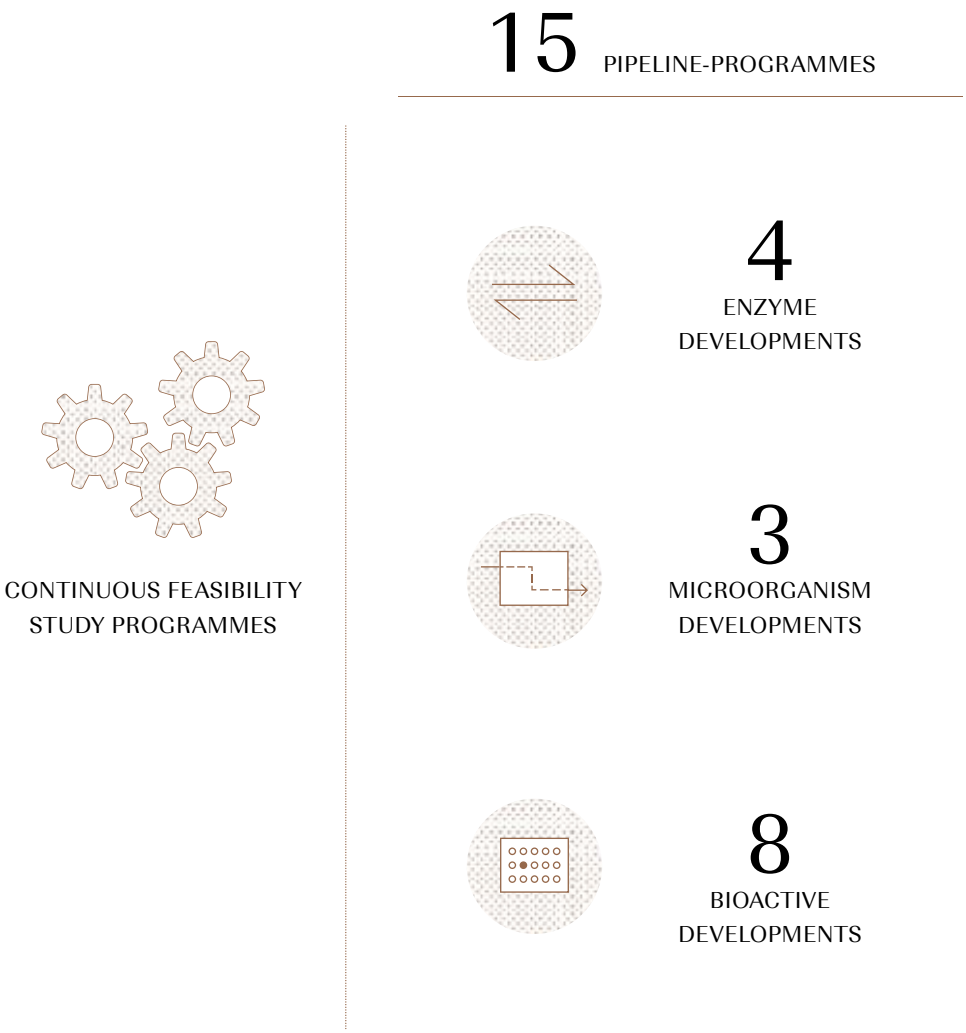
Managing Director: Thomas Kessler

Product portfolio

As part of BRAIN's industrialisation strategy, an attractive portfolio of product candidates for the BioIndustrial segment has been established over the past years. Such research and development work is in various development stages.

In a "steady state", the company aims for a relatively constant volume in its development pipeline. New projects are started as soon as development lines transfer to the marketing phase. They previously undergo intensive testing in terms of technical and commercial feasibility to optimise the programme's probability of success. At the project evaluation level,

FIGURE 02.5 **NEW PRODUCT DEVELOPMENT**



BRAIN can call upon extremely rapid and reliable expertise at every research and development stage.

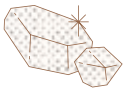
BRAIN is currently pursuing 15 product development programmes in its BioIndustrial segment, addressing a total of six market categories. Successful product candidates are to be launched on the market in the coming years.

6 DIFFERENT MARKETS ADRESSED

FOOD
& BEVERAGES

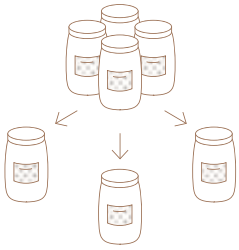
FEED

WOUND CARE

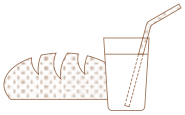


GREEN & URBAN MINING

BIOPLASTICS



PRODUCT LAUNCHES
IN THE COMING YEARS



FOOD
& BEVERAGES

FEED

COSMETICS

Highlights of the 2016/2017 business year

DOLCE

EY Entrepreneur Of The Year™
Finalist 2016

2016 — 2017

October — November — December — January

6 October 2016

Successful interim evaluation of the ZeroCarbFP strategic alliance

The committee of consultants appointed by the German Federal Ministry of Education and Research (BMBF) recommends that support for the ZeroCarbFP strategic alliance be continued for the upcoming second phase, during which the bio-based processes that have already been identified are to be brought to market. BRAIN acts as the coordinator of this alliance.

16 November 2016

Two large food product categories participate in DOLCE programme

The first two product categories, breakfast cereals and snacks, are partnering with the DOLCE programme. The consumer goods companies taking part are mainly interested in replacing or reducing sugar with natural substitutes or sweetness enhancers, with the aim of producing healthier foodstuffs.

18 November 2016

BRAIN CEO nominated "Entrepreneur of the Year 2016"

Jürgen Eck, CEO of BRAIN AG, is a finalist in the Entrepreneur of the Year 2016 contest. The title is awarded by independent economic experts for innovative corporate management.

2 December 2016

A "SYMPCURSION" in and to Zwingenberg

BRAIN is organising its first "sympcursion". This neologism is a mix between a SYMPosium and an exCURSION. Biotechnological research issues will be presented and discussed in a round of interdisciplinary talks.

19 December 2016

BRAIN publishes provisional figures for the 2015/2016 business year

The provisional figures for the BRAIN Group indicate a slight growth in total operating performance of 2 % to € 26.1 million. Sales grew by 8 % to € 22.8 million in the period under review. The BioScience and BioIndustrial Segments both contributed to this result.

16 January 2017

BRAIN publishes Annual Report

BRAIN confirms the provisional figures published in December 2016 for the 2015/2016 business year. BRAIN's first Annual Report following its IPO bears the title "Engineering Biology", and offers exciting insights into the world of industrial biotechnology.

31 January 2017

BRAIN proposes candidates for election to the Supervisory Board at ordinary shareholders' meeting

BRAIN's Management Board proposes Dr Anna Eichhorn, Dr Martin Jager and Dr Georg Kellinghusen for election as new Supervisory Board members, since several existing members will withdraw from the Supervisory Board at the forthcoming ordinary shareholders' meeting.

February

March

April

May

9 February 2017

Free float of BRAIN share successfully increased

BRAIN has announced that MIG-Fonds, a long-standing shareholder of the company, has sold all of its shares. These sales increase the free float of the BRAIN share from 22 % to 37 %.

28 February 2017

BRAIN gets off to stable start in 2016/2017 business year

In the period from October to December 2016, the BRAIN Group achieved total operating performance of € 6.6 million as compared with € 7 million in the same period of the previous year. Sales revenues rose slightly from € 6 million to € 6.1 million.

9 March 2017

BRAIN's first ordinary shareholders' meeting since IPO goes off successfully

BRAIN's first ordinary shareholders' meeting since the IPO was held on 9 March 2017. All points on the agenda were approved by a large majority of the participating shareholders.

21 March 2017

BRAIN extends patent coverage for Aurase® enzyme for the treatment of chronic wounds

BRAIN has received extensive patent coverage for its new Aurase® enzyme for applications in the treatment of skin, scars and wounds. This important step lays the foundations for subsequent marketing in a total of 20 countries in Europe, Asia, North America, Oceania and Africa.

6 April 2017

NatLifE 2020 alliance partners take positive stock at 2017 annual meeting

Over 40 scientists took part in the regular meeting of the NatLifE 2020 strategic alliance and summed up its results on a positive note in light of recent research findings. The alliance is developing a new generation of sustainably produced and biologically active ingredients for the food and cosmetics industries using biotechnology and an understanding of biological systems. BRAIN has been in charge of coordinating the alliance since its inception.

12 May 2017

BRAIN nominated for gold award in largest European competition for theme-based communication

BRAIN's first Annual Report since its IPO has been nominated for the "Best of Content Marketing" award in the "reporting" category. The prize will be awarded at the BCM congress in Berlin.

31 May 2017

BRAIN on course for growth in first six months of 2016/2017

The BRAIN Group succeeded in increasing its total operating performance by 3 % between October 2016 and 31 March 2017 as compared with the same period of the previous year. Sales revenues rose by 9 % and EBIT dropped from € –5.3 million to € –5.6 million.

reddot award 2017
winner

June | July | August | September

13 June 2017

Kunst *privat!* at BRAIN AG focuses on "Habitats"

Once again, BRAIN is participating in the art initiative Kunst *privat!* This year's initiative will showcase works on the theme of "Habitats" (Lebensräume) by artists Daniel T. Braun, Thomas Mies, Tatjana Urban and Julia Roppel.

21 June 2017

BRAIN and Roquette successfully wind up multi-year research project

BRAIN and Roquette have now concluded a research project that aimed to improve the efficiency and sustainability of production processes for food ingredients. To this end, BRAIN identified, developed and optimised biological resources from its BioArchive.

12 July 2017

Global beverage corporation joins DOLCE

BRAIN, AnalytiCon and Roquette are pleased to announce that a U.S. beverage corporation with global operations has been acquired as a new member of the strategic DOLCE partnership. The new product categories to join the partnership comprise "non-alcoholic beverages", "milk and yogurt drinks" and "ginger ale and tonic".

2 August 2017

Successful conclusion of joint BRAIN AG and BASF SE research project

10 August 2017

BRAIN AG receives prestigious design and creativity award for first post-IPO annual report

15 August 2017

Scientific study proves high dental treatment costs due to excessive sugar consumption

29 August 2017

Strong demand for BRAIN shares from institutional investors

31 August 2017

BRAIN achieves notable top- and bottom-line improvements in the first nine months 2016/17

7 September 2017

BRAIN acquires new long-term investor as part of capital increase

The company is increasing its cash capital, making partial use of the authorised capital. Some 10 % of the previous equity capital will be provided by a new long-term investor, DAH Beteiligungs-GmbH, Mannheim.

Press review

Biotech boom drives jobs for young people

Bergsträßer Anzeiger, 17 October 2016

Hall of Fame – Entrepreneur of the Year

EY Werte, Wege, Wachstum, 18.11.2016

First Annual General Meeting after IPO a resounding success

hv magazin, 01.2017

Stock exchange celebrity from the Bergstrasse

FAZ, 02.02.2017

BRAIN jumps on the health bandwagon

Börsen-Zeitung, 18.03.2017

Sweet hopes

Handelsblatt, 23.03.2017

Biology replaces toxic chemicals in mining

EURO AM SONNTAG, 18.03. – 24.04.2017

BRAIN in top spot of German IPOs for 2016

23 May 2017, finanzen.net

Positive results for "NatLifE 2020"

7 April 2017, Darmstädter Echo

BRAIN is one of the most innovative companies in Germany

May 2017, BRAND EINS

Hello sweeties!

7 June 2017, Brigitte

The capital market appreciates BRAIN's IPO performance

2017, Deutscher Biotechnologiereport

Gold from scrap

17 August 2017, HR Hessenschau TV

The light-filled technology campus and the openly designed outdoor spaces make for a working environment that buzzes with innovation and encourages creativity. This promotes staff identification with the company's visions.

Lively corporate culture

Technology campus

In 1996, BRAIN bought a technology campus consisting of 2,500 square metres of laboratories, production and office facilities in Zwingenberg, a town in Hesse's Bergstrasse region. The core of the campus is the Bauhaus building, classed as a historic monument. Further generously dimensioned areas were added in 2010. The new glass building, which serves as the lobby, with access passages and exhibition rooms, builds an optical bridge between the complex of listed buildings and a hall that houses further offices, lab space and production units.

The light-filled technology campus, with rooms that offer individual privacy, and the openly designed outdoor spaces make for a working environment that buzzes with innovation and encourages creativity. This promotes staff identification with the corporate vision of a bioeconomy.

Guided by the Bauhaus philosophy

The headquarters of the BRAIN Group is one of the few remaining examples of industrial Bauhaus architecture. The building once housed Deutsche Milchwerke AG, and was also known as the Fissan factory due to its brand name. Back in the 1930s, successful biotechnological research and development activities were therefore already being carried out in Zwingenberg, and there was already a successful product portfolio. After taking over the complex, BRAIN revitalised the building in meticulous detail in 1996, and in 1998 won the prestigious Josef Maria Olbrich prize awarded by the Association of German Architects (BDA).

An aesthetic appearance, a high degree of functionality and innovative approaches were the hallmark of the Bauhaus era and the basis for its success. Until today, BRAIN has taken guidance from some aspects of the Bauhaus philosophy. Interdisciplinary work within a team is marked by open discussions, mutual support and a joint approach both to scientific and administrative work. BRAIN considers it important to initiate and support an eye for functional aesthetics in its daily operations.

Cultural involvement as part of the company profile

BRAIN sees its activities as being part of creative societal processes. The company consciously links up with art and culture to strengthen its own creative power and beyond this, to contribute its own aims and visions to public discourse. BRAIN's cultural activities constitute a targeted form of involvement in a dialogue that broadens horizons.

This is also the rationale behind BRAIN's many years of participation in the Kunst privat! art initiative launched by the Hessian Ministry of Economics, Energy, Transport and Regional Development. The works of selected young artists that refer to the company's operations are exhibited on BRAIN's premises and made accessible to the public on guided tours. The artists are generally available for in-depth discussions during the exhibition. Selected exhibits remain

Kunst *privat!*

One example of BRAIN's cultural involvement is its annual participation in the Kunst *privat!* art initiative launched by the Hessian Ministry of Economics, Energy, Transport and Regional Development.

on show for a longer period, and accompany BRAIN staff throughout their working day. BRAIN thus offers a constant platform for a productive exchange between science and art.

Award-winning corporate communications

BRAIN considers communication, information and design to be key components of its activities. Alongside lavishly designed annual reports, BRAIN also publishes the regular periodical BLICKWINKEL, in tandem with the company's quarterly and six-monthly reports. This periodical serves to provide information on company-specific themes and trends, and places them in relation to economic, scientific and social affairs. The design of this medium consciously distinguishes it from other publications in this sector. The photography and graphic design in particular are unconventional. Each issue is individually illustrated. Exclusively created photographs underline the aesthetic side to the company's apparently technical line of work – the bioeconomy. Recently, an inter-active internet site has been developed for the periodical, which strengthen's BRAIN's initial involvement in social media.

BRAIN has received numerous awards for its unusual activities related to art, culture and communication. Following the company's IPO in February 2016, the first Annual Report 2015/2016 received the prestigious Red Dot Award in June 2017. In May 2017, the annual report had already been nominated for a Best of Content Marketing Award, and later received a silver medal. In September 2016, BRAIN received the coveted WERKBUND Label for groundbreaking, innovative activities that are of importance to society, or stand for good design. In addition to these, BRAIN also received a special mention for the exceptional design quality of BLICKWINKEL at the 2014 German Design Awards presented by the German Design Council. The company magazine received the iF communication design award in 2013 from iF Industrie Forum Design e.V.

BRAIN's first annual report in 2015/2016 received the Red Dot Award and Best of Content Marketing Award Silver Certificate.

BRAIN started to expand its internet presence at the end of the 2016/2017 business year. Thus a dedicated internet site has been established for the longstanding quarterly BLICKWINKEL. All issues from business year 2015/2016 can be found at www.brain-biotech.de/en/blickwinkel.

A BRAIN Twitter account (@BRAINbiotech) has been set up and successfully positioned. Further measures are being prepared.

BRAIN's quarterly magazine BLICKWINKEL offers accessible, flexible and compact information on company trends.

You can now find all issues online at: www.brain-biotech.de/en/blickwinkel.

Staff culture

"At BRAIN, entrepreneurial personalities address new challenges each day with passion and creativity. A remarkable corporate culture, to my way of thinking."

Dr-Ing. Ute Dechert — Unit Head Organisation & Processes

Within the BRAIN Group, highly qualified scientists, engineers, technicians and managers work on a variety of different subject areas. Their scientific curiosity and entrepreneurial thinking stamp BRAIN as an interdisciplinary and cross-sectoral think tank. Work within the organism that is BRAIN is characterised by a focus on dialogue and teamwork. Constructive discourse, and the heated debates that arise from it, support the rapid and reliable transfer of an idea through to scientific validation and on to marketing. This culture that everyone at BRAIN lives and breathes, and the diversity of the people, expertise and talents that exist within the company, combine to foster a wealth of ideas. This often enables BRAIN to recognise research and market opportunities long before they are perceived by the competition.

The constellation of the BRAIN Group makes it possible to discuss and realise completely closed value chains. The aim is not to assimilate the Group's companies. Rather, all companies within the BRAIN Group act as independent entities, with their own skills, strengths and cultures. BRAIN sees itself as the core that drives innovation and maintains an open and creative dialogue with its partners. Barrier-free thinking and the broadening of mental horizons are practised as a strategy for creative problem-solving in the Group. This facilitates differentiated thought patterns and modes of perception, and enables rapid clarification processes and the targeted realisation of solutions.

Staff in the BRAIN Group

At the end of the business year in September 2017, a total of 245 colleagues were employed by the BRAIN Group, 127 of them at BRAIN AG, 68 at AnalytiCon Discovery GmbH, 18 at WeissBioTech, 19 at L. A. Schmitt and 13 at MONTEIL. 2

Networking and promoting education and training

BRAIN maintains informal and official networks with famous scientists and research institutions around the world, and takes part in public basic and development research and a number of forums in order to contribute its own expertise and experience to the bioeconomy and to learn from its interactions with others.

In this environment, BRAIN also offers space for students to work on independent research projects with a strong practical bent. For this purpose, it maintains longstanding cooperation arrangements with several universities.

It has also set up training partnerships with companies in the Rhine-Main-Neckar metropolitan region. This is BRAIN's contribution to training young people, an unbroken tradition since 1996. Since 2016, the company has offered an independent course of training for office

2 All statements made here reflect the status in September 2017, including executive officers and trainees.

management assistants. In 2018, BRAIN will also become an independent training company for biology laboratory technicians.

The constantly growing BRAIN alumni platform unites trainees, students and present and former staff to promote personal and professional exchange.

The BRAIN share and the capital market

→ BRAIN AG is a growth company from the up-and-coming area of the bioeconomy and industrial biotechnology, and the only company of its type in the German equity market.
→ Given the closing price of € 19.70 on the last trading day of the financial year (29 September 2017), the share price gain compared with the previous year's close of € 11.70 amounts to more than 68 %.

Capital market environment

The capital market environment in the 2016/17 financial year proved to be largely positive. Apart from short-term setbacks, such as ahead of the US presidential elections, the North Korea crisis, reporting on the diesel subject in the German automotive industry and an appreciating euro thanks to an indicated change in European monetary policy, the DAX index of leading German equities reported gains over almost the whole period. The index touched its low of 10,259 points as early as 4 November 2016. The high for the year was reached on 19 June 2017 at almost 12,889 points (XETRA closing prices in each case). On a year view, the DAX closed on 29 September 2017 at 12,829 points, representing a significant gain of 22.1%. The SDAX small cap index that is more relevant for BRAIN performed mainly in line with the DAX. From mid-July, when weak automotive stocks and the stronger euro increasingly weighed down on the DAX, the SDAX clearly decoupled, outperforming the DAX with a more than 6 % gain the reporting period.

Price performance of the BRAIN share

BRAIN AG is a growth company from the up-and-coming area of the bioeconomy and industrial biotechnology, and the only company of its type in the German equity market. Accordingly, the performance of the BRAIN share is significantly more dependent on the company's growth successes and prospects than on general stock market trends. This is also underscored by the very positive but equally volatile trend in the BRAIN share price, especially during the first five months of the financial year elapsed. The BRAIN share already marked its low[1] for the year of € 11.60 on 6 October 2016, rising to its high[1] for the year of € 24.49 on

1 In each case based on the closing price.

27 January 2017. During the periods surrounding share sales by previous shareholders with the expiry of the lock-up phase (the shares of the early-phase investor MiG Fund were successfully placed among institutional long-term investors during the night of 8 February 2017, thereby boosting the free float to around 40 % and tangibly reducing the share's volatility) and the lacklustre start to the new financial year, the share relinquished most of these gains up to the AGM in March 2017. This setback in the share price proved to be only short-term, however. The share rapidly recovered, trading in a range between € 17.00 and € 19.00 from mid-April 2017, supported by a flow of positive company news. Given the closing price of € 19.70 on the last trading day of the financial year (29 September 2017), the share price gain compared with the previous year's close of € 11.70 amounts to more than 68 %. The BRAIN share consequently outperformed its relevant benchmark indices again – the DAX, SDAX and the DAXsubsector Chemicals, Specialty Performance Index – which registered gains of 22.1 %, 28.3 % and 26.0 % respectively over the same period.

Successful capital increase for further growth

On 7 September 2017, BRAIN AG acquired a further long-term investor by way of a capital increase with DAH Beteiligungs-GmbH, a company run by financial investor Daniel Hopp. This entailed issuing a total of 1,641,434 new ordinary registered shares, corresponding to around 10 % of the previous share capital, to DAH Beteiligungs-GmbH. This transaction raised the share capital of BRAIN AG from € 16,414,348.00 to € 18,055,782.00. Gross issue proceeds of around € 28 million accrued to the company from this measure. According to planning, the funds are to be deployed for the further implementation of the sustainable growth strategy of BRAIN AG, especially to finance small and medium-sized acquisitions.

The capital measure and the new investor were received positively by the stock market. During the three weeks following the capital increase (and up until the financial year-end), the share price rose by around 10 %, thereby breaking out of its previous trading range. This positive reaction underscores again the high future potential that investors meanwhile ascribe to the advancing biologisation of classic industrial processes to achieve greater resource efficiency, sustainability, and protection of nature and the climate.

FIGURE 02.6 **BRAIN SHARE PRICE PERFORMANCE (INDEXED)**

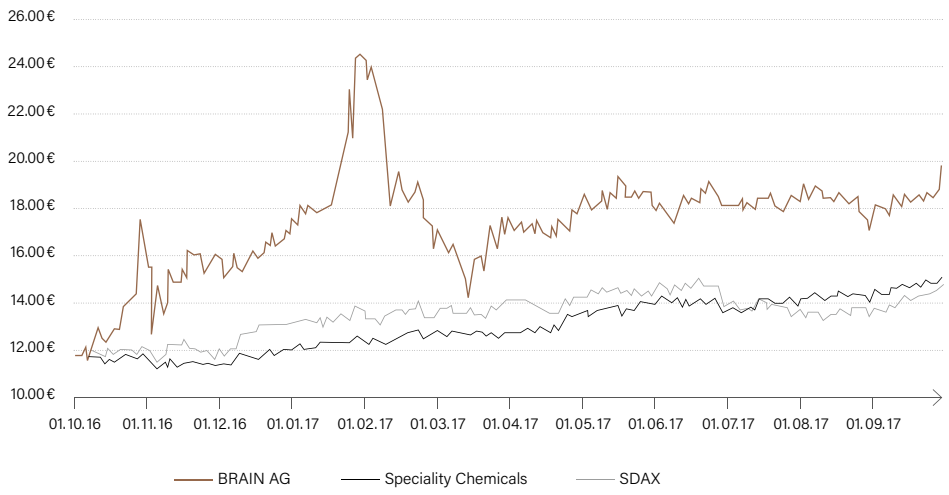


TABLE 02.1 **KEY SHARE DATA**

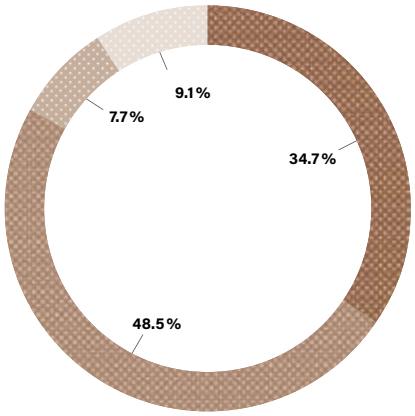
Share class	No-par-value registered shares
Stock exchanges	XETRA, Frankfurt, Berlin, Düsseldorf, Munich, Stuttgart, Tradegate
Transparency level	Prime Standard
Number of shares	18,055,782
Share capital	€ 18,055,782
ISIN	DE0005203947
WKN	520394
Ticker symbol	BNN
Specialist	ODDO SEYDLER Bank AG
Designated Sponsor	ODDO SEYDLER Bank AG
Paying agent	Bankhaus Gebr. Martin
Share price on 29.09.2017[2]	€ 19.70
52-week high[3]	€ 24.49
52-week low[3]	€ 11.60
Market capitalisation on 29.09.2017[2]	€ 355.70 million
Average daily trading volume (52 weeks as of 29.09.2017[2])[3]	30,208 shares/day

2 Last trading day of the 2016/17 financial year
3 In each case based on the closing price.

Shareholder structure

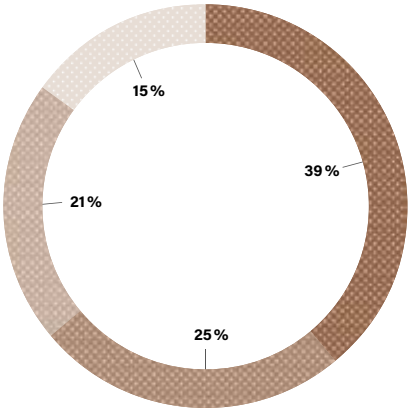
As a result of the capital increase in September 2017, the number of shares in issue of BRAIN AG increased to 18,055,782. Thanks to placements of previous shareholders' investments, the free float increased significantly during the financial year elapsed, and at 47.6 % stands currently almost twice as high as on 9 September 2016. This also exerts positive effects on the liquidity and tradeability of the BRAIN share. The shareholder structure of BRAIN AG as of 30 September 2016 (and as of the previous year's reporting date) is as follows:

FIGURE 02.7 **SHAREHOLDER STRUCTURE**



SHAREHOLDER STRUCTURE ON 30.09.2017

MP Beteiligungs-GmbH:	34.7 %
Free float:	48.5 %
Founders and management:	7.7 %
DAH Beteiligungs-GmbH:	9.1 %



SHAREHOLDER STRUCTURE ON 30.09.2016

MP Beteiligungs-GmbH:	39 %
Free float:	25 %
Founders and management:	21 %
MIG Fonds:	15 %

Analysts

Estimates and recommendations relating to BRAIN AG are published by the following research houses:

Company	Analyst
Baader Helvea Equity Research	Markus Mayer, Laura López Pineda
Deutsche Bank AG	Falko Friedrichs, Gunnar Romer
EQUI.TS	Thomas Schiessle
ODDO BHF-Bank	Igor Kim, Sebastien Malafosse

Financial communication

BRAIN AG is listed on the Frankfurt Stock Exchange in the Prime Standard segment of the Regulated Market, the stock exchange segment entailing the highest transparency requirements. Along with corresponding mandatory publications such as quarterly statements and half-year financial reports, BRAIN informed investors, analysts and other interested capital market participants in two ad hoc announcements, 24 press announcements and 15 IR announcements, as well as through telephone conferences and individual meetings, about the company's further development and the bioeconomy's global growth potential. As part of roadshows (a total of 18 days), especially in January (after the publication of the annual financial statements) and September (after the capital increase), company representatives met with investors in Brussels, Chicago, Düsseldorf, Frankfurt, Helsinki, Cologne, London, Lyon, Munich, Paris and Zürich in 2017. The focus here was on presenting the company and its future prospects to interested new investors. Company representatives were also consistently available at relevant conferences such as the ODDO Finance Conference in January in Lyon, the DVFA Spring Conference in Frankfurt/Main, the Baader Investment Conference in Munich, as well as the Equity Capital Forum in Frankfurt/Main. Financial announcements and publications as well as all other publications of relevance to the capital market are permanently available on the company's website at www.brain-biotech.de/investor-relations/.

Annual General Meeting

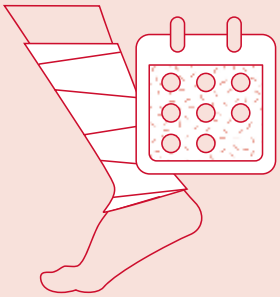
The first Annual General Meeting of BRAIN AG, which was held on 9 March 2017 in Zwingenberg, represented an important high point of investor relations work in the 2016/17 financial year. A total of 70.77 % of the share capital of BRAIN AG, which is divided into 16,414,348 shares, was represented there. The participating shareholders accepted all agenda items with large majorities. The voting results can be viewed on the Internet at www.brain-biotech.de/investor-relations/hauptversammlungen/hauptversammlung-gj-2015-16. Votes were held concerning the respective discharge of the members of the Management and Supervisory boards for the 2015/16 financial year, the election of a new auditor, the election of four Supervisory Board members and the creation of new authorised capital. At the end of the AGM, temporary CFO Dr Georg Kellinghusen returned to the company's Supervisory Board. As planned, Frank Goebel replaced him as the CFO on the Management Board of BRAIN AG.

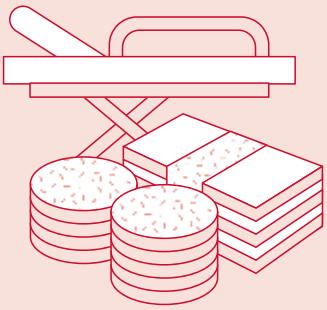
Biological care for wound patients

The combination of natural biodiversity and biotechnology opens up new prospects in wound treatment. This benefits patients, nursing staff and the health system in equal measure. Special enzymes point the way.

There are a growing number of patients with chronic wounds in Europe and other parts of the world. The number of cases in Germany alone is estimated at three million, but there are surely a large number of unreported cases. Since this mainly concerns elderly people, demographic change is pushing up patient figures. Other factors include diet-related conditions such as obesity, diabetes or malnutrition.

BRAIN's researchers have developed a new treatment to improve the situation of wound patients. The active principle is an enzyme with the product name Aurase®, which is modelled on the maggots of the common green bottle fly *(Lucilia sericata*). It has been known for centuries that open wounds infected with these maggots heal better.



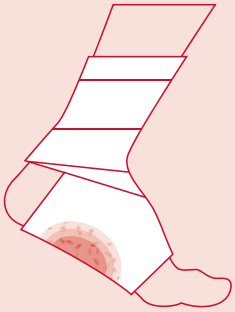


40 m

There are more than **40 million patients with chronic wounds** worldwide. Doctors speak of chronic cases when treatment takes longer than eight weeks. In Germany, the wounds of about one third of patients become chronic.

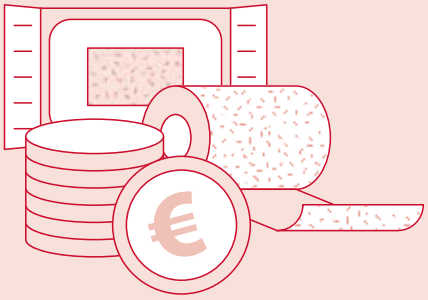
EUR 10,000

The costs of treating patients with chronic wounds amount to EUR 2 – 4 billion each year in EU member states. **Individual treatment costs are around EUR 10,000 per patient**. Wound dressings and bandages account for about a fifth of these costs.



50 %

About **half of all patients with decubitus ulcers** (also known as bed sores) and diabetic foot syndrome **become chronic wound patients**. Treatment may take many months or even years.



USD 20 bn

Experts presume that the **global market for wound treatment products and bandages** will reach an annual volume of **more than USD 20 billion by 2020**. The average annual growth rate of this market between 2014 and 2020 is estimated at eight per cent.

BRAIN's researchers have developed a new treatment to improve the situation of wound patients. The active principle is an enzyme with the product name Aurase®, which is modelled on the maggots of the common green bottle fly (*Lucilia sericata*).

BRAIN has translated this gift from nature's treasure trove into new wound care products.

The starting point was the identification of an enzyme that promotes wound healing in maggot therapies. The high-purity Aurase® enzyme is produced by means of biotechnological processes. The product name was based on the Latin for gold (aurum) and refers to the German name of the fly (literally "golden bottle fly") that served as the natural model.

BRAIN extended its patent coverage for commercial use of Aurase® in the 2016/17 business year. We are currently exploring specific applications and various marketing options.

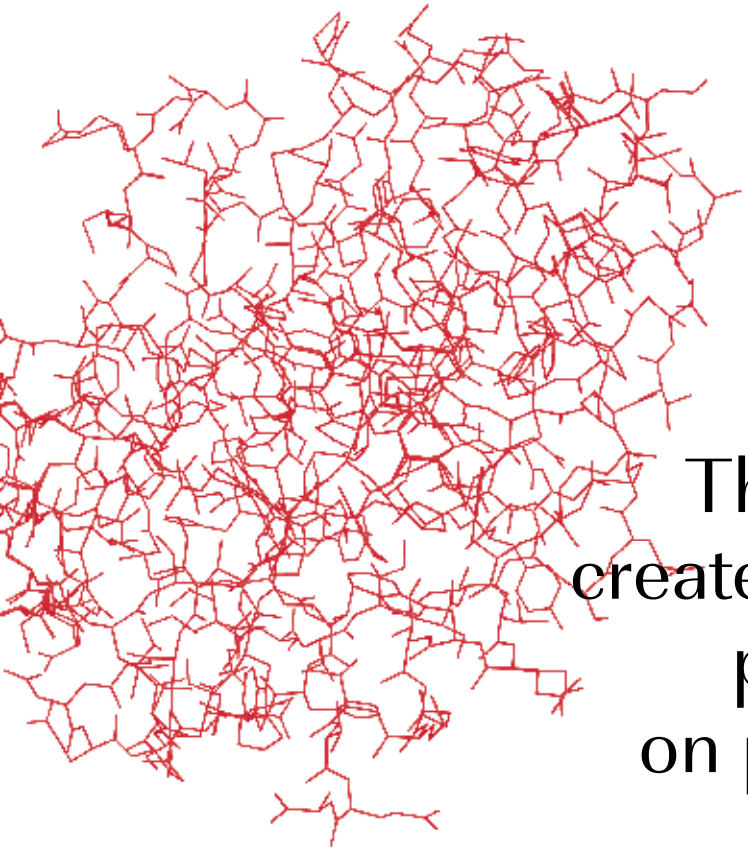
Aurase® ...

... is a new enzymatic active ingredient developed by BRAIN for the **biological treatment of open wounds**.

... illustrates the **enormous and still largely untapped potential of biodiversity**, here based on the common green bottle fly as a natural model. BRAIN's BioArchive contains a sliver of this biodiversity.

... is a new enzyme product for which BRAIN has already received **patent coverage in some 20 countries** of Europe, Asia, North America, Oceania and Africa for the fast growing market for the treatment of chronic wounds.

... is a **gentle option** for the growing number of chronic wound patients, and an **effective addition** to other sometimes painful and unpleasant procedures such as surgical debridement or maggot therapy.



The objective is to create a range of Aurase® products based on proven processes.

Our Aurase® enzyme unites bio-tech with nature

An interview with Dr Bela Kelety, Unit Head New Business Development at BRAIN AG, and Dr Alexander Pelzer, Project Manager and Platform Coordinator Tailor-made Biocatalysts

What is the special challenge involved in the treatment of open wounds?

BELA KELETY

Our skin acts as a barrier that protects us from pathogens. If this barrier is destroyed, there is a risk of contamination and infection that adds to the task of wound healing. Open wounds therefore require regular cleaning. To allow new tissue to grow, dead tissue has to be continually removed. This procedure is called debridement, and can be performed surgically under anaesthetic or by applying enzymatic substances. A third option is maggot therapy, in which fly maggots feed on the dead tissue. The choice of suitable debridement procedure depends on the type and size of the wound.

What was the starting point of your research into the Aurase® enzyme?

ALEXANDER PELZER

We worked on the assumption that therapies using the maggots of the common green bottle fly rely on the action of specific enzymes. Enzymes are proteins (biocatalysts) that speed up biochemical reactions. Nature offers a rich collection of these biomolecules that are essential to life.

How do enzymes act in maggot therapy?

ALEXANDER PELZER

Maggots use the wound debris as a source of nutrients and export enzymes that break down the protein fibrin, among others. That is one of the main constituents of the wound debris that impedes wound healing. Before we carried out our work, it was not known which enzyme plays a key role in this biological process. We knew that maggot therapies are either very unpleasant or completely unacceptable for many patients. That spurred us on to decode the process involved.

What were the essential steps in this research?

ALEXANDER PELZER

We have managed to develop a gentle biological option for wound treatment that unites nature and biotechnology. First of all, we succeeded in identifying exactly which maggot enzyme breaks down fibrin without attacking the surrounding

healthy tissue. We characterised this enzyme, which we later baptised Aurase®, and then developed a biotechnological process to produce it in large volumes with a high degree of purity. The microorganism Pichia Pastoris is the production organism here. This involves a safe biotechnological expression system that is already being widely used.

How did people discover that the maggots of the common green bottle fly have medical properties?

BELA KELETY

It has been known since the Middle Ages that open wounds infected with maggots often heal better. Some even say that the Maya, the indigenous people of America, and the aborigines in Australia used maggots to heal wounds. The first scientific foundations were laid in the 1920s. This form of treatment fell into oblivion due to the development of antibiotics, and only regained popularity in the 1990s. Its current applications in hospitals are based on this ancient knowledge, and make use of specially bred sterile maggots.

What advantages does the Aurase® enzyme offer as compared with other enzymatic active substances?

ALEXANDER PELZER

The Aurase® developed by BRAIN is an enzyme derived from the serin protease family that can break down proteins or peptides. Aurase® acts very specifically on the protein fibrin. This is not always the case with other enzymes. Some wound treatment enzymes are obtained from pineapple plants or pathogens. Such enzymes act unspecifically and not only break down fibrin, but may also damage healthy tissue. They are therefore used in low concentrations or only applied for short periods of time. That makes nursing more time-consuming and lengthens the wound cleaning process.

What positive effects do you expect from the Aurase® products?

BELA KELETY

Our interest focuses on wound patients whom we would like to offer a well-tolerated, effective alternative to the sometimes very painful and unpleasant

“Aurase® will be easy to use and fit smoothly into existing processes.”

Dr Bela Kelety

forms of therapy available at present. While both surgical debridement and maggot therapy are effective, they are also time-consuming and cost-intensive forms of treatment, which call for a specialised infrastructure and detailed medical knowledge. We hope the Aurase® products will reduce the need to train nursing staff and the overall healing outlay. Aurase® will be easy to use and fit smoothly into existing wound management processes at hospitals, nursing homes or nursing care at home.

What form will the final Aurase® products take?

ALEXANDER PELZER

Various forms are conceivable in theory. A wound gel containing the active ingredient Aurase® has proved to be favourable, and has been shown to be effective and well-tolerated in pre-clinical trials.

Can we expect BRAIN to focus on pharmaceutical biotechnology as well in future?

BELA KELETY

Our focus is and remains industrial biotechnology. In this context, we concentrate on developing new enzymes, natural active ingredients and high-performance microorganisms. However, our expertise in these three areas also enables us to address a variety of tasks. Aurase® is a medical product, and this is admittedly an unusual market segment for BRAIN. But when we realised the benefits we could harness with our know-how for patients and nursing staff, we couldn’t just ignore it. Apart from that, this offers attractive market opportunities.

What are the next steps in realising Aurase® products?

BELA KELETY

On the one hand, we are presently working to optimise the yield of the biotechnological production system for the Aurase® enzyme. Parallel to this, we are taking steps to extend patent coverage. We are also in touch with experts to prepare clinical studies for our first Aurase® products and to obtain marketing authorisation.

When do you intend to launch Aurase® products on the market, and what business model will you use?

BELA KELETY

We will continue to drive development forward until we receive marketing authorisation and make the products available on the market. We intend to show that Aurase® products work under real-life nursing conditions and offer clear advantages for patients, nursing staff and doctors. We expect our first sales at the end of the decade, and are currently examining various options for business models to grow this business in future.

Experts estimate the annual sales volume of the market that BRAIN can address for Aurase®-based products at more than EUR 100 million in Europe alone. We intend to take part in this development.

The next steps include expanding patent coverage and preparing for a clinical study in order to obtain market authorisation.

We succeeded in identifying exactly which maggot enzyme breaks down fibrin without attacking the surrounding healthy tissue. We are presently working to optimise the yield of the biotechnological production system for the Aurase® enzyme.

Tailor-made enzymes for various industries

The BRAIN Group researches efficient enzymes for food and beverage manufacturers and for special applications in a variety of industries.

WeissBioTech has distribution partners around the globe that provide excellent access to markets.

Improved enzyme systems for starch-processing industries

The inclusion of WeissBioTech GmbH in the BRAIN Group in 2014 combined proven research expertise with a global production and distribution network, thereby harnessing potential for new development and growth. WeissBioTech is familiar with the manifold applications for a huge variety of enzymes and has distribution partners around the globe that provide excellent access to markets. A joint development project is looking into more efficient enzyme systems that boost the hydrolysis of starch into glucose and thus enhances glucose yield. These enzyme systems are relevant for industrial manufacturers of starch, alcohol, beer and bioethanol.

Nature-based lactase prevents lactose intolerance

BRAIN and WeissBioTech are developing and producing a variety of special enzymes for various sectors of the food industry. The focus is also on a new nature-based lactase formulation for dairy products in response to the growing problem posed by lactose intolerance. Lactase is an enzyme that breaks milk sugar (lactose) down into its constituents. Lactase deficiency causes digestive problems in those affected. The BRAIN Group is able to produce lactase enzymes in a fermentation process. The development of new lactase products also aims to reduce unpleasant taste in lactose-free food and minimise the residual milk sugar in dairy products.

Proteases for *in vitro* diagnostics

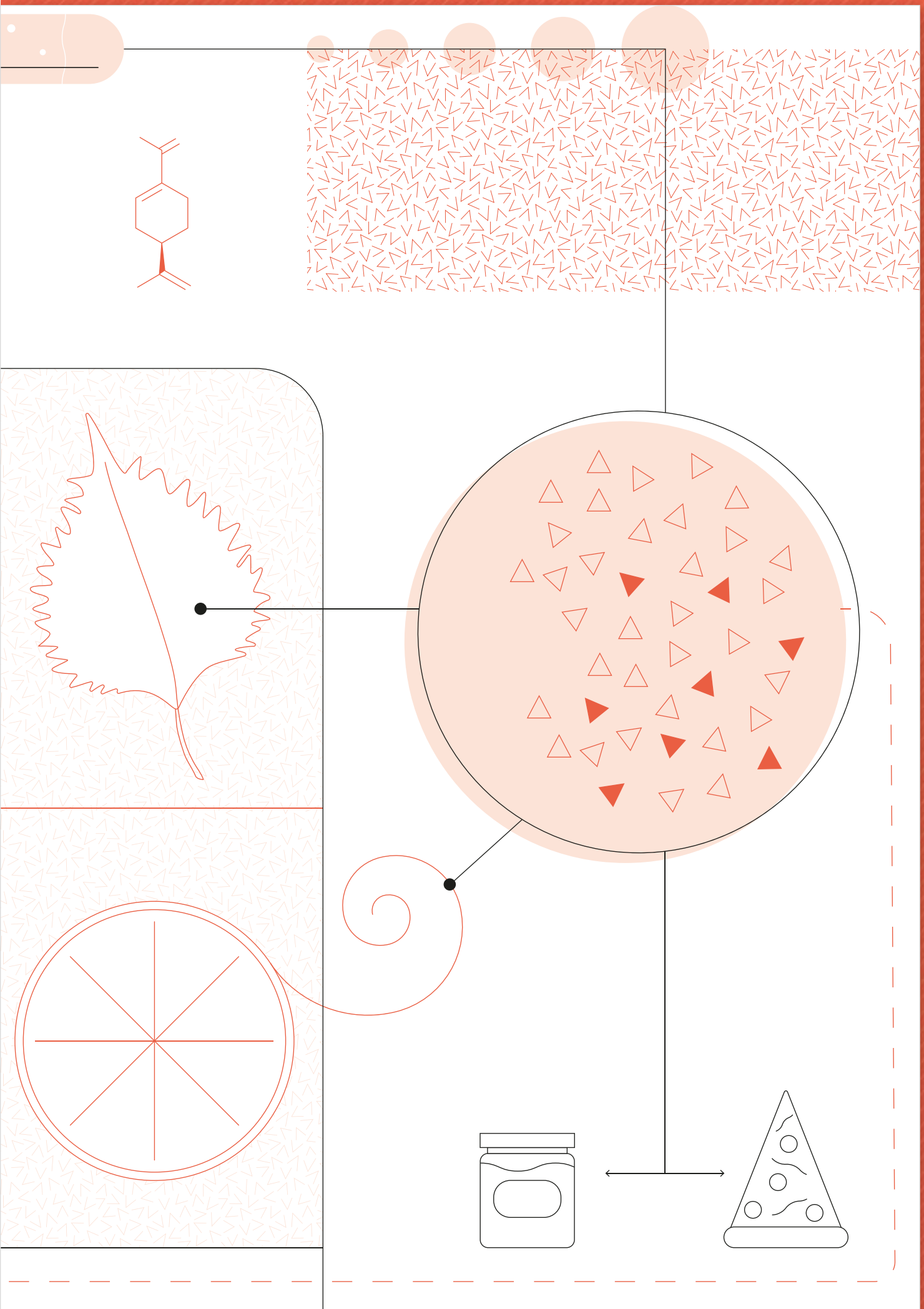
Based on BRAIN's own BioArchive and its special expertise in identifying and subsequently optimising new enzyme candidates, BRAIN is able to develop a continuous series of efficient solutions for special applications. This includes a new enzyme from the protease family, which hydrolyses other proteins, i.e. breaks them down by means of a chemical process using water. Proteases are also used to remove protein impurities from blood and tissue samples prior to analyses in medical and clinical diagnostics. BRAIN has developed a protease product for this application that is currently being evaluated for possible application.

Pectinase enzymes for fruit juice and wine

Fruit juice and wine producers depend on pectinases. This family of enzymes breaks down plant pectins and plays a key role in terms of product quality and process yield. There is a growing demand for non-genetically-engineered pectinases for fruit juice and wine production. WeissBioTech performs research for this market segment based on traditional production strain developments. This has made it possible to develop new types of pectinase enzymes for special applications and to improve well-known enzyme lines.

Learn more:
www.brain-biotech.de/en

Illustration: David Lemm

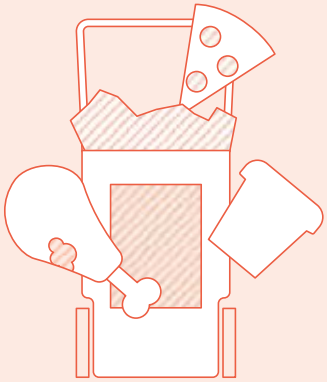


Nature-based freshness and product stability

Plants serve as natural resources for bioactive substances that are used as flavourings in foods, and skin-care ingredients in cosmetics. In addition, they also stabilise products. Bioprocesses enable the sustainable production of plant-based active ingredients.

The quality standards to be met by consumer goods products are becoming more and more stringent. Consumers are mainly interested in environmental protection, product safety and sustainable production processes. Foods, feedstuffs and cosmetics are preparing the ground for a change in demand for biobased products. There is also an urgent need to reduce product losses. According to estimates, one third of all food produce worldwide is thrown away.

BRAIN faces up to these challenges by developing bioactive natural substances for industrial use. BRAIN's PerillicActive development programme focuses on the edible plant Perilla frutescens. Its constituents show properties that are useful for many market segments. The active ingredients of perilla protect

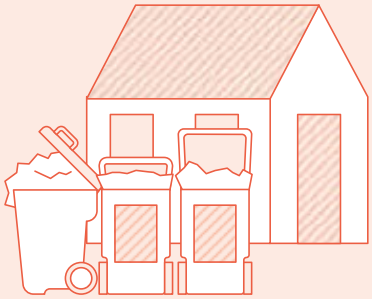


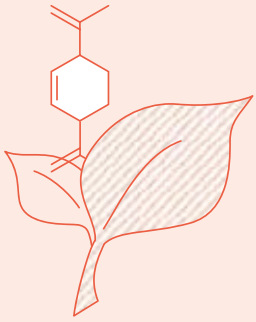
1.3 bn

1.3 billion metric tons of foods are thrown away around the world every year, according to estimates by the Food and Agriculture Organization (FAO) of the United Nations. This is mainly due to the raw materials being infested by pests and disease, and to bacterial decay of food products.

61 %

of food waste is generated by private households, according to a study by the University of Stuttgart, followed by 17 per cent from bulk consumers such as restaurants, canteens and catering firms. Industry and trade together account for 21 per cent.



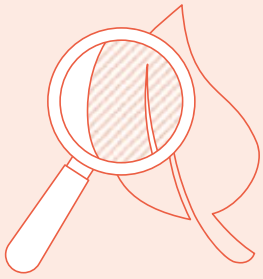


220,000

bioactive natural ingredients of plant origin have been identified and structurally categorised by 2015. They have enormous potential for industrial applications in a variety of market segments.

1,780

new plant species were discovered in 2017 according to the State of the World's Plants Report. Some of them can add to our range of foodstuffs. There are a total of 390,000 plant species in all.



PerillicActive from BRAIN responds to the growing demand for natural and sustainably produced ingredients.

foods and cosmetics against microbial decay and keep products fresh, so they can be stored and enjoyed longer. In skin-care products, they support and harmonise dermal microflora.

BRAIN has harnessed these properties using biotechnological processes. The starting material for the PerillicActive development programme is the oil from orange peel, a natural raw material that is left over from fruit juice manufacture. A soil microorganism converts the orange oil into bioactive ingredients that can be processed for a variety of applications.

In the 2016/17 business year, BRAIN's PerillicActive development programme began to strategically address potential target markets.

BRAIN PerillicActive ...

... is a **BRAIN programme** that is designed to develop natural active ingredients based on fermented oil from orange peel or other citrus fruits.

... is a **portfolio of BRAIN products** with bioactive substances containing virtually 100% pure ingredients and microbial extracts with 90% pure ingredients, depending on the requirements of the segment in which they are used.

... is **based on the properties of ingredients from the edible perilla plant,** which has been used in food preparation for many generations, particularly in Asia.

... is relevant for various market segments including foods and beverages as an **active antimicrobial ingredient**. It can also be used in cosmetics to protect products and to support and harmonise the skin's microflora.

The aim is to incorporate the PerillicActive portfolio into suitable formulations and then bring it to market.

PerillicActive is based on fermented orange oil

An interview with Dr Michael Krohn, Member of BRAIN's Management Board and Unit Head BioActives & Performance Biologicals, Dr Jessica Rehdorf, New Business Development, and Dr Yvonne Tiffert, Project Manager & Platform Coordinator.

What is so interesting about *Perilla frutescens*?

MICHAEL KROHN

We have noticed a trend towards natural and sustainably produced products and ingredients. Consumers have become more critical and are questioning production processes and product composition. In this context, one of our three main research areas is bioactive natural substances. Our subsidiary AnalytiCon Discovery is a market leader with an extensive library of natural substances. Together we have identified the perilla plant as an attractive candidate for a myriad of applications.

JESSICA REHDORF

The perilla plant has been in use for many years, especially in Asia. Our research focuses on the plant's natural constituents, more precisely on its essential oils. Its active ingredients have been comprehensively characterised, are safe to use and suitable for many different fields of application. They can also be found in the human body after eating oranges. The body converts them into other metabolic products.

Is this trend also reflected in the political arena?

MICHAEL KROHN

Our research work is embedded in the NatLife-2020 innovation alliance supported by the German Federal Ministry of Education and Research (BMBF). BRAIN coordinates the alliance, and our subsidiaries AnalytiCon Discovery and L.A. Schmitt are also on board.

What is special about your process to obtain active ingredients from perilla?

YVONNE TIFFERT

One option is to cultivate and harvest the perilla plant and then to extract its active ingredients. We rely on biotechnological processes for a number of ecological and economic reasons. The starting material is the oil from the peel of oranges or other citrus fruits that is generated in large volumes during food production. We can use it for other utilisation steps in the value chain.

The orange oil is distilled to obtain an extract that consists of more than 90 per cent natural substance

(limonene). We use this limonene as a substrate in our biotechnological process, in which a microorganism converts it into the active ingredients of perilla that we want to obtain. This microorganism is a soil bacterium that provides all the enzymes required for biotransformation of the limonene.

JESSICA REHDORF
The raw product obtained from biotransformation is then further processed and purified in a series of steps. This gives us products of different purity levels that meet the requirements of the different fields of application and can be further formulated for the relevant markets.

Which microorganism do you use and have you modified it by biotechnological means?
YVONNE TIFFERT
We use an ordinary soil bacterium as the production strain for this biotransformation. This comprehensively characterised organism is widespread and we use it in its wild-type form as it occurs in nature. That also makes our production strain more attractive for sensitive applications such as foods and cosmetics.

That all sounds very complicated. Are there any alternatives?
MICHAEL KROHN
The production of pure active perilla ingredients in several stages does not call for any extraordinary outlay, as we have shown. But there are also ways of shortening the process. Whether that is desirable depends on the end product. Cleaning agents have to meet lower standards in terms of purity or appearance than foods or body-care products. So we can also offer perilla extracts with a purity of about 90 per cent as well as the pure product.

Doesn't it cost less to synthesise the active ingredients chemically?
JESSICA REHDORF
Our continual challenge is to develop bioprocesses that can match up to products already established on the market in economic as well as ecological terms. Within the NatLife 2020 alliance, we

> “Owing to their anti-microbial properties, the active ingredients of perilla can be used wherever undesirable microbes may cause problems.”
>
> **Dr Jessica Rehdorf**

carried out extensive sustainability studies for our bioprocess with Denmark’s Technical University (DTU). One priority was to compare it with a chemical production process. We were able to clearly demonstrate that the bioprocess is much more sustainable and ecological.

What other applications do you envisage?

JESSICA REHDORF

Owing to their antimicrobial properties, the active ingredients of perilla can be used wherever undesirable microbes may cause problems. That applies to medical care and to handling foods, feedstuffs and beverages. A lot of food gets wasted every day because it has gone off. We see possibilities of using the product during food storage, transportation and packaging.

As regards cosmetics, applications from our PerillicActive development programme might include high-quality ingredients for skin-care products, since they harmonise the microflora of the skin. The natural active ingredients also help to stabilise cosmetic products.

Can the active ingredients of perilla also be used for plant protection?

YVONNE TIFFERT

We are currently examining this option. In the laboratory, the active ingredients of perilla have also proved effective against fungi and bacteria that cause plant diseases. This may end up being useful for many crop plants and offer effective alternatives to conventional chemical plant protection products.

How far are you from launching the first products on the market?

JESSICA REHDORF

We submitted the first patent applications during the first project phase of NatLife 2020. At present we are concerned with driving product ideas forward to find specific market applications, developing the suitable formulations and preparing the required authorisation processes. We expect to launch the first products on the market in a few years from now.

What business model do you envisage for marketing the products that come out of this programme?

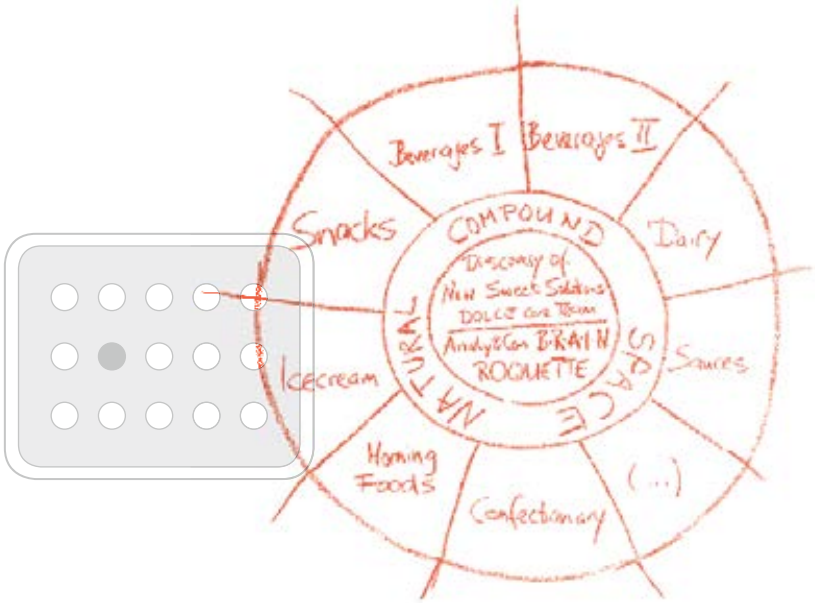
MICHAEL KROHN

We need partners who can reliably manufacture the products from our PerillicActive programme and bring them to customers. Whether we will handle marketing ourselves or set up partnerships with other companies remains to be seen. The second option is more likely.

Product ideas are currently being driven forward to identify specific applications on the market. The suitable formulations are being developed and preparations made for the required authorisation procedures.

Plant-based bio-active ingredients

BRAIN develops nature-based bioactive ingredients for a multitude of applications and different target industries. The unique library of natural substances held by subsidiary AnalytiCon Discovery is of key importance for these purposes.

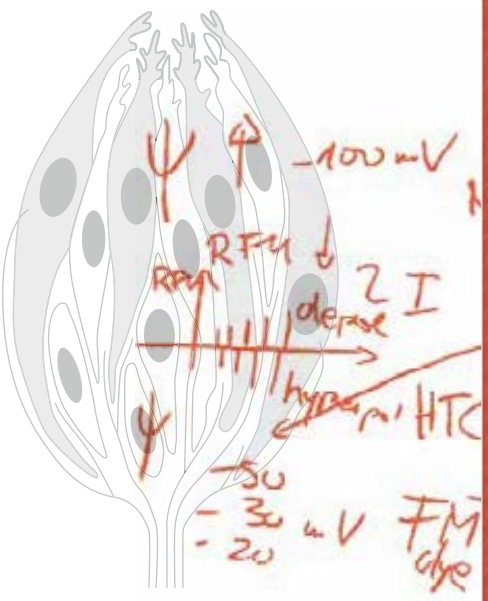


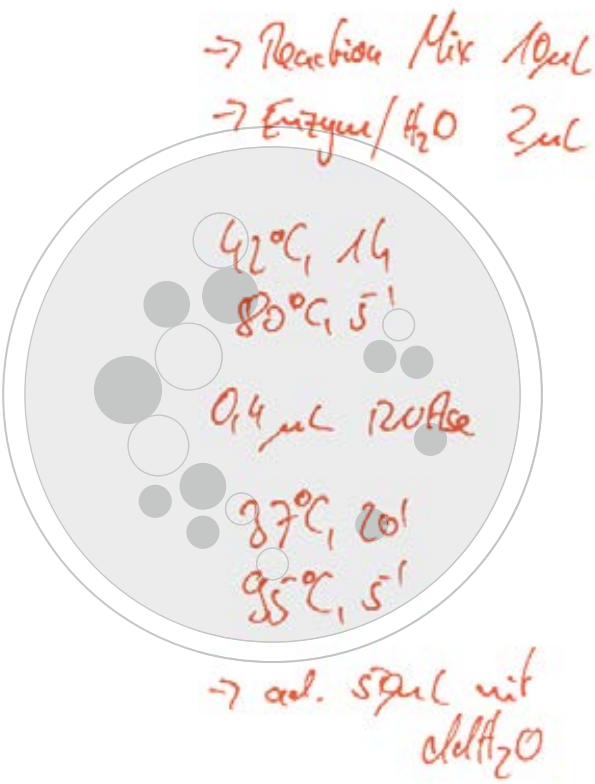
Reducing sugar and calories with DOLCE

Together with AnalytiCon Discovery and the French Roquette company, BRAIN launched the DOLCE programme for natural sweeteners and sweetness enhancers in August 2016 to reduce excessive levels of sugar and calories in foodstuffs. The core team's "sweetbox" grew to encompass some 60 natural substances in the 2016/17 business year. The first suitable natural substances for specific applications are now being selected with companies from the food and beverage industries. Partners for the breakfast cereals and snacks segments were found in November 2016 via a global market player. In July 2017, a globally active beverages firm came on board with access to DOLCE innovations for non-alcoholic drinks, milk and yogurt drinks, and ginger ales and tonics. BRAIN envisages entering into partnerships for other product categories.

Healthy nutrition without sacrificing taste

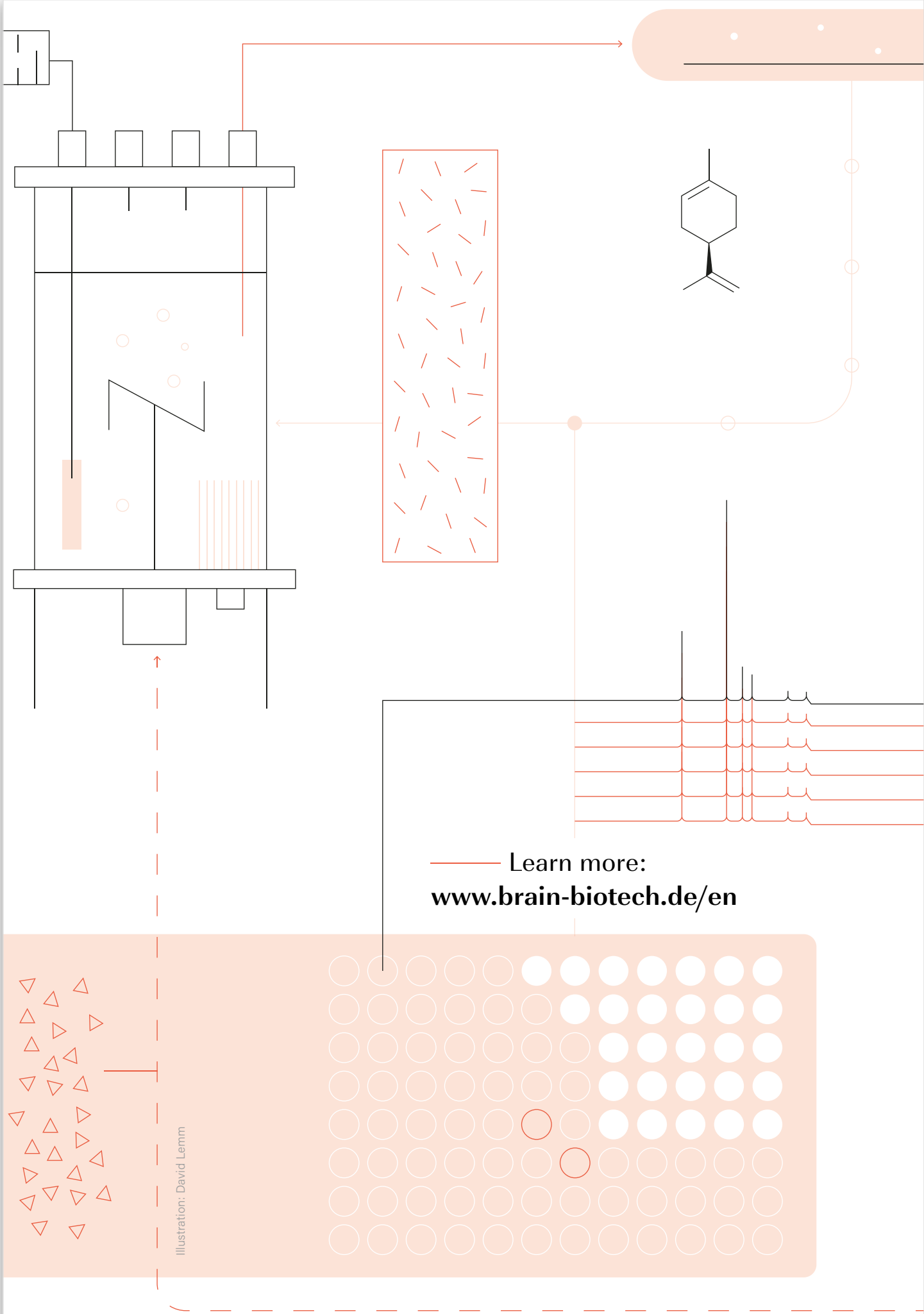
Based on the patented technology developed by BRAIN for the cultivation of human taste cells in the laboratory, scientists at BRAIN are now examining further ways of improving human nutrition. One focus, for example, is on salt and fat, which, like sugar, can cause health problems if eaten in excessive quantities. The bitter taste is another research topic, since this is often activated together with other taste receptors. The aim is to develop alternative flavourings for healthier foodstuffs without sacrificing quality. Industrial partnerships will also be set up to pursue these innovations.





Antimicrobial natural substances

Freshness is a key criterion for the production, marketing and sale of foods. Other market segments are also highly sensitive in terms of hygiene and cleanliness. Harmful organisms such as bacteria, yeasts or fungi have the evolutionary ability to develop resistance against their foes. This, and the increasing demand for natural over chemical cleaning agents and preservatives opens up market opportunities for the bioeconomy. In the 2016/17 business year, BRAIN and AnalytiCon Discovery identified several hundreds of promising "jump-start" candidates and initially characterised their effect on various problematic pathogens. Edible plants served as the starting material. Scientists use this research to identify product candidates for various fields of application.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www.brain-biotech.de/en
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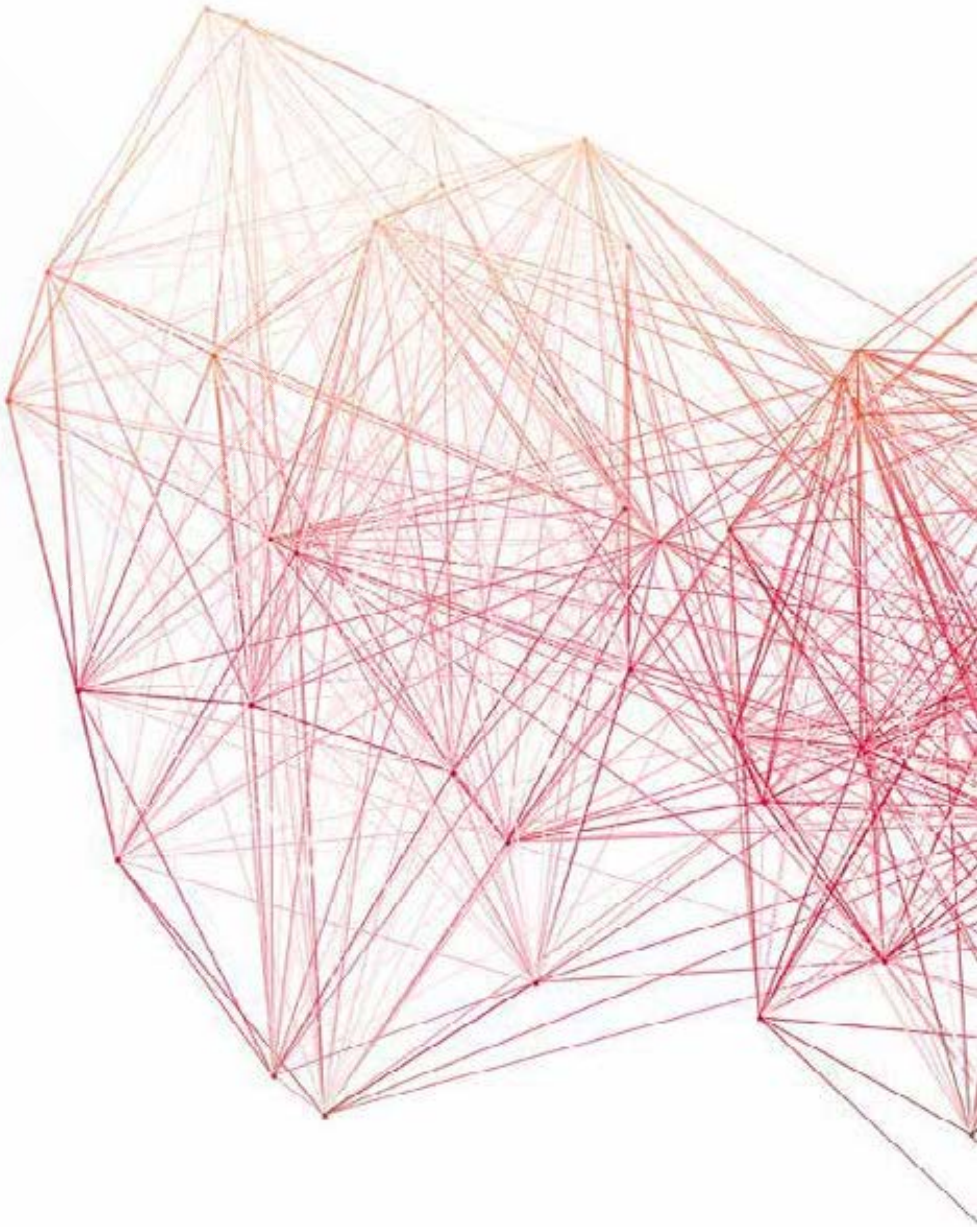
Financial calendar

28 February 2018	**Publication of the quarterly report for the period ending 31 December 2017 (3M)**
08 March 2018	**Annual General Meeting, Zwingenberg**
30 May 2018	**Publication of the interim report for the period ending 31 March 2018 (6M)**
31 August 2018	**Publication of the quarterly report for the period ending 30 June 2018 (9M)**



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