



CNB Action Plan 2018-2021

Approved by the CNB Governing Board

June 15, 2017

Critical analysis (SWOT)

WEAKNESSES

MANAGEMENT

Due to its status as a centre affiliated with a Public Research Organisation, operation of the CNB is governed by a regulatory framework common to all entities of the General Government Administration and does not take into account the special characteristics of a scientific research institute.

Among other limitations, the CNB does not have its own mechanisms to attract talent with stable contracts and a competitive salary, which reduces its competitive advantage relative to other Spanish research centres that have this possibility such as the CNIO or CRG.

Limitations on staff recruitment, particularly of non-EU researchers, make it difficult to internationalize the CNB, as can be deduced from the reduction of the centre's foreign scientific and technical personnel by 35% over the last 5 years.

HUMAN RESOURCES STRUCTURE

The very limited public employment offer in recent years, as well as the dissolution of research groups led by young scientists due to lack of funding, have contributed to excessive aging of the CNB staff and only limited renewal of research lines. The average age of CNB group leaders is now 55 years, and only 6 of the 69 group leaders are under 45 years old.

Profound cuts in research project funding over the past several years have led to a significant reduction –around 30% – in the number of research grant-associated contracts for postdoctoral researchers and predoctoral students. This loss of critical mass is exacerbated by the grouping of very different areas in a single institute, which hinders implementation of a shared scientific programme.

Another great weakness of the CNB is the lack of positions for structural personnel consistent with the size of the centre and the large volume of funded projects. The shortage of posts and of mechanisms to contract highly qualified technicians for the scientific-technical services and for R&D+i management reduces the institute's competitiveness. In addition, it obliges the centre to allocate a substantial part of research project financing, including the funds for the Severo Ochoa Centres of Excellence project, to structural costs.

INFRASTRUCTURE

The CNB budget is insufficient for the maintenance and renovation of an internationally competitive scientific and technical infrastructure commensurate with the centre's size; this not only jeopardizes the continuity of research lines that require cutting-edge equipment, but also notably affects the institute's operation in its most basic aspects.

The accumulation of obsolete equipment also jeopardizes the viability and competitiveness of the CNB's scientific-technical services, leading to loss of income obtained by providing services to external users.

THREATS

ADAPTATION TO A NEW FRAMEWORK OF COMPETITIVENESS

With the establishment of foundations by the state public sector (CNIO, CNIC, etc.) and the autonomous regions (Ikerbasque, ICREA, etc.), a model of R&D+i resource management has been introduced in Spain that combines the stability and transparency of a public institution with the agility and flexibility of a private company. This new generation of research centres has taken a qualitative leap forward and created a new framework in which the CNB has lost and will continue to lose competitiveness, given the weaknesses described in the previous section; this is especially the case as regards the lack of autonomy, agility and flexibility in recruiting and contracting talent.

Another threat arises from the increasing professionalization of the support and management units in the centres with which the CNB competes for public and private financing, given their more qualified staff, with better contractual conditions, for project management, technology transfer, external relations, communication and dissemination.

The most basic needs of the CNB in these areas are met by CSIC support units and self-supported staff. These mechanisms are nevertheless insufficient and cannot cover the current prerequisites of an internationally competitive institute of the CNB's size and characteristics.

The lack of qualified personnel in key R&D+i management positions lessens the CNB's visibility and reduces its ability to compete for external funding. These problems have been alleviated in part thanks to the resources of the Severo Ochoa Centres of Excellence project, although beyond the duration of this project, we are unable to offer a competitive level of remuneration to key personnel for the correct function of the centre.

The insufficient provision of the CNB with positions for technicians in its scientific and technical services, non-competitive salaries, and lack of mechanisms for the promotion and stability of technical staff likewise render the institute less competitive, both when competing for funds in calls for scientific-technical platforms and in the commercialization of scientific-technical services.

Another threat to the competitiveness and economic viability of the CNB services is the imminent implementation of a homogeneous tariff structure for CSIC centres that does not reflect real costs nor adapt to market prices.

STRENGTHS

RESEARCH

Over the 2012-2016 period, CNB researchers published 1201 articles in journals indexed in Journal Citation Reports, with a cumulative impact factor of 6917 points and a mean impact of 5.8. The quality of the CNB's scientific output is reflected by the fact that 80% of these publications are included in the first quartile (Q1) of journals with the highest impact in their respective fields, and 37% in the first decile (D1). Of these publications, 57% result from international collaborations the institute maintains with research groups in more than 60 countries.

The scientific quality of the CNB is endorsed by the eight projects funded by the European Research Council (ERC grants). On the CNB's staff are 8 EMBO members, one of whom is for the third consecutive year among the most influential scientific minds in the world according to the Thomson Reuters ranking, which includes scientists whose work is in the top 1% most-cited.

The relevance of the CNB's scientific production is reflected in the 44 patents and 22 licencing agreements signed with national and international companies between 2012 and 2016. During this period, CNB scientists fostered the creation of three biotechnology and consulting companies (Proteobotics, KineStat Pharma and Scienseed). The CNB-promoted spin-off Integromics was acquired by the multinational company Perkin Elmer in 2013.

SCIENTIFIC-TECHNICAL SERVICES

One of the CNB's most important assets is its scientific and technical services platform, which offers leading-edge technology in the fields of structural and cellular biology (electron microscopy and cryo-electron microscopy, X-ray crystallography, advanced optical microscopy), emerging 'omic' techniques cellomics, genomics, proteomics, and various protein tools), genetically modified mouse models (transgenesis, embryo cryopreservation, histology) as well as in bioinformatics and computational biology (bioinformatics for genomics and proteomics, scientific computation, sequence analysis and structure prediction).

The quality of the centre's scientific-technical services and its contribution to front-line research projects have enabled the CNB to play a relevant role in the development of the European roadmap of scientific infrastructures (ESFRI). Examples of this include CNB's participation in EMMA/Infrafrontier as the Spanish node for the generation, archiving and distribution of genetically modified mouse models, or the CNB's contribution to INSTRUMENT as the headquarters of the European reference centre for image processing in structural biology (Instruction Image Processing Centre, I2PC). In addition, the CNB adds its resources to various initiatives and regional networks (Redlab), as well as national (PRB2-ISCiii) and international (human proteome project) research platforms.

SHARED SCIENTIFIC PRIORITIES

One of the effects of the R&D funding cuts over the last few years has been the reduction in size of the CNB research groups. The re-orientation of R&D+i priorities, spurred by the European

Union through the H2020 programme, toward large socio-economic challenges, offered an opportunity to generate synergies and recover critical mass. The CNB seeks to take advantage of this opportunity by defining shared scientific objectives and cross-cutting projects that focus on four major challenges: infectious disease, inflammatory processes and cancer, sustainability of food production, and environmental pollution.

EUROPEAN REFERENCE INFRASTRUCTURES

Integration of the CNB into pan-European infrastructures (ESFRI) led to the creation of a national node at the CNB for the generation and distribution of genetically modified mouse models (EMMA/Infrafrontier project) and implementation of an Instruct Image Processing Centre for the processing of electron microscopy images within the framework of the European infrastructure for structural biology (INSTRUCT project).

The Severo Ochoa Centres of Excellence programme, with the help of the CSIC and collaboration of the CIB, allowed implementation of a new electronic cryomicroscopy service, equipped with a state-of-the-art electronic microscope unique in Spain and one of the few of these characteristics in Europe. FEI, the leading company in electronic microscopy equipment, has selected the CNB as its European reference centre. In addition, the flow cytometry service was named a European reference centre by Beckman Coulter. These awards give visibility to the CNB at the forefront of research in Europe.

A new opportunity to position the CNB at the front line of European infrastructures derives from its leadership in the standardization and normalization of tools and components of interest for new approaches to synthetic biology; this includes a unique repository of genetic tools for the construction of functional circuits in bacteria (SEVA platform), which is maintained at the CNB.

NEW APPROACHES IN QUANTITATIVE BIOLOGY

New approaches in quantitative biology set the course for an impending transformation of research in the life sciences. The multidisciplinary character of the CNB, the focus of its Severo Ochoa Centres of Excellence project on the fields of computational biology and systems biology, as well as a commitment to new technologies of integrative and correlative imaging, together with their application to problems of biotechnological interest, provide the CNB with an excellent opportunity to defend its role as a reference at the vanguard of biotechnology.

SELECTIVE ADVANTAGES

MULTIDISCIPLINARITY

The CNB stands out for its multidisciplinary. Its research lines cover the principal areas of biology and biomedicine as well as agricultural sciences, and address experimental systems in viruses, bacteria, plants, animals and humans. Mathematical approaches, bioinformatics,

biophysics, structural biology, virology, microbiology, molecular and cellular biology complement and converge on shared objectives in areas of application of great relevance to society, including infectious disease, inflammatory diseases and cancer, sustainable agriculture and environmental pollution. The collaboration of experts in different knowledge areas endows the CNB with an exceptional capacity to approach biological problems from an integrative perspective of quantitative and systems biology.

SCIENTIFIC-TECHNICAL SERVICES PLATFORM

The scientific excellence of the CNB and its competitive advantage as a truly multidisciplinary centre is supported by a platform of scientific and technical services that covers with advanced technology the areas of structural biology (electron microscopy and cryo-electron microscopy, X-ray crystallography), cell biology (advanced optical microscopy, flow cytometry, protein tools, cell culture, in vitro plant culture), genetically modified animal models (transgenesis, embryo cryopreservation, histology), proteomics, genomics and bioinformatics (bioinformatics for genomics and proteomics, sequence analysis and structure prediction, scientific computation).

Among these services, cryo-electron microscopy and advanced optical microscopy are prominent as they boast state-of-the-art equipment unique in Spain (FEI TALOS Arctica 200 kV cryo-electron microscope with a FALCON II direct electron detector) or available only in a few centres (super-resolution microscopy equipment with stimulated emission depletion technology and total internal reflection).

SCIENTIFIC EXCELLENCE

The CNB stands out for the high quality of its scientific production in all its research areas (80% of its publications in first-quartile journals, 37% in first-decile journals) and the ability to showcase the scientific advances achieved (44 patents, 22 licencing agreements, and promotion of three companies over the last 5 years). The CNB's excellence is also backed by international recognition of its scientists (8 EMBO members, 8 ERC grants) and its accreditation as a Severo Ochoa Centre of Excellence in 2013.

Strategic objectives

General

RENEWAL OF SEVERO OCHOA CENTRE OF EXCELLENCE ACCREDITATION

The renewal of accreditation as a Severo Ochoa Centre of Excellence, which expires at the end of June 2018, is a maximum priority for the CNB. The amount of support associated with the accreditation, and above all the flexibility with which it can be used, is of vital importance to continue a series of priority actions that are already part of the current Severo Ochoa project and are essential for the smooth running of the institute. These actions are:

- Recruit experts in the application and management of research projects, to improve competitive fund-raising.
- Recruit an expert in innovation, to identify and implement opportunities for the commercialization and industrial development of scientific advances by CNB scientists.
- Recruit an expert in communication and promotion to increase the visibility of the CNB and promote outreach projects.
- Recruit highly qualified technicians for the scientific services of the centre that lack technical staff.
- Recruit postdoctoral researchers to cushion the loss, of approximately 30% in the last 5 years, of research grant-funded scientific personnel.
- Participate in programmes for training and hiring of research personnel whose funding requires accreditation as a centre or unit of excellence.
- Invest in scientific equipment and IT infrastructure needed by scientific and technical services to remain competitive.

A NEW DIRECTION IN INSTITUTIONAL COLLABORATION

The second half of 2017 will see the launch of the Severo Ochoa and Maria de Maeztu Alliance of Centres and Units of Excellence. The objective of this alliance, financed by the Secretary of State for R&D+i as a Network of Excellence, is to achieve a new model of collaboration to:

- increase national and international visibility of the interdisciplinary, interconnected Spanish research ecosystem of excellence
- promote the exchange of knowledge, technology and good practices among its members, the international scientific community, and the main stakeholders
- to have a voice in Spanish and European scientific policy.

Research

The CNB will prioritize the development of four scientific areas that benefit the institute as a whole, given their transverse nature. These areas are:

- The number of research projects that require expert support in the field of **BIOINFORMATICS** is increasing exponentially. Existing bioinformatics support at the CNB does not meet this demand nor does it have free capacity to implement new tailor-made approaches to evaluate and interpret the data generated by experiments in proteomics, genomics and advanced optical and electron microscopy technologies. The recruitment of bioinformaticians for these areas will be a priority in coming years.
- Beyond excellent bioinformatics support, the CNB aspires to be a reference centre in **COMPUTATIONAL BIOLOGY**. This objective has already been achieved for image analysis in electron microscopy. Nonetheless, the introduction of new experimental approaches to systems biology and synthetic biology has not been accompanied by adequate development of theoretical and computational facets such as the modelling of complex systems. Over the next few years, the CNB will seek to correct this imbalance by recruiting scientists specialized in computational biology.
- Over the last few years, the CNB has made considerable efforts to promote cross-cutting research with tools of **SYSTEMS BIOLOGY** and **SYNTHETIC BIOLOGY**. Among other developments, the CNB created a collection and a database of genetic tools standardized and annotated in normalized language. The CNB-housed SEVA (Standard European Vector Architecture) collection already has hundreds of users in Europe. The objective for the immediate future, based on this unique collection, is to build a European reference platform for synthetic biology research.
- Another area in which the interests of most CNB research groups converge is **REAL TIME ANALYSIS OF BIOLOGICAL PROCESSES IN SINGLE CELLS** using super-resolution microscopy techniques and new approaches to integrative and correlative microscopy. Based on recent investments in electron microscopy and advanced optical microscopy equipment, together with our in-house developments and implementation of single-particle cryomicroscopy techniques, cryo-electron tomography and X-ray cryotomography, and the adaptation of single-cell biophysical techniques (magnetic clamps, atomic force microscopy) to the study of biological processes, we will promote this area in the future by recruiting research and technical personnel.

The balanced development of these four priority areas will be carried out with the vision to create a unique scientific ecosystem, ideal for positioning the CNB at the forefront of a new era of **QUANTITATIVE BIOLOGY**.

Technology Transfer

STRATEGIC ALLIANCES

Bringing the basic research carried out at the CNB closer to the real needs of society is an important priority.

In the field of health, the CNB will continue to encourage contact between its researchers and physicians in hospitals in the region. One way to promote and formalize this approach will be the participation by CNB scientists in the Institutes of Health Research, made up of the most important university hospitals in Madrid, following the procedures established for this purpose by the CSIC.

Another means of cooperation to be consolidated by the CNB is collaboration between its structural biologists and the IMDEA Nanoscience Centre. This allows combining the CNB's electronic microscopy experience with the development of new technologies and industrial applications in the emerging areas of nanomanufacturing, nanosensors and functional nanomaterials. With this objective, the CNB will renew the agreement that formalizes the constitution of an Associated Unit between the two centres.

CNB participation in the Severo Ochoa and Maria de Maeztu Alliance of Centres and Units of Excellence will also help increase the centre's visibility in the private sector, as well as in the exchange of good practices and new technology transfer strategies.

DIVERSIFICATION OF TECHNOLOGICAL OFFER

Most of the CNB's licenced patents and current technological offerings centre on conventional approaches to the diagnosis and treatment of human diseases (vaccines, antibodies, small molecule drugs, etc.). Another segment of the technological offer focuses on genetic tools to increase the yield of plants of agricultural interest and to improve their pathogen resistance.

A priority in coming years is to re-evaluate the potential of the CNB's research results, to diversify and expand the centre's technological offer with a focus on products and technologies derived from recent approaches to synthetic biology. For this task, it will be essential to contract an expert in innovation management who knows CNB science in detail and maintains a close relationship with the scientists.

A CULTURE OF INNOVATION

The CNB intends to expand its portfolio of seminars, courses and workshops intended to inform and train the institute's scientists in matters related to the generation, protection and commercialization of intellectual and industrial property. Likewise, these activities will try to inculcate a culture of innovation in the CNB's scientific life.

Training

Training activities at the CNB attempt to encompass all phases of the academic and professional training of a scientist, adding value to initiation in the scientific method and the corresponding experimental approaches.

This year for the first time, the CNB joined a call linked to its accreditation as a Severo Ochoa Centre of Excellence, managed by the CSIC's Postgraduate Studies Department, which grants master's degree scholarships to outstanding students during the 2017-2018 academic year. The CNB intends to renew the Severo Ochoa accreditation and to continue this call, to strengthen recruitment and training of master's students, and to expand its offering of MSc degree projects.

Another priority will be to consolidate and expand the training programme for pre-doctoral students through in-house courses and workshops that provide complementary instruction in soft skills and greater focus on various aspects of professional orientation.

The CNB, in line with the principles and values of the CSIC's Code of Good Scientific Practice and of the National Declaration on Scientific Integrity, endorsed by the institution in 2015, considers scientific integrity a pressing issue that must be present in the training of young scientists. With this view, the CNB plans to offer its scientists a programme of its own on scientific integrity.

Outreach

In its communication, dissemination and promotion tasks, the CNB has the support of the CSIC Press and Scientific Culture Units. The large volume of internal communication tasks, the organization of internal events of a divulgative nature, as well as the development of own scientific communication and dissemination activities require a communications expert who knows the centre and its scientists in all facets, and develops his/her activities in permanent contact with the CNB management team. Hiring of a communications expert is thus a priority for the CNB.

For the next few years, the CNB intends to explore the feasibility of implementing citizen science projects, seeking opportunities for citizens to participate in the centre's research in the health or agricultural sciences, with a view to aiding citizens to achieve a better understanding of the scientific method in an attractive way in an open, interactive and transverse context.

Internationalization

Cutbacks in the funding of research projects and training programmes for research staff, coupled with a regulatory environment that discourages recruitment of non-EU researchers, has contributed to the departure of foreign scientists. In 2011, 23% of the CNB's scientific-technical staff was from outside of Spain. At present, this percentage has fallen by 8 points (based on absolute numbers, by 35%), to 15%.

The financing of postdoctoral contracts through the Severo Ochoa Centres of Excellence project and, linked to this accreditation, the CNB's participation in the InPhinit programme of the "La Caixa" Foundation for international pre- and postdoctoral fellowships are the only means available to the CNB to stem the exodus of foreign researchers.