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Postprint of the Microbial Resources and Big Data Center, Institute of Microbiology, Chinese Academy of Sciences

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Abstract

Full Text

Preamble

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Establishment of the Center

In 2016, the Institute of Microbiology of the Chinese Academy of Sciences established the Microbial Resources and Big Data Center (hereinafter referred to as “the Center”). The Center focuses on functional mining of microbial physical resources and their associated data resources, innovating research strategies and methodologies to enhance the sharing, development, and utilization of microbial resources. Big data-based research and information discovery has emerged as a new paradigm in life science research, particularly in microbiology, transforming the landscape of the bioindustry and catalyzing new business models. The Center comprises three departments: the Biological Resource Preservation Department, the Microbial Resource Development and Technical Service Department, and the Data Integration and Service Department. Leveraging China’s largest microbial species diversity resource repository, the Center conducts specialized resource collection and develops new methods and technologies. Combined with research on big data analysis strategies for microbial omics, it provides novel approaches and tools for the mining and utilization of microbial resources. The Center also builds a large-scale biotechnology service platform to meet the demands of biotechnological innovation and industrialization, thereby serving national economic development.

1. Biological Resource Preservation Department

The Biological Resource Preservation Department of the Microbial Resources and Big Data Center, also known as the China General Microbiological Culture Collection Center (CGMCC), is China's largest microbial culture collection center. It is dedicated to the conservation, sharing, and sustainable utilization of microbial resources, providing professional technical services including patent biological material deposition and microbial identification and testing.

CGMCC was established in 1979 with the core mission of exploring, discovering, and collecting microbial resources both domestically and internationally to meet China's major needs in life science research, biotechnological innovation, and industrial development, while ensuring their proper long-term preservation and management. Under the premises of ensuring biosafety and protecting intellectual property rights, CGMCC provides microbial species resources, genetic resources, information resources, and professional technical services for industrial and agricultural production, health and sanitation, environmental protection, and scientific research and education. As a patent microorganism deposition center designated by the State Intellectual Property Office, CGMCC has undertaken the management of biological material depositions for patent purposes since 1985. In 1995, it was approved by the World Intellectual Property Organization to become an International Depository Authority under the Budapest Treaty. It is also one of nine national-level microbial preservation centers recognized by the Ministry of Science and Technology and the Ministry of Finance under the National Microbial Resources Platform, and a member of the World Federation for Culture Collections (WFCC).

Currently, CGMCC preserves over 57,000 strains of various microorganisms, representing more than 5,900 species, and maintains over 1 million clones of microbial genomic and metagenomic libraries. Among these, more than 13,600 strains of microorganisms, animal cell lines, and plant seeds are deposited for patent purposes, ranking second among the 46 International Depository Authorities under the Budapest Treaty worldwide. In 2010, CGMCC passed certifications for quality, environmental, and occupational health management systems, becoming China's first biological resource preservation center to obtain ISO9001 quality management system certification. The Center has established a world-class preservation technology platform and comprehensive microbial classification and identification methodologies ranging from morphological to DNA molecular levels. CGMCC continuously conducts standardized curation, identification, and evaluation of preserved strains to improve the quality of shared resources and technical service capabilities, thereby meeting the growing demand for microbial resources in research, teaching, and production.

As China's most extensive public and service-oriented preservation center in terms of microbial species and strain numbers, CGMCC has provided over one million strains to various sectors of society over the past decades. These resources have been widely applied in scientific research, education, industrial

and agricultural production, medicine and health, and environmental protection, playing a positive role and generating tremendous social and economic benefits for the establishment and rapid development of China's life science and biotechnology research, antibiotic industry, enzyme preparation industry, and other modern fermentation industries, as well as technological advancement in traditional brewing industries. Concurrently, CGMCC leverages its technical capabilities and professional team to provide specialized technical services such as strain identification, cellular component analysis, and safety evaluation for research, education, and production institutions, focusing on microbiology research and major themes including biosafety, food safety, and environmental protection. These services support government administration and promote orderly industrial development.

CGMCC has established substantive collaborations with regional networks such as the Asian Network for Research Resource Centers (ANRRC) and the European Microbial Resource Centre Consortium (EMbaRC), as well as national networks in Russia, Thailand, and Portugal, providing regional data management and sharing services. The microbial big data platform is currently in stable operation and service phase, with cumulative visits exceeding 100,000 times. It has built an important collaborative platform for scientists in the microbial field worldwide, strengthening scientific and technological exchanges and cooperation. The Microbial Resources and Big Data Center has convened the International Workshop on Microbial Data for six consecutive years and has jointly organized multiple international training courses on microbial data with UNESCO and other institutions, attracting over 100 experts and scholars from 25 countries and regions globally. With a global perspective, the Center released the "China Microbial Resources Development Report 2016" in Beijing in 2016, analyzing the current status and output of China's microbial resource preservation and depicting the development of China's microbial research from the perspectives of resource preservation and research output, providing reference for scientific research planning and R&D direction formulation.

2. Data Integration and Application Service Department

The Data Integration and Application Service Department of the Microbial Resources and Big Data Center has established a big data mining platform for microbial resources based on existing data resources, influence, and data analysis from the Global Catalogue of Microorganisms. This platform integrates bioinformatics analysis platforms, microbial genome analysis, metabolic network reconstruction and pathway design, and cross-omics data integration analysis technologies. Its key component is the WFCC-MIRCEN World Data Centre for Microorganisms (WDCM).

WDCM was established by the World Federation for Culture Collections in the 1960s and represents the most important physical resource data platform in the global microbial field. In 2010, WDCM was located at the Institute of Microbiology of the Chinese Academy of Sciences, marking the first world data

center in China's life science field. Director Ma Juncai of the Microbial Resources and Big Data Center serves as the Chair of WDCM. Leveraging WDCM as a platform, the Data Department of the Microbial Resources and Big Data Center actively pursues "China-led" international cooperation by promoting the Global Catalogue of Microorganisms (GCM) major international cooperation program for microbial data resources. This initiative aims to provide information services on microbial strain resources to the global scientific and industrial communities through a unified data portal, providing crucial support for the implementation and execution of the Convention on Biological Diversity in the microbial domain. As a big data platform integrating microbial digital resources, GCM also utilizes advanced data mining approaches to extract information on subsequent research and utilization of microbial resources from over 6 million published microbial literature and patent documents worldwide. Currently, 110 microbial resource preservation institutions from 43 countries and regions, including the United States, France, Germany, and the Netherlands, have officially participated in this program.

3. Microbial Resource Development and Technical Service Department

The Microbial Resource Development and Technical Service Department of the Microbial Resources and Big Data Center focuses on developing functional platforms including metabolite preparation and separation platforms, high-throughput enzyme screening, functional compound libraries, metagenomic libraries, and biosynthetic component libraries.

The Microbial Resources and Big Data Center of the Institute of Microbiology, Chinese Academy of Sciences, provides China with an effective mechanism and platform for integrating global microbial resource data. This platform enables the inventory of global microorganisms and their genetic resources while promoting the sharing and utilization of microbial resources under the premise of the Convention on Biological Diversity, which aims to protect the interests of resource-providing countries. As a collaborative platform, the Center enables Chinese scientists to organize and coordinate relevant forces from a global perspective and establish worldwide cooperation.

(See color inserts I and II for relevant figures)

Note: Figure translations are in progress. See original paper for figures.

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