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OUTLOOK ON BIOECONOMY DEVELOPMENT IN UKRAINE

INTRODUCTION OF MOLECULAR AND CELL BIOTECHNOLOGIES IN 2010-2013

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Abstract

The article reviews main research results in applying molecular and cell biotechnologies in Ukrainian as a component of emerging bio-economy. In particular, it shows the main results of this interdisciplinary research carried out by NAS of Ukraine for the period 2011 - 2013, namely: new approaches to counteract the most widely spread and dangerous human and animal diseases; scientific grounds for developing new medicinal drugs, their therapeutic application and efficient systems for their targeted delivery in the body; modern diagnostics and treatment methods for socially important human diseases; modern aspects of creating new forms of plants and micro-organisms – producers of medicinal drugs with the help of gene engineering methods; new, environmentally friendly biotechnologies to enhance productivity and sustainability of agricultural plants in unfavorable biotic and abiotic conditions; molecular mechanisms of biologically active substances action for new high-efficient fertilizers-growth-regulators, and plants protection means. The article also presents trends in bio-economy development on the basis of biotechnologies application in medicine and pharmaceutics of Ukraine. It provides the main directions for modern NBIC-technologies development and utilization of nano- and biomaterials in Ukrainian medicine. These research results could be widely used for emerging bio-economy both in the world developed countries and in Ukraine.

Keywords: bio-economy, molecular and cell biotechnologies, NBIC-technologies, convergence, biomaterials

INTRODUCTION

Many scientists and specialists consider that in the XXI century bio-economy together with nano-economy as well as info-cognitive economy would play a more decisive role in developing and implementing high technologies in the national and global scales (Arundel and Sawaya, 2009; Davidson and Greblov, 2005; Gazit, 2011; Kyzym and Matyushenko, 2011). As it is expected, in the XXI century nano- and bio-technologies' achievements would create new therapy methods as well as potential pre-conditions to enhance human physical capabilities (Matyushenko and Buntov, 2011; Matyushenko and Buntov, 2012; Matyushenko and Khanova, 2014; Roco and Bainbridge, 2003; Roco and Bainbridge, 2005; Roco and Bainbridge, 2006a; Roco and Bainbridge, 2006b; Roco and Montemango, 2004).

METHODS

Content analysis has been used as the main method of research, which allowed making a meaningful analysis of classic papers and researches of modern economists-practitioners devoted to the peculiarities of the modern prospects of bioeconomy, molecular and cell biotechnologies with using of NBIC-technologies and biomedicine.

RESULTS

Development of molecular and cell biotechnologies in Ukrainian in 2010-2013

At the beginning of the XXI century many well-known and recognized scientists and specialists (including Ukrainian's scientists) definite that by different estimations molecular and cell biotechnologies as one of NBIC-technologies components will lead to the most radical break-through in the innovation endeavors.

To develop nano-biotechnical research and commercialize its results in Ukraine the Ukrainian National Academy of Science has started a *special purpose comprehensive interdisciplinary program for scientific research: "Fundamental grounds for molecular and cell biotechnologies" for the period 2010 – 2014,* as specified in the resolution of the Ukrainian Academy of Science Presidium dated 07.07.2010, №222 (Resolution of the Ukrainian Academy of Science Presidium №222, 2010). Within the framework of the adopted Program concept it was decided to carry out purposeful research in the following areas of modern biology:

Study the properties and functioning mechanisms of bio-macro-molecules, permolecular systems, sub-cell and membrane structures in norm and pathology; develop fundamental grounds of molecular and cell technologies for diagnostics, prevention and treatment of diseases and for genetic improvement of living organisms; structural, functional and

comparative genomics of humans, animals, plants and micro-organisms; modern aspects of creating biologically active drugs, new forms of plants and micro-organisms.

The Ukrainian Academy of Science Presidium decree №573, dated 01.09.2010, "On approving the list of projects integral to comprehensive interdisciplinary program for scientific research: "Fundamental grounds for molecular and cell biotechnologies" established a range of projects for the named program (Resolution of the Ukrainian Academy of Science Presidium №573, 2010). Within the framework of that program it is planned to perform the following actions by ways of employing novice methods of molecular physiology, biochemistry and genetic engineering to develop new approaches to counteract the most common and dangerous human and animals' diseases; create scientific grounds for developing new medicinal drugs, their therapeutic application and efficient systems for their delivery in organism; develop up-to-date methods for diagnosis and treatment of socially important human diseases; study modern aspects of creating new forms of plants and micro-organisms – producers of medicinal drugs with the help of genetic engineering; develop new environmentally friendly biotechnologies enhancing productivity and sustainability of agricultural plants at unfavorable biotic and abiotic factors; research molecular mechanisms of biologically active substances action to create new high-efficient fertilizers' growth- regulators and means of plants protection.

The most prominent results of the indicated program implementation during 2010–2013 are presented in Table 1.

Table 1: The most prominent results of accomplishing comprehensive interdisciplinary program for scientific research: "Fundamental grounds for molecular and cell biotechnologies" in 2010-2013

Year	**Program direction**	**The most prominent result**	**Practical value**	**Branch**	**Global problem**
1	2	3	4	5	6
2011	Properties of bio-macromolecules systems	Search for inhibitors to become the ground for creating new anti-bacterial medicines with selective action against pathogen bacteria was performed	Anti-bacterial drugs against TB and human enterococcus infections	Medicine	Depopulation and ageing factor
	Molecular and cell technologies	Test systems prototypes for DNA-diagnostics are developed for the most spread in Ukraine monogenetic inherited diseases and for genetic factors of the inherited predisposition to strokes	DNA-diagnostics of inherited diseases	-«-	-«-
	Genomics	Vectors that contain sustainability genes to withstand herbicides were constructed	Getting herbicide-resistant plants	Agriculture	Food deficiency problem

	Biologically active substances	Laboratory technology to get biologically active substances from marine stock, enriched with biogenic stimulators, was developed	Bio-active supplements for food and as medicines components	Agriculture, medicine	Food deficiency Depopulation and ageing factor
2012	Properties of bio-macromolecules systems	Scientific grounds to develop new test-systems for diagnosing and treating human inherited diseases were created together with efficient systems for therapeutic genes delivery to cells	Genetic therapy, therapeutic use of stem cells	Medicine	Depopulation and ageing factor
		Research was carried out to improve methods of target-oriented search for selective bio-active substances	Selective bio-active substances	-«-	-«-
	Molecular and cell technologies	Scientific aspects of creating new strains of micro-organisms' and plants' – medicine drugs producers, were studied	New producers of medicines	-«-	-«-
		Creation of new biotechnologies to enhance productivity of agricultural plants resistant to biotic and abiotic factors was started	Increasing productivity & sustainability of plants	Agriculture	Food deficiency
	Genomics	Scientific grounds for comparative genomics of plants and animals (including rare and vanishing species) were developed	Gene pool preservation and search for new genes	Agriculture	Food deficiency
	Biologically active substances	Research of molecular mechanisms of bio-active substances action as well as growth regulators and plants protection means was carried out	Creation of insecticides, fungicides, herbicides	Agriculture	Food deficiency
2013	Properties of bio-macromolecules systems	Highly-expressive producer of recombinant scFv-antibodies, specific for human protein C, was obtained. Work was carried out to obtain mono-clonal antibodies specific for human protein	Immune-enzyme method to determine protein C concentration in human blood plasma	Medicine	Depopulation and ageing factor
		Research was carried out for studying differentiation and integration of neutral stem cells, transplanted at modeling of brain ischemic damage in vitro and in vivo. By cerebral ischemia modeling results those cells are capable of renewing the damaged gipokalm tissue functions creating synaptic terminals	Using stem cells to restore function of the damaged gipokalm tissue	-«-	-«-

	Translational research of the expression of protein kinase of the family PKD1 and PKD2 in stomach malignant tumors. It was ascertained that the expression level PKD2 in the stomach malignant tumors correlates with tumor spread and stage, including the availability of metastases. Test-system was created for differential determination of the expression level of human мRNA protein kinase	Developing test-systems to diagnose stomach malignant tumor	-«-	-«-
Molecular and cell technologies	Test system prototype was created to determine inherited predisposition for the development of ischemic stroke and forecasting antiplatelet therapy efficiency in specialized health care establishments	Developing test-system prototype to diagnose ischemic stroke	-«-	-«-
	Usage of “vector cells” was researched as multi-purpose tooling to change micro-environment	Using stem cells	Medicine	Depopulation and ageing factor
Genomics	Three types of trichinella were identified in wild animals on the territory of Ukraine: Trichinella britovi, Trichinella native, Trichinella spiralis.	Setting first in Ukraine DNA library for Trichinella	Agriculture	Food deficiency
Biologically active substances	Molecular-genetic polymorphism of winter soft wheat varieties and lines was researched to identify impact of Glu-Blal on the indicators of baking quality	Opportunity for quick differentiation of pedigree wheat samples	Agriculture	Food deficiency

Source: Prepared according to Report on the performance of the Ukrainian Academy of Science in 2011, Part 2, 2012; Report on the performance of the Ukrainian Academy of Science in 2012, 2013; Report on the performance of the Ukrainian Academy of Science in 2013, 2014.

Development of new technologies for creating national medicinal drugs to ensure human health care and satisfy the needs of veterinary medicine in Ukraine in 2013

Since 2013, the State Special-Purpose Scientific-Technical Program To Develop New Technologies For Creating National Medicinal Drugs To Ensure Human Health Care And Satisfy The Needs Of Veterinary Medicine In The Period 2011 - 2015 has been under way.

The Program purpose is to develop molecular and cell technologies for creating the national medicinal drugs to ensure human health care and satisfy the needs of veterinary medicine. The ways to reach the indicated goal are as follows (Ukrainian Cabinet of Ministers

Resolution №2254, 2010) to develop technologies of targeted generation of synthetic chemical compounds and luminescent bio-medical diagnostic materials with the determined biological activity; create new diagnostic means on the bases of DNA- and RNA-technologies; develop diagnostic means on the basis of recombinant proteins and immune-chemical approaches; create therapeutic drugs and agents on the basis of recombinant proteins and anti-bodies, blood- and plasma-derived products and drugs for cell therapy; create medical drugs' exploratory prototypes and develop master batch records for their production.

The program tasks are (Ukrainian Cabinet of Ministers Resolution №725, 2011) to create and support functioning of the research scientific-production basis of molecular and cell bio-technologies; create new diagnostic means on the basis of DNA- RNA-technologies; develop diagnostic means on the basis of recombinant proteins-bodies and immune-chemical approaches; create therapeutic drugs on the basis of recombinant proteins, anti-bodies and DNA, RNA-technologies; create and implement innovation systems for developing medicinal substances. Table 2 presents the most prominent results of the mentioned Program implementation in 2013.

Table 2: The State Special-Purpose Scientific-Technical Program To Develop New Technologies For Creating National Medicinal Drugs To Ensure Human Health Care And Satisfy The Needs Of Veterinary Medicine In 2013

Year	Program direction	The most prominent result	Practical value	Branch	Global problem
1	2	3	4	5	6
	Medicinal drugs for humans	The technology of obtaining test-system components to determine $25OHD_3$ in blood serum ($25OHD_3$ as a marker of bone system's diseases) was developed	Foundation for creating immune-enzyme diagnosticum of $25OHD_3$ content	Medicine	Depopulation and ageing factor
		Characteristics of a new compound KMC5 were researched; the compound has the properties of ASTIC1a-channels inhibitor; it provided for increasing the scope of further optimization of antagonists ASIC1a. These channels' new antagonist has neuro-protection properties	Using KMC5 as a promising pharmacophore for anti-ischemic drugs	-«-	-«-

	Test-systems to determine content of the main components of fibrinolytic system in blood plasma was created. Standard operating procedure to determine plasminogen tissue activator content was developed. Method to determine plasminogen tissue activator and tissue activator inhibitor was practiced.	Diagnosticum to evaluate the condition of thrombus destruction system and to assess the thrombosis risk was developed	Medicine	Depopulation and ageing factor
2013	Conditions of accumulation, purification and quality control for the obtained adenoviral antigen were optimized.	Highly sensitive and specific test-system to determine anti-bodies to that virus in patients' blood serum was created	-«-	-«-
	Methods for identification, quality control and quantitative definition of morinoxine were developed; grounds for creating analytical-regulating documents for the substance were laid; its impact on the interferon status of test animals was determined	Optimal schemes to apply morinoxine against virus infection were substantiated	-«-	-«-
	Computer search for new inhibitors of protein-tyrosine-phosphatase 1B was performed in the database of 65,000 organic synthetic nitrogen-containing hetero-cycles. New structures, potential inhibitors PTP1B, were synthesized; the activity of some of them was assessed.	Potential inhibitors of protein-tyrosine-phosphatase within in vitro systems were developed	-«-	-«-
	The technology to obtain new generation antiviral drug on the basis of bacillary lectin and its isoforms was optimized	Prevention and treatment of flu infection	-«-	-«-

Source: Prepared according to Report on the performance of the Ukrainian Academy of Science in 2013, 2014

CONCLUSIONS

On the basis of the above mentioned facts we may conclude that in the XXI century bio-economy together with nano-economy as well as info-cognitive economy would play a more decisive role in developing and implementing high technologies in the national and global scales. Molecular and cell biotechnologies, as one of the directions that use convergence of NBIC-technologies, by different evaluations would cause the most radical break-through in this branch of innovations. Bio-nano-technologies achievements would provide for creating new methods in therapy as well as potential preconditions to increase human physical capacity.

In Ukraine, within the frameworks of the special purpose comprehensive interdisciplinary program for scientific research: “Fundamental grounds for molecular and cell biotechnologies” launched by the Ukrainian Academy of Science, and using modern methods of molecular physiology, biochemistry and gene engineering in the period 2011 – 2013 the following was achieved: new approaches to counteract the most widely spread and dangerous human and animal diseases were developed; scientific grounds for developing new medicinal drugs, their therapeutic application and efficient systems for their targeted delivery in the body were set; modern diagnostics and treatment methods were developed to counteract socially important human diseases; modern aspects of creating new forms of plants and micro-organisms – producers of medicinal drugs, were studied with the help of gene engineering methods; new, environmentally friendly biotechnologies to enhance productivity and sustainability of agricultural plants in unfavorable biotic and abiotic conditions were developed; molecular mechanisms of biologically active substances action were researched to create new high-efficient fertilizers-growth-regulators, and plants protection means.

Within the framework of the Ukrainian State Special-Purpose Scientific-Technical Program To Develop New Technologies For Creating National Medicinal Drugs To Ensure Human Health Care And Satisfy The Needs Of Veterinary Medicine In The Period 2011 – 2015, as of the end of 2013 the following was accomplished: technologies for targeted obtaining of synthetic chemical compounds and luminescent biochemical diagnostic materials with the determined biological activeness were developed; new diagnostic means on DNA- and RNA-technologies basis were created; diagnostic means on the basis of recombinant proteins and immune-chemical approaches were developed; therapeutic drugs and means were created on the basis of recombinant proteins and anti-bodies, blood and plasma products as well as products for cell therapy; research prototypes of medicinal drugs were created and master batch record for their production was developed. With this regard the Ukrainian scientists’ developments could be widely used in medical practice both in the world developed countries and in Ukraine.

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