



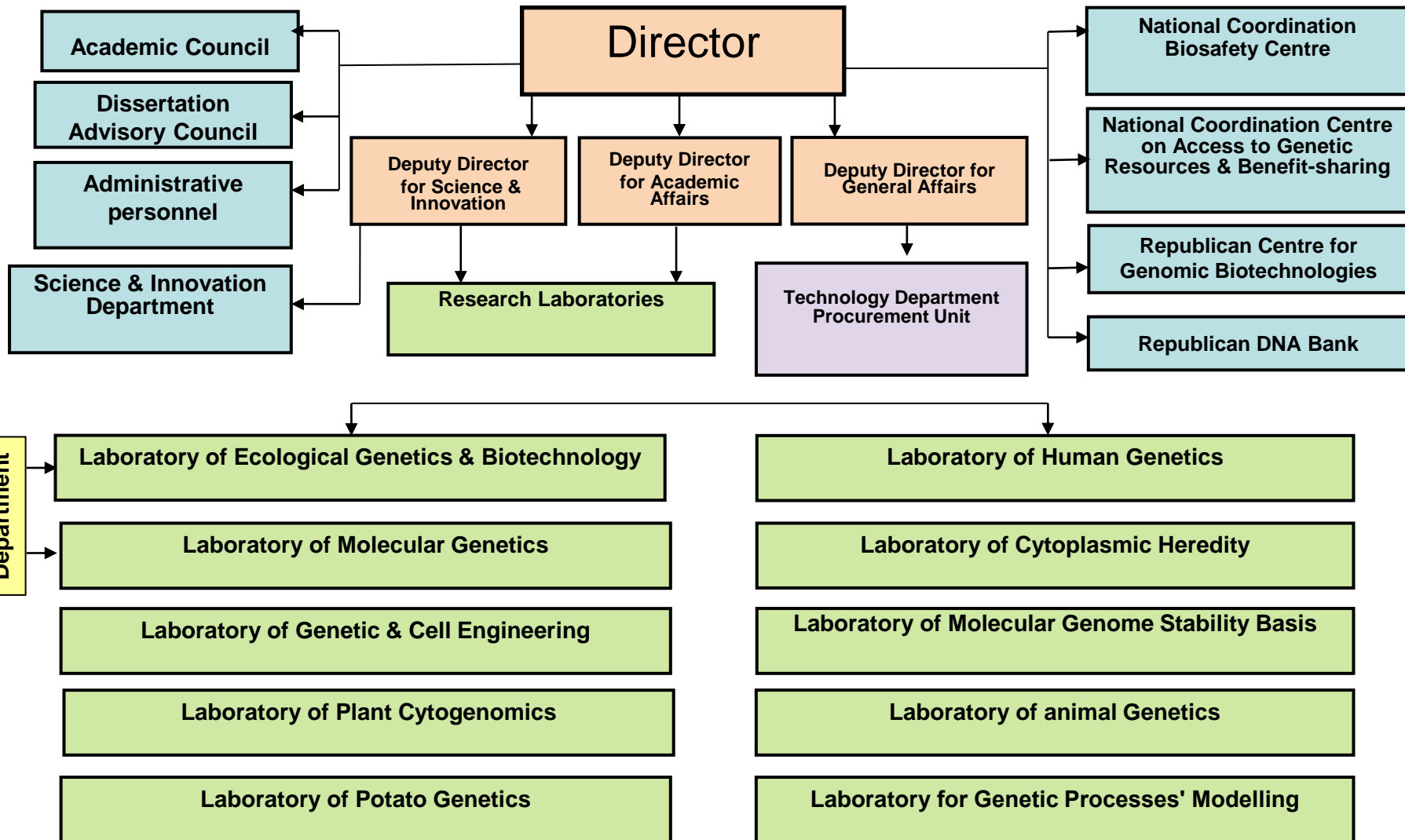
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# Institute of Genetics & Cytology, NAS of Belarus: Key Directions of Scientific Research



*Workshop, 10 December 2018, Minsk  
Institute of Genetics & Cytology,  
NAS of Belarus*

- The Institute is the lead Scientific Institution in the country in the field of genetics, genomics and biotechnology.
- 160 staff members; 108 research associates, including 12 D.Sc.s and 42 PhDs



# Key Directions of Scientific Research

- **Study of the structural and functional organization of plant, animal, microorganism and human genomes**
- **Development of genetic and cell engineering related issues**
- **Development of genomic and cell biotechnologies for agriculture, medicine, sports, environmental protection**
  - **Study of biosafety related issues**

# Research Activities in 2018

Programme type	Number of programmes	Number of research activities
State Research Programmes	3	18
State Programmes	2	20
State Scientific-Technical Programmes	1	4
Scientific-Technical Programmes of the Union State	1	9
Innovative Projects of the Ministry of Health	1	1
Agreements with the Belarusian Republican Foundation for Fundamental Research	-	26
Grants of the Presidium of NAS of Belarus to PhD students	-	1
Other Research Activities	-	4
<b>TOTAL:</b>		<b>83</b>

# SCIENTIFIC-TECHNICAL PROGRAMME OF THE UNION STATE

**Development of innovative  
genogeographic and genomic technologies for the  
identification of a person and his/her individual  
characteristics based on the study of the gene  
pools of Union State Regions**

**(DNA identification)**

- **Contracting Authority from Belarus – NAS of Belarus**
- **Contracting Coordinating Authority – Federal Agency for Scientific Organizations of the Russian Federation**
- **Time frame 2017-2021**

# Directions and Outcomes of Genomic Research of the Institute of Genetics and Cytology, NAS of Belarus

<b>Objects</b>	<b>Directions</b>	<b>Outcomes</b>
<b>Plants</b>	<b>DNA marking Transgenesis</b>	<b>DNA identification of agricultural crops Marker assisted selection Transgenic plants</b>
<b>Animals</b>	<b>DNA marking</b>	<b>DNA identification of agricultural and wild animals Marker assisted selection</b>
<b>Humans</b>	<b>DNA marking</b>	<b>DNA diagnostics, prognosis and monitoring of hereditary determined diseases DNA testing in sports</b>
<b>Microorganisms</b>	<b>DNA marking</b>	<b>DNA identification of microorganism strains</b>
<b>Food products</b>	<b>GMO detection</b>	<b>Detection of genetically modified ingredients (GMIs) in the food raw material and food products</b>

# Brand Directions

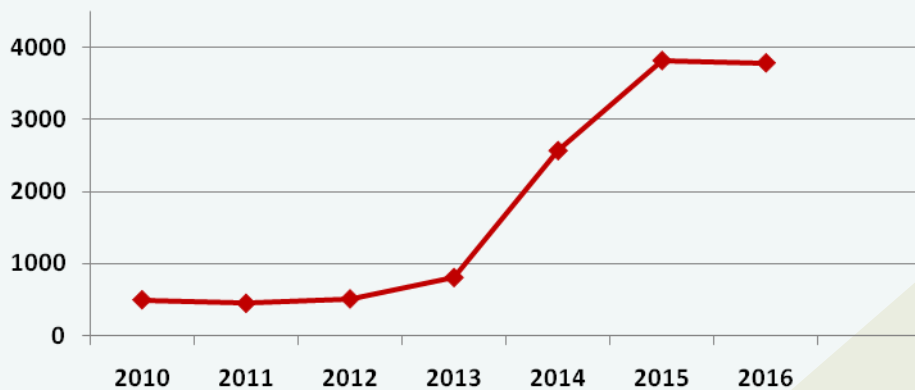
The volume of import substitution services delivered in domestic and foreign markets in 2010-2017 amounted to more than 2.7 million USD

▶ Genetic certification of plants and plant origin products

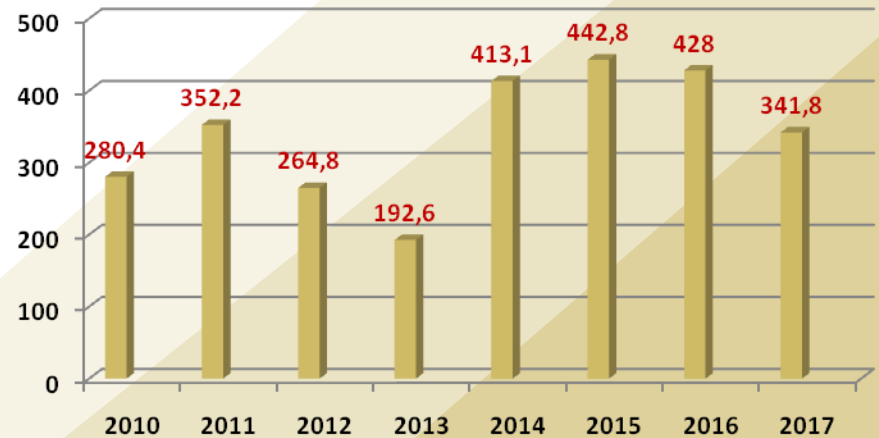
▶ Genetic certification of animals and animal origin products

▶ DNA Human Health Certificate

◆ Количество генетических анализов, шт.



■ Объем оказанных услуг, в тыс. долл. США



9 мес.

# Genetic Certification of Plants and Animals

## Genetic Certification Systems Developed:



Varieties and Hybrids of Agricultural Plants	Agricultural Animals
wheat	cattle
barley	pigs
tomatoes	horses
potatoes	fish of the sturgeon family
sunflower	
pear	
apple	
flax	
soya	
sugar beetroot	



Reference DNA Certificates designed:

- Wheat – 38 varieties
- tomato – 33 varieties and hybrids
- potato – 60 varieties
- flax – 39 varieties
- barley – 100 varieties



Over the 2008-2017 period, more than 5000 DNA Certificates for pedigree animals issued.

**DNA Certificates** allow to identify plant varieties, control the genetic purity of varieties; assess the hybridity level; verify the origin of pedigree animals; contribute to the accelerated and improved quality of the breeding process.



# DNA Testing of Fish

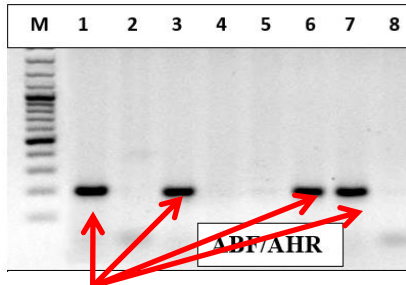


DNA testing to establish (verify) the species belonging of fish of the *Acipenseridae* family and products from them (including caviar).

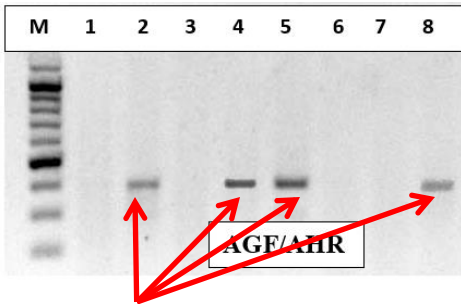
Issuing of a DNA Certificate in conformity with CITES requirements.

The expertise is based on the method of molecular genetic analysis of highly polymorphic regions of nuclear and mitochondrial DNA.

For the *Acipenseridae* genotyping, a kit of five microsatellite loci (Afug41, Afug51, An20, AoxD161, AoxD165) is used (A.E. Barmintseva, N.S. Myuge, 2013). Alleles are specific for different species, which allows them to be used for the species identification of the *Acipenseridae* and products from them and determination of hybrid origin individuals and parenthood.



Siberian sturgeon



Russian sturgeon



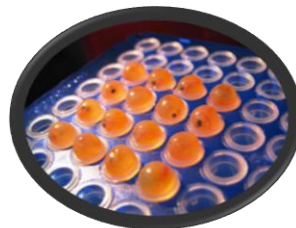
# Species Identification of *Salmonidae*

Identification of commercially valuable species of fish (Atlantic salmon, rainbow trout, pink salmon and etc.) becomes complicated due to the fact that external species characteristics are lost during processing (e.g. fish filleting).

The **development of molecular-genetic identification technology for salmon species** in the aquatic and aquaculture fish products will allow for DNA testing to establish the species belonging to the *Salmonidae* family and products from them, including red caviar, which will allow to identify adulterated products and protect consumer interests.

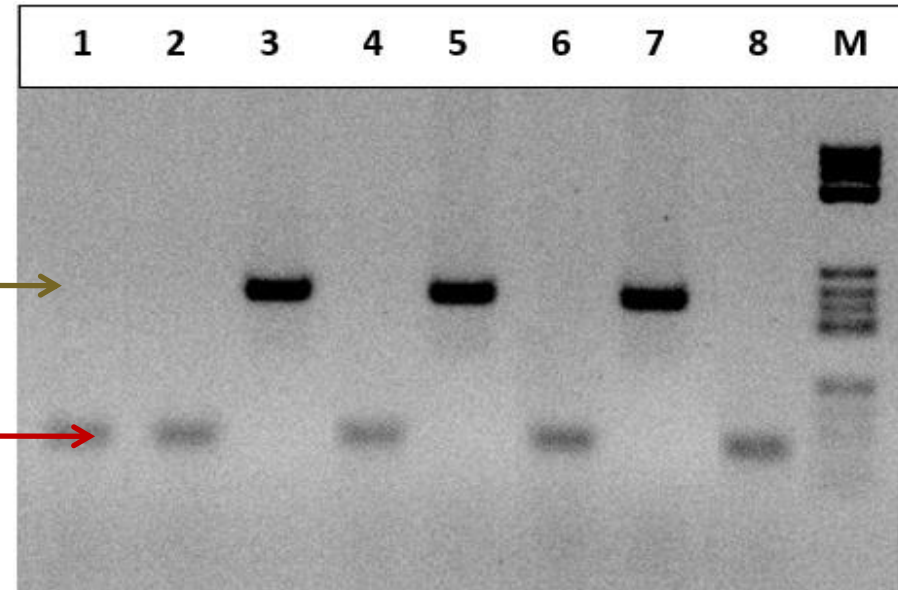


The group is represented by 5 species of the Pacific salmon (*Oncorhynchus*), including:  
rainbow trout (*O. mykiss*)  
sockeye salmon (*O. nerka*)  
pink salmon (*O. gorbuscha*)  
chum salmon (*O. keta*),  
chinook salmon (*O. tshawytscha*)  
coho salmon (*O. kisutch*)  
*Salmo*: Atlantic salmon (*S. salar*) and brown trout (*S. trutta*).



Atlantic salmon  
(*Salmo salar*)

Rainbow trout  
(*Oncorhynchus mykiss*)



**Upon request of the State Customs Committee of the Republic of Belarus, DNA testing of the clonal seedling stock of an apple-tree got into the country's territory was carried out.**

### **Traditional Identification**



### **Genetic Identification**



**As a result of the testing conducted, an amount of about 100 thousand USD went into the country's budget.**



It was established that the material corresponds to the clonal seedling stocks of the apple trees M26 and MM-106 recorded in the State Register of Varieties and approved for production, sale and use in the territory of the Republic of Belarus.



# Genomic technologies for the environmental protection and to combat poaching.

Genomic biotechnologies are used to study genetic diversity and assess the population structure:

For the bison, recommendations are given to match more distant pairs for breeding. This will allow to increase the heterogeneity of bison micropopulations and avoid the effects of closely related breeding.



*Bison bonasus*



Red deer



European roe deer



Big white-headed gulls

The results formed the basis of the Action Plan for the Conservation and Sustainable Use of Bison and the 2015-2019 PROGRAMME.

For a number of protected and resource species (European bison, European roe deer, red deer, wild boar), species-specific DNA markers allowing to identify the biological material with a high degree of certainty by verifying its species belonging were selected, which can be used to combat poaching.

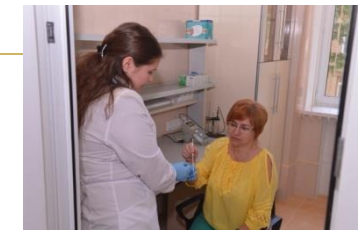
# Approaching P4 Medicine: Predictive, Preventive, Personalized and Participatory with regard to patients

**DNA testing methods by 19 diseases** developed (cardiovascular, type 2 diabetes, osteoporosis, hearing loss, mitochondrial pathologies, etc.).



**DNA testing of more than 9000 individuals** conducted.

**Pharmacogenetic tests** are being developed to optimize the dosage of medicaments (anticoagulants, antipsychotics).



**Technology to prognosticate the effectiveness of “Clopidogrel” and “Warfarin” therapy.**

The therapy effectiveness depends on the genetic characteristics of a patient, which can cause both immunity and hypersensitivity to these drugs.



Molecular genetic testing allows to choose the right dosage of a drug or replace it with a more suitable analogue to prevent dangerous consequences, such as bleeding or thrombosis.



**Partners:** Republican Scientific and Practical Centre “**Mother and Child**”, Republican Scientific and Practical Centre “**Cardiology**”, State Educational Institution “**Belarusian Medical Academy of Postgraduate Studies**”, **Belarusian State Medical University** and etc.

# DNA Reproductive Health Certificate

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## DNA testing to identify genetic reasons for non-carrying of pregnancy.

It is conducted by 14 genetic markers associated with disorders of the normal physiological course of pregnancy. Unfavorable variants of genes are identified and their effects are corrected with antithrombotic and folic acid preparations, which contributes to the successful completion of pregnancy.

**More** than 5000 women with unknown causes of miscarriages (non-carrying of pregnancy) **tested**.



## Analysis of DNA damages in male sperm using the DNA comet method.

It is performed to establish possible genetic causes of male infertility.

Testing has been carried out since 2016. Over 18 months, more than 500 men with unknown causes of male infertility have applied to the Institute following the recommendations of their doctors.

In case of detected DNA damages in sperm, a course of treatment is prescribed in clinics after which the **number of DNA damages** in male sperm **reduces** by 50% on average, which **indicates an improvement** in the reproductive health of patients.

# DNA testing in sports

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**More than 500 representatives of 30 Olympic and national teams of the Republic of Belarus tested.**

**DNA Bank of elite athletes created.**

## DNA testing programmes developed:

- To choose the beginners in sports (by sporting aptitude genes)
- For sporting profilisation
- To correct the training process
- To adjust the biomedical maintenance of an athlete

**DNA testing allows to improve the selection process in sports; optimize the training process and adjust the biomedical support of athletes, which ultimately helps increase their effectiveness and enhance the realization of the athlete's sporting potential.**



# Republican Centre for Genomic Biotechnologies

## Functioning since 2011

Accredited with the State Committee for Standardization of the Republic of Belarus

License of the Ministry of Health for the right to medical services

Certificate for conformity with the quality management STB ISO 9001–2009



## Scope of Accreditation

- Detection of genetically modified ingredients (GMIs) in the food raw material and food products
- Detection of GMIs in agricultural products, feedstuff and the seed material
- Determination of DNA markers for the identification and certification of agricultural crops
- Identification of genes responsible for economically valuable traits and hereditary diseases of animals
- Identification of genes responsible for various individual characteristics of a person
- Verification of species belonging to the ingredients of animal and vegetable origin
- Molecular-genetic verification of origin and species and breed belonging of animals

**Prospects: scaling of Centre's activities: modernization of laboratory facilities and instrumentation, expanding a range of services, increasing the volume of laboratory tests performed up to 86 900 per year.**



21 October 2017, the Republican Centre issued the **10 000th DNA Certificate**

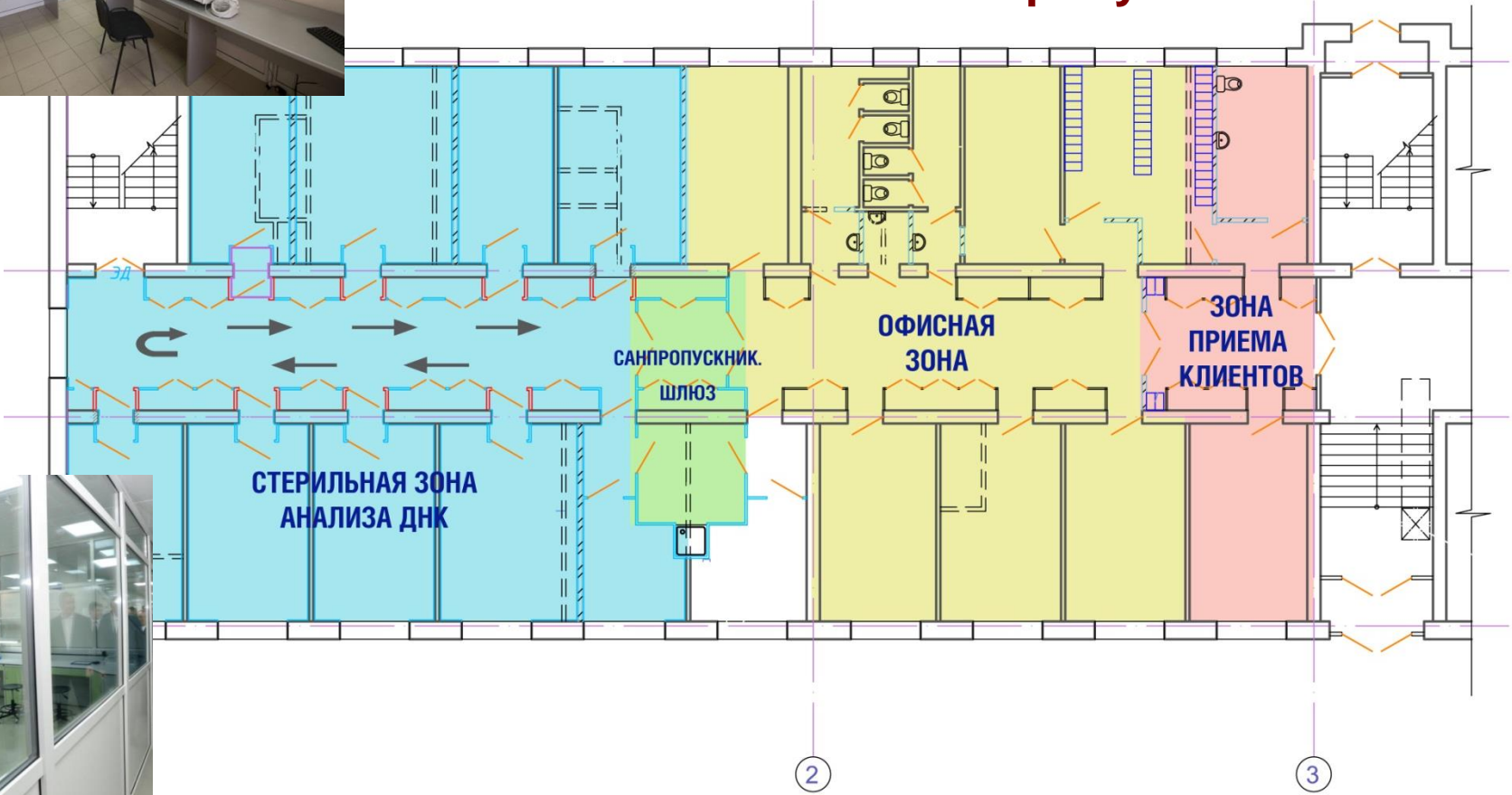
The Certificate owner is  
Davyd Stashkevich,  
a young resident of Minsk



# Integrated modernization (2017-2020)

Creation of two high-tech units for the activities in the field of genomic analysis.

It will allow to increase the volumes of genetic testing up to 86 900 per year.



# Republican DNA Bank of a Human, Animals, Plants and Microorganisms

**Created for the long-term and centralized storage and use of unique DNA samples for:**

- Scientific research
- Medicine and agricultural practices
- Biotechnologies

## Priority goals:

- Collection, storage and systematization of information on genetic material collections
- Organization of effective communication with other DNA Banks and genetic material collections to exchange samples, technologies and information
- Inventory and conservation of genetic resources of rare and endangered plant and animal species of the Republic of Belarus



## It includes 5 sections (more than 11 thousand samples):

- DNA Bank of a Human
- DNA Bank of Animals
- DNA Bank of Plants
- DNA Bank of Microorganisms
- DNA Rare and Endangered Plant and Animal Species of the Republic of Belarus



In 2016, the National Heritage status was awarded to the DNA Bank.

# National Coordination Biosafety Centre

It was established in 1998 with a view of effective participation of the Republic of Belarus in conservation of biological diversity and coordination of activities related to the use of modern biotechnology achievements under the UN Convention on Biological Diversity and the Cartagena Protocol on Biosafety.



## Key directions of its activities:

- **Collection, analysis and systematization of information** on legislation and scientific research on biosafety, field trials, import/export, commercial use of genetically modified organisms (GMO)
- **Organization of scientific safety expertise** of GMOs and products based on them, the testing or use of which is planned in the Republic of Belarus
- **Providing biosafety information** to stakeholders
- **Sharing of information** with Biosafety Centers of other countries and international organizations

# National Coordination Centre on Access to Genetic Resources and Benefit-sharing

It was established in **2014** with a view of effective participation of the Republic of Belarus in addressing the issues related to access to genetic resources and the fair and equitable sharing of benefits arising from their utilization to the UN Convention on Biological Diversity and the Nagoya Protocol.



## Key directions of its activities:

- **Collection, analysis and systematization of information** on legislation and genetic resources of the Republic of Belarus stakeholders can be granted access to
- **Specification of terms and conditions for access** to and use of genetic resources of the Republic of Belarus, including benefit-sharing
- **Providing information** to stakeholders on access to genetic resources and terms and conditions for their use
- **Organization of expertise** on projects and agreements on access to genetic resources of the Republic of Belarus and the terms and conditions for their use
- **Exchange of information** with Coordination Centres of other countries and international organizations on access to genetic resources and benefit-sharing



**Institute of Genetics and Cytology, NAS of Belarus**

**Thank you for your attention!**

