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OPEN SCIENCE AND PUBLIC ENGAGEMENT FOR THE DISSEMINATION OF ACHIEVEMENTS OF LIFE SCIENCES: LESSONS LEARNED FROM IVAN FRANKO NATIONAL UNIVERSITY OF LVIV

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Background. Implementation of responsible research and innovation (RRI) practices in biosciences is important for better understanding of research by society. Public Engagement as the first RRI key can be implemented through Open Science. Strengthening interaction with the society is a significant aspect of Open Science and a prevalent challenge for biologists.

Methods and Results. The project “RESponsible research and innovation grounding practices in BIOSciences (ResBios)” comprises interrelated research and implementation designed to achieve the specific objectives. The project runs for three years (January 2019 – December 2022) and focuses on biosciences at the crossroads of science and society. The activities organized in work packages include technical assistance, learning process on RRI-oriented structural change, monitoring and assessment, communication and dissemination of knowledge, and project management.

Results and Discussion. This article is dedicated to the description of the experience of the Department of Biochemistry team in engagement of different actors. The Department of Biochemistry of Ivan Franko National University of Lviv participates in the ResBios project and implements the RRI grounding practices, particularly Public Engagement through Open Science. Within the project framework a number of activities were held with a view to popularizing biosciences in society. Among others, a Workshop on pharmaceutical and house chemicals for schoolchildren and teachers of secondary schools and annual Summer School on Nutrition for undergraduate and graduate students of universities were organized. Besides, educational and popular-science videos were created, and the YouTube Chanel of the Department of Biochemistry was launched.



Conclusion. Participation in the ResBios project enabled us to improve Public Engagement through Open Science in the activities organized by the team of the Department of Biochemistry. Taking into account the feedback obtained from the participants it could be concluded that these activities will have a prolonged effect on communication between biologists and citizens in Ukraine and abroad.

Keywords: Responsible Research and Innovation, Open Science, Public Engagement, ResBios

INTRODUCTION

What is Responsible Research and Innovation in Biosciences? First publications on Responsible Research and Innovation (RRI) date from the beginning of the 2010s (Owen, Macnaghten, & Stilgoe, 2012; Stahl *et al.*, 2021; von Schomberg, 2012). However, the necessity of integration of responsibility into research and innovation in educational and industrial institutions was postulated earlier. On the one hand, Scientists emphasized that this approach promotes the realization of talents and involves communication with society. On the other hand, there is a need for governance in the field of research and innovation that will help scientists to understand expectations of the society and receive more relevant and well-timed results. Another approach implemented through a successful governance is to combine different kinds of knowledge and knowledge producers, industries, the public and authority both at the international and regional level (Arnold *et al.*, 2003). Significant progress in the governance and implementation of RRI was achieved under the auspices of the European Commission. The adoption of RRI frameworks led to acceptance of its theoretical basis, operationalization, feasibility, and practical, social, economic and political implications (O'Grady & Mangina, 2022; Stahl *et al.*, 2021; Tabarés *et al.*, 2022). Nevertheless, further efforts in understanding the concepts, significance and development of ways to implement RRI are important.

The term Responsible Research and Innovation (RRI) associates with anticipation, reflexivity, inclusiveness, openness, and responsiveness of scientific and innovative developments and is based on 5 keys (Colizzi *et al.*, 2019; HubIT RRI Key Success Indicators, 2022):

- **Public Engagement.** The goal is to maximize the number of people involved in the scientific process through the engagement of representatives of different groups to the research and innovation process (e.g., researchers, citizens, policy makers, persons involved in business and industry, schoolchildren, and teachers).
- **Gender Equality.** The goal is to advance gender equality in the research and innovation production.
- **Education.** The goals are to provide future researchers and other members of society with capacities for taking responsibility in the research and innovation process as well as to maximize science communication to attract children and youth to science.
- **Open Access.** The goal is to make research and innovation free and easily accessible.
- **Ethics.** The goal is to enhance ethical standards in the research and innovation production. This means the conformity to fundamental rights and ethical standards, and maintaining high-quality research results.

Modern biological science is undergoing globalization. This is due to the fact that in order to obtain valuable results, scientists work in groups. Each scientist performs a separate task, which is necessary to find a solution to the whole problem. Often members of the team work in different cities, or even in different countries. Therefore, it is often impossible to control the quality of the conducted research. Thus, there is a need for complete trust in another person's work. Along with that, it implies the personal responsibility of everyone not only for their own result but also for the result of the whole team. Given this, there is no doubt about the importance of RRI approach in biosciences inasmuch as it ensures the ethical sustainability and veracity of science and innovation outcomes. As mentioned earlier, RRI provides an interdisciplinary approach to research, whereby responsibility is considered to be a collective phenomenon. It involves researchers, innovators, funders, policy makers, and other stakeholders like universities, businesspeople, entrepreneurs, governments, and civil society to responsibility for the research conduction and the obtained results (Owen *et al.*, 2012, 2013; Stahl *et al.*, 2021; Stilgoe, Owen, & Macnaghten, 2013; Von Schomberg, 2013).

The need for RRI implementation in biosciences stems from the problems of understanding of biotechnological and biomedical research. The information is often perceived with an emphasis on the negative impact of these new technologies. To avoid the problem, the principles of RRI are applied by policymakers and researchers in two directions. Firstly, they focus on ways to conduct responsible science and develop technology. Secondly, RRI is applied not only during research process, but also in commercialization and market introduction processes (Lubberink, Blok, Ophem, & Omta, 2017) to convey a proper context-sensitive understanding of introducing innovations (van Oudheusden, 2014). Here, not economic aspects are important, but ethical ones (Jakobsen, Fløysand, & Overton, 2019).

Since RRI involves enhanced communication, it allows researchers to disseminate the results of their work. Due to this, society knows on which research purposes countries or grant-providing institutions spent funds. Likewise, responsibility helps to analyze the current needs of society and adjust the purpose of research according to market conjuncture. Responsibility is the combination of a responsible process and desirable outcomes (Stahl *et al.*, 2021; Stilgoe *et al.*, 2013; von Schomberg, 2012).

Open Science and Public Engagement. Science with and for society. Public Engagement as the first RRI key can be implemented through Open Science. The scientific process based on cooperative work and disseminating knowledge by using digital technologies and collaborative tools is a new approach of Open Science. The main goal of Open Science could be described as “to make the primary outputs of publicly funded research results – publications and the research data – publicly accessible in digital format with no or minimal restriction” (Bueno de la Fuente, n.d.). In fact, the tasks of Open Science are much broader. Among these tasks are extending the principles of openness to the whole research cycle, fostering sharing and collaboration as early as possible thus entailing a systemic change to the way science and research is done. Universities and other research performing organizations are key locations for realizing Open Science. Today, Open Science is becoming the basis for research and innovation.

Sharing knowledge and tools between researchers in different disciplines and with society as a whole is the main aim of Open Science. To make research cultures more open, it actively seeks to invite and engage stakeholders and citizens from beyond

the academic area into research and innovation processes, for example through public engagement and citizen science (Owen, 2021).

Over the past few decades, numerous initiatives have attempted to involve members of the public in decision-making related to life sciences and biotechnology. This was facilitated by the conviction that such participation satisfies the interests of society. However, what these initiatives hope to achieve depends on the motivation behind seeking public input. In some cases, they reflect the belief that citizens have a right to participate in decision-making and to be involved in scientific work, especially when the research is funded by their tax contributions (this is what sociologists term normative justification). In other cases, they reflect a desire to reduce misunderstandings, help (re)build trust between citizens and scientists, and facilitate new innovations (in other words, the reason is instrumental). In still other cases, such initiatives reflect the idea that the involvement of the people who will create the technologies will raise questions about how the designs will actually function once they leave the lab. Perhaps this will lead to innovations that are more effective in complex real-world environments, or that may be more socially, economically and environmentally viable (Marris & Rose, 2010).

Open Science and Public Engagement in Ukraine. Current state. The modern discourse on science in Ukraine is not sufficiently developed. However, the discussion of scientific achievements is at a noticeable level, at least for more or less active users of the Internet and social networks. First of all, it is communication of popular science mass media content while adapting scientific information to the level of perception by the general public. Over the past few years, a number of science popularization formats have been actively developed in Ukraine.

Today, in Ukraine there are several online platforms that provide scientific information in an accessible form to citizens and provide feedback to readers. The “My Science” portal (<https://my.science.ua>) was created in the fall of 2011 and works as a platform where active scientists and teachers can share interesting scientific facts, talk about new achievements of Ukrainian and world science, inform about forthcoming popular scientific events such as lectures, excursions, etc. Readers have the opportunity to receive feedback in the form of answers to questions provided by specialists from various fields of scientific knowledge (Moya nauka – populyaryzatsiya nauky vid ukrayyns'kykh vchenykh [My science – popularization of science from Ukrainian scientists], n.d.). With the participation of “My Science” portal, the popular science campaign “Days of Science” (Days of Science – My Science (<https://my.science.ua/dni-nauky>)) was launched. “Days of Science” have been held in many scientific institutions of Kyiv, Lviv, Kharkiv, Odesa and other cities of Ukraine (Tarasenko, 2021).

Another science popularizing platform is “Real Science” which is a popular science lecture and video channel with lectures on natural sciences (Real Science, n.d.). Its mission is to acquaint the public with the developments of the world science and the achievements of Ukrainian scientists in various fields to ensure dialogue between scientists and representatives of business, government, and society. The lectures can be viewed on the YouTube video channel (<https://www.youtube.com/channel/UCwqAbelS3bESmgVSrpaUezg>) and on the Facebook page (<https://www.facebook.com/RealScienceU>).

The “Interesting Science” channel aims to raise scientific literacy among everyone who wants to receive information in the Ukrainian language. The channel is engaged

in the translation and dubbing of popular science and educational videos on various scientific topics in physics, astronomy, biology, geography and mathematics, which can be seen on Facebook (<https://www.facebook.com/CikavaNaukaStudio>) and YouTube (<https://www.youtube.com/cikavanauka>) (Tarasenko, 2021).

“Science picnics” (Science picnics – My science (<https://my.science.ua/directory/naukovi-pikniki>, <https://www.facebook.com/ScientificFun>) is an initiative that popularizes science, research and experimental work, scientific and technical creativity among children and young people. They are held annually in the fresh air, on the central squares and in the parks of the cities of Ukraine. Picnics attract specialists, scientists, and enthusiasts who share their knowledge with the public, combining science with fun. On picnics, they reveal the secrets of physics, chemistry, biology and other fields of science, showing that science is literally all around us (Tarasenko, 2021).

The platform of the Junior Academy of Sciences of Ukraine (JASU) (http://man.gov.ua/ua/about_the_academy/jasu) contributes to the formation of the scientific worldview of secondary and high school students and their involvement in research and scientific work. Students of the JASU are participants in various regional, all-Ukrainian and international intellectual contests, tournaments, Olympiads and demonstrate a high level of knowledge and creative abilities. As an institution that performs nationwide functions for the search, development and support of gifted and talented students, JASU annually implements dozens of large-scale scientific and educational projects and events for gifted secondary and high school students and teachers, such as: “Open Educational Laboratory”, All-Ukrainian Summer specialized scientific schools, Children’s Academy “Futurum”, “Destination Imagination” in Ukraine, all-Ukrainian scientific mobile studios, exhibition-competition of youth innovative projects “Future of Ukraine”, etc.

Today, the Junior Academy of Sciences of Ukraine educates professionally oriented young people armed with appropriate scientific and research tools, who know their purpose, direction, scientific vocation yet at school and go to higher education institutions with clear understanding in which scientific field they want to work (Tarasenko, 2021).

The active position of Ukraine regarding the education of promising scientists of the future depends on many factors, in particular, on the popularization of scientific knowledge, that is, on the productive communication of scientists with the public. Its development can be facilitated by an increase in the volume of popular science content in the media space, the creation and use of new communication platforms for its effective promotion, the involvement of non-state innovation centers, non-governmental organizations, and individual scientists in the popularization of science. Ukraine opens up the possibilities of Open Science and Public Engagement, and confidently looks into its future (Horovyi, 2021; Tarasenko, 2021).

According to A. Senenko, a popularizer of science in Ukraine, senior researcher at the Institute of Physics of the National Academy of Sciences of Ukraine, who runs his own blog about science, “popularization of science in Ukraine is like riding a flaming bicycle through a forest fire. For us, it is a completely voluntary business. All projects that exist in Ukraine rest on the enthusiasm of those who are engaged in it. Why do these people promote science? They are either offended by the fact that the officials “don’t know” that there is science in Ukraine that needs to be supported, or they are people who are really driven by the fact that they discover something new for people, even if these are some elementary things, such as why the sky is blue” (Tarasenko, 2021).

Challenges in the implementation of responsible research and innovation in the Ivan Franko National University of Lviv (Ukraine). The application of the principles of RRI in various institutions of higher education is the evidence of change in the research paradigm of these institutions towards values based on joint work to obtain valuable knowledge, the importance of inclusiveness and transdisciplinarity for more socially responsible research. The current development of science is increasingly based on an understanding of the importance of conducting research that meets societal needs and the value of public involvement (Owen *et al.*, 2013). However, the process of implementing RRI practices in higher education institutions remains rather strenuous (Levikov, Quacinella, & Duca, 2020). For the successful integration of RRI into the daily work of institutions of higher education, they must become mediators or even initiators of communication and cooperation of educational/scientific structures with industries, government and the public. In this role, the university acts as a channel of transmission that contributes to economic and social development (Kinash, Andrusiv, Popadynets, & Golovnia, 2019; Stahl *et al.*, 2021).

Ukraine, as a country that historically was in the communist and post-communist eras and, accordingly, was economically and politically isolated from the West for a considerable period of time. These circumstances have negatively affected the quality of national education and science, to the point where there is virtually no connection between universities and business or society (Kwiek, 2018).

Fortunately, in recent years the situation has begun to change for the better, which is due to Ukraine receiving the status of an associate member of the European Union (EU). One of the important steps on the way to the integration of higher education into the European space was the adoption of the Law of Ukraine “On Higher Education” in 2014 (Pro vyshchu osvitu | vid 01.07.2014 № 1556-VII [About higher education dated 01.07.2014 No. 1556-VII], 2014). This Law removed obstacles to the integration of the Ukrainian system of higher education into the international one. Article 26 of the Law outlines the main tasks of a higher education institution such as:

- to ensure an organic combination of educational, scientific and innovative activities in the educational process;
- to disseminate knowledge among the population, raise the educational and cultural level of citizens;
- to establish international contacts and promote international activities in the fields of education, science, sports, art and culture;

The adoption of the Law of Ukraine “On Higher Education” creates prerequisites for the implementation of RRI principles in scientific and educational activities.

An equally important event that undoubtedly contributes to Ukraine’s integration into the European Research Area was the signing of the Agreement on Participation of Ukraine in Horizon 2020 – EU Framework Program for Research and Innovation.

In accordance with the requirements of the Law of Ukraine “On Higher Education” and the way of the development of higher education in the direction of European integration under the auspices of the Ministry of Education and Science of Ukraine, the “Strategy for the development of higher education in Ukraine for 2021–2031” was adopted in 2020. This Strategy states a stable demand among young people for obtaining a higher education (Pro skhvalennia Stratehii rozvytku vyshchoi osvity v Ukraini na 2022–2032 roky [On the approval of the Strategy for the Development of Higher Education in Ukraine for 2022–2032], 2022). Higher education in Ukraine has a mass

character, the level of higher education coverage of the population of traditional official schooling age is high – 82.7 %, according to this indicator, Ukraine occupied the 14th place out of 131 countries in the Global Innovation Index of 2020.

The entrant prefers to receive a complete secondary education, which allows them to obtain a higher education (bachelor's degree and then a master's degree) in a wider range of specialties. The trend that has developed opens up opportunities for active cooperation of higher education institutions with institutions of secondary and secondary vocational education regarding early career guidance and motivation of schoolchildren.

Analysis of the distribution of entrants by specialty indicates the lack of demand for higher education in natural and technical (except for computer sciences) specialties. According to the indicator of the number of graduates in the field of natural sciences and technology (a component of the Global Innovation Index) in 2020, Ukraine ranked 35th (25.3 % of all graduates of higher education). Such distribution contradicts the prospective needs of the innovative development of the country.

The low level of interest in natural sciences among young people is due to several groups of problems that are interconnected and reinforce each other:

- low intensity of cooperation of higher education institutions with business, local self-government bodies, united territorial communities as consumers of educational, scientific and technical services;
- low level of interaction of educational and scientific institutions in the implementation of educational, scientific and innovative projects;
- insufficient preparedness of the public to participate in the development of standards and training programs;
- decline in the authority of higher education in society;
- low level of professional orientation of entrants, insufficient cooperation of higher education institutions with institutions of secondary and pre-higher education.
- imbalance of demand for higher education from entrants in terms of specialties and current and prospective needs of the economy and society

In view of the above, the “Strategy for the development of higher education in Ukraine for 2021–2031”, the strategic and operational goals and objectives of the development of higher education in Ukraine until 2031 are directed at

- the development of informational support measures for the popularization of specialties and professions that are in demand among domestic employers and are in acute shortage, but are not in demand on the market of educational services
- facilitating interaction with institutions of secondary, secondary professional and pre-higher education, creation of educational complexes, support of the system of early career guidance for the purpose of selecting motivated individuals.
- introduction of a mechanism for stimulating higher education institutions to provide educational services to adults.
- promoting the concept of “lifelong learning” in society.
- expanding the representation of academic startup clubs, business incubators, university centers in stakeholder partnership programs on international crowd-funding platforms.
- the development of networks of research laboratories and centers in partnership with businesses and commercialization of intellectual property.
- encouraging higher education institutions to hold international educational, scientific and cultural events.

Considering the current situation regarding the low popularity of natural and technical sciences among potential students, it is important to involve the higher education institutions of Ukraine in the popularization of these areas of science.

One of the most important goals of popularizing science is to attract young people to science through an increasing interest in solving scientific problems and methods of scientific knowledge. This is especially true for Ukraine, where there is already a significant gap between the older and younger generations that are represented in science. Consequently, there is the risk of a school dropout for the training of young scholars. Such a depressing situation can eventually lead to a collapse of science in Ukraine. Therefore, popularization of Ukrainian science must build a reliable bridge to scientific research that future generations will conduct.

The current school curriculum is overloaded and does not provide enough interest for children and, accordingly, their comprehensive development. A significant problem, at present, is the lack of prestige of the profession of a teacher and scientist. It should be noted, however, that despite the difficult situation of Ukrainian scientists, there are still positive shifts. The first steps to popularize science are the resources created by Ukrainian scholars such as Science Picnics, Real Science, My Science, and others, which are important in the development of science and industry.

The Faculty of Biology of Ivan Franko National University of Lviv actively participates in such events, in particular, lecturers and PhD students take part in the All-Ukrainian “Days of Science” organized by the non-governmental organization “Scientific Union” and the project “My Science”. Within the framework of this event, there is the Open Doors Day at the Zoological Museum where all interested people can attend lectures and excursions.

However, in practice such measures are not enough for effective popularization of biology as a science in society.

Methods. The Department of Biochemistry of the Faculty of Biology of Ivan Franko National University of Lviv together with other 11 partners implements the project “Responsible research and innovation grounding practices in biosciences (ResBios)” (<https://resbios.eu>) (ResBios, n.d.) that embeds Responsible Research and Innovation practices within four universities and research institutions (“beginners”) in the field of Biosciences in four European countries (Ukraine, Spain, Greece, and Croatia) through the implementation of RRI Grounding Actions to achieve sustainable institutional changes. The project involves 12 partners from 11 European countries: University of Rome Tor Vergata (Italy); AgrobiolInstitute (Bulgaria); Knowledge & Innovation Srls (Italy); Institut de Ciències del Mar, Spanish National Research Council (Spain); Democritus University of Thrace (Greece); European science engagement association – EUSEA (Austria); Faculty of Agriculture Zagreb University (Croatia); Ivan Franko National University of Lviv (Ukraine); University of Aarhus (Denmark); University of Bremen (Germany); University of Gdansk (Poland); University of Primorska (Slovenia). This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 872146.

The project runs for three years (January 2019 – December 2022); it comprises interrelated research and implementation designed to achieve the specific objectives and focuses on biosciences at the crossroads of science and society. It is building upon the European Union project StarBios2, which ran between 2016 and 2020, setting the scene for transformative practices and testing interventions aligned with these new

science policy frameworks. The activities organized in work packages include technical assistance, learning process on RRI-oriented structural change, monitoring and assessment, communication and dissemination of knowledge, and project management. The results of the ResBios activities will be communicated and disseminated through conferences, workshops, YouTube Channel, professional publications and social media. Research news and multimedia will also be published online on the project website, social media and social networks to increase transparency and outreach.

RESULTS AND DISCUSSION

Not only does Ivan Franko National University of Lviv play a role of a knowledge transmitter but also participates in the governance of relations between science and society. Participation in this project, among others, allows popularization of science among schoolchildren and university students.

The work of the Ukrainian team during ResBios implementation was conventionally divided into seven steps. The first step was to collect information about Ivan Franko National University of Lviv framework as a potential implementer of RRI principles. The next step was planning of activities including communication with external and internal stakeholders and devising of tools (workshops, meetings, data sharing, videos etc.) to carry out the activities. The third and fourth steps were connected with in-depth preparation of activities and communication with stakeholders and expected participants, as well as promotion of upcoming events. Preparation and running of activities was the next step of ResBios project. The last two steps deal with dissemination of the project results and ensuring sustainability / long-term impact of the activities and their results. It is a good background for improving the dialogue between science and society.

The Department of Biochemistry of the Faculty of Biology was involved in the implementation of two RRI keys – Education and Ethics/Open Access. The borders between the RRI keys are blurred out, therefore under the realization of activities devoted to Education and Ethics/Open Access significant steps were made in Public Engagement and Open Science.

To achieve the goals, a concept was formed and a number of measures were developed to popularize science and biological professions among citizens and representatives of the academic community. The performed activities were used as tool kits for popularization of biosciences and addressed two targets: informal education of schoolchildren and informal education of undergraduate, graduate and PhD students, as well as young researchers (**see Table**).

The European Commission makes efforts to engage four types of stakeholders (academia, industry, government and civil society) involved in Responsible Research and Innovation practices (Commission Staff Working Document, 2017). RRI practices engage the following internal and external stakeholders: individual researchers, research organizations, research ethics committees, research and innovation users, civil society of different levels with political decision-making powers, professional bodies, legislators, educational organizations, and non-governmental bodies (Stahl, 2013).

Based on this policy and the experience of ResBios partners, a transparent and balanced database of stakeholders was created. A variety of stakeholders were involved and took part in public engagement, event planning, promotion and fulfilment of activities. Categories of stakeholders are presented in the **Figure**.

Roadmap of public engagement activities

	“Developing a workshop on pharmaceutical and house chemicals for schools”	“Experimenting and establishing informal education activities at the Department of Biochemistry”	
The overall objective	To contribute to the development of an RRI mission statement for the Faculty of Biology and other Faculties of Ivan Franko National University. It will improve recognition of the Department of Biochemistry in civil society and promote an achievement of structural change in the interaction of higher education and secondary school.	To improve and harmonize different forms of education (formal and informal) in order to respond to individuals' and organizations' needs initially at the Department of Biochemistry.	
The specific aims	To familiarize schoolchildren and teachers with the chemical properties of pharmaceuticals, household chemistry, cosmetics and their effects on the human and animal body, and environment.	As a tool for public engagement and popularization of Biosciences video Blog “Basic Techniques in Biochemistry and Molecular Biology” was used, as well as presentations on the themes “Stress in uncertainty”, “Biology of viruses. Our friends or enemies” and “Viruses and the immune system of a multicellular organism” and a brochure to accompany the videos.	To enhance the practical skills of students, to expand their scientific outlook and the possibility of realizing themselves as professionals.
Structure of activity	Workshop on pharmaceutical and house chemicals for schools was divided into several parts: 1. Part 1 covered such themes: what are pharmaceuticals and how they work; water pollution with pharmaceuticals; dangerous household chemicals. 2. “Practical group workshop” for pupils and teachers “The culture of the use of pharmaceuticals and household chemistry”. At the meeting, were discussed the ways to reduce chemical exposures at home: opportunities for action. 3. Part 2 of the Workshop was dedicated to the biochemistry of beauty. The science and pseudo-science of beautiful skin 4. Training activities for teachers and students of universities, as to prepare and follow-up the workshop “The culture of the use of pharmaceuticals and household chemistry” in ordinary school classes.	The main part of the video blog is represented by educational videos. Also, the video blog contains popular science videos. A separate section of Video Blog contains recordings of seminars that were held within the framework of ResBios activities.	In the framework of the Summer School for students and PhD Students “Functional foods – new challenges for balanced nutrition and treatment of metabolic disorders” lectures presenting modern knowledge on nutrition, usage of functional foods for correction of pathological changes at the metabolic disorders were delivered. A “Practical group workshop” devoted to analysis of everyday diet of the participants and investigation of the influence of functional foods (yacon and red wine polyphenols) on biochemical parameters in the model of diabetes mellitus and metabolic syndrome was conducted.
Main actors	Pupils, teachers, undergraduate, graduate and PhD students, lecturers, and researchers		Student’s association, undergraduate, graduate and PhD students, lecturers, researchers
Results	Popularization of biological science among citizens. Discussion of the importance of biology for everyday life	Formation of the scientific worldview of future specialists based on appropriate use of scientific achievements	Facilitation of the access of young researchers to biology professions, and promotion of biology awareness culture in the society



Internal and external stakeholders mobilized in ResBios project by the Core Team of the Department of Biochemistry of Ivan Franko National University of Lviv

Universities in Europe tend to be configured by three logics as this relates to research: the first of these, the ivory tower, is grounded in the independence of researchers, who are free to pursue research with the primary goal of producing knowledge that contributes to understanding of the natural and social worlds. In broad terms it can be regarded as 'fundamental' or 'basic' research. Open science seems to align well with this logic. A second logic, the utilitarian university, places emphasis on "useful" knowledge, impact and external partnerships. It can be thought of broadly as "applied research", innovation and research that is aimed at meeting strategic policy challenges. Open science in its fullest sense seems to only partially align with this logic. Open Science also only partially aligns with a third important logic in universities, that of the managed bureaucracy (Owen, 2021).

Ivan Franko National University of Lviv is a classical higher educational institution with powerful scientific schools, old traditions and modern innovation approaches. Its principal aim is to provide high educational and scientific standards, meet cultural and social needs of a person, the society and state in the process of training highly qualified specialists.

IFNUL adheres to the third logic - managed bureaucracy, which looks at how large organizations with layers of management can work efficiently and rationally. The educational and research processes at the University are determined by strictly defined rules and requirements. Scientific research is carried out in accordance with the thematic plan, which is formed for each calendar year in accordance with ongoing projects and grants. That is why Open Science is only partially consistent with logic of managed bureaucracy at the IFNUL. Despite this, university scientists have some experience in conducting scientific popularization events (Scientific picnics, Science days, Open days, etc.) with the participation of Lviv residents and guests of the city. Members of the

Junior Academy of Sciences of Ukraine are involved in the research under the guidance of IFNUL scientists.

Participation in the ResBios project is a good opportunity to improve the communication between the employees of the Department of Biochemistry of Ivan Franko National University of Lviv and society. The main goal of the project is to set in RRI practices within four research performing organizations (mentioned above as “beginners”) in the field of Biosciences. The project is focused on the biosciences sector at the crossroads of science and society. (<https://www.flipsnack.com/resbios/resbios-policy.html>) (“ResBios Policy by Chris Styles – Flipsnack,” n.d.).

The team of the Department of Biochemistry carried out the main activities concerning public engagement in accordance with the RRI key “Education”. In ResBios project, this key encompasses many forms of educational activities, such as: combining formal and informal education at university level, lifelong learning activities, capacity building on RRI for students and researchers, science education in schools carried out by researchers, and establishment of strategic alliance between research organizations and schools (<https://www.flipsnack.com/resbios/resbios-policy.html>) (“ResBios Policy by Chris Styles – Flipsnack,” n.d.). In particular, the team of the Department of Biochemistry performed activities aimed at combining formal and informal education at the university level as well as improving communication between scientists, society and stakeholders.

RRI implementation at universities can significantly influence the training and preparation of the next generation of researchers. Open science offers many educational opportunities, and the team of the Department of Biochemistry has engaged in various learning and training activities (see **Table**). In ResBios project, new initiatives addressing the community were launched: workshop on pharmaceutical and house chemicals for schools, experimenting and establishing informal education activities at the Department of Biochemistry. All initiatives were free, thus empowering citizens to become involved in innovation in biosciences and biotechnology, and contribute to informal and lifelong learning education. Other long-term effects of learning and training activities were cultivation of values of solidarity, a sense of autonomy and shared responsibility essential to communication between public and scientists.

The Covid-19 pandemic became a serious obstacle in realization of activities aimed at improving communication between scientists and society. Quarantine measures made it impossible to conduct “practical group workshop” for pupils and teachers within the framework of workshop on pharmaceutical and house chemicals for schools. As an alternative to the off-line workshop, the team of the Department of Biochemistry held this event using the online platform “Zoom”. Teachers and future teachers (students of Faculty of Biology) actively participated in all parts of the workshop and in discussions of its arrangement in local schools.

Workshop and “practical group workshop” for pupils and teachers “The culture of the use of pharmaceuticals and household chemistry” and training activities for teachers and students of secondary schools were the tools for popularization of biological sciences in society and citizen engagement.

With the participants’ permission, all meetings and discussions, were recorded and posted on YouTube Chanel of the Department of Biochemistry (Department of Biochemistry (Ivan Franko National University), n.d.). Thus, YouTube channel “Кафедра біохімії ЛНУ імені Івана Франка / The Department of Biochemistry IFNUL” became

a powerful tool for public engagement. The creation of a channel and the production of comprehensible videos on biosciences benefitted the science-society relations. It also increased transparency and public awareness of the research and knowledge dissemination activities of the Department of Biochemistry of Ivan Franko National University of Lviv.

The availability of video recordings provided an opportunity of viewing these materials at any convenient time, and accessibility to a wide range of interested people. Eventually, a larger number of participants were attracted than planned in the beginning. Different social media platforms were used to promote the workshop, among them Facebook, Telegram, and the web-site of the Faculty of Biology. The use of social networks made it possible to expand the number of participants and diversify their qualitative composition.

Another reflection on the Covid-19 pandemic is related to the creation of presentations “Stress in uncertainty”, “Biology of viruses. Our friends or enemies” and “Viruses and the immune system of a multicellular organism”. These materials offer understandable explanations to the general public of the nature and consequences of viral infections, the importance of vaccination to maintaining collective immunity. The presentations are an alternative way to realize Open Science principles by the team of the Department of Biochemistry.

During the period of Covid restrictions cancellation, one of the most successful tools for public engagement and promotion of Biology as a science was participation in science promotion activities organized at the city or even country level. For example, the team of the Department of Biochemistry took part in Science Picnics “OpenLab Scientific Festival”. This festival combines the theory and practice in the format of edutainment (learning through play), it is a platform for popularizers of science and their followers, an environment in which scientific phenomena are observable and accessible in daily life.

Another prosperous activity organized by the Department of Biochemistry during ResBios project was the Summer School for students and PhD Students “Functional foods – new challenges for balanced nutrition and the treatment of metabolic disorders”. The aim of the Summer School was an introduction of its participants to the concept of healthy food, an emerging field which connects food sciences to the pharmaceutical sciences. The concepts of nutraceuticals and functional foods was provided, together with some examples of the most widely used foods or food supplements marketed as healthy products. A role of functional foods in the prevention and/or delay of the onset of specific health disorders or disease syndromes was demonstrated and justified. The school was specifically oriented to attract young researchers, who evaluate experimental data obtained from the scientific literature and epidemiological sources as a basis to generate ideas for further research and investigation, critically examine current literature relating to innovation and development as well as marketing of novel functional foods. The participants took part in didactic lectures and discussion sessions, evolved valuable practical skills through a group workshop. Due to Covid-19 pandemic restriction the Summer School lectures and discussion were conducted in on-line mode. The “practical group workshop” was held in the laboratory of the Department of Biochemistry, but the number of participants was limited.

The Annual Summer School became a tool for informal education at universities. It allowed combining theoretical knowledge and practical skills and provided full under-

standing of the basic principles of biology. The rational balance between formal and informal education will ultimately have a positive impact on a person's soft skills and professional flexibility, socio-economic development of the country and democratization of society, and will increase access to education for citizens wishing to study biology. It was postulated that the Summer School should be based on RRI grounding practice and promote sustainability of principles of responsiveness in biosciences.

Response to a crisis situation due to Covid-19 pandemic became the "new normal" reality for educational and research institutions of the whole world. Universities are considering keeping their education activities online in the future, at least partially. Other activities, such as focus groups, multi-stakeholder workshops and other interactive experimental efforts are now conducted via video communication and online in ways that seemingly offer instant and easy access (Braun, Blok, Loeber, & Wunderle, 2020).

Russian invasion into Ukraine is a dreadful challenge for Ukrainian society. The war and associated sanctions impact the global economy via trade disruptions, inflation induced by rapidly increasing energy, food and other commodity prices and turmoil in financial markets. Undoubtedly, war directly affects science and education. In the long-term perspective, the invasion into Ukraine, will have dramatic effect on social stability, in particular it will influence migration patterns. On the one hand, a large-scale emigration of the population leads to skills flow out of the country. On the other hand, it could eventually result in the development of new and innovative solutions to meet the changed local needs, triggering new social learning processes. Consequently, more fundamental transformation of society and facilitation of the design, adoption and diffusion of socially-responsible innovative solutions can be proposed in times of crisis (Ravet *et al.*, 2022). For the local community and relocated persons, research and innovation implemented by the Department of Biochemistry can play a role in diminishing the consequences of the war for society, which are expected to be pronounced.

CONCLUSIONS

Participation in the ResBios project allowed the team of the Department of Biochemistry to develop a number of activities that improve Public Engagement through Open Science. To such activities belong workshop on pharmaceutical and house chemicals for schools and the creation of educational and popular-science videos, as well as the launch of YouTube Chanel of the Department of Biochemistry. Annual Summer School on Nutrition was launched during ResBios. The conducted activities involved a significant number of participants who represent different social and professional groups (individual researchers, research organizations, research ethics committees, research and innovation users, civil society of different levels with political decision-making powers, professional bodies, legislators, educational organizations, and public bodies). Participants' feedback allows to conclude that society is very interested in RRI grounding practices and is ready to support its implementation. The activities conducted by the Department of Biochemistry will be ongoing beyond the ResBios project to shape science, research, and technology development in societally acceptable directions.

COMPLIANCE WITH ETHICAL STANDARDS

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Human Rights: This article does not contain any studies with human subjects performed by the any of the authors.

Animal studies: This article does not contain any studies with animal subjects performed by the any of the authors.

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REFERENCES

- Arnold, E., Boekholt, P., Deiacco, E., McKibbin, S., De la Mothe, J., Simmonds, P., Stroya, J., & Zaman, R. (2003). *Research and innovation governance in eight countries*. Technopolis, Brighton, UK.
[Google Scholar](#)
- Braun, R., Blok, V., Loeber, A., & Wunderle, U. (2020). COVID-19 and the onlineification of research: kick-starting a dialogue on Responsible online Research and Innovation (RoRI). *Journal of Responsible Innovation*, 7(3), 680–688. doi:10.1080/23299460.2020.1789387
[Crossref](#) • [Google Scholar](#)
- Bueno de la Fuente, G. (n.d.). What is Open Science? Introduction. *Foster Open Science*. Retrieved October 9, 2022, from <https://www.fosteropenscience.eu/content/what-open-science-introduction>
[Google Scholar](#)
- Colizzi, V., Mezzana, D., Ovseiko, P. V., Caiati, G., Colonnello, C., Declich, A., ... Montesano, C. (2019). Structural Transformation to Attain Responsible BIOSciences (STARBIOS2): Protocol for a Horizon 2020 Funded European Multicenter Project to Promote Responsible Research and Innovation. *JMIR Research Protocols*, 8(3), e11745. doi:10.2196/11745
[Crossref](#) • [PubMed](#) • [PMC](#) • [Google Scholar](#)
- Commission Staff Working Document. (2017). *Chapter VII Guidelines on Stakeholder Consultation*. Retrieved from <https://ec.europa.eu/info/sites/default/files/better-regulation-guidelines.pdf>
- Department of Biochemistry (Ivan Franko National University). (n.d.). YouTube. Retrieved October 9, 2022, from https://www.youtube.com/channel/UCTEzxtJEIBsAeTpb0jS_K5A/videos (In Ukrainian)
- Horovyi, V. (2021). Analitychniy poglyad. Shliakhy rozvytku ukrainskoi nauky [Analytical view. Ways of development of Ukrainian science]. In *Informational and Analytical Bulletin Based on Operational Information* (Vol. 5). Retrieved from <http://nbuviap.gov.ua/images/nauka/2021/5.pdf> (In Ukrainian)

- HubIT RRI Key Success Indicators. (2022). Online resources. Retrieved October 9, 2022, from <https://www.hubit-project.eu/success-indicators>
- Jakobsen, S. E., Fløysand, A., & Overton, J. (2019). Expanding the field of Responsible Research and Innovation (RRI) – from responsible research to responsible innovation. *European Planning Studies*, 27(12), 2329–2343. doi:10.1080/09654313.2019.1667617
[Crossref](#) • [Google Scholar](#)
- Kinash, I., Andrusiv, U., Golovnia, O., & Popadynets, I. (2019). Aspects of the formation and development of innovation infrastructure in Ukraine. *Management Science Letters*, 9(13), 2403–2414. doi:10.5267/j.msl.2019.7.015
[Crossref](#) • [Google Scholar](#)
- Kwiek, M. (2018). A comparative study of social stratification, work patterns and research productivity. In *Changing European Academics*. London and New York: Routledge. doi:10.4324/9781351182041
[Crossref](#) • [Google Scholar](#)
- Levikov, N., Quacinella, D., & Duca, E. (2020). Embedding RRI in a Higher Education Institution: Lessons learned from Malta. *International Journal of Higher Education Management*, 7(1), 15–28. doi:10.24052/ijhem/v07n01/art-2
[Crossref](#) • [Google Scholar](#)
- Lubberink, R., Blok, V., Ophem, J. van, & Omta, O. (2017). Lessons for responsible innovation in the business context: a systematic literature review of responsible, social and sustainable innovation practices. *Sustainability*, 9(5), 721. doi:10.3390/su9050721
[Crossref](#) • [Google Scholar](#)
- Marris, C., & Rose, N. (2010). Open engagement: exploring public participation in the biosciences. *PLoS Biology*, 8(11), e1000549. doi:10.1371/journal.pbio.1000549
[Crossref](#) • [PubMed](#) • [PMC](#) • [Google Scholar](#)
- Moya nauka – populyaryzatsiya nauky vid ukrayins'kykh vchenykh [My science – popularization of science from Ukrainian scientists]. (n.d.). Online resources. Retrieved October 9, 2022, from <https://my.science.ua> (In Ukrainian)
- O'Grady, M., & Mangina, E. (2022). Adoption of responsible research and innovation in citizen observatories. *Sustainability*, 14(12), 7379. doi:10.3390/su14127379
[Crossref](#) • [Google Scholar](#)
- Owen, R. (2021). *Enabling open science and societal engagement in research*. Publications Office of the European Union. doi:10.2777/057047
[Crossref](#) • [Google Scholar](#)
- Owen, R., Macnaghten, P., & Stilgoe, J. (2012). Responsible research and innovation: from science in society to science for society, with society. *Science and Public Policy*, 39(6), 751–760. doi:10.1093/scipol/scs093
[Crossref](#) • [Google Scholar](#)
- Owen, R., Stilgoe, J., Macnaghten, P., Gorman, M., Fisher, E., & Guston, D. (2013). A framework for responsible innovation. In: R. Owen, J. R. Bessant, & M. Heintz (Eds.). *Responsible innovation: managing the responsible emergence of science and innovation in society* (pp. 27–50). John Wiley. doi:10.1002/9781118551424.ch2
[Crossref](#) • [Google Scholar](#)
- Pro skhvalennia Stratehii rozvytku vyshchoi osvity v Ukraini na 2022–2032 roky [On the approval of the Strategy for the Development of Higher Education in Ukraine for 2022–2032]. (2022). Online resources. Retrieved October 11, 2022, from <https://zakon.rada.gov.ua/laws/show/286-2022-p#Text> (In Ukrainian)
- Pro vyshchu osvitu vid 01.07.2014 № 1556-VII [About higher education dated 01.07.2014 No. 1556-VII]. (2014). Online resources. Retrieved October 9, 2022, from <https://zakon.rada.gov.ua/laws/show/1556-18#Text> (In Ukrainian)
- Ravet, J., Di Girolamo, V., Mitra, A., Peiffer-Smadja, O., Canton, E., & Hobza, A. (2022). *EU Research and innovation and the invasion of Ukraine Main channels of impact*. Publications Office of the European Union. doi:10.2777/54321
[Crossref](#)

- Real Science. (n.d.). YouTube. Retrieved October 9, 2022, from <https://www.youtube.com/channel/UCwqAbelS3bESmgVSrpaUezg/about> (In Ukrainian)
- ResBios. (n.d.). Online resources. Retrieved October 9, 2022, from <https://resbios.eu>
- Resbios policy by Chris Styles – flipsnack. (n.d.). Online resources. Retrieved October 9, 2022, from <https://www.flipsnack.com/resbios/resbios-policy.html>
- Stahl, B. C. (2013). Responsible research and innovation: the role of privacy in an emerging framework. *Science and Public Policy*, 40(6), 708–716. doi:10.1093/scipol/sct067
[Crossref](#) • [Google Scholar](#)
- Stahl, B. C., Akintoye, S., Bitsch, L., Bringedal, B., Eke, D., Farisco, M., ... Ulicane, I. (2021). From Responsible Research and Innovation to responsibility by design. *Journal of Responsible Innovation*, 8(2), 175–198. doi:10.1080/23299460.2021.1955613
[Crossref](#) • [Google Scholar](#)
- Stilgoe, J., Owen, R., & Macnaghten, P. (2013). Developing a framework for responsible innovation. *Research Policy*, 42(9), 1568–1580. doi:10.1016/j.respol.2013.05.008
[Crossref](#) • [Google Scholar](#)
- Tabarés, R., Loeber, A., Nieminen, M., Bernstein, M. J., Griessler, E., Blok, V., ... Frankus, E. (2022). Challenges in the implementation of responsible research and innovation across Horizon 2020. *Journal of Responsible Innovation*. doi:10.1080/23299460.2022.2101211
[Crossref](#) • [Google Scholar](#)
- Tarasenko, N. (2021). Proyekt y z populyaryzatsiyi nauky v Ukrayini [Projects on the popularization of science in Ukraine]. Retrieved October 9, 2022, from http://nbuviap.gov.ua/index.php?option=com_content&view=article&id=5252:proekti-z-populyarizatsiji-nauki-v-ukrajini-3&catid=66&Itemid=377 (In Ukrainian)
- Van Oudheusden, M. (2014). Where are the politics in responsible innovation? European governance, technology assessments, and beyond. *Journal of Responsible Innovation*, 1(1), 67–86. doi:10.1080/23299460.2014.882097
[Crossref](#) • [Google Scholar](#)
- Von Schomberg, R. (2012). Prospects for technology assessment in a framework of responsible research and innovation. In: M. Dusseldorp & R. Beecroft (Eds.). *Technikfolgen abschätzen lehren* (pp. 39–61). VS Verlag für Sozialwissenschaften. doi:10.1007/978-3-531-93468-6_2
[Crossref](#) • [Google Scholar](#)
- Von Schomberg, R. (2013). A vision of responsible research and innovation. In: R. Owen, M. Heintz, & J. Bessant (Eds.). *Responsible innovation: managing the responsible emergence of science and innovation in society* (pp. 51–74). doi.org/10.1002/9781118551424.ch3
[Crossref](#) • [Google Scholar](#)

ВІДКРИТА НАУКА ТА ЗАЛУЧЕННЯ ГРОМАДСЬКОСТІ ДЛЯ ПОШИРЕННЯ ЗДОБУТКІВ НАУК ПРО ЖИТТЯ: УРОКИ ДІЯЛЬНОСТІ ЛЬВІВСЬКОГО НАЦІОНАЛЬНОГО УНІВЕРСИТЕТУ ІМЕНІ ІВАНА ФРАНКА

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Вступ. Діяльність, що забезпечує відповідальність у наукових дослідженнях і впровадження інновацій у біологічних науках (ВДІ) є важливим кроком до порозуміння між суспільством і науковцями. Залучення громадськості як перший ключовий підхід ВДІ можна здійснювати за допомогою відкритої науки. Сприяння взаємодії зі суспільством є важливим аспектом відкритої науки та головним викликом для біологів.

Матеріали та методи. Проєкт “Діяльність, що забезпечує відповідальність у наукових дослідженнях та впровадження інновацій у біологічних науках” (REsponsible research and innovation grounding practices in BIOSciences – ResBios) виконується впродовж 3 років (січень 2019 – грудень 2022) і спрямований на сектор біологічних наук, які є перехрестям зв’язків між наукою та суспільством. ResBios є продовженням проєкту StarBios2, що виконувався за фінансової підтримки Європейської Унії впродовж 2016–2020 років і створив підґрунтя для впровадження практики змін і поширення цієї діяльності у поєднанні з новими підходами щодо стратегічних цілей науки.

Результати. Кафедра біохімії ЛНУ імені Івана Франка залучена у виконання проєкту ResBios, метою якого є впровадження практики відповідальних досліджень та інновацій, зокрема, залучення громадськості через відкриту науку. Для популяризації біологічних наук у суспільстві було створено концепцію та проведено низку заходів, серед яких семінар про фармацевтичні препарати та побутову хімію для учнів і вчителів середніх шкіл, щорічна міжнародна Літня школа про функціональні харчові продукти для студентів і аспірантів університетів. Також було створено навчальні та науково-популярні відео й розпочато роботу YouTube каналу кафедри біохімії.

Висновки. Участь у проєкті ResBios дала змогу реалізувати залучення громадськості через відкриту науку до освітніх заходів, організованих представниками кафедри біохімії. Беручи до уваги реакцію учасників цих заходів, було зроблено висновки про довготривалий вплив цих заходів на комунікацію між біологами та представниками громадськості в Україні та за кордоном.

Ключові слова: відповідальні дослідження та інновації, відкрита наука, залучення громадськості, ResBios