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BIOTECHNOLOGY TERMINOLOGY IN KAZAKH: HISTORICAL STRATA, EDUCATIONAL USE AND STANDARDIZATION ISSUES

Abstract. This article examines the formation and contemporary use of Kazakh biotechnology terminology in educational and scientific contexts through historical-lexicographic, comparative and frequency analysis. The study aims to identify the stages at which biotechnology terms became established in Kazakh scientific language, describe the composition of the terminology used in teaching materials, and propose approaches to standardizing variant terms and definitions. The research draws on records of subject-specific terminology from the Alash period, biological and medical terminographic materials, fourteen biotechnology textbooks and teaching resources, a trilingual terminological dictionary containing 485 entries, and subject-specific terminology resources. The compiled corpus register contains 1,422 term records and 115 abbreviation records, yielding 1,537 source-level records. Of the terms identified, 206 occur in at least two sources; including abbreviations, the number of recurrent units is 237. Frequency analysis identifies vector, clone, gene, genome, hybridoma, in vitro, in vivo, biotransformation, cloning, mutation and plasmid as core terms. The analysis also reveals competing forms, including клетка/жасуша/торша ‘cell’, ұлпа/тін ‘tissue’, ақуыз/нәруыз ‘protein’ and гибрид/будан ‘hybrid’, alongside inconsistencies in definitions. The findings indicate a need for concept-oriented organization of Kazakh biotechnology terminology, consistent coordination of term definition abbreviation trilingual-equivalent relationships, and the development of a specialized electronic termbase.

Keywords: biotechnology terminology, Kazakh scientific language, term formation, terminography, frequency analysis, terminological variation, standardization.

Introduction

Biotechnology is a rapidly developing field at the intersection of biology, genetics, microbiology, medicine, agriculture, ecology and engineering. Its conceptual apparatus is continually extended by new technologies and research methods. In this context, communicating scientific information accurately in Kazakh involves more than translating a foreign designation: a term’s conceptual boundaries, its systemic relations to other terms, its written form, its abbreviation and its use in educational texts must be coordinated. As a conventional designation in scientific communication, a stable term is an important prerequisite for mutual understanding among specialists, continuity across textbooks and the consistent transmission of knowledge. Kazakh terminology studies have long addressed the use of the national language’s internal resources, the adoption of loan terms, calquing, the application of word-formation processes and the treatment of terms as elements of a system [1].

The formation of subject-specific terminology in Kazakh scientific language cannot be considered independently of historical experience. When developing subject-specific vocabulary in the early twentieth century, Alash intellectuals sought to name new scientific concepts through the lexical and word-formational resources of Kazakh. This process combined the creation of native designations with the adoption of international terms adapted to the language’s conventions. This approach to term formation remained relevant in subsequent periods. K. Zhubanov’s reflections on scientific language, A. Kaidar’s account of the relationship between terminology and the mechanisms of national-language development, and Sh. Kurmanbayuly’s systematization of the sources of terminological enrichment and methods of term formation provide a theoretical foundation for evaluating contemporary subject-specific terminology [2].

International terminology studies likewise tend to treat a term not as an isolated word but as an element of a particular conceptual system. ISO 704:2022 [3] and ISO 1087:2019 [4] recommend

clarifying the relationship between object, concept, definition and designation, organizing the relations between concepts, and ensuring that designations are unambiguous and suitable for use. The work of J. Sager [5] and M.T. Cabré [6]. demonstrates the interrelationship between terminology, scientific communication, specialized texts and the organization of professional knowledge. These principles are particularly relevant to biotechnology, a field characterized by closely interconnected concepts and a substantial proportion of international terms.

Specialized glossaries and multilingual dictionaries are among the principal resources used in international biotechnology terminology. The OECD framework for biotechnology statistics emphasizes consistent interpretation of the field's key concepts [7]. The FAO biotechnology glossary systematizes the meanings of terms used in food and agriculture [8]. Studies of the structural and derivational characteristics of English biotechnology terminology likewise show that the terminology constitutes a complex and continuously evolving system [9]. Although the number of biotechnology textbooks and teaching resources in Kazakh has increased, work on compiling their terminology into a single corpus, comparing recurrent and competing terms, and examining the consistency of definitions has not yet been sufficiently systematized.

Accordingly, this study aims to identify the historical strata of Kazakh biotechnology terminology, establish patterns of term frequency and variation in teaching materials, and propose linguistic approaches to standardization. The following objectives were set: (1) to describe the continuity between early biological, medical and botanical designations and the terminology underlying biotechnology; (2) to determine the quantitative composition of terms and abbreviations in contemporary teaching materials; (3) to identify a recurrent terminological core; (4) to examine competing terms and inconsistencies in definitions; and (5) to formulate principles of concept-oriented standardization.

Materials and Methods

The research materials were compiled from several groups of sources. The first comprised materials documenting early twentieth-century subject-specific vocabulary and historical practices in Kazakh terminology. Terminological resources concerning Pän sözderi ('Subject Terms'), biological and medical designations of the Alash period, and the term-formation practices of Kh. Dosmukhameduly and Zh. Kuderiuly were used for this purpose [10]. The second group consisted of Soviet-era and post-independence educational publications on biology and biotechnology. The principal corpus included works by Kh. A. Aubakirov [11], S.Q. Turasheva [12], S. K. Turasheva [13], K.Zh. Syman [14], Zh.O. Otesinov [15], B.K. Zayadan [16], R.U. Beisembaeva [17], B. Begimkulov [18], Zh.Zh. Zhatkanbaev [19], K.Kh. Almagambetov [20], G.O. Bayadilova [21] and B.A. Zhumabaeva [22], together with the teaching resource by B.Sh. Kedelbaev [23]. The third group comprised a trilingual dictionary of genetics, biotechnology and molecular biology and the State Terminology Commission's database of approved terms [24].

In compiling the register from the teaching-material corpus, designations presented as individual entries in glossaries, reference sections or thematic term lists were counted. When the same term occurred in several publications, its record in each source was counted separately. Across the fourteen sources, this procedure yielded 1,422 term records and 115 abbreviation records, amounting to 1,537 source-level records. The compiled trilingual list contained 485 terminological units. Terms occurring in at least two sources were grouped separately and their frequencies were calculated. This procedure made it possible to assess a term's stability across educational publications rather than its incidental occurrence in a single text.

The study employed historical-comparative and descriptive methods, lexicographic comparison, content analysis and frequency analysis. The historical-comparative method was used to examine continuity between earlier designations and contemporary biotechnological concepts. Lexicographic comparison focused on Kazakh, Russian and international forms of terms, as well as substantive differences between definitions. Frequency analysis was used to make a provisional distinction between the terminological core and the periphery on the basis of recurrence. In assessing variation, the analysis also considered conceptual accuracy, conciseness, conformity with

linguistic norms, stability across sources and suitability for professional use [25]. These criteria are consistent with the principles of systematicity and concept-oriented description in general terminology studies (Table 1).

Table 1 – Historical strata in the formation of Kazakh biotechnology terminology

Stratum	**Principal source / period**	**Examples of terms**	**Connection with contemporary biotechnology**
I	Alash period; subject-specific vocabulary	ұлпа, тұқым, ұрық, микроб, белок, ядро, гибрид	Cell and tissue biotechnology; genetics; microbiology
II	Soviet period; biological and medical dictionaries	жасуша/торша, ұлпа/тін, ақуыз, будан, фермент, микроағза	Basic scientific concepts underlying biotechnology
III	Post-independence period; textbooks and glossaries	вектор, клон, геном, гибридома, плазмида, in vitro, ПТР	Molecular, cellular, medical and environmental biotechnology

Note: compiled from the research materials [6–22].

Results and Discussion

Three principal strata become apparent when the current composition of Kazakh biotechnology terminology is examined in terms of historical continuity. The first consists of the national system of scientific designations developed in the early twentieth century. Although the term biotechnology in its present-day sense did not appear in the subject-term collections of the 1920s and 1930s, many designations that would later become fundamental to the field were beginning to take root. Native units such as *ұлпа* ‘tissue’, *тұқым* ‘seed’, *ұрық* ‘embryo’, *мүше* ‘organ’ and *жұқпа* ‘infection’, together with international or borrowed forms such as *микроб* ‘microbe’, *белок* ‘protein’, *ядро* ‘nucleus’ and *гибрид* ‘hybrid’, formed the initial stock of scientific vocabulary. Kh. Dosmukhameduly’s terminology in natural history, zoology and medicine strengthened the practice of expressing such concepts as living organism, tissue, blood, gland, embryo and seed in Kazakh. Zh. Kuderiuly’s botanical terminology demonstrated the language’s analytical and derivational resources [25].

The relevance of this historical stratum to contemporary biotechnology is twofold. First, many new technological concepts are designated using established biological base terms. Units such as *жасуша* ‘cell’, *ұлпа* ‘tissue’, *ұрық* ‘embryo’, *тұқым* ‘seed’, *мүше* ‘organ’, *фермент* ‘enzyme’ and *ағза* ‘organism’ have become the head or modifying components of complex terms such as *жасушалық инженерия* ‘cell engineering’, *ұлпа культурасы* ‘tissue culture’, *ұрық культурасы* ‘embryo culture’ and ферменттік технология ‘enzyme technology’. Second, early term-formation practices showed that a new concept need not invariably be borrowed in its foreign form: its semantic motivation can be expressed through the internal resources of the national language. This continuity remains important in contemporary term formation, since biotechnology terminology requires a balance between international forms and Kazakh equivalents.

The second stratum is associated with Soviet-era biological and medical terminography. Specialized dictionaries helped stabilize many basic designations, including *жасуша* ‘cell’, *ұлпа* ‘tissue’, *ақуыз* ‘protein’, *тұқымқуалаушылық* ‘heredity’, *өзгергіштік* ‘variability’, *будан* ‘hybrid’, *мүше* ‘organ’, *жүйе* ‘system’, *фермент* ‘enzyme’ and *вирус* ‘virus’. Nevertheless, two or three forms continued to coexist for some concepts: *клетка-жасуша-торша* ‘cell’, *ткань-ұлпа-тін* ‘tissue’, *белок-ақуыз-нәруыз* ‘protein’, *микроорганизм-микроағза* ‘microorganism’ and *гибрид-будан* ‘hybrid’. This variation arose partly from translation traditions in different historical periods, partly from the influence of Russian models, and partly from subsequent terminological renewal. The materials indicate that the continued use of terminological variants depends not on a dictionary decision alone, but also on their frequency in textbooks, research and professional communication.

The third stratum developed after independence, as biotechnology became established as a distinct academic subject and research field. Terms associated with molecular genetics, cell engineering, immunobiotechnology, environmental biotechnology, and medical and veterinary biotechnology entered active use during this period. Terms such as *вектор* 'vector', *клон* 'clone', *геном* 'genome', *гибридома* 'hybridoma', *плазмида* 'plasmid', *электропорация* 'electroporation', *ген экспрессиясы* 'gene expression', *рекомбинанттық ДНҚ* 'recombinant DNA', in vitro and in vivo became established through international scientific communication. Contemporary biotechnology terminology thus developed into a multilayered system in which native designations, calqued phrases, assimilated loanwords, international Latin-script forms and abbreviations coexist (Table 2).

Table 2 – Term and abbreviation records in textbooks and teaching resources

No.	Source	Terms	Abbreviations	Total
1	Kh. A. Aubakirov. Biotechnology	362	37	399
2	B. Begimkulov. Molecular Genetics and Fundamentals of Biotechnology	175	5	180
3	Zh. Zh. Zhatkanbaev. Biotechnology	156	3	159
4	S. K. Turasheva. Fundamentals of Cell Biotechnology	107	0	107
5	S. K. Turasheva. Cell Biotechnology	107	0	107
6	B. K. Zayadan. Environmental Biotechnology	70	27	97
7	K. Kh. Almagambetov. Fundamentals of Biotechnology	90	2	92
8	Zh. O. Otesinov. Biotechnology and the Environment	80	0	80
9	R. U. Beisembaeva. Medical and Veterinary Biotechnology	68	1	69
10	K. Zh. Syman. Fundamentals of Biotechnology	44	17	61
11	K. Zh. Syman. Objects of Biotechnology	59	1	60
12	B. Sh. Kedelbaev, A. K. Mamyrbekova. Medical and Veterinary Biotechnology	58	2	60
13	G. O. Bayadilova. Technology for Multiplying Virus-Free Potato Seed Material	16	20	36
14	B. A. Zhumabaeva. Fundamentals of Biotechnology: Animal Biotechnology	30	0	30
	Total	1422	115	1537

Note: when the same designation occurred in several sources, its record in each source was counted separately.

The figures in Table 2 indicate that the terminological material is unevenly distributed across educational publications. Kh.A. Aubakirov's textbook Biotechnology contains 399 records, the highest number in the corpus examined [11]. It is followed by B. Begimkulov's work on molecular genetics and biotechnology and Zh.Zh. Zhatkanbaev's teaching resource [19]. These differences depend not only on the length of a publication but also on the author's approach to compiling a glossary, the subject areas covered and whether abbreviations are listed as separate terminological entries. For example, abbreviations account for a larger share of the material in publications with an environmental or molecular focus, whereas some publications on cell biotechnology present terms in their full forms.

The compiled material contains 206 terms occurring in at least two sources. When abbreviations are included, the number of recurrent units rises to 237. This finding indicates that the field has developed a shared terminological core. In frequency terms, *вектор* 'vector' was recorded

twelve times, *клон* ‘clone’ eleven times, *ген* ‘gene’ nine times, and *геном* ‘genome’ and *гибридома* ‘hybridoma’ eight times each. In vitro, in vivo, *биотехнология* ‘biotechnology’, *биотрансформация* ‘biotransformation’, *клондау* ‘cloning’, *мутация* ‘mutation’ and *плазмида* ‘plasmid’ occurred seven times each. *Аллель* ‘allele’, *антидене* ‘antibody’, *биомасса* ‘biomass’, *вируленттік* ‘virulence’, *генотип* ‘genotype’ and *электропорация* ‘electroporation’ each occurred six times. These groups show that concepts from molecular biology, genetics, cell engineering and immunobiotechnology occupy a central position in educational discourse on biотechnology (Figure 1).



Figure 1 – Frequency profile of biotechnology terms in the teaching-material corpus

Frequency does not automatically determine a term’s normative status, but it does help assess the extent to which the term has become established in professional discourse. International terms such as *вектор* ‘vector’, *ген* ‘gene’, *клон* ‘clone’, *геном* ‘genome’ and *плазмида* ‘plasmid’, for example, recur in the same forms across several teaching resources. This indicates a high degree of stability in designation. Where a national equivalent or historical variant coexists with another designation, however, frequency does not demonstrate that one term has completely displaced the other. A term’s definition, subject-specific context and textual function must also be considered.

Comparison of the corpus revealed variation in definitions as well as in designations. Definitions of terms such as *вектор* ‘vector’, *клон* ‘clone’, *ген* ‘gene’, *геном* ‘genome’, *гибридома* ‘hybridoma’, in vitro, in vivo, *биотрансформация* ‘biotransformation’, *клондау* ‘cloning’, *мутация* ‘mutation’ and *плазмида* ‘plasmid’ recur across several publications, yet differ in length, defining characteristic and explanatory approach. One definition may precisely identify the superordinate concept and distinguishing characteristic, another may describe only a function, and a third may emphasize an example or an area of application. In some cases, a definition from one publication reappears in another with only minor editorial changes. Although such recurrence may indicate that a term is established, definitional dependence between sources must also be considered. Terminological evaluation therefore requires comparison of the logical structure of definitions, not merely the designations themselves.

Some competing forms have been inherited from different stages in the history of Kazakh term formation. The series *клетка/жасуша/торша* combines a Russian-mediated international form, an established Kazakh equivalent and an earlier alternative. The pair *ұлпа/тін* is differentiated according to disciplinary traditions in medicine and biology. The use of *ақуыз/нәруыз* is likewise inconsistent across educational publications and scientific texts. In

гибрид/будан, an international designation and a native equivalent function in parallel. Simply eliminating one variant does not resolve the problem. The concept's precise disciplinary boundaries should first be established, after which the preferred designation, an admitted variant and a cross-reference form should be distinguished. This principle should be applied consistently in terminological dictionaries and textbook glossaries alike.

Abbreviations are another important component of biotechnology terminology. Units such as *ДНҚ, РНҚ, ПТР, кДНҚ, АТФ, АУФ, БАЗ, ГМО* and *ИФТ* occur frequently in the materials examined. Some follow international or Russian graphic conventions, whereas others are based on the corresponding full Kazakh designations. Three factors matter in abbreviation standardization: correspondence with the full form, recognition among specialists and intelligibility in international information exchange. Altering an abbreviation established in international scientific texts solely on the basis of translation logic, for example, may hinder information retrieval and identification in databases (Table 3). The domains in which international symbols and national abbreviations are used therefore need to be distinguished functionally.

Table 3 – Main types of variation in biotechnology terminology

Variants	**Type of variation**	**Principal issue**	**Standardization approach**
клетка – жасуша – торша	Historical and translation-related	Several designations for one concept	Establish a preferred term and present other variants as cross-reference forms
ұлпа – тін	Disciplinary differentiation	Different traditions in biology and medicine	Clarify conceptual boundaries by discipline
ақуыз – нәруыз	Competing Kazakh equivalents	Inconsistent use across textbooks	Give priority to one variant within the same educational system
гибрид – будан	International and native equivalents	Variation by genre and discipline	Specify preferred and admitted equivalents
микроорганизм – микроағза	Borrowed and calqued forms	Unequal frequencies of use	Assess corpus frequency together with professional acceptance
АТФ – АУФ	Abbreviation variants	Correspondence with the full term and international usage	Standardize the abbreviation together with its full designation
in vitro – «*жасанды ортада*»	Term and explanatory rendering	Relationship between the translation and the international form	Retain the Latin form and provide a Kazakh explanation in the definition

Terminological consistency concerns not only linguistic preference but also educational quality. When the same concept is given different names in different textbooks, learners may find it more difficult to acquire; when the same term is defined differently, its conceptual boundaries become less clear. Studies of other fields likewise document inconsistent use of approved terms across textbooks, dictionaries and legislative documents. Biotechnology terminology therefore also requires examination of the relationship between approval and actual use. Although the State Terminology Commission's database provides a normative point of reference, it needs to be compared regularly with usage in educational publications [26].

An effective standardization model should proceed from concept to designation. The first step is to establish the concept's content, its generic and specific characteristics, and its relations to adjacent concepts. The second is to collect all Kazakh and international forms designating that concept. The third is to assess their frequency, conformity with linguistic norms, brevity, capacity to generate derived terms and recognition in professional settings. The fourth is to select the preferred designation and present other variants through «see» cross-references. The fifth is to formulate the definition according to a consistent model and link it to Russian and English equivalents and the

international abbreviation. The conceptual systematicity advocated in ISO standards and established practices in terminological data processing may provide guidance in this process [2].

Establishing precise Kazakh-Russian-English equivalence is particularly important in biotechnology. As much of the field's scientific literature is published in English, an inaccurate English equivalent for a Kazakh term can make it difficult for a student or researcher to retrieve the required information from international databases. The 485-entry trilingual dictionary used in this study provides a basis for establishing these links [24]. Trilingual terminology work, however, involves more than placing three designations side by side. The terms in all three languages must designate the same concept, and their grammatical forms and abbreviations must correspond. Where a concept has an established international abbreviation, for example, the full English designation and its abbreviation should be provided, while the Kazakh definition should explain the concept precisely.

The findings support a practical procedure for improving Kazakh biotechnology terminology: develop an electronic corpus that continuously collects terms from specialized textbooks and dictionaries; provide fields for each term's source, frequency, definition, variants, abbreviation and trilingual equivalents; prioritize the evaluation of frequently used core terms; submit competing forms to joint review by a biotechnology specialist and a linguist specializing in terminology; and periodically monitor the use of approved or recommended forms in textbooks. Such a resource would enable terminography to move beyond static dictionary compilation towards a dynamic system of expert assessment.

Terms in the middle of the frequency range also help clarify the field's conceptual structure. Units such as *антиген* 'antigen', *гендер амплификациясы* 'gene amplification', *каллус* 'callus', *эксплант* 'explant', *ген экспрессиясы* 'gene expression', *моноклондық антиденелер* 'monoclonal antibodies', *протопласт* 'protoplast', *транскрипция* 'transcription', *трансляция* 'translation', *трансформация* 'transformation', *фермент* 'enzyme' and *штамм* 'strain' recur in four or five sources and designate particular technological processes and laboratory objects. The occurrence of *андрогенез* in vitro 'in vitro androgenesis', *гендік инженерия* 'genetic engineering', *генетикалық код* 'genetic code', *сомалық будандастыру* 'somatic hybridization', *рекомбинация* 'recombination', *трансдукция* 'transduction', *мутагенез* 'mutagenesis', *репликация* 'replication', *секвенирлеу* 'sequencing' and *рекомбинанттық ДНҚ* 'recombinant DNA' in only two or three publications does not imply that they are unimportant. Rather, their use depends on a publication's specialization: certain terms are prominent in plant biotechnology, while others predominate in medical or molecular biotechnology. Frequency assessment must therefore distinguish between the overall corpus and specialized subcorpora. A term with a low overall frequency may be central to a particular subfield.

Comparison of term definitions also yielded important findings. For example, one publication explains vector as a structure that transfers a foreign gene into a cell, whereas another emphasizes its status as an independently replicating genetic structure. Definitions of gene consistently identify it as a structural and functional unit of hereditary information, although some also specify that it is a particular segment of DNA. Genome is described in one source as a cell's genetic constitution and in another as the complete system of genes in a haploid chromosome set. Definitions of in vitro and in vivo retain the basic contrast between «in glass/in an artificial environment» and «in a living organism», but explanations at the level of plants, animals or cells vary. Such differences should not immediately be treated as errors: some clarify different aspects of the concept. In educational terminography, however, it is useful to maintain a consistent definitional core and add disciplinary characteristics as supplementary information.

Assessment of a term's quality in educational publications should also consider its word-formational potential in context. A base designation that readily supports derived and multiword terms is more likely to become established within a terminological system. For example, *ген* 'gene' underlies a whole conceptual series, including *гендік инженерия* 'genetic engineering', *ген экспрессиясы* 'gene expression', *генетикалық код* 'genetic code' and *гендер амплификациясы* 'gene amplification'. *Жасуша* 'cell' similarly supports the systematic formation of *жасушалық инженерия* 'cell engineering', *жасуша культурасы* 'cell culture' and *жасушалық*

биотехнология ‘cell biotechnology’. Competing forms do not necessarily display equal derivational productivity. Standardization should therefore assess not only whether a word is «Kazakh» or international, but also its capacity to form a terminological family, its stability in naming related concepts and its grammatical adaptability within a sentence. This requirement is consistent with the effective use of Kazakh’s internal term-formation resources [27].

From the perspective of trilingual terminography, mechanically matching a Kazakh designation with a Russian or English term is insufficient. A single designation in one language may correspond to several semantic distinctions in another, or, conversely, several designations may correspond to one international term. Assigning each term a concept identifier, treating its definition as the principal criterion and linking equivalents to that concept is therefore a sound approach. The trilingual list of 485 entries examined here could serve as an initial basis for such a database [28]. Adding textbook frequency, approval status, source, variants, abbreviations and domain of use would transform the dictionary from a translation aid into a full terminological knowledge base. International glossaries and terminological standards likewise prioritize conceptual relationships [29].

These results also have direct implications for teaching and learning. When students first encounter a biotechnological concept and find *жасуша* in one textbook, *клетка* in another and *торша* in a third, the issue extends beyond recognizing synonyms: they must distinguish the primary designation used in academic writing from historical or disciplinary variants. University textbook glossaries should therefore be designed not as simple word lists, but as small-scale models of a subject’s conceptual map. Providing each principal term with a concise normative definition, Russian and English equivalents, an international abbreviation and, where necessary, a variant and a «see» cross-reference would support the systematic development of students’ terminological competence. This approach would facilitate precise term use in scientific writing, translation, database searches and professional communication.

Conclusion

The study shows that Kazakh biotechnology terminology is a multilayered system shaped by both historical continuity and international scientific influence. Its earliest stratum originates in early twentieth-century subject-specific vocabulary and national designations developed in biology, medicine and botany. The second consists of basic terms stabilized through Soviet-era specialized dictionaries. The third encompasses international and new technological designations that developed after independence as biotechnology became a distinct scientific and educational field. These three strata coexist in the current terminology, sometimes complementing one another and sometimes generating competing forms.

Quantitative analysis of fourteen educational sources identified 1,422 term records and 115 abbreviation records, yielding 1,537 records in total. The presence of 206 terms occurring in at least two sources, or 237 recurrent units when abbreviations are included, demonstrates the emergence of a shared terminological core. The high frequencies of vector, clone, gene, genome, hybridoma, in vitro, in vivo, mutation and plasmid indicate that contemporary educational discourse is oriented towards molecular genetics. At the same time, series such as *клетка/жасуша/торша* ‘cell’, *ұлпа/тін* ‘tissue’, *ақуыз/нәруыз* ‘protein’ and *гибрид/будан* ‘hybrid’ show that terminological variation remains a significant issue.

The principal conclusion is that standardizing biotechnology terminology should begin with the organization of conceptual systems rather than the isolated selection of designations. Discrepancies between textbooks and dictionaries can be reduced only when a term, its definition, its abbreviation and its trilingual equivalents are linked within a single record. Future research should develop an expanded electronic corpus that includes scientific articles, dissertations, patents and industrial documentation alongside educational publications, automatically calculate frequencies of actual term use, and compare the results with specialists’ assessments. In practical terms, this work would improve the quality of Kazakh biotechnology terminology, promote consistency in educational texts and support the national scientific language’s participation in international communication.

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ҚАЗАҚ ТІЛІНДЕГІ БИОТЕХНОЛОГИЯ ТЕРМИНОЛОГИЯСЫ: ТАРИХИ ҚАБАТТАРЫ, ОҚУ-ӘДІСТЕМЕЛІК ҚОЛДАНЫСЫ ЖӘНЕ БІРІЗДЕНДІРУ МӘСЕЛЕЛЕРІ

Аңдатпа. Мақалада қазақ тіліндегі биотехнология терминологиясының қалыптасу арналары мен қазіргі оқу-ғылыми қолданысы тарихи-лексикографиялық, салыстырмалы және жиілік талдау негізінде қарастырылады. Зерттеудің мақсаты – биотехнологиялық атаулардың қазақ ғылыми тілінде орнығу кезеңдерін айқындау, оқу-әдістемелік әдебиеттердегі терминдік қордың құрылымын сипаттау және жарыспалы атаулар мен анықтамаларды біріздендірудің негізгі бағыттарын ұсыну. Зерттеу материалы ретінде Алаш кезеңіндегі пән сөздері жөніндегі деректер, биология мен медицина терминографиясының материалдары, биотехнология саласындағы 14 оқу-әдістемелік еңбек, 485 бірлікті қамтитын үштілді терминологиялық сөздік және салалық терминологиялық ресурстар пайдаланылды. Корпустық тіркелімде 1422 термин мен 115 қысқарту, барлығы 1537 қолданыс белгіленді. Кемінде екі дереккөзде қайталанған терминдер саны 206, қысқартуларды қоса есептегенде 237 бірлікті құрады. Жиілік талдауында вектор, клон, ген, геном, гибридома, in vitro, in vivo, биотрансформация, клондау, мутация және плазмида тәрізді атаулардың терминологиялық өзек құрайтыны анықталды. Сонымен бірге клетка/жасуша/торша, ұлпа/тін, ақуыз/нәруыз, гибрид/будан тәрізді жарыспалы нұсқалар мен анықтамалардың әркелкілігі байқалды. Зерттеу нәтижелері қазақ тіліндегі биотехнология терминдерін ұғымға негізделген қағидамен жүйелеу, атау–анықтама–қысқарту–үштілді балама байланысын біріздендіру және салалық электрондық терминқор қалыптастыру қажеттігін көрсетеді.

Тірек сөздер: биотехнология терминологиясы, қазақ ғылыми тілі, терминжасам, терминография, жиілік талдауы, жарыспалы термин, біріздендіру.

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БИОТЕХНОЛОГИЧЕСКАЯ ТЕРМИНОЛОГИЯ КАЗАХСКОГО ЯЗЫКА: ИСТОРИЧЕСКИЕ ПЛАСТЫ, УЧЕБНО-МЕТОДИЧЕСКОЕ ИСПОЛЬЗОВАНИЕ И ПРОБЛЕМЫ УНИФИКАЦИИ

Аннотация. В статье рассматриваются пути формирования и современное учебно-научное функционирование казахской биотехнологической терминологии на основе историко-лексикографического, сравнительного и частотного анализа. Цель исследования – определить этапы закрепления биотехнологических наименований в казахском научном языке, описать структуру терминологического фонда в учебно-методической литературе и предложить основные направления унификации вариантных наименований и дефиниций. Материал исследования составили сведения о предметной лексике периода Алаш, материалы биологической и медицинской терминографии, 14 учебно-методических изданий по биотехнологии, трехъязычный терминологический словарь, включающий 485 единиц, а также отраслевые терминологические ресурсы. В корпусе зафиксировано 1422 термина и 115 сокращений, всего 1537 регистраций. Число терминов, повторяющихся минимум в двух источниках, составило 206, а вместе с сокращениями – 237 единиц. Частотный анализ показал, что термины вектор, клон, ген, геном, гибридома, in vitro, in vivo, биотрансформация, клонирование, мутация и плазмида образуют ядро исследованного терминологического массива. Одновременно выявлена вариативность единиц клетка/жасуша/торша, ұлпа/тін, ақуыз/нәруыз, гибрид/будан, а также неоднородность ряда дефиниций. Полученные результаты обосновывают необходимость понятийно ориентированной унификации терминов, согласования связей «наименование – дефиниция – сокращение – трехъязычный эквивалент» и создания специализированного электронного терминологического ресурса.

Ключевые слова: биотехнологическая терминология, казахский научный язык, терминообразование, терминография, частотный анализ, вариантный термин, унификация.

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HYBRID TERMS IN KAZAKH: THEORETICAL FOUNDATIONS AND CRITERIA FOR CLASSIFICATION

Abstract. The article examines the theoretical foundations of hybrid terms in Kazakh and the criteria needed to distinguish them from borrowed terms and morphologically adapted loanwords. The study aims to clarify the relationship between etymological heterogeneity, word formation, and specialised naming, while retaining the distinction between the Kazakh designations будан and гибрид. A critical narrative review is combined with comparative and structural-semantic analysis of theoretical accounts and illustrative examples from Kazakh and other linguistic traditions. The comparison identifies three recurrent sources of disagreement: the treatment of borrowed bases with native affixes, the classification of formations imported as complete lexical units, and the relationship between morphological structure and terminological function. English, German, French, Turkish, and Russian approaches are considered alongside the development of Kazakh terminology studies. The analysis supports a recipient-language perspective in which component origin, formation history, structural pattern, degree of integration, and specialised function are recorded separately. On this basis, a working classification distinguishes recipient-language hybrid formations, borrowed terms of hybrid origin, and a boundary class of derivatives based on loans. The historical discussion connects these distinctions with changing practices of translation and adaptation in Kazakh. The proposed framework provides a basis for consistent terminographic description; it is an analytical proposal rather than an empirically validated classification or a new estimate of hybrid-term frequency.

Keywords: hybrid term; lexical hybridisation; Kazakh terminology; borrowing; morphological adaptation; word formation; terminography.

Introduction

The concept of a hybrid term occupies an intermediate position between borrowing, translation, and word formation. In Kazakh terminology studies, it is commonly applied to designations that combine a borrowed component with a Kazakh element. However, this apparently straightforward definition conceals several different objects: a newly formed compound, a partially translated foreign designation, a derivative built on a borrowed base, or a term already composed of elements from different languages before entering Kazakh. Kurmanbayuly's discussion of the