Supplementary A: Rational process for the sample of pharmacy programs

Selection criteria and sample rationale

The sample was defined according to a purposive sampling strategy, appropriate to the exploratory and qualitative nature of the study. Ten undergraduate Pharmacy courses were selected, distributed to represent the five macro-regions of Brazil (North, Northeast, Midwest, Southeast, and South), with two institutions per region—one public and one private.

This distribution aims to reflect the socioeconomic, cultural, and institutional heterogeneity of the Brazilian higher education system, ensuring a diverse overview of curricular and pedagogical practices.

The choice of a small, intentional sample (n=10) is justified by the emphasis on in-depth documentary analysis and comparative interpretation between different educational contexts. The objective is not statistical generalization, but rather the identification of patterns, gaps, and good curricular practices related to the incorporation of technological and digital innovation in Pharmacy courses.

Theoretical and Methodological Justification

The choice of an intentional and comparative sampling design is based on two central premises:

• The continental nature of Brazil, with heterogeneous socioeconomic and educational realities, imposes the need to observe regional trends and institutional differences;

• Higher education institutions with better academic performance can more clearly reflect trends in curricular innovation and the degree of alignment of pharmaceutical training with emerging technological skills, allowing for discussion of the extent to which the educational field is keeping pace with the transformations of the Digital Revolution in the pharmaceutical sector.

This approach makes it possible to construct analytical inferences, pointing out both advances and gaps in the process of incorporating technological and digital innovation into Brazilian pharmaceutical education.

Procedure for searching and identifying HEIs

The document selection and sample definition process was structured in five main stages:

a) Stage 1 – National survey:

An initial mapping of all Pharmacy courses recognized by the Ministry of Education (MEC) was carried out, based on data from the Anísio Teixeira National Institute for Educational Studies and Research (INEP) and the results of the National Higher Education Assessment System (SINAES).

b) Stage 2 – Application of performance criteria:

Priority was given to HEIs that received a score of 4 or 5 in SINAES, both in the Preliminary Course Concept (CPC) and in the most recent General Course Index (IGC) available (base year 2019). This choice is based on the assumption that institutions with better institutional performance tend to demonstrate greater capacity for curriculum updating, especially with regard to the "Technology and Innovation in Health" axis provided for in the National Curriculum Guidelines (DCNs) for Pharmacy.

c) Stage 3 – Final selection and regional representation:

After the initial screening, two HEIs per region (one public and one private) were selected according to the above criteria, ensuring the presence of different academic management models and pedagogical infrastructures. This choice also aims to enable comparisons between the public and private contexts, given the influence of institutional and regional factors in the training process.

d) Stage 4 – Obtaining documents:

The PP were obtained from public institutional repositories, official university websites, and, when necessary, through direct requests to course coordinators.

e) Step 5 – Screening and validation:

PP that were incomplete or unclear about curricular structures and educational competencies were excluded. In the end, a final sample of 10 valid PP was used for analysis.

Supplemantary B: Protocol for evaluating the alignment of Pharmacy Undergraduate Educational Projects in light of the challenges posed by the Fourth Industrial Revolution

University				
Date of reading and analysis of the PPC:				
Percentage of workload for the technology and innovation learning axis:				
General conceptual approaches related to technology, innovation, and entrepreneurship	Strong evidence	No evidence	Partial evidence	Observations
Course concepts and definitions				
Competencies and skills				
Course profile				
Course objectives				
Professional profile (of graduates)				
Pedagogical approaches and practices related to technology, innovation, and entrepreneurship connected to 4IR*	Strong evidence	No evidence	Partial evidence	Observations
Interdisciplinary approach: the curriculum promotes collaboration between different disciplines, encouraging interaction between areas of knowledge to deal with complex problems.				
Critical thinking and problem-solving skills: the curriculum encourages the development of analytical skills, critical thinking, and problem-solving, allowing students to adapt to constantly changing scenarios				
Active and practical learning: the curriculum includes practical learning approaches, such as projects, internships, simulations, and laboratory experiences, which allow students to apply concepts in real-life situations				
Development of social and emotional skills: the curriculum includes the development of skills such as effective communication, teamwork, empathy, and resilience, which are increasingly valued in today's professional environment.				
Emphasis on lifelong learning: the curriculum promotes a culture of continuous learning, encouraging students to stay up to date with rapid technological changes.				
Innovation and entrepreneurship: the curriculum addresses concepts of innovation, entrepreneurship, and value creation, preparing students to identify opportunities and create innovative solutions.				
Startups: Does the curriculum expose students to startup events and programs?				
Market and industry connections: The curriculum maintains ties with the pharmaceutical and health innovation industries and professionals active in the field, allowing students to be aware of current demands and trends.				
Flexibility and personalization: Does the curriculum offer flexibility so that students can tailor their studies to their own areas of interest and goals?				
Final Course Projects: the curriculum allows for the presentation of Business Plans and/or Business Models				
Mentoring: faculty members offer mentoring for business modeling				
Innovation and entrepreneurship events: participation in these types of events is encouraged				
ST&I structures related to 4IR technologies	Strong evidence	No evidence	Partial evidence	Observations
Integration of emerging technologies: the curriculum incorporates artificial intelligence, machine learning, automation, the Internet of Things, and virtual/augmented reality.				
Laboratory infrastructure: the course offers innovation laboratories				
Promotion of Research, Development, and Innovation (RD&I)				
Incorporation of innovative technologies into professional practices				

* The term “Strong Evidence” was used to indicate that the situation, condition, or criterion described was fully present or completely applicable to the context under analysis. In other words, all relevant aspects are clearly identified and pertinent to the object of study or the situation observed. The term “No evidence” was used to indicate the absence of any concrete data or information that could confirm the existence or applicability of a particular condition, phenomenon, or criterion in the context analyzed. In other words, no elements were found to support the hypothesis or statement. The term “partial evidence” was used when there was evidence or information that partially supported the existence or applicability of a particular condition, phenomenon, or criterion. However, this evidence is not sufficient or conclusive to fully confirm the hypothesis or statement, leaving room for uncertainty or the need for further investigation.

Supplemantary C: Thematic summary of the main references on pharmaceutical education and transformations associated with the Fourth Industrial Revolution (4IR)

Thematic Area Subtopics	Approach	Key References	Main Focus
Disruptive innovation and educational transformation	Theoretical foundations of disruptive innovation applied to pharmaceutical training	Christensen et al. (2009); Alsharif (2019); Maine (2019); Nouri et al. (2020)	Analyzes how disruptive innovations transform pharmaceutical education and practice, demanding new pedagogical and professional models.
Active methodologies, creativity, and curricular innovation	Innovative curricula and integration of digital technologies	Cain (2019); Friebe (2020); Nouri et.al. (2020)	Explores active teaching methods and creative learning (e.g., TED Talks, problem-based learning) focused on pharmaceutical education in the digital age.
Emerging technologies and the Digital Revolution (4IR)	Integration of AI, IoT, nanotechnology, big data, and automation into pharmaceutical curricula and practices	Baines et al. (2020)	Discusses the impact of emerging technologies on pharmacy practice and education, emphasizing the need for new digital skills.
Proposals for curricular reform and modernization	Reformulation of training programs with a focus on technology, innovation, and digital skills	Nouri, Hassali & Hashmi (2020)	Presents the TARGET model as a strategy for curriculum restructuring and adaptation of pharmaceutical education to the demands of the 4IR.
Lifelong learning and professional development	Continuing education and adaptation of pharmacists to new technologies and emerging practices	FIP (2020); Jin HK, Kim E, 2024	Highlights the importance of continuing education and lifelong learning as a response to digital transformations in the sector.

Supplementary D: Application of Protocols and Analysis of Course Pedagogical Projects (PPC) and example Excerpts

The analyses resulted in the development of a general table, in which four (04) broad themes (questions) related to the Fourth Industrial Revolution (4IR) were broken down into analytical categories. For each category, the PPCs were classified according to three levels of evidence — strong evidence (SE), partial evidence (PE), or no evidence (NE) — accompanied by excerpts or elements extracted from the documents themselves to justify this classification. This general table served as the analytical basis for constructing the synthesis presented in the tables included in the main body of the article.

Question 01:

Evidence on general conceptual approaches related to technology, innovation, and entrepreneurship recorded in the PPCs		
Analytical Categories – Course 01	Evidence	Excerpt from the PPC
Concepts and Definitions of the Course	PE	"The course proposal aims to provide a generalist pharmaceutical education, focused on the three main axes proposed by the Curriculum Guidelines for Pharmacy Courses: Health Care, Health Technology and Innovation, and Health Management, permeated by the development of decision-making skills and the ability to provide appropriate attention to the health of the population in which it is embedded, with the capacity to transform it. In order to fulfil this primary objective, efforts are directed towards training ethical professionals, capable of making decisions, who learn to learn continuously, and who are able to lead and communicate with respect for diversity, confidentiality, and attitudinal accessibility."
Competencies and Skills	SE	"The implementation of the Health Technology and Innovation axis requires competencies that include: I - To research, develop, innovate, produce, control and ensure the quality of: a) drugs, medicines and inputs; b) biopharmaceuticals, biomedicines, blood components, blood derivatives, and biotechnological and biological products; immunobiologicals and other products; c) chemical and biochemical reagents and other products for diagnostic purposes; d) foods, parenteral and enteral preparations, dietary and nutritional supplements; e) cosmetics, sanitisers and household sanitation products; f) other health-related products. II - To research, develop, innovate, regulate, manage and ensure the quality of process and service technologies directed towards the health field (...)"
Course Profile	SE	"In the Health Technology and Innovation axis, knowledge is developed and applied in research, development, production, quality, and the provision of goods and services. Furthermore, these are applied to solve technological problems, encompassing the introduction or improvement of processes, products, strategies, or services, with a positive impact on individual and collective health (health innovation), in accordance with Resolution CNE/CES No. 6, of 19 October 2017. Within this axis, the pharmacist is integrated across the entire pharmaceutical product chain, from the industrial setting—whether involving medicines, cosmetics, and/or foods—with direct involvement in production activities."
Course Objectives	PE	"The course proposal aims to provide a generalist pharmaceutical education, focused on the three main axes proposed by the Curriculum Guidelines for Pharmacy Courses: Health Care, Health Technology and Innovation, and Health Management, permeated by the development of decision-making skills and the ability to provide appropriate attention to the health of the population in which it is embedded, with the capacity to transform it. In order to fulfil this primary objective, efforts are directed towards training ethical professionals, capable of making decisions, who learn to learn continuously, and who are able to lead and communicate with respect for diversity, confidentiality, and attitudinal accessibility."
Professional Profile (Graduate)	SE	"The graduate of the Pharmacy Course, in accordance with Resolution CNE/CES No. 6 of 19 October 2017, has the following profile: a health professional with training centred on drugs, medicines, and pharmaceutical services, and, in an integrated manner, with training in clinical and toxicological analyses, cosmetics, and foods, aimed at promoting the health care of individuals, families, and communities. A professional with a humanistic, critical, reflective, and generalist education, grounded in ethical and scientific principles, qualified to work at different levels of complexity within the health system, through actions of disease prevention, health promotion, protection, and recovery, as well as in research and the development of services and health-related products."
Analytical Categories – Course 02	Evidence	Excerpt from the PPC

Evidence on general conceptual approaches related to technology, innovation, and entrepreneurship recorded in the PPCs		
Concepts and Definitions of the Course	NE	_
Competencies and Skills	PE	"In the Health Technology and Innovation axis, students are expected to develop competencies related to the research, development, production, and quality assurance of medicines and other related products."
Course Profile	NE	_
Course Objectives	NE	_
Professional Profile (Graduate)	PE	"The Pharmacy Undergraduate Programme has, as the profile of its graduate/professional, the Pharmacist—a health professional with training centred on drugs, medicines, and pharmaceutical services, and, in an integrated manner, with training in clinical and toxicological analyses, cosmetics, and foods, aimed at promoting the health care of individuals, families, and communities."
Analytical Categories – Course 03	Evidence	Excerpt from the PPC
Concepts and Definitions of the Course	NE	_
Competencies and Skills	NE	_
Course Profile	NE	_
Course Objectives	NE	_
Professional Profile (Graduate)	PE	"He/she is a professional with broad scientific knowledge, technical training, and skills for the formulation, promotion, and implementation of health policies, acting as a member of a multiprofessional team at all levels of health care, while respecting current legislation, the ethical principles of the profession, as well as diversity, solidarity, freedom, justice, and democracy. His/her practice is carried out through the exercise of critical thinking and professional judgement; management; data analysis; decision-making and problem-solving; communication; knowledge construction and professional development; and social interaction. He/she must understand the different conceptions of the health–disease process, the psychosocial and ethical principles of human relationships, and the foundations of scientific methods, acting towards the transformation of realities for the benefit of society, with the consequent improvement of the population's quality of life in an ever-changing contemporary world."
Analytical Categories – Course 04	Evidence	Excerpt from the PPC
Concepts and Definitions of the Course	SE	"The project was based on the discussion and approval of health and social principles that guided the development of the curricular organisation and the definition of competencies, content, and strategies for the education of pharmacists. The health and social principles considered in the curricular design are: Health is a right of all and a duty of the State, guaranteed through social and economic policies aimed at reducing the risk of disease and other health conditions, as well as ensuring universal and equitable access to actions and services for its promotion, protection, and recovery (Art. 196, 1988 Constitution). Pharmaceutical sciences and the profession are essential for Brazil's social and economic development and for ensuring national sovereignty in innovation, development, production, and control of drugs, medicines, and diagnostic inputs. The Pharmacy Undergraduate Programme must be aligned with the entire health–disease process of individuals, families, and communities; with the epidemiological, socioeconomic, cultural, and professional reality; ensuring the comprehensiveness of actions in Health Care, Health Technology and Innovation, and Health Management (Art. 6, National Curriculum Guidelines, 2017)."
Competencies and Skills	SE	"To research, develop, innovate, produce, control, and ensure the quality of: Biopharmaceuticals, biomedicines, immunobiologicals, blood components, blood derivatives, and other biological products; Chemical and biochemical reagents and other products for diagnostic purposes; Foods, parenteral and enteral preparations, dietary and nutritional supplements; Cosmetics, sanitisers, and household sanitation products; Other health-related products.

Evidence on general conceptual approaches related to technology, innovation, and entrepreneurship recorded in the PPCs		
		To research, develop, innovate, regulate, manage, and ensure the quality of process technologies in the health field, involving: Technologies related to health processes, practices, and services; Environmental sustainability and risk minimisation; Assessment of the infrastructure required for the adequacy of facilities and equipment."
Course Profile	SE	"The education should be grounded in ethical and scientific principles, enabling the professional to work at different levels of complexity within the health system, through actions of disease prevention, health promotion, protection, and recovery, as well as in research and the development of services and health-related products."
Course Objectives	SE	"The Pharmacy Undergraduate Programme at XXX aims to provide the conditions for the development of competencies, encompassing the knowledge, skills, and attitudes/values necessary to support the training of pharmacists committed to the health of the Brazilian population and to ethical, science-based professional practice, based on a graduate profile structured around the axes of: (i) Health Care; (ii) Health Technology and Innovation; and (iii) Health Management, as established by the National Curriculum Guidelines."
Professional Profile (Graduate)	SE	"The Pharmacy graduate at XXX is a health professional prepared to work in the field of pharmaceutical services, understood as an integrated set of practices and knowledge related to medicines, clinical and toxicological analyses, management, and technological development and production."
Analytical Categories – Course 05	Evidence	Excerpt from the PPC
Concepts and Definitions of the Course	NE	_
Competencies and Skills	NE	_
Course Profile	NE	_
Course Objectives	NE	_
Professional Profile (Graduate)	NE	_
Analytical Categories – Course 06	Evidence	Excerpt from the PPC
Concepts and Definitions of the Course	NE	_
Competencies and Skills	NE	_
Course Profile	NE	_
Course Objectives	NE	_
Professional Profile (Graduate)	NE	_
Analytical Categories – Course 07	Evidence	Excerpt from the PPC
Concepts and Definitions of the Course	SE	"The Pharmacy programme aims to train professionals with a solid scientific and technological background, capable of working in the research, development, production, and control of medicines, health products, and clinical analyses, contributing to scientific and technological advancement and innovation in the pharmaceutical sector."
Competencies and Skills	SE	"To develop, produce, and control medicines, pharmaceutical inputs, and health-related products; To engage in scientific and technological research aimed at the development of new pharmaceutical products and processes; To manage services, production processes, and technologies within the health industrial complex."
Course Profile	SE	"The programme provides a generalist, critical, and reflective education, grounded in scientific and technological knowledge, enabling professionals to work in medicines, clinical analyses, foods, and cosmetics, as well as in research, innovation, and technological development."
Course Objectives	SE	"To train pharmacists capable of working in the research, development, production, and control of medicines and health-related products, contributing to scientific and technological advancement and to the improvement of population health conditions."
Professional Profile (Graduate)	SE	"The graduate should possess a scientific, critical, and technological education that enables them to work in innovation, in the development of pharmaceutical products and processes, in service management, and in industrial production."
Analytical Categories – Course 08	Evidence	Excerpt from the PPC
Concepts and Definitions of the Course	NE	_
Competencies and Skills	PE	"To carry out activities related to the production, quality control, and development of medicines, cosmetics, foods, and health-related products; to participate in scientific and technological

Evidence on general conceptual approaches related to technology, innovation, and entrepreneurship recorded in the PPCs		
		research activities aimed at the development of new products and processes; To act in the management of services and processes related to pharmaceutical services."
Course Profile	NE	_
Course Objectives	NE	_
Professional Profile (Graduate)	PE	"The graduate should possess a generalist, humanistic, critical, and reflective education, with a solid scientific foundation; should be capable of working in the areas of medicines, clinical analyses, foods, and pharmaceutical services; and should be able to carry out activities related to the control, production, and development of pharmaceutical products."
Analytical Categories – Course 09	Evidence	Excerpt from the PPC
Concepts and Definitions of the Course	PE	"The Pharmacy programme seeks to train professionals with a solid scientific and technological foundation, capable of working in different areas of the pharmaceutical sciences, integrating knowledge and responding to contemporary demands in the health sector."
Competencies and Skills	SE	"The Pharmacy programme seeks to train professionals with a solid scientific and technological foundation, capable of working across different areas of the pharmaceutical sciences, integrating knowledge and responding to contemporary demands in the health sector."
Course Profile	NE	_
Course Objectives	PE	"To train pharmacists with a solid scientific, technical, and humanistic education, prepared to work across the various areas of the pharmaceutical sciences.
Professional Profile (Graduate)	PE	The graduate should possess scientific training and critical capacity to operate in the different areas of the pharmaceutical sciences."
Analytical Categories – Course 10	Evidence	Excerpt from the PPC
Concepts and Definitions of the Course	PE	"The Pharmacy programme aims to train professionals with a solid scientific background, capable of working in the research, development, production, and control of medicines and other health-related products."
Competencies and Skills	SE	"To carry out activities in research, development, and innovation of medicines, biotechnological products, and pharmaceutical inputs; to apply scientific and technological knowledge in the production and quality control of pharmaceutical products."
Course Profile	NE	_
Course Objectives	PE	"To train pharmacists with a solid scientific education, capable of working across the various areas of the pharmaceutical sciences and contributing to scientific and technological development."
Professional Profile (Graduate)	PE	"The graduate should possess a strong scientific background and critical capacity to operate in the different areas of the pharmaceutical sciences."

Question 02: Evidence on pedagogical approaches and practices related to technology, innovation, and entrepreneurship connected to the 4IR, as described in the PPCs

Evidence on pedagogical approaches and practices related to technology, innovation, and entrepreneurship connected to the 4IR, as described in the PPCs		
Analytical Categories – Course 01	**Evidence**	**Excerpt from the PPC**
The curriculum promotes collaboration across different disciplines, encouraging interaction between areas of knowledge to address complex problems	PE	Identified approaches: The curricular structure promotes integration among different curricular components, fostering articulation between basic, technological, and applied knowledge.
The curriculum encourages the development of analytical skills, critical thinking, and problem-solving, enabling students to adapt to constantly changing scenarios	PE	Identified approaches: The programme seeks to develop professionals with critical and reflective capacity, capable of making decisions grounded in scientific principles.
The curriculum includes practical learning approaches, such as projects, placements, simulations, and laboratory experiences, enabling students to apply concepts in real-world situations	PE	Identified approaches: The programme includes practical activities and supervised placements that allow students to apply the knowledge acquired in real professional contexts.
The curriculum includes the development of competencies such as effective communication, teamwork, empathy, and resilience, which are increasingly valued in the current professional environment.	PE	Identified approaches: The trained pharmacist is expected to work collaboratively within multiprofessional teams, demonstrating social responsibility and ethical conduct.
The curriculum promotes a culture of continuous learning, encouraging students to remain up to date in the face of rapid technological changes.	PE	Identified approaches: The programme seeks to train professionals committed to continuing education and the ongoing updating of knowledge.

The curriculum addresses concepts of innovation, entrepreneurship, and value creation, preparing students to identify opportunities and develop innovative solutions.	PE	Identified approaches: The pharmacist is expected to be able to work in the management of pharmaceutical services and in the organisation of processes related to health care.
Analytical Categories – Course 02		
The curriculum promotes collaboration across different disciplines, encouraging interaction between areas of knowledge to address complex problems.	PE	Identified approaches: The programme's curricular structure seeks to integrate content from different areas of the pharmaceutical sciences, promoting an interdisciplinary education.
The curriculum encourages the development of analytical skills, critical thinking, and problem-solving, enabling students to adapt to constantly changing scenarios.	PE	Identified approaches: The programme aims to train critical and reflective professionals, capable of analysing health problems and making decisions based on scientific evidence.
The curriculum includes practical learning approaches, such as projects, placements, simulations, and laboratory experiences, enabling students to apply concepts in real-world situations.	PE	Identified approaches: The programme includes practical activities and supervised placements that enable students to apply theoretical knowledge in real professional contexts.
The curriculum includes the development of competencies such as effective communication, teamwork, empathy, and resilience, which are increasingly valued in the current professional environment.	PE	Identified approaches: The pharmacist is expected to work in an integrated manner within multiprofessional teams, demonstrating social responsibility and ethical conduct.
The curriculum promotes a culture of continuous learning, encouraging students to remain up to date in the face of rapid technological changes.	PE	Identified approaches: The graduate is expected to be prepared for lifelong learning and the continuous updating of knowledge throughout their career.
The curriculum addresses concepts of innovation, entrepreneurship, and value creation, preparing students to identify opportunities and develop innovative solutions.	NE	-
Analytical Categories – Course 03	**Evidence**	**Excerpt from the PPC**
The curriculum promotes collaboration across different disciplines, encouraging interaction between areas of knowledge to address complex problems.	PE	The curriculum matrix includes units such as "Interdisciplinary Practices and Teaching–Service–Community Interaction I" and, subsequently, "Teaching–Service–Community Interaction Practices II", which provides partial evidence of articulation between areas and practice settings.
The curriculum encourages the development of analytical skills, critical thinking, and problem-solving, enabling students to adapt to constantly changing scenarios.	PE	There are indirect indications in components such as "Pharmacy, Health and Society", "Reading and Production of Academic Texts", and "Elements of Biostatistics".
The curriculum includes practical learning approaches, such as projects, placements, simulations, and laboratory experiences, enabling students to apply concepts in real-world situations.	PE	The matrix shows the presence of laboratories, experimental techniques, and various supervised placements in pharmacy, pharmaceutical care, hospital pharmacy, clinical analyses, pharmaceutical sciences, and public health.
The curriculum includes the development of competencies such as effective communication, teamwork, empathy, and resilience, which are increasingly valued in the current professional environment.	PE	Teaching–service–community interaction, along with components such as "Pharmacy, Health and Society", suggests the development of communication, teamwork, and social responsibility.
The curriculum promotes a culture of continuous learning, encouraging students to remain up to date in the face of rapid technological changes.	PE	The structure includes elective courses, in addition to complementary academic activities, indicating the expansion of educational pathways.
The curriculum addresses concepts of innovation, entrepreneurship, and value creation, preparing students to identify opportunities and develop innovative solutions.	NE	_
Analytical Categories – Course 04	**Evidence**	**Excerpt from the PPC**
The curriculum promotes collaboration across different disciplines, encouraging interaction between areas of knowledge to address complex problems.	PE	The PPC states that the programme is student-centred, seeking comprehensive education through the articulation of teaching, research, extension, and pharmaceutical services; it also notes that the education encompasses the sciences "in an integrated and interdisciplinary manner."
The curriculum encourages the development of analytical skills, critical thinking, and problem-solving, enabling students to adapt to constantly changing scenarios.	PE	The PPC emphasises the teacher as a facilitator of the teaching–learning process and the centrality of the student, mediated through an active learning approach.
The curriculum includes practical learning approaches, such as projects, placements, simulations, and laboratory experiences, enabling students to apply concepts in real-world situations.	PE	The programme includes mandatory placements in clinical-laboratory analyses and in drugs, medicines, and pharmaceutical services, in addition to extensive curricular integration of extension activities through programmes, projects, courses, and events formally recognised in the academic record.

The curriculum includes the development of competencies such as effective communication, teamwork, empathy, and resilience, which are increasingly valued in the current professional environment.	PE	Comprehensive education, articulation with extension activities, and engagement in community-based educational actions indicate the development of communication and collaboration.
The curriculum promotes a culture of continuous learning, encouraging students to remain up to date in the face of rapid technological changes	PE	The strong presence of curricular extension and complementary activities suggests a culture of lifelong learning.
The curriculum addresses concepts of innovation, entrepreneurship, and value creation, preparing students to identify opportunities and develop innovative solutions.	NE	-
Analytical Categories – Course 05	**Evidence**	**Excerpt from the PPC**
The curriculum promotes collaboration across different disciplines, encouraging interaction between areas of knowledge to address complex problems.	NE	-
The curriculum encourages the development of analytical skills, critical thinking, and problem-solving, enabling students to adapt to constantly changing scenarios.	NE	-
The curriculum includes practical learning approaches, such as projects, placements, simulations, and laboratory experiences, enabling students to apply concepts in real-world situations.	PE	The University Pharmacy is presented as a distinctive practice setting for teaching and learning, integrating theory and professional practice, with services, compounding, and dispensing included in the educational pathway.
The curriculum includes the development of competencies such as effective communication, teamwork, empathy, and resilience, which are increasingly valued in the current professional environment.	PE	Work within multiprofessional teams and integrated actions across levels of health care provide partial evidence for communication and teamwork.
The curriculum promotes a culture of continuous learning, encouraging students to remain up to date in the face of rapid technological changes.	PE	The PPC includes research, extension activities, and active methodologies as part of the training, which may promote continuous updating of knowledge.
The curriculum addresses concepts of innovation, entrepreneurship, and value creation, preparing students to identify opportunities and develop innovative solutions.	NE	-
Analytical Categories – Course 06	**Evidence**	**Excerpt from the PPC**
The curriculum promotes collaboration across different disciplines, encouraging interaction between areas of knowledge to address complex problems.	PE	The PPC explicitly states a “systemic, interdisciplinary, and interprofessional view of care and the management of health products and technologies”, which supports the evidence.
The curriculum encourages the development of analytical skills, critical thinking, and problem-solving, enabling students to adapt to constantly changing scenarios.	PE	The document includes “critical analysis of scientific evidence for decision-making”, “critical and analytical thinking”, and “decision-making processes and problem-solving”.
The curriculum includes practical learning approaches, such as projects, placements, simulations, and laboratory experiences, enabling students to apply concepts in real-world situations.	PE	The PPC describes learning settings involving clinical cases, problem-based situations, skills laboratories, simulation laboratories, and a university pharmacy.
The curriculum includes the development of competencies such as effective communication, teamwork, empathy, and resilience, which are increasingly valued in the current professional environment.	PE	The programme outlines aspects related to clear communication, active listening, teamwork, leadership, and proactivity.
The curriculum promotes a culture of continuous learning, encouraging students to remain up to date in the face of rapid technological changes.	PE	The PPC mentions lifelong and continuing education, in addition to a curricular structure that includes training through university extension activities.
The curriculum addresses concepts of innovation, entrepreneurship, and value creation, preparing students to identify opportunities and develop innovative solutions.	NE	-
Analytical Categories – Course 07	**Evidence**	**Excerpt from the PPC**
The curriculum promotes collaboration across different disciplines, encouraging interaction between areas of knowledge to address complex problems.	PE	The PPC states that Pharmacy education encompasses, in addition to research and extension, the sciences “in an integrated and interdisciplinary manner”.
The curriculum encourages the development of analytical skills, critical thinking, and problem-solving, enabling students to adapt to constantly changing scenarios.	PE	The document mentions critical analysis of the health–disease–care process and establishes that placements must include “critical analysis based on the practice setting”.
The curriculum includes practical learning approaches, such as projects, placements, simulations, and laboratory experiences, enabling students to apply concepts in real-world situations.	PE	The PPC details supervised placements in health care, dispensing pharmacy, hospital pharmacy, foods, clinical analyses, and the production of medicines and cosmetics, in addition to teaching–service integration from the beginning of the programme.
The curriculum includes the development of competencies such as effective communication, teamwork, empathy, and	PE	There is explicit mention of innovative practices, leadership skills, an entrepreneurial profile, articulation with interprofessional

resilience, which are increasingly valued in the current professional environment.		health teams, and experience within multiprofessional teams in service settings.
The curriculum promotes a culture of continuous learning, encouraging students to remain up to date in the face of rapid technological changes.	PE	The PPC articulates teaching, research, and extension, records encouragement for participation in PIBIC, PIBIT, and PAIC, and treats extension as an educational, cultural, and scientific process integrated with teaching and research.
The curriculum addresses concepts of innovation, entrepreneurship, and value creation, preparing students to identify opportunities and develop innovative solutions.	NE	-
Analytical Categories – Course 08	**Evidence**	**Excerpt from the PPC**
The curriculum promotes collaboration across different disciplines, encouraging interaction between areas of knowledge to address complex problems.	NE	-
The curriculum encourages the development of analytical skills, critical thinking, and problem-solving, enabling students to adapt to constantly changing scenarios.	PE	The pedagogical project indicates that the programme seeks to train professionals with a solid scientific foundation; capable of working in different areas of the pharmaceutical sciences; and able to interpret and apply scientific knowledge in the field of health. The curricular structure also includes courses related to: scientific methodology; laboratory analysis; and evaluation of pharmaceutical processes.
The curriculum includes practical learning approaches, such as projects, placements, simulations, and laboratory experiences, enabling students to apply concepts in real-world situations.	PE	The PPC specifies: practical workload detailed in the teaching plan; and integration between theory and practice throughout the training.
The curriculum includes the development of competencies such as effective communication, teamwork, empathy, and resilience, which are increasingly valued in the current professional environment.	PE	The PPC emphasises the training of professionals capable of: working in multiprofessional health teams; exercising ethical and social responsibility; and interacting with different contexts within the health system.
The curriculum promotes a culture of continuous learning, encouraging students to remain up to date in the face of rapid technological changes.	PE	The PPC incorporates research activities, university extension, and scientific training aimed at continuous professional development. In addition, the curriculum includes participation in complementary academic activities and extension programmes.
The curriculum addresses concepts of innovation, entrepreneurship, and value creation, preparing students to identify opportunities and develop innovative solutions.	NE	-
Analytical Categories – Course 09	**Evidence**	**Excerpt from the PPC**
The curriculum promotes collaboration across different disciplines, encouraging interaction between areas of knowledge to address complex problems.	**PE**	"The PPC promotes the integration between constructed knowledge and reality, strengthening the conception of knowledge as a network of meanings and enabling a global and systemic view of knowledge."
The curriculum encourages the development of analytical skills, critical thinking, and problem-solving, enabling students to adapt to constantly changing scenarios.	**PE**	"The PPC adopts methodologies that allow students the continuous exercise of critical thinking, problem-solving, and creativity."
The curriculum includes practical learning approaches, such as projects, placements, simulations, and laboratory experiences, enabling students to apply concepts in real-world situations.	**PE**	"The curriculum integrates practice and theory from the outset through active methodologies, with structured practical activities."
The curriculum includes the development of competencies such as effective communication, teamwork, empathy, and resilience, which are increasingly valued in the current professional environment.	**PE**	"The PPC addresses theoretical content aimed at the development of talents and social competencies."
The curriculum promotes a culture of continuous learning, encouraging students to remain up to date in the face of rapid technological changes.	NE	-
The curriculum addresses concepts of innovation, entrepreneurship, and value creation, preparing students to identify opportunities and develop innovative solutions.	**PE**	-
Analytical Categories – Course 10	**Evidence**	**Excerpt from the PPC**
The curriculum promotes collaboration across different disciplines, encouraging interaction between areas of knowledge to address complex problems.	**PE**	The PPC was developed and organised around the axes defined by the National Curriculum Guidelines (DCN) and demonstrates articulation between different educational dimensions.
The curriculum encourages the development of analytical skills, critical thinking, and problem-solving, enabling students to adapt to constantly changing scenarios.	**PE**	The PPC mentions active teaching and assessment methods in varied situations, competencies, and skills, including realistic simulation; this supports evidence for reasoning and problem-solving.

The curriculum includes practical learning approaches, such as projects, placements, simulations, and laboratory experiences, enabling students to apply concepts in real-world situations.	PE	The programme articulates strategic courses for placements, includes placements from intermediate semesters onwards, and uses realistic simulation rooms, clinical laboratories, and hospital settings.
The curriculum includes the development of competencies such as effective communication, teamwork, empathy, and resilience, which are increasingly valued in the current professional environment.	PE	The PPC indicates that it equips graduates with self-awareness, social and environmental awareness, self-management, relationship management, leadership, collaboration, and resilience in the face of adversity.
The curriculum promotes a culture of continuous learning, encouraging students to remain up to date in the face of rapid technological changes.	NE	-
The curriculum addresses concepts of innovation, entrepreneurship, and value creation, preparing students to identify opportunities and develop innovative solutions.	PE	The "Health Technology" axis is explicitly described in the PPC and includes research, development, innovation, production, and management, but does not address clear concepts of innovation and entrepreneurship.

Question 03:

Evidence identified in the PPCs regarding structures of technology, innovation, and entrepreneurship, and educational practices linked to the Fourth Industrial Revolution		
Analytical Categories – Course 01	**Evidence**	**Excerpt from the PPC**
Does the curriculum connect students with startup events and programmes?	PE	The PPC mentions student participation in: extension activities; academic projects; integration activities with the community and with different sectors of the health system. These activities include participation in: academic events and scientific seminars.
Does the curriculum maintain links with the pharmaceutical industry and health innovation, as well as with active professionals in the field, allowing students to be aware of current demands and trends?	PE	The PPC highlights: supervised placements; practical activities in health services; and interaction with different professional settings in the pharmaceutical field. It also mentions engagement with: pharmaceutical services; clinical analyses; and medicine production sectors.
Does the curriculum offer flexibility so that students can adapt their studies to their own areas of interest and objectives?	PE	The curriculum includes: elective courses; complementary activities; and participation in extension and research projects.
Does the curriculum allow for the presentation of Business Plans and/or Business Models?	PE	The document includes content related to: management of pharmaceutical services and organisation of work processes in health.
Does the curriculum, through its teaching staff or ad hoc mentors, offer mentoring for business modelling?	PE	The PPC describes: academic supervision throughout the programme; guidance in research activities; and supervision in placements and academic work.
Is there encouragement for the promotion, organisation, and participation in innovation and entrepreneurship events?	NE	-
Analytical Categories – Course 02	**Evidence**	**Excerpt from the PPC**
Does the curriculum connect students with startup events and programmes?	NE	-
Does the curriculum maintain links with the pharmaceutical industry and health innovation, as well as with active professionals in the field, allowing students to be aware of current demands and trends?	PE	The PPC of the University of Brasília (UnB) provides for various professional practice settings, including: supervised placements in different areas of Pharmacy; work in health services and pharmaceutical services; and experiences in laboratories and institutions related to the pharmaceutical field.
Does the curriculum offer flexibility so that students can adapt their studies to their own areas of interest and objectives?	PE	The curriculum includes elements that allow a certain degree of flexibility in training, such as: elective courses; complementary academic activities; and participation in research and extension projects.
Does the curriculum allow for the presentation of Business Plans and/or Business Models?	NE	-
Does the curriculum, through its teaching staff or ad hoc mentors, offer mentoring for business modelling?	NE	-

Is there encouragement for the promotion, organisation, and participation in innovation and entrepreneurship events?	NE	-
Analytical Categories – Course 03	**Evidence**	**Excerpt from the PPC**
O currículo aproxima os estudantes dos eventos e programas de startups?	NE	-
O currículo mantém laços com a indústria farmacêutica e de inovação em saúde e profissionais ativos no campo, permitindo que os estudantes estejam cientes das demandas e tendências atuais	NE	-
O currículo oferece flexibilidade para que os estudantes possam adaptar seus estudos às suas próprias áreas de interesse e objetivos	NE	-
O currículo permite a apresentação de Planos de Negócios e/ou Modelos de Negócios	NE	-
O Currículo, por meio do seu corpo docente, ou mentores *ad hoc* oferece mentorias para modelagem de negócios	NE	-
Há estímulo à promoção, organização e participação em eventos de inovação e empreendedorismo	NE	-
Analytical Categories – Course 04	**Evidence**	**Excerpt from the PPC**
Does the curriculum connect students with startup events and programmes?	NE	
Does the curriculum maintain links with the pharmaceutical industry and health innovation, as well as with active professionals in the field, allowing students to be aware of current demands and trends?	NE	-
Does the curriculum offer flexibility so that students can adapt their studies to their own areas of interest and objectives?	PE	The PPC provides mechanisms that enable flexibility in the academic pathway, such as Complementary Academic Activities (AAC), allowing students to participate in teaching, research, and extension activities; participation in research projects (undergraduate research) and extension; and elective or optional courses.
Does the curriculum allow for the presentation of Business Plans and/or Business Models?	NE	-
Does the curriculum, through its teaching staff or ad hoc mentors, offer mentoring for business modelling?	NE	-
Is there encouragement for the promotion, organisation, and participation in innovation and entrepreneurship events?	NE	-
Analytical Categories – Course 05	**Evidence**	**Excerpt from the PPC**
Does the curriculum connect students with startup events and programmes?	NE	-
Curricular links with the pharmaceutical and health innovation industry and active professionals in the field	NE	-
Curricular flexibility allowing students to adapt their academic pathway	PE	The PPC presents mechanisms that allow flexibility in academic training, including: elective courses that enable students to deepen their knowledge in specific areas of the pharmaceutical sciences; complementary academic activities, including participation in scientific events, research projects, and extension activities; and participation in undergraduate research programmes and university extension projects, which allow students to direct their training towards specific fields of interest.
Development and presentation of Business Plans and/or Business Models	NE	-
Mentoring for business modelling provided by teaching staff or ad hoc mentors	NE	-
Encouragement for the promotion, organisation, and participation in innovation and entrepreneurship events.	NE	-
Analytical Categories – Course 06	**Evidence**	**Excerpt from the PPC**
Curricular connection with startup events and programmes.	NE	-

Curricular links with the pharmaceutical and health innovation industry and active professionals in the field, allowing students to be aware of current demands and trends.	NE	-
Curricular flexibility allowing students to adapt their studies to their own areas of interest and objectives.	PE	The PPC records curricular flexibility resulting from: elective courses; complementary academic activities; participation in research and extension projects; and undergraduate research activities.
Development and presentation of Business Plans and/or Business Models.	NE	-
Mentoring for business modelling provided by teaching staff or ad hoc mentors.	NE	-
Encouragement for the promotion, organisation, and participation in innovation and entrepreneurship events.	NE	-
Analytical Categories – Course 07	**Evidence**	**Excerpt from the PPC**
Does the curriculum connect students with startup events and programmes.	NE	-
Does the curriculum maintain links with the pharmaceutical industry and health innovation, as well as with active professionals in the field, allowing students to be aware of current demands and trends.	NE	-
Does the curriculum offer flexibility so that students can adapt their studies to their own areas of interest and objectives.	PE	The PPC provides flexibility in the academic pathway, such as Complementary Academic Activities (AAC); participation in teaching, research, and extension activities; participation in research projects, undergraduate research, and extension; and elective courses.
Does the curriculum allow for the presentation of Business Plans and/or Business Models.	NE	-
Does the curriculum, through its teaching staff or ad hoc mentors, offer mentoring for business modelling.	NE	-
Is there encouragement for the promotion, organisation, and participation in innovation and entrepreneurship events.	NE	-
Analytical Categories – Course 08	**Evidence**	**Excerpt from the PPC**
Does the curriculum connect students with startup events and programmes?	NE	-
Does the curriculum maintain links with the pharmaceutical industry and health innovation, as well as with active professionals in the field, allowing students to be aware of current demands and trends?	PE	The PPC provides training articulated with real professional practice settings, including: supervised placements in different areas of the pharmaceutical sciences, including industry; laboratory practical activities; integration with health services and pharmaceutical services; and participation in extension and research projects.
Does the curriculum offer flexibility so that students can adapt their studies to their own areas of interest and objectives?	PE	The PPC provides mechanisms that allow flexibility in the academic pathway, including: curricular extension components; complementary academic activities involving participation in scientific events, research projects, and extension activities; and the offer of open elective courses.
Does the curriculum allow for the presentation of Business Plans and/or Business Models?	NE	-
Does the curriculum, through its teaching staff or ad hoc mentors, offer mentoring for business modelling?	NE	-
Is there encouragement for the promotion, organisation, and participation in innovation and entrepreneurship events?	NE	-
Analytical Categories – Course 09	**Evidence**	**Excerpt from the PPC**
Curricular connection with startup events and programmes?	NE	-
Does the curriculum maintain links with the pharmaceutical industry and health innovation, as well as with active professionals in the field, allowing students to be aware of current demands and trends?	PE	The PPC brings students closer to professional reality through active teaching–learning methodologies that involve problem-solving and the analysis of real situations; practical rotations and activities in professional settings, allowing contact with different areas of pharmaceutical practice; and participation in practical activities and

		integrative projects aimed at applying knowledge in the context of the health sector.
Does the curriculum offer flexibility so that students can adapt their studies to their own areas of interest and objectives?	PE	The PPC allows partial personalisation of the educational pathway, including: a flexible training pathway that enables students to direct part of their education according to their academic and professional interests; elective curricular components; and participation in complementary activities and academic projects.
Does the curriculum allow for the presentation of Business Plans and/or Business Models?	NE	-
Does the curriculum, through its teaching staff or ad hoc mentors, offer mentoring for business modelling?	NE	-
Is there encouragement for the promotion, organisation, and participation in innovation and entrepreneurship events?	NE	-
Analytical Categories – Course 09	**Evidence**	**Excerpt from the PPC**
Does the curriculum connect students with startup events and programmes?	NE	-
Curricular links with the pharmaceutical and health innovation industry and active professionals in the field.	PE	The PPC emphasises pharmaceutical education based on the integration of teaching, research, and extension, as well as the insertion of students into different professional practice settings. The curriculum includes: laboratory practical activities in areas such as pharmaceutical technology, clinical analyses, and drug development; supervised placements in different professional practice contexts; and participation in scientific research projects, often linked to university research groups and laboratories.
Curricular flexibility allowing students to adapt their academic pathway.	PE	The PPC provides mechanisms that allow flexibility in the educational pathway, such as: elective courses; participation in undergraduate research projects; involvement in university extension activities and academic projects; and participation in extracurricular activities and institutional research programmes.
Development and presentation of Business Plans and/or Business Models.	NE	-
Mentoring for business modelling provided by teaching staff or ad hoc mentors.	NE	-
Encouragement for the promotion, organisation, and participation in innovation and entrepreneurship events.	NE	-