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# Bio-entrepreneurial Intention in Bio-Innovation Service Ecosystems: A Systematic Review of Key Determinants

Ayat Alborno[1], Hasliza Hassan[1]، Nasreen Khan[1], Magiswary Dorasamy[2]

[1] Faculty of Management, Multimedia University, Cyberjaya, 63100, Selangor, Malaysia.
[2] Faculty of Business & Law, Taylor's University, 47500 Subang Jaya, Selangor, Malaysia.
*dr.ayat.alborno@gmail.com*

**Abstract.** Bio-entrepreneurial intention plays a critical role in enabling bio-innovation and sustainable value creation within science-driven service ecosystems. While prior studies have identified various psychological, educational, institutional, and policy-related determinants of Bio-entrepreneurial intention, this body of research remains conceptually fragmented and largely focused on isolated factors. This systematic literature review aims to consolidate and critically interpret recent empirical evidence on the determinants of Bio-entrepreneurial intention, with particular attention to how individual cognition interacts with bio-innovation service structures and innovation-support mechanisms. Following PRISMA 2020 guidelines, a structured literature search was conducted in the Scopus database covering studies published between 2020 and 2024. From an initial pool of 5,673 records, seven peer-reviewed empirical studies met the inclusion criteria. Data were analyzed using qualitative thematic synthesis to identify recurring psychological, educational, institutional, and ecosystem-related determinants shaping Bio-entrepreneurial intention. The synthesis identified seven key determinants: bio-innovation ecosystem support, Bio-entrepreneurial education, university spin-off mechanisms, government and policy support, environmental and regulatory conditions, entrepreneurial self-efficacy, and entrepreneurial attitude. Rather than operating as independent predictors, these determinants are interpreted as interconnected enabling conditions within bio-innovation service systems. The synthesis indicates that educational services, ecosystem support, and institutional arrangements shape perceived feasibility, legitimacy, and motivation by facilitating knowledge flows, innovation logistics, and technology transfer pathways. Entrepreneurial self-efficacy and attitude mediate how these systemic inputs are internalized at the individual level. Given the limited and emerging evidence base, the findings should be interpreted as exploratory and agenda-setting rather than generalizable. The contribution of this review lies not in proposing a new conceptual framework, but in clarifying Bio-entrepreneurial intention as a system-embedded phenomenon arising from the interaction between individual cognition and innovation-support services. The study offers implications for bio-innovation education, policy design, and service-oriented ecosystem development, and outlines directions for future research toward more integrative and theory-driven models of Bio-entrepreneurial intention.

**Keywords:** Bio-entrepreneurship; Systematic Review; PRISMA; Biotechnology Innovation, Entrepreneur Intention, Sustainable entrepreneurship.

# 1. Introduction

Determinants refer to psychological, educational, and contextual factors that influence individuals' decision-making, while "intention" is conceptualized according to the Theory of Planned Behavior (TPB; Ajzen, 1991) as an individual's motivational readiness to engage in entrepreneurial action (Ajzen, 2020). TPB provides a robust foundation for studying entrepreneurial intention through attitudes, subjective norms, and perceived behavioral control as shown on **Figure 1**. However, in the context of bio-entrepreneurship, institutional and ecosystem-level support mechanisms, such as incubators, regulatory frameworks, university spin-offs, and bio-innovation service infrastructures, play an equally influential role but remain under-integrated in conventional theoretical models. Entrepreneurship has long been recognized as a key mechanism for transforming knowledge into economic, social, and technological value. Within science-driven sectors, particularly biotechnology, the entrepreneurial process involves distinct dynamics that extend beyond conventional venture creation. As global economies shift toward knowledge-based and innovation-driven models, entrepreneurship has become essential for generating employment, advancing technology, and fostering sustainable development (Alshanfari et al, 2021; Mago & Merwe, 2023). In alignment with the United Nations 2030 Agenda for Sustainable Development, nations are urged to integrate economic, social, and environmental dimensions to achieve long-term growth (UNEP, 2024). Within this context, bio-entrepreneurship—the integration of biotechnology and entrepreneurship, has emerged as a transformative domain that bridges scientific discovery with market-oriented innovation (Birch,2020; Lisboa & Souza, 2023).

Historically, the roots of bio-entrepreneurship trace back to the late 1970s with the commercialization of recombinant DNA technology, laying the foundation for modern biotechnology enterprises (Sinha et al., 2021). Over the past two decades, rapid advancements in genomics, biopharmaceuticals, and bioinformatics have fueled a surge in biotech startups, university spin-offs, and innovation service networks (Bettanti et al., 2022). The global biotechnology market, valued at approximately USD 497 billion in 2020, is projected to exceed USD 800 billion by 2027, growing at a CAGR of 9.4% (Global Market Insights, 2024). This expansion reflects the industry's capacity to address global challenges such as pandemics, climate change, and food security, particularly highlighted by the COVID-19 pandemic, which emphasized biotechnology's role in vaccine development, diagnostics, and resilient biomanufacturing (Fu et al., 2021, Veena, 2024). The growth of bio-entrepreneurship is driven not only by market and technological opportunities but also by its contribution to sustainable economic diversification, high-tech employment, and improvements in healthcare and agricultural productivity (Kumar et al., 2024). Emerging economies increasingly recognize bio-entrepreneurship as a strategic pathway for achieving bioeconomic competitiveness, technological self-reliance, and science-driven development (Tonon et al., 2024). However, despite these opportunities, systemic barriers persist, including high startup costs, limited venture capital, regulatory complexity, and scarcity of specialized human capital, which hinder the translation of scientific innovation into commercial impact (Sieg et al., 2023; Renko et al., 2022). These barriers often impede the critical transition from laboratory discovery to market-ready solutions, highlighting the need for coordinated bio-innovation service systems.

While the bioeconomy sector continues to expand, scholarly understanding of the determinants influencing entrepreneurs' intention to enter bio-entrepreneurship remains fragmented and conceptually underdeveloped. Existing studies often focus narrowly on technological, financial, or market factors, overlooking psychological, educational, institutional, and system-level determinants that jointly shape entrepreneurial motivation and capability (Kumar et al., 2024; Gurunani et al., 2021). Therefore, an integrated examination of these determinants within the framework of bio-innovation service ecosystems is essential for fostering innovation-driven bioeconomic development, particularly in regions with emerging biotechnology infrastructures. Bio-entrepreneurship has emerged as a critical mechanism for translating scientific knowledge into sustainable economic and societal value, particularly within bioeconomy-driven and innovation-dependent contexts. While prior research has

extensively examined entrepreneurial intention from individual-level psychological perspectives, and separate strands of literature have addressed institutional support, education, and innovation ecosystems, these bodies of knowledge remain largely fragmented,especially in the context of biotechnology-based venture creation. Existing reviews tend to catalog determinants in isolation, offering limited analytical integration across cognitive, educational, and ecosystem-level dimensions.

Accordingly, this study is justified by the need to systematically consolidate and critically interpret dispersed empirical evidence on Bio-entrepreneurial intention, with particular attention to how individual-level intention constructs are shaped, enabled, or constrained by bio-innovation service environments. Rather than proposing a new conceptual framework, the review responds to calls for theory-informed synthesis that clarifies patterns of interaction, convergence, and tension among determinants identified across disciplines. By doing so, the study contributes an interpretive foundation that can inform future theory-building, policy design, educational programming, and the development of biotechnology-oriented incubation and innovation support systems.

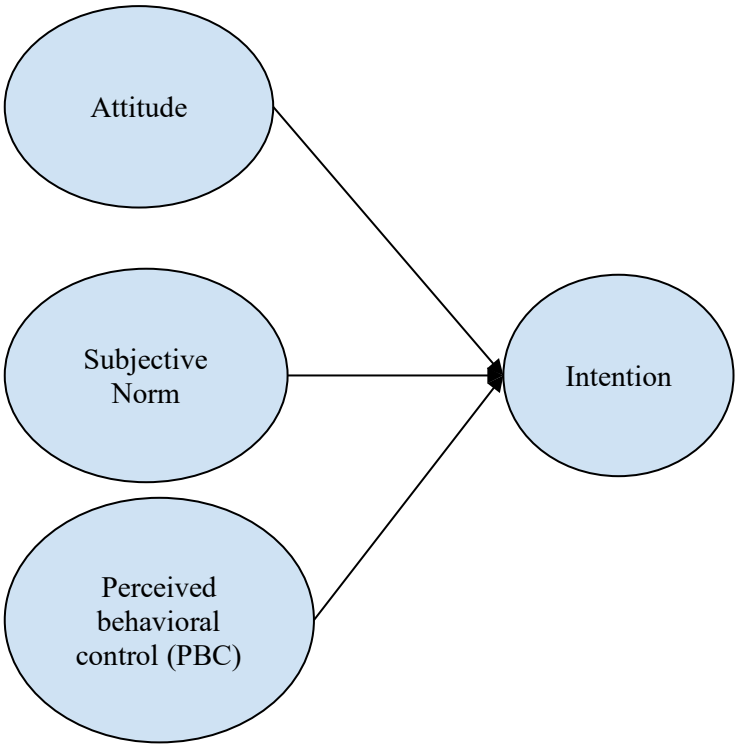


Fig.1: Theory of Planned Behavior (TPB) by Icek Ajzen (1919).

The objective of this systematic literature review is to identify, organize, and analytically synthesize the key determinants influencing Bio-entrepreneurial intention among individuals at the pre-venture stage, including biotechnology students, scientists, early-career researchers, and innovation-oriented professionals considering entry into biotechnology-based entrepreneurship. Specifically, the review seeks to (i) map dominant psychological, educational, institutional, and ecosystem-level determinants reported in recent empirical studies; (ii) examine how these determinants are conceptually and empirically connected across levels of analysis; and (iii) highlight structural gaps, underexplored linkages, and contextual limitations within the existing evidence base. Through this integrative synthesis, the review advances understanding of how intentional engagement in bio-entrepreneurship

is shaped within bio-innovation service systems, while positioning its findings as agenda-setting rather than generalizable, and as a platform for subsequent conceptual modeling and empirical testing.

# 2. Literature Review

## 2.1. Service ecosystems in bio-entrepreneurship and bio-innovation

Bio-entrepreneurship lies on the border of biotechnology and entrepreneurship that translates a scientific discovery into a market-facing product by forming a venture, licensing, and technology transfer (Birch, 2020; Sinha et al., 2021). In contrast to the traditional entrepreneurial environment, biotechnology-based venturing is normally marked by extensive time spent in the development phase, high capitals, specialized human capital requirements, and extensive regulatory oversight, which raises uncertainty and heightens reliance on coordinated support systems (Renko et al., 2022). Consequently, the individual capability is often not a factor that defines entrepreneurial involvement into biotechnology; rather it is highly influenced by accessibility and quality of ecosystem services that facilitate the transfer of knowledge, resources, and technologies between labs and markets. Biological innovation service ecosystems may be perceived in this context as a set of actors and service mechanism, such as universities, incubators, intermediaries, funders, technology transfer offices, mentors, and regulators, that help opportunities develop and materialize (Audretsch and Belitski, 2022). Such ecosystems offer infrastructure (labs, prototyping and testing, etc.), innovation logistics (clinical/regulatory navigation, IP support, partnering), and legitimacy mechanisms (institutional endorsement, signaling, and governance coordination) that make venture formation less difficult and entrepreneurial paths more easily attainable (Bettanti et al., 2022). Such ecosystem conditions are not peripheral in biotechnology: they are in many cases determiners of whether scientific possibility becomes entrepreneurial intention and ultimately, entrepreneurial action.

## 2.2. Intention to entrepreneurship and the Theory of Planned Behavior in science-related fields

Entrepreneurial intention is often defined as a motivational state that implies the willingness to take entrepreneurial action, and has often been theorized through the Theory of Planned Behavior (TPB) (Ajzen, 2020). TPB describes intention as a factor conditioned by (i) attitude toward the behavior (ii) subjective norms and (iii) perceived behavioral control that together determine the perceived desirability and feasibility of entrepreneurship. TPB has been consistently employed in the entrepreneurship literature to foresee intention both in student and young-career samples and to test the influence of education, social context and perceived capability on the entrepreneurial motivation (Batista-Canino et al., 2023). In biotechnology and other science-based industries, however, the intention formation process can manifest itself in institutionalized commercialization systems in a structurally different context than that of a small business. 3 Bio-entrepreneurship feasibility is closely linked to the availability of special resources (labs, IP, clinical pathways), translational skills, and institutional support that determines an impression of behavioral control and legitimacy unattainable by individual cognition alone (Hayter and Link, 2022). This indicates that TPB can still be useful as an intention lens, but its explanatory potential in bio-entrepreneurship could be reliant on incorporation of ecosystem-level and institutional service conditions that can influence the formation of attitudes and control impression.

## 2.3. Weaknesses and threats to Bio-entrepreneurial intention in previous studies

Though studies specifically termed Bio-entrepreneurial intention are few, related studies on the academic entrepreneurship, science-based entrepreneurship, and entrepreneurial ecosystems are found to determine a number of recurrent determinants applicable to biotechnology setting. These

determinants are commonly considered in four areas in relations to each other, including educational services, psychological aspects, institutional processes, and policy/regulatory environments.

### *2.3.1. Bio-entrepreneurial knowledge and competency training*

One of the most continuously highlighted predeterminants of the entrepreneurial intention is entrepreneurship education, especially in cases when it is experiential and directly related to the issues of commercialization. Within the bio-based setting, education acts not as general business education but as a translation service, which allows scientists to reframe technical knowledge and knowledge in relation to opportunity identification, market logic, and implementation channels (Boh et al., 2023). Intention can be reinforced by practice-based interventions, i.e., by project-based learning, commercialization workshops, or science-to-market training, which augment perceived behavioral control and reduce the psychological distance between laboratory work and venture creation (Atmojo et al., 2022). The effects of education are also enhanced when it is enshrined within the positive institutional environments that endow the provision of mentoring, networks, and practical commercialization exposure (Dietershagen and Bammann, 2023).

### *2.3.2. Sustainability orientation, prosocial motivation and entrepreneurial attitude*

The entrepreneurship attitudes, particularly those connected with innovation, impact, and autonomy persist in the central role of predicting intention and typically serve as a cognitive filter, which external supports are considered (Ajzen, 2020). Values-oriented orientations may also be especially topical in the context of bio-based entrepreneurship, where biotechnology projects are often explained by the discourse of benefit to society (e.g., global health, food security, climate resilience). According to the available literature on green and purpose-driven entrepreneurship, there are indications that environmental and social motivation may enhance desirability and persistence, particularly in times of uncertainty (Alvarez-Risco et al., 2021). The literature in social bio-entrepreneurship also shows that impact orientation is also a motivational factor in the development of a non-profit or hybrid form of entrepreneurial engagement (Sadeghi et al., 2021). This implies that the intent towards bio-entrepreneurship can be strengthened when people see a fit between the activity of venture and personal/professional meaning.

### *2.3.3. Entrepreneur self-efficacy and perceived behavioral control*

The entrepreneurial self-efficacy is often considered to be a predictor of intention since it measures the perceived ability to complete entrepreneurial work and overcome uncertainty. In science-based entrepreneurship, self-efficacy can be nurtured by a combination of progressive self-exposed innovation practices, mentoring, cross-disciplinary teamwork, and regular commercialization-based experiences (Atmojo et al., 2022). Based on the evidence presented by training programs on biotechnology-related topics, structured intervention is capable of advancing opportunity assessment, leadership and commercialization pathway confidence, which enhances intention and perceived feasibility (Khan et al., 2025). This supports the opinion that self-efficacy is not only a personal characteristic but a result of learning and ecosystem conditioned cognitive process.

### *2.3.4. Spin-off pathways, institutional support, and commercialization of universities*

Universities are often called anchor institutions within science-based ecosystems, which offer infrastructure, reputation, and organizational frameworks that define the entrepreneurial opportunities (Sieg et al., 2023). Uncertainty can be lowered in biotechnology through spin-offs and technology transfer mechanisms at universities which provide organized pathways to the development of IP, establishment of partnerships and mobilization of early resources (Scuotto et al., 2020). Besides,

institutional legitimacy, which is given by affiliation, technology transfer offices, incubators, and formal commercialization programs, may affect the perception of bio-entrepreneurship as a socially accepted and viable career path, particularly in high-risk sectors, where individual credibility and regulatory willingness are important (Hernandez-Chea et al., 2021). Comparative and policy-based descriptions also show that in a case where markets are less advanced, in university the compensation is often achieved through playing the role of a central coordination point in the system of innovations (Naczyk & Ban, 2022).

### *2.3.5. Ecosystem support services and facilitating organizations*

Outside of universities, the support of the ecosystem is also being projected as a configuration of services that make it possible to collaborate, coordinate, and access specialized resources. The dynamics of collaboration, learning, and resource flows are conditioned by intermediary organizations, incubator, accelerator, translational hubs, and support organizations, which affect the process of individuals evaluating feasibility and risk (Hernandez-Chea et al., 2021). On a biotechnological scale, ecosystem support may encompass mentorship networks, translational funding programs, regulatory guidance support, and commercialization deals that overcome discovery-to-use bottlenecks (Bettanti et al., 2022). These types of supports are expected to have an indirect effect on intention through enhancing perceived control and a reality about entrepreneurial outcomes.

### *2.3.6. Government/ policy, regulation and enabling conditions*

The government support is commonly known as a macro-level enabler that defines the opportunity environment with the help of funding tools, strategic emphasis, and regulatory certainty. Entrepreneurial ecosystem literature highlights that a successful policy mix can minimize uncertainty and align resources among actors, especially in high technology industries (Wang et al., 2023). Regulation is not merely merely a feature of feasibility perceptions in biotechnology, but also a characteristic of regulation: the policy to simplify approvals, to encourage translational infrastructure, and to indicate national interest in bioeconomy development can enhance legitimacy and minimize the perceived barriers (Naczyk & Ban, 2022). On the contrary, intention can be undermined by regulatory complexity and insufficient support that increases the perceived costs and uncertainty (Sieg et al., 2023).

## 2.4. Conceptual gaps and the need for integrative synthesis

The common shortcoming of these literature strands is fragmentation: psychological determinants are commonly modeled outside the context of institutional and ecosystem circumstances, and ecosystem and policy research often does not sufficiently specify how individual cognition and intention are formed by service processes and learning. This is especially evident in bio-entrepreneurship where the constancy of (i) educational services converting science into entrepreneurial potency, (ii) institutional channels of sanctioning and activating commercialization, and (iii) ecosystem enablers of reducing uncertainty and operational bottlenecks are likely to affect intention formation. In this connection, it is necessary to have an ecosystem-based interpretation to explain how determinants act in a concerted and not independent manner. This interpretation is consistent with the requests to stop focusing on single-level explanations and shift to more integrative models of intention in knowledge-intensive and innovation-dependent settings (Audretsch & Belitski, 2022). This gives the justification to synthesize empirical findings on Bio-entrepreneurial intention determinants available in recent times in a systematic manner and explain them as interdependent enabling conditions in the bio-innovation service ecosystems.

# 3. Methodology

## 3.1. Literature search and search strategy

An efficient and systematic literature search was conducted using the Scopus electronic database to identify peer-reviewed empirical studies relevant to Bio-entrepreneurial intention. Scopus was selected as the primary data source due to its broad multidisciplinary coverage, particularly in entrepreneurship, biotechnology, innovation management, and social sciences, making it well-suited for capturing research on entrepreneurial intention within science-driven domains (Tan et al., 2020; Ruiz-Alba et al., 2021; Batista-Canino et al., 2023). Compared to alternative databases such as Web of Science or PubMed, Scopus offers more comprehensive indexing of management and entrepreneurship journals, which are central to the conceptualization of entrepreneurial intention in the Bio-entrepreneurial context. The search covered studies published between 2020 and 2024 and included quantitative, qualitative, and mixed-method research designs, such as case studies, descriptive analyses, and comparative studies conducted in Bio-entrepreneurial or biotechnology-related settings. To ensure consistency and replicability, all database searches were conducted on a single day (December 9, 2024), minimizing potential bias arising from daily database updates. A structured Boolean search strategy was applied using combinations of the following keywords: entrepreneur, entrepreneurship, intention, biotechnology, bio, and bio-entrepreneurship. Boolean operators (AND, OR) were employed to capture variations in terminology and ensure comprehensive retrieval of relevant studies. Only studies explicitly addressing Bio-entrepreneurial intention, its determinants, or ecosystem-related enabling factors were considered eligible. The detailed search strategy and results are summarized in Table 1.

Table 1: Search Strategy and results.

| Databases | Search Terms | Search Results |
|---|---|---|
| SCOPUS | ("entrepreneur" OR "entrepreneurship") AND ("intention") AND ("biotech" OR "bio" OR "biotechnology") AND ("bio-entrepreneurship" OR "bioentrepreneur" OR "bioenterprise") | 5673 |
| | TITLE-ABS ("entrepreneur" OR "entrepreneurship") AND ("intention") AND ("biotech" OR "bio" OR "biotechnology") AND ("bio-entrepreneurship" OR "bioentrepreneur" OR "bioenterprise") | 7 |

**source:** Own elaboration.

## 3.2. Inclusion Criteria

The inclusion criteria were designed to ensure the selection of high-quality and thematically relevant studies examining Bio-entrepreneurial intention. Eligible studies were required to:

1. Be peer-reviewed journal articles published in English between 2020 and 2024.
2. Focus explicitly on entrepreneurial intention within biotechnology, life sciences, or bio-based sectors.
3. Examine populations such as biotechnology students, scientists, researchers, professionals, or early-stage bioentrepreneurs.
4. Provide empirical evidence on determinants, drivers, or enabling factors influencing Bio-entrepreneurial intention.

Both case studies and descriptive analyses were included, provided they offered conceptual or empirical insights into the psychological, educational, institutional, or ecosystem-level factors shaping Bio-entrepreneurial motivation in innovation-intensive contexts.

## 3.3. Exclusion Criteria

Studies were excluded based on publication, thematic, and methodological considerations. Exclusion criteria included:

1. Publications released before 2020, non-English studies, conference proceedings, book chapters, and grey literature;
2. Studies lacking full-text availability;
3. Research focusing solely on general entrepreneurship, technology transfer, or innovation commercialization without explicit analysis of entrepreneurial intention;
4. Articles addressing biotechnology or life sciences without a Bio-entrepreneurial or intention-based perspective.

These exclusion decisions were applied consistently to maintain thematic focus and methodological coherence across the review.

## 3.4. Study Selection Process and Critical Reflection

The study selection process followed the PRISMA 2020 guidelines for systematic reviews (Page et al., 2021), encompassing the stages of identification, screening, eligibility, and inclusion. During the identification stage, 5,673 records were retrieved from the Scopus database using the predefined search strategy. During the screening phase, titles, abstracts, and keywords were independently examined to assess their alignment with the predefined inclusion criteria. A substantial number of records were excluded at this stage because they addressed general entrepreneurship, biotechnology commercialization, or technology transfer without an explicit focus on entrepreneurial intention within a Bio-entrepreneurial context. This initial screening reduced the dataset to 10 potentially relevant studies. In the eligibility phase, full-text assessment was conducted to verify conceptual relevance and methodological alignment. One article was excluded at this stage because, despite its biotechnology focus, it did not examine entrepreneurial intention as a core analytical construct. Ultimately, seven empirical studies satisfied all inclusion criteria and were retained for qualitative thematic synthesis.

Although PRISMA 2020 was applied rigorously, it is acknowledged that certain screening decisions required informed subjective judgment. Specifically, conceptual judgment was necessary to distinguish studies on bio-entrepreneurship from those focusing solely on biotechnology commercialization, innovation diffusion, or academic technology transfer without intention-based analysis. Given the interdisciplinary nature of bio-entrepreneurship, boundaries between these domains are often blurred, making purely mechanical screening insufficient. In addition, reliance on a single multidisciplinary database (Scopus) may have introduced disciplinary bias toward management-, education-, and innovation-oriented journals, potentially underrepresenting relevant studies published in biomedical or policy-focused outlets. To mitigate this limitation, strict inclusion criteria and transparent reporting of exclusion rationales were applied. Consequently, the findings of this review should be interpreted as exploratory and agenda-setting, offering conceptual clarity rather than statistical generalization. The complete selection process is visually summarized in **Figure 2**, which illustrates the systematic flow of information according to PRISMA 2020.

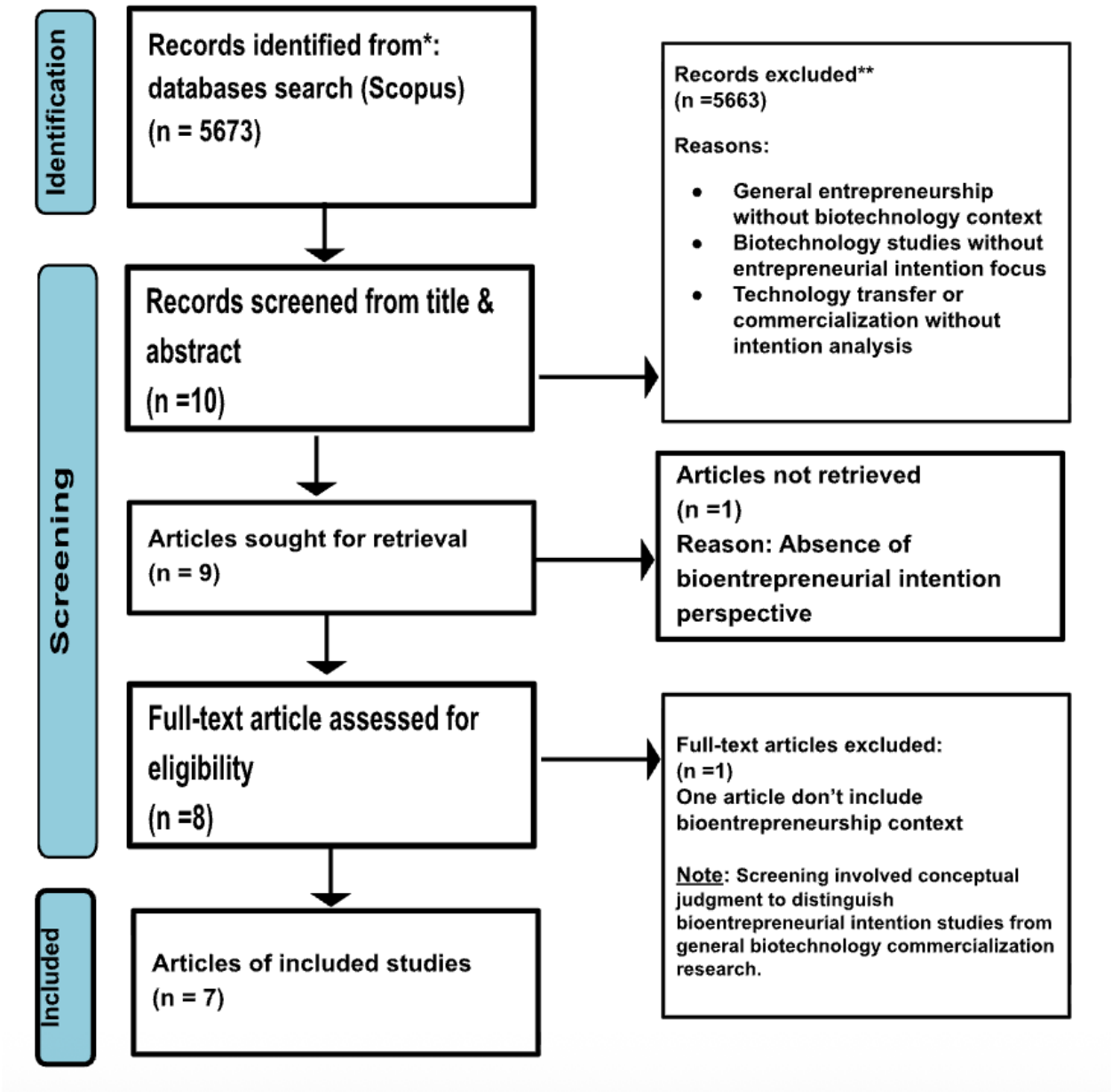


Fig.2: The systematic flow of information according to PRISMA 2020.
Source*:* Adapted from Page et al. (2021).

# 4. Results

## 4.1. Overview of the Included Articles

Following the PRISMA 2020 guidelines (Page et al., 2021), seven peer-reviewed studies published between 2021 and 2024 met all inclusion criteria. The literature search was conducted exclusively through the Scopus database and finalized on 9 December 2024, ensuring procedural transparency and replicability. The limited number of included studies reflects the emerging and conceptually fragmented nature of bio-entrepreneurship research rather than shortcomings in the review protocol. The included studies employed diverse methodological approaches, including qualitative case studies, quantitative survey-based analyses, and mixed-method designs. Substantively, they covered multiple bio-innovation contexts, such as biomedical venture creation, Bio-entrepreneurial education programs, university spin-off initiatives, policy-driven bioeconomic development, and socially oriented bio-innovation. This

heterogeneity highlights that Bio-entrepreneurial intention is examined across dispersed disciplinary lenses rather than within a unified theoretical or systems-oriented framework. Rather than representing isolated psychological motivations, the reviewed studies implicitly situate Bio-entrepreneurial intention within broader bio-innovation service ecosystems, where educational services, institutional arrangements, regulatory environments, and knowledge-transfer mechanisms interact with individual cognition. However, these system-level dimensions are rarely theorized explicitly, reinforcing the need for integrative synthesis rather than simple aggregation of findings.

Although the evidence base is numerically small, this outcome is consistent with methodological guidance for systematic reviews in nascent research domains, where strict conceptual screening often yields a limited but analytically meaningful set of studies. Page et al. emphasize that such reviews should be interpreted as exploratory and agenda-setting, particularly when fields lack standardized definitions and dominant theoretical models. Accordingly, the findings of this review should not be read as statistically generalizable but as indicative of emerging patterns in Bio-entrepreneurial intention formation. Table 2 summarizes the characteristics of the included studies, detailing their research focus, methodological design, and reported determinants of Bio-entrepreneurial intention. Across the reviewed literature, determinants cluster into interconnected individual- and system-level domains, including bio-innovation ecosystem support, Bio-entrepreneurial education services, university spin-off and technology transfer mechanisms, government and policy support structures, entrepreneurial attitude, environmental or sustainability motivation, and entrepreneurial self-efficacy and skill development. Importantly, these determinants are not treated as independent variables but as functionally interdependent elements shaping perceived feasibility, desirability, and control within bio-innovation service systems.

Table 2. Summary of Included Studies on Bio-entrepreneurial Determinants

| Study ID | Authors (Year) | Research Focus | Methodology | Key Determinants | Outcomes |
|---|---|---|---|---|---|
| 1 | Gertsch & Chicca (2024) | Drug Discovery in Academia and its translation to industry. | Case studies and descriptive analysis of NCCR TransCure projects | -Bio-entrepreneurial ecosystem support<br>-Bio-entrepreneurial education<br>- University spin-offs | Highlights the importance of fostering ecosystems and support systems, offering examples of how academic spin-offs like Synendos successfully navigate challenges in translation and commercialization. |
| 2 | Schweickart et al. (2023) | Biomedical Entrepreneurship Skills; Introduces an educational | quantitative and qualitative mixed- | Bio-entrepreneurial education, | The study highlights the critical role of educational interventions in fostering entrepreneurial intentions and skills among biomedical |

| Study ID | Authors (Year) | Research Focus | Methodology | Key Determinants | Outcomes |
|---|---|---|---|---|---|
| | | program to bridge gaps in entrepreneurial training among biomedical researchers. | method approach | Entrepreneurial attitude | researchers. Increased likelihood of pursuing commercialization post-course. |
| 3 | Naczyk & Ban (2022) | Covid-19 as Biotech Innovation success factor in Russia | Comparative case study methodology involving Russia, Cuba, and CEE countries | University spin-offs<br>- Government support<br>- -Bio-entrepreneurial ecosystem support | Highlights the role of strategic policy frameworks in advancing biotech innovation and entrepreneurship. |
| 4 | (Sadeghi et al., 2021) | Social Bio-entrepreneurship | Qualitative data review and market analysis conducted. | -Entrepreneurial Attitude and social impact<br>-Bio-entrepreneurship Education | Highlights the intention, motivation, operational and strategic aspects of bio-entrepreneurship in the non-profit sector. |
| 5 | Supriatno et al. (2023) | Promoting biology teachers' entrepreneurship skills | Experimental intervention | Bio-entrepreneurial education; Skill development | Demonstrates that the CAPAB(L)E learning model enhances entrepreneurial competencies and practical bio-based innovation skills. |
| 6 | Atmojo et al. (2022) | Empowering bioentrepreure skills in food | Quantitative quasi- | Bio-entrepreneurial | Indicates that experiential biotechnology modules foster self-efficacy and |

| Study ID | Authors (Year) | Research Focus | Methodology | Key Determinants | Outcomes |
|---|---|---|---|---|---|
| | | biotechnology education | experimental design | education; Entrepreneurial self-efficacy | entrepreneurial intention among science students. |
| 7 | Alvarez-Risco et al. (2021) | Green entrepreneurship intentions during COVID-19 | Qualitative multiple-case study | Entrepreneurial attitude; Perceived behavioral control; Environmental motivation | Finds that attitude and perceived behavioral control significantly predict green and Bio-entrepreneurial intention. |

**Source:** Compiled by authors based on systematic review results (Scopus, 9 December 2024).

## 4.2. Synthesis of Key Determinants

Table 2 presents the frequency with which key determinants of Bio-entrepreneurial intention appear across the seven included studies. While frequency counts provide a useful descriptive overview of the evidence base, they do not imply causal priority or relative importance. Instead, the table serves as an organizing device to map how determinants recur across heterogeneous empirical contexts within an emerging research field. Bio-entrepreneurial education appears most frequently (five out of seven studies), reflecting the strong emphasis in the literature on education as a primary entry point for fostering Bio-entrepreneurial intention. However, the synthesis indicates that education operates not as an isolated driver, but as a foundational service capability that enhances other determinants, particularly entrepreneurial attitude and self-efficacy, when embedded within supportive institutional environments. Ecosystem and institutional support, identified in three studies, play a critical coordinating role within bio-innovation service systems. These determinants encompass university infrastructure, incubation services, policy frameworks, and innovation support mechanisms that enable the translation of scientific knowledge into entrepreneurial action. Although less frequent than education, ecosystem support exerts a systemic influence by shaping perceived feasibility and reducing structural barriers associated with biotechnology commercialization.

Psychological determinants, including entrepreneurial attitude, social impact orientation, environmental motivation, and self-efficacy, appear with moderate frequency but demonstrate high conceptual significance. Their influence is contingent upon the presence of enabling services and institutional arrangements. For example, entrepreneurial attitude and environmental motivation are reinforced through policy alignment and societal legitimacy, while self-efficacy is strengthened through experiential education and ecosystem-based learning opportunities. University spin-offs and government support, although less frequently cited, function as critical innovation logistics mechanisms. They facilitate knowledge transfer, regulatory navigation, and resource mobilization, thereby linking research institutions to market systems. Their lower frequency reflects empirical scarcity rather than limited conceptual relevance, particularly given the early-stage nature of bio-entrepreneurship research. Accordingly, the determinants summarized in Table 3 should be interpreted as interdependent

components of a bio-innovation service ecosystem rather than as standalone predictors. The synthesis demonstrates that Bio-entrepreneurial intention emerges from the interaction between individual-level cognition and system-level services that jointly shape desirability, feasibility, and perceived behavioral control.

Table 3. Frequency of Key Determinants Identified Across the Seven Included Studies

| # | **Determinants** | **Review Paper ID** | **Frequency (N=7)** |
|---|---|---|---|
| 1 | Bio-entrepreneurial ecosystem support/ institutional support | [I], [III] | 2 |
| 2 | Bio-entrepreneurial education | [I],[II], [IV],[VI], [VII] | 5 |
| 3 | Government support | [III] | 1 |
| 4 | University Spin-offs | [I], [III] | 2 |
| 5 | Bio-entrepreneurial Attitude and Social Impact | [IV], [II], [VI] | 3 |
| 6 | Environmental or green motivation | [III] | 1 |
| 7 | Entrepreneurial self-efficacy/skill development | [IV], [VI] | 2 |

**Source:** Synthesized from seven Scopus-indexed studies (2021–2024).

# 5. Discussion

This systematic review provides a synthesized interpretation of recent evidence (2020–2024) on the determinants shaping Bio-entrepreneurial intention, moving beyond categorical reporting of factors toward a system-level understanding of how entrepreneurial intention emerges in biotechnology contexts. Rather than functioning as isolated predictors, the reviewed determinants collectively indicate that Bio-entrepreneurial intention is an emergent outcome arising from the interaction between education-oriented services, institutional and policy frameworks, innovation ecosystems, and individual cognitive dispositions. From this perspective, bio-entrepreneurship should not be understood solely as an individual career choice or a direct extension of scientific capability. Instead, the findings suggest that entrepreneurial intention in biotechnology develops through a co-evolutionary process in which human capital formation, institutional enablement, and innovation infrastructures jointly shape perceptions of feasibility, desirability, and legitimacy of venture creation.

## 5.1. Bio-entrepreneurial Ecosystem and Institutional Support: Bio-entrepreneurial Intention as an Ecosystem-Embedded Process

Rather than functioning as a direct or isolated determinant, Bio-entrepreneurial ecosystem and institutional support emerge from the reviewed literature as a contextual infrastructure within which entrepreneurial intention is formed and sustained. Across the included studies, ecosystems characterized by coordinated networks, access to research and commercialization infrastructure, incubation services, and institutional backing consistently shape the *conditions* under which individuals perceive bio-entrepreneurship as feasible and legitimate. In this sense, ecosystems facilitate the translation of

scientific knowledge into entrepreneurial opportunity by structuring access to resources, information flows, and collaborative relationships (Mago & Merwe, 2023; Audretsch & Belitski, 2022). Empirical evidence suggests that ecosystem-level interventions such as mentorship programs, translational training, and targeted funding schemes do not independently trigger entrepreneurial action but instead reduce uncertainty and perceived risk associated with biotechnology commercialization. By lowering structural and cognitive barriers, these interventions indirectly strengthen Bio-entrepreneurial intention, particularly in science-driven and regulation-intensive contexts (Federico, 2024). Ecosystems that explicitly integrate technological, social, and environmental objectives further reinforce this process by aligning entrepreneurial activity with broader societal and sustainability goals, which enhances the perceived desirability and legitimacy of bio-based ventures (Schweickart et al., 2023).

Critically, the influence of Bio-entrepreneurial ecosystems is most pronounced when they operate in alignment with educational and organizational structures. The reviewed studies indicate that ecosystems function less as standalone drivers and more as integrative coordination platforms that amplify the effects of education, skill development, and institutional affiliation. When educational services, university-based support mechanisms, and policy instruments are embedded within a coherent ecosystem, individual capabilities are more effectively converted into entrepreneurial intention. This highlights the systemic role of ecosystems in aligning scientific capability with market-oriented and societal value creation (Seo, 2020; Hernández-Chea et al., 2021). Accordingly, these findings position Bio-entrepreneurial ecosystems as enabling architectures rather than causal predictors, underscoring that Bio-entrepreneurial intention emerges from the interaction between individual cognition and the surrounding innovation service environment. Such an ecosystem-embedded perspective advances understanding beyond factor-based explanations by emphasizing coordination, complementarity, and contextual embeddedness as central mechanisms shaping entrepreneurial intention in biotechnology.

## 5.2. Bio-entrepreneurial Education: Education as a Translational Service Mechanism

Bio-entrepreneurial education emerges from the reviewed literature as a core translational service that connects scientific knowledge production with entrepreneurial intention formation. Rather than functioning solely as a skills-enhancement tool, education in biotechnology operates as an intermediary mechanism through which individuals reinterpret technical expertise in entrepreneurial terms. Entrepreneurship-oriented science education consistently strengthens opportunity recognition, innovation-oriented cognition, and confidence in navigating commercialization pathways (Boh et al., 2023; Hayter & Link, 2022). Empirical evidence indicates that experiential, interdisciplinary, and practice-based educational models play a pivotal role in reducing the cognitive distance between laboratory research and market application. Pedagogical approaches such as the CEL-BaDis up model explicitly link scientific problem-solving with value creation and commercialization logic, thereby enhancing entrepreneurial readiness among science students and early-career researchers (Atmojo et al., 2022). Similarly, interdisciplinary programs foster entrepreneurial self-efficacy by exposing participants to real-world innovation challenges, regulatory considerations, and market dynamics, enabling a smoother transition from discovery-driven research to venture-oriented thinking (Treanor et al., 2020).

Importantly, the effectiveness of Bio-entrepreneurial education is contingent upon its integration within broader ecosystem and institutional contexts. The reviewed studies suggest that educational interventions are most impactful when embedded within supportive innovation environments that provide access to mentorship, incubation services, and commercialization infrastructure. In such contexts, education functions as a mediating service mechanism that amplifies ecosystem effects by converting structural support into perceived entrepreneurial feasibility and desirability (Dietershagen & Bammann, 2023). From a system-level perspective, Bio-entrepreneurial education does not act as an isolated determinant but as a dynamic interface between individual cognition and bio-innovation service ecosystems. By aligning scientific capability with market-oriented reasoning and institutional support

structures, education facilitates the transformation of latent scientific potential into intentional entrepreneurial engagement. This reinforces the view that Bio-entrepreneurial intention emerges through coordinated interactions between educational services, ecosystem resources, and individual cognitive readiness rather than through isolated factor effects.

## 5.3. University Spin-offs and Academic Commercialization: Institutional Structures and the Activation of Entrepreneurial Pathways

University spin-offs (USOs) emerge in the reviewed literature not merely as commercialization outcomes, but as institutional activation mechanisms through which Bio-entrepreneurial intention is translated into entrepreneurial action. While prior studies emphasize the role of USOs in leveraging proprietary technologies from academic laboratories (Fu et al., 2022; Scuotto et al., 2020), the synthesis of findings suggests that their deeper significance lies in structuring and legitimizing entrepreneurial pathways within science-driven contexts. Academic institutions provide more than tangible resources such as infrastructure, funding access, and technology transfer offices; they also confer legitimacy and cognitive validation that are critical in high-risk, regulation-intensive biotechnology sectors. This institutional legitimacy reduces uncertainty, lowers perceived barriers, and reinforces individuals' confidence in pursuing venture creation (Gertsch & Chicca, 2024; Kwon & Lee, 2023). As a result, spin-off structures function as enabling environments that transform entrepreneurial intention from a cognitive disposition into a feasible and socially sanctioned course of action.

From a system-level perspective, university spin-offs operate as boundary-spanning institutional structures that align academic research, policy priorities, and market needs. They connect educational services, ecosystem resources, and regulatory frameworks into a coherent commercialization pathway. This integrative role is particularly salient in emerging and transitional economies, where universities often act as central innovation anchors compensating for fragmented markets and underdeveloped private-sector ecosystems (Naczyk & Ban, 2022). In such contexts, academic commercialization mechanisms reinforce Bio-entrepreneurial intention indirectly by reducing structural, informational, and coordination barriers. Rather than acting as independent determinants, university spin-offs amplify the effects of education, ecosystem support, and policy frameworks, illustrating how Bio-entrepreneurial intention emerges through institutionalized pathways that bridge scientific capability and entrepreneurial opportunity.

## 5.4. Government and Policy Support: Policy Frameworks as Contextual Enablers

Government and policy support emerge in the reviewed literature not as direct motivational drivers, but as contextual enablers that structure the opportunity landscape within which Bio-entrepreneurial intention develops. Rather than influencing individual decision-making in isolation, policy frameworks operate at the macro level by shaping regulatory certainty, access to resources, and long-term strategic orientation in the life sciences sector. Policy mixes combining financial incentives, public grants, and regulatory flexibility function as coordination instruments that reduce systemic uncertainty and lower entry barriers for science-based entrepreneurship (Wang et al., 2023). Empirical cases from Ecuador and China illustrate how government-supported green entrepreneurship initiatives and innovation-oriented biotechnology policies align sustainability objectives with entrepreneurial activity, thereby reinforcing the perceived societal relevance of bio-based ventures (Pardo-del-Val et al., 2024).

Beyond material support, policy frameworks serve a critical signaling function. By prioritizing biotechnology, health innovation, and environmental sustainability within national development agendas, governments convey normative legitimacy and social endorsement of bio-entrepreneurship as a desirable and valued economic activity. This signaling effect is particularly salient for nascent bioentrepreneurs operating in high-risk and regulation-intensive environments, where perceived institutional backing influences confidence and intention formation. Importantly, the influence of policy support is amplified through its interaction with educational institutions and innovation ecosystems.

When aligned with university commercialization structures and entrepreneurship education, policy frameworks reinforce perceptions of feasibility, long-term viability, and societal contribution. In this sense, government support contributes to the normalization of bio-entrepreneurship as a legitimate career pathway, embedding individual entrepreneurial intention within a broader, coordinated bio-innovation system.

### 5.5. Entrepreneurial Attitude, Social Motivation, and Environmental Consciousness: Individual Cognition and Motivational Alignment

Psychological determinants, particularly entrepreneurial attitude, social motivation, and environmental consciousness, emerge as micro-level cognitive mechanisms through which system-level conditions are interpreted and internalized. Rather than operating independently, these individual-level factors shape how educational services, institutional arrangements, and ecosystem signals are translated into Bio-entrepreneurial intention. The reviewed studies indicate that individuals are more likely to develop Bio-entrepreneurial intention when entrepreneurial activity aligns with their personal values, professional identity, and perceived societal contribution. Entrepreneurial attitudes oriented toward innovation, autonomy, and impact function as cognitive filters that render biotechnology ventures meaningful and desirable career pathways (Marlow et al., 2020). In parallel, pro-social and ethical motivations reinforce commitment and persistence, particularly in bio-based innovation contexts characterized by long development cycles and high uncertainty (Martins et al., 2020).

Environmental consciousness further strengthens this motivational alignment by embedding bio-entrepreneurship within broader sustainability and societal narratives. The increasing integration of ecological and social considerations into entrepreneurial decision-making reflects the rise of purpose-driven bio-entrepreneurship, where intention formation is shaped not only by economic opportunity but also by perceived contribution to sustainable development goals (UNEP, 2021). In this sense, environmental and social motivations do not merely complement entrepreneurial attitude; they anchor Bio-entrepreneurial intention within legitimacy, responsibility, and long-term value creation. Importantly, these psychological drivers mediate the influence of structural and institutional inputs. Ecosystem support, education, and policy frameworks exert their strongest effects when individuals cognitively perceive coherence between innovation outcomes and personal meaning. This highlights that Bio-entrepreneurial intention is not a direct response to opportunity structures, but an outcome of motivational alignment between individual cognition and system-level signals.

### 5.6. Entrepreneurial Self-Efficacy and Skill Development: A Cognitive Bridge between Systems and Action

Entrepreneurial self-efficacy plays a central integrative role in Bio-entrepreneurial intention by linking external support structures to internal readiness for action. Rather than functioning as an isolated psychological trait, self-efficacy emerges from cumulative exposure to education, mentorship, and ecosystem participation. The reviewed evidence demonstrates that structured learning environments, experiential training, and hands-on commercialization activities significantly enhance confidence in entrepreneurial competencies, including opportunity evaluation, project management, and innovation leadership (Atmojo et al., 2022). Such confidence transforms technical expertise into perceived feasibility, enabling individuals to envision themselves as capable actors within bio-innovation systems. Self-efficacy thus mediates the relationship between educational and ecosystem-level inputs and intention formation. While education provides knowledge and skills, and ecosystems offer resources and legitimacy, self-efficacy represents the cognitive mechanism through which these inputs are converted into entrepreneurial intention. This finding reinforces the argument that fostering bio-entrepreneurship requires not only structural support but also deliberate interventions that enhance individuals' perceived capability to navigate scientific, regulatory, and market complexities (Boh et al., 2023; Treanor et al., 2021).

## 5.7. Integrated Interpretation: Bio-entrepreneurial Intention as a System-Level Outcome

The reviewed literature collectively conceptualizes Bio-entrepreneurial intention not as the result of isolated determinants, but as an emergent outcome of interdependent educational, institutional, psychological, and policy-level processes operating within bio-innovation service systems. This perspective moves beyond linear or single-factor explanations and frames intention formation as a dynamic interaction between individual cognition and structured innovation environments. Across the reviewed studies, education and ecosystem support consistently function as mutually reinforcing service mechanisms. Educational interventions build scientific, entrepreneurial, and translational capabilities, while enabling ecosystems—through infrastructure, mentorship, and institutional coordination—amplify the effectiveness of these learning processes. Intention formation is strongest where educational services are embedded within supportive innovation ecosystems, highlighting the interdependence between capability development and opportunity realization (Treanor et al., 2021; Dietershagen & Bammann, 2023). Institutional arrangements, particularly university spin-offs and academic commercialization structures, operate as activation mechanisms within this system. These structures translate latent scientific and entrepreneurial potential into feasible venture pathways by providing legitimacy, organizational support, and access to innovation logistics. In parallel, policy frameworks shape the broader opportunity landscape by signaling strategic priorities, reducing uncertainty, and normalizing bio-entrepreneurship as a viable and socially valued career trajectory (Kwon & Lee, 2023).

At the individual level, entrepreneurial self-efficacy, social motivation, and environmental consciousness serve as cognitive integration mechanisms that align external system inputs with personal values, perceived feasibility, and long-term commitment. These psychological drivers mediate how individuals interpret educational experiences, institutional signals, and policy incentives, anchoring Bio-entrepreneurial intention within both capability and purpose (UNEP, 2021). Thus, the findings advance a system-oriented interpretation of Bio-entrepreneurial intention, positioning it as a relational and process-driven phenomenon rather than a static individual disposition. Intention emerges through the alignment of education services that build competence, institutional structures that enable translation, policy environments that shape opportunity conditions, and individual cognition that integrates motivation and perceived control. This integrated interpretation represents the central theoretical contribution of the review. By shifting the analytical focus from enumerating determinants to explaining their interaction, the study reframes Bio-entrepreneurial intention as a product of coordinated service ecosystems. Accordingly, fostering bio-entrepreneurship requires aligned strategies across education design, institutional support, ecosystem development, and individual capability formation, offering a coherent foundation for policy, academic programming, and ecosystem governance aimed at sustainable bio-innovation.

## 5.8. Limitations

This study has several limitations that should be considered when interpreting its findings. First, while the review highlights conceptual fragmentation in the literature, it is important to note that the study does not empirically test a system-level model of Bio-entrepreneurial intention. The contribution is therefore primarily conceptual and agenda-setting, aiming to identify gaps and synthesize determinants rather than establish causal relationships. Future research is needed to develop and empirically validate integrative models that capture the dynamic interactions between psychological, institutional, and ecosystem-level factors. Second, the literature search was conducted exclusively in the Scopus database. Although Scopus provides broad coverage of entrepreneurship and biotechnology journals, this approach may have excluded relevant studies indexed in other databases such as Web of Science, PubMed, or specialized regional repositories. As a result, some determinants or contextual insights may not have been captured. Future reviews could extend the search to additional databases to provide a more comprehensive synthesis. Third, the final evidence base included only seven studies, reflecting both the emerging nature of research on Bio-entrepreneurial intention and the scarcity of system-level

investigations. This small number of studies limits the strength and generalizability of the conclusions. Accordingly, the findings should be interpreted as exploratory and intended to guide future research rather than serve as definitive evidence. Expanding the empirical base and conducting longitudinal or cross-context analyses will be essential to strengthen the robustness of future insights.

# 6. Conclusion

This systematic literature review examined the determinants shaping entrepreneurs' intentions to engage in bio-entrepreneurship and clarified how psychological, educational, institutional, and policy-related factors interact within bio-innovation service ecosystems. Rather than attributing intention formation to isolated individual traits or single institutional inputs, the synthesis indicates that Bio-entrepreneurial intention emerges from the interaction between individual cognition and coordinated educational services, institutional arrangements, and policy-driven innovation infrastructure. This system-oriented interpretation responds to recent calls to move beyond fragmented, single-level explanations of entrepreneurial intention in science-based and knowledge-intensive sectors (Autio et al., 2021; Audretsch & Belitski, 2022). The review shows that key determinants, such as entrepreneurship education, ecosystem support mechanisms, university spin-offs, and government policies, primarily function as enabling service structures rather than direct causal drivers of intention. These structures shape the conditions under which entrepreneurial motivation develops by reducing uncertainty, enhancing perceived feasibility, and legitimizing entrepreneurial engagement through knowledge translation, innovation logistics, and coordinated support across actors in the bioeconomy (Hernández-Chea et al., 2021; Seo, 2020). At the individual level, entrepreneurial attitude, self-efficacy, and value-driven motivations, particularly social and environmental orientations, mediate how such systemic inputs are internalized, aligning personal aspirations with socially relevant and sustainable innovation goals (Martins et al., 2020; UNEP, 2021).

Importantly, this review does not propose a new conceptual framework. Instead, its contribution lies in offering an integrative, theory-informed synthesis that clarifies how diverse determinants operate together within bio-innovation service systems. Given the limited and emerging evidence base, the findings should be interpreted as exploratory and agenda-setting rather than generalizable. Nevertheless, the qualitative integration remains meaningful by revealing consistent patterns of interaction, particularly the reinforcing relationships between education, ecosystem readiness, institutional legitimacy, and individual entrepreneurial cognition, across the reviewed studies (Treanor et al., 2021; Dietershagen & Bammann, 2023). From a practical perspective, the findings suggest that fostering Bio-entrepreneurial intention requires coordinated strategies that align educational design, innovation services, technology transfer mechanisms, and policy instruments. Universities, incubators, and policymakers should focus on strengthening service interfaces, such as structured commercialization pathways, interdisciplinary training models, and data-enabled incubation platforms, that facilitate the movement of knowledge, capital, and technology from research environments to markets. Such service-oriented approaches are particularly critical in high-uncertainty and regulation-intensive biotechnology contexts (Kwon & Lee, 2023; Federico, 2024). Finally, future research should expand methodological diversity through longitudinal designs, cross-regional comparisons, and deeper engagement with informatics and innovation logistics perspectives. Broader empirical coverage would enable more robust theorization of how Bio-entrepreneurial intention evolves within complex service ecosystems. Advancing this research agenda can support the design of resilient and sustainable bio-innovation systems that contribute to economic development while addressing pressing societal and environmental challenges.

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## References

Alshanfari, N., Hassan, H., & Migin, M. W. (2021). Entrepreneurial intention to venture into flea market retailing: An empirical study in Oman. The Journal of Asian Finance, Economics and Business, 8(6), 163-168.

Alvarez-Risco, A., Mlodzianowska, S., García-Ibarra, V., Rosen, M. A., & Del-Aguila-Arcentales, S. (2021). Factors affecting green entrepreneurship intentions in business university students in COVID-19 pandemic times: Case of Ecuador. Sustainability, 13(11), 6447.

Atmojo, I. R. W., Ardiansyah, R., & Saputri, D. Y. (2022). Empowering science-based entrepreneurship (SciPreneur) skills through CEL-BaDis up learning model on food biotechnology materials. International Journal of Instruction, 15(3), 83-102.

Audretsch, D. B., & Belitski, M. (2022). A strategic alignment framework for the entrepreneurial university. Industry and Innovation, 29(2), 285-309.

Baste, I. A. (2021). Making peace with nature: a scientific blueprint to tackle the climate, biodiversity and pollution emergencies.

Batista-Canino, R. M., Santana-Hernández, L., & Medina-Brito, P. (2023). A scientometric analysis on entrepreneurial intention literature: Delving deeper into local citation. Heliyon, 9(2).

Bettanti, A., Lanati, A., & Missoni, A. (2022). Biopharmaceutical innovation ecosystems: a stakeholder model and the case of Lombardy. The Journal of Technology Transfer, 47(6), 1948-1973.

Birch, K. (2020). Technoscience rent: Toward a theory of rentiership for technoscientific capitalism. Science, technology, & human values, 45(1), 3-33.

Boh, W. F., Huang, C. J., & Wu, A. (2020). Investor experience and innovation performance: The mediating role of external cooperation. Strategic Management Journal, 41(1), 124-151.

Dietershagen, J., & Bammann, H. (2023). Opportunities for youth in the bioeconomy: Opportunities and barriers for youth employment and entrepreneurship in the emerging bioeconomy sectors (Vol. 30). Food & Agriculture Org.

Fu, X., Buckley, P. J., Sanchez-Ancochea, D., & Hassan, I. (2021). The world has a unique opportunity: Accelerating technology transfer and vaccine production through partnerships. Journal of International Business Policy, 5(3), 406.

Gertsch, J., & Chicca, A. (2024). CNS Drug Discovery in Academia: Where Basic Research Meets Innovation. ChemBioChem, 25(19), e202400397.

Global Market Insights. Biotechnology market size, share, and trends analysis report. [Internet]. 2024 [cited 2024 Nov 26]. Available from: https://www.gminsights.com/industry-analysis/biotechnology-market

Gurunani SG, Mangrulkar SV, Jawal DT, Chaple DR. Bio-entrepreneurship: A venture for commercializing biotechnological knowledge. Int J Clin Anal Appl Pharm. 2021;5. doi:10.18231/J.IJCAAP.2021.009

Hayter, C. S., & Link, A. N. (2022). From discovery to commercialization: Accretive intellectual property strategies among small, knowledge-based firms. Small Business Economics, 58(3), 1367-1377.

Hernández-Chea, R., Mahdad, M., Minh, T. T., & Hjortsø, C. N. (2021). Moving beyond intermediation: How intermediary organizations shape collaboration dynamics in entrepreneurial ecosystems. Technovation, 108, 102332.

Khan, S., Rahman, H. M., Khan, N., & Lenga, O. T. S. (2025) Factors Influencing Digital Security in Malaysia's Journey through Industry Revolution 5.0. Journal of Logistics, Informatics and Service Science, 12(6).

Kumar, R. K., Pasumarti, S. S., Figueiredo, R. J., Singh, R., Rana, S., Kumar, K., & Kumar, P. (2024). Innovation dynamics within the entrepreneurial ecosystem: a content analysis-based literature review. Humanities and Social Sciences Communications, 11(1), 1-15.

Kwon, G. J., & Lee, W. I. (2023). Evolution of innovation clusters from park-type to network-type: Focusing on innovation cluster analysis and strategic direction setting. Journal of Logistics, Informatics and Service Science, 10(1), 221-236.

Lisboa, E., & Souza, C. C. (2023). Entrepreneurial Intention in Biotechnology Bachelor Courses. In Academy of Management Proceedings (Vol. 2023, No. 1, p. 14146). Briarcliff Manor, NY 10510: Academy of Management.

Mago, S., & van der Merwe, S. (2023). Exploring entrepreneurial ecosystems in developed countries: A systematic review. Sage Open, 13(4), 21582440231217886.

Martins, I., & Perez, J. P. (2020). Testing mediating effects of individual entrepreneurial orientation on the relation between close environmental factors and entrepreneurial intention. International Journal of Entrepreneurial Behavior & Research, 26(4), 771-791.

Micol, F., Battaglia, D., & Ughetto, E. (2025). Private entrepreneurial support organizations in European fintech entrepreneurial ecosystems. The Journal of Technology Transfer, 50(3), 1170-1198.

Naczyk, M., & Ban, C. (2022). The Sputnik V moment: biotech, biowarfare and COVID-19 vaccine development in Russia and in former Soviet satellite states. East European Politics, 38(4), 571-593.

Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & McKenzie, J. E. (2021). PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. bmj, 372.

Pardo-del-Val, M., Cerver-Romero, E., Martinez-Perez, J. F., & Mohedano-Suanes, A. (2025). From startup to scaleup: Public policies for emerging entrepreneurial ecosystems. Journal of the Knowledge Economy, 16(2), 7874-7907.

Renko, M., Yli-Renko, H., & Denoo, L. (2022). Sold, not bought: Market orientation and technology as drivers of acquisitions of private biotechnology ventures. Journal of Business Venturing, 37(1), 106022.

Ruiz-Alba, J. L., Guzman-Parra, V. F., Vila Oblitas, J. R., & Morales Mediano, J. (2021). Entrepreneurial intentions: a bibliometric analysis. Journal of Small Business and Enterprise Development, 28(1), 121-133.

Sadeghi, A. H., Koldeweij, C., Trujillo-de Santiago, G., Tannazi, M., Hosseinnia, N., Loosbroek, O. V., ... & Alvarez, M. M. (2021). Social non-profit bio-entrepreneurship: current status and future impact on global health. Frontiers in Public Health, 9, 541191.

Schweickart, T., Hill-Whilton, Z., Chitale, S., Cobos, D., Gilon-Yanai, M., Achuonjei, J., ... & Gold-von Simson, G. (2023). The biomedical entrepreneurship skills development program for the advancement of research translation: foundations of biomedical startups course, metrics, and impact. Journal of Clinical and Translational Science, 7(1), e77.

Scuotto, V., Del Giudice, M., Garcia-Perez, A., Orlando, B., & Ciampi, F. (2020). A spill over effect of entrepreneurial orientation on technological innovativeness: an outlook of universities and research based spin offs. The Journal of Technology Transfer, 45(6), 1634-1654.

Seo, R. (2020). Entrepreneurial collaboration for R&D alliance performance: a role of social capital configuration. International Journal of Entrepreneurial Behavior & Research, 26(6), 1357-1378.

Sieg, P., Posadzińska, I., & Jóźwiak, M. (2023). Academic entrepreneurship as a source of innovation for sustainable development. Technological Forecasting and Social Change, 194, 122695.

Sinha, D., Singh, A., & Kumar, P. (2021). Introduction to bio-entrepreneurship. In Bio-entrepreneurship and Transferring Technology Into Product Development (pp. 1-21). IGI Global Scientific Publishing.

Supriatno, B., Kusumawaty, D., Tallei, T. E., Emran, T. B., & Suwandi, T. (2023). Introducing CAPAB (L) E: A Learning Model to Promote Prospective Biology Teacher's Entrepreneurship Skills. Jurnal Pendidikan IPA Indonesia, 12(2), 265-275.

Tan, L. P., Le, A. N. H., & Xuan, L. P. (2020). A systematic literature review on social entrepreneurial intention. Journal of Social Entrepreneurship, 11(3), 241-256.

Tonon, A. P., & Amaral, C. S. T. (2024). Enhancing the entrepreneurial process in biotechnology.

Treanor, L., Noke, H., Marlow, S., & Mosey, S. (2021). Developing entrepreneurial competences in biotechnology early career researchers to support long-term entrepreneurial career outcomes. Technological Forecasting and Social Change, 164, 120031.

Treanor, L., Noke, H., Marlow, S., & Mosey, S. (2021). Developing entrepreneurial competences in biotechnology early career researchers to support long-term entrepreneurial career outcomes. Technological Forecasting and Social Change, 164, 120031.

Veena, M. (2024). Recent Developments and Challenges in COVID-19 Care. Innovational: Journal of Nursing and Healthcare, 21-25.

Wang, H., Zhao, T., Cooper, S. Y., Wang, S., Harrison, R. T., & Yang, Z. (2023). Effective policy mixes in entrepreneurial ecosystems: A configurational analysis in China. Small Business Economics, 60(4), 1509-1542.

XQ, F. (2020). Venture capital investment in university spin-offs: Evidence from an emerging economy.