

Project Information and Status

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1. Executive Summary

Over the last decade, the global vaccine field has rapidly advanced, driven by a combination of novel technological tools, new platforms to design, deliver, and manufacture vaccines as well as a massive influx of investment driven by the recent COVID-19 pandemic. These changes have left an enhanced vaccine R&D landscape with a range of new tools and approaches that better target a wide range of diseases of both commercial and global health importance. For example, advances in structural biology have led to the licensing of highly effective RSV vaccines after more than 50 years of failures, adjuvanted vaccines such as Shingrix have enabled the ability to protect aging adults at efficacy levels not seen in previous vaccines, while mRNA platforms enabled the unprecedented development of COVID-19 vaccines in less than a year. As technologies continue to improve, application to a range of disease targets can yield advances. At the same time, the pace of innovation continues to push forward through the use of AI technologies which are now being applied across the product development continuum, from AI-assisted antigen design, data analysis to the optimization of clinical studies, and tools like systems immunology to enhance our ability to understand and target specific components of the immune systems to drive better protection and public health outcomes. It is within this global context where the Japanese vaccine industry simultaneously plays the roles of innovator, collaborator, and borrower within this international ecosystem. Over the coming years, Japanese scientific institutions and funders have the opportunity to leverage domestic strengths to continue to address diseases both of commercial and global health importance, while increasingly utilizing and building upon technologies emanating outside of Japan to further the impact of Japanese R&D.

In this context, KPMG, Peak Value and Next Frontier Advisors (NFA) have undertaken this GHIT-funded project to systematically identify, assess, and analyze Japan-originated technologies that have significant potential to contribute to global health innovation, with a particular focus on vaccines and vaccine-related platforms and enabling technologies. Five thematic areas emerged that reflect key areas of the Japanese R&D ecosystem including: 1) Mucosal immunity strategies; 2) Vaccine platform and adjuvant technologies; 3) Computationally enabled vaccine design; 4) Manufacturing and access innovation; and 5) Vaccines for high burden and neglected diseases.

Key findings from the project include: 1) Japan's vaccine ecosystem demonstrates particular strength in enabling technologies; 2) Platform technologies are increasingly being validated through diseases with strong commercial or pandemic relevance; 3) Japan's innovation pipeline may extend beyond publicly visible technologies; and 4) GHIT is well positioned to accelerate the application of enabling technologies to diseases of greatest global health need.¹

¹ The technologies underlying the findings are outlined in **Table 1**.

Finally, major recommendations that emerged from the project include: 1) Prioritize investments in technologies that demonstrate potential for cross-pathogen applicability; 2) Invest in emerging technologies with transformative potential; 3) Address translational bottlenecks to ensure that innovation translates to public health impact; and 4) Continue to monitor Japan's enabling technology landscape to identify new and emerging technologies.

2. Background and Objectives

2.1 Background: Global Health and the Vaccine Landscape

Global health continues to face persistent and emerging challenges, including infectious diseases such as tuberculosis, malaria, neglected tropical diseases (NTDs), ongoing outbreaks of high-threat pathogens such as the Bundibugyo ebolavirus, as well as the growing risk of future pandemics from novel respiratory viruses. While significant progress has been made through vaccine development and deployment, substantial gaps remain in terms of access, scalability, and preparedness for novel pathogens.

In recent years, attention has increasingly shifted toward platform and enabling technologies that can support vaccine research, development, and manufacturing across multiple disease areas. These technologies—such as novel antigen design platforms, delivery systems, manufacturing processes, and computational design approaches—have the potential to enhance efficiency, adaptability, and long-term sustainability of global vaccine innovation ecosystems.

Against this backdrop, there is a growing need to systematically identify and assess technologies that can strengthen global vaccine R&D pipelines and contribute to equitable access, particularly in low- and middle-income countries (LMICs).

2.2 Rationale for Focusing on Japanese Innovations

Japan has developed a diverse range of advanced scientific and technological capabilities across academia, public research institutes, and the private sector, including strengths in biotechnology, materials science, diagnostics, manufacturing engineering, and digital technologies.

Yet, the COVID19 pandemic revealed that vaccine R&D capabilities in Japan have been stagnant for over a decade and that Japanese innovations with potential relevance to global health and vaccines were not invested nor leveraged to be of equal footing with international product development

pathways, including PDPs, global pharmaceutical companies, international funders, and other global health R&D partners. In addition to vaccine R&D being low priority for Japanese government as well as major Japanese pharmaceuticals this was partly due to perceived information gaps, limited international visibility, and insufficient linkage between domestic innovation ecosystems and global health stakeholders. Post COVID19, however, investments in vaccine R&D have accelerated significantly both by public and private sectors in Japan, and therefore, there is a strong rationale for conducting a systematic landscape analysis of the existing and emerging innovations in Japan at this juncture.

Focusing on Japanese innovations, this project aims to:

- Identify technologies with potential global health impact
- Bridge information and communication gaps between Japanese innovators and global product development entities including PDPs and industry partners
- Enhance Japan's contribution to global vaccine R&D in a manner aligned with international public health priorities

This approach is consistent with the broader objective of strengthening global health innovation through diversified and inclusive technology sourcing.

2.3 Objectives and Scope of the Project

The objective of this project is to systematically identify, assess, and analyze existing and emerging Japanese innovation that has the potential to contribute to global health innovation, with a particular focus on vaccines and vaccine-related platforms and enabling technologies.

The scope of the project includes:

- Comprehensive desktop research using publicly available sources, including academic literature, patent databases, global health databases, and business information platforms
- Identification of a broad long list of candidate technologies, followed by structured screening and shortlisting
- Qualitative validation through expert interviews with relevant stakeholders in academia, research institutions, and related organizations
- Analysis of the relevance of identified technologies to GHIT's strategic priorities, including target diseases, access and equity considerations, and potential applicability to PDP activities

The project includes disease-specific products but emphasizes cross-cutting technologies that can support multiple vaccine and global health innovation pathways.

2.4 Relevance to GHIT Mission

This project is designed to directly support the mission of the Global Health Innovative Technology (GHIT) Fund by strengthening the upstream identification and assessment of technologies that may contribute to future investment opportunities, partnerships, and product development collaborations. By providing GHIT with a structured landscape of vaccine-related technologies that currently exist in Japan, the project contributes to:

- Expanding the pipeline of innovation opportunities relevant to GHIT investments
- Improving alignment between domestic R&D assets and GHIT's strategic focus areas
- Facilitating informed engagement between Japanese technology holders and a broader range of global health R&D partners

In this sense, the project functions as a foundational, evidence-based input that enhances GHIT's ability to catalyze partnerships between Japanese innovators and global health R&D partners, ultimately supporting the development of vaccines for diseases of global public health importance.

2.5 Limitation of Study

Technologies were evaluated using publicly available information against a common set of strategic, scientific, access, and organizational criteria to enable consistent comparison across a diverse portfolio. However, the technologies varied considerably in maturity, available evidence, and intended application, limiting direct like-for-like comparison. Quantitative scores, when used, were dependent on the quantity and quality of publicly available information and should therefore be interpreted as indicative rather than definitive. The assessment is intended to identify promising areas for further exploration and investment rather than to rank technologies based on their ultimate likelihood of success.

3. Methodology

3.1 Overall Approach

The research primarily targeted Japanese companies and research institutions, while remaining attentive to the global context and potential collaboration by Japanese partners with vaccine R&D efforts underway outside Japan. This market and landscape study of vaccine and vaccine related technologies was conducted over a six-month period from November 2025 to May 2026.

Based on technical information derived from a combination of desktop research using publicly available sources and interviews, the technology selection proceeded in four stages, namely

development of Master List, Long List, and Short List, which ultimately led to the proposal of selected candidates. The specific procedures for the selection are described below.

3.2 Data Sources

The technology assessment was conducted primarily through desktop research using publicly available information and was supplemented by targeted interviews with venture capital firms, technology licensing organizations and other experts in the field. Comprehensive database searches were also performed to identify technologies that had yet to gain wide recognition in the global health arena but showed strong potential (e.g., startup information and conference abstracts). The specific information sources are as follows:

- Japan Agency for Medical Research and Development (AMED) / Strategic Center of Biomedical Advanced Research and Development for Preparedness and Response (SCARDA)
- International global health R&D funding organizations: Wellcome Trust, Gates Foundation, PATH, Coalition for Epidemic Preparedness Innovations (CEPI)
- General Database : The National Center for Industrial Property Information and Training (INPIT)/Japan Platform for Patent Information (Jplat-Pat), Crunchbase
- Academic Literature and Societies: CiNii, Japanese vaccine-related academic societies
- Interviews with the following selected organizations and experts:
 - Venture capital : University of Tokyo Edge Capital (UTEC), Japan Investment Corporation (JIC), AAIC, European research organization
 - Technology licensing organizations : The University of Tokyo's Technology Licensing Organization (TODAI TLO), TLO-KYOTO, Tohoku Techno Arch

3.3 Master List Creation

The team compiled key words and search terms representing core components of traditional vaccine design and new technologies that now have significant influence in vaccine R&D to be applied in the desk research. To identify key words aligned with global trends, NFA mined reports, white papers and historical data to include emerging terms that would surface new and novel approaches.

Candidate technologies were collected through desktop research and interviews based on the aforementioned information sources, and a Master List of the identified technologies was compiled. For vaccine technologies, disease-specific exclusion criteria were not applied, in recognition that a technology developed for one disease may be extensible to vaccine development for other diseases.

In addition to vaccines themselves, platform and enabling technologies relevant to vaccines were also broadly collected.

For each technology, the technology name, source of identification, developer/owner, type of technology (Platforms and Antigen Design; Adjuvants and Immune Modulators; Delivery and Expression Systems; Vaccine-Adjacent Technologies; Analytic and Technical Enablers), a concise explanation/summary, target disease, development timeline, and current stage of the technology were documented.

3.4 Long List Creation

The Master List was narrowed through an expert review conducted by NFA, drawing on the team's understanding of the global vaccine innovation landscape. Technologies were assessed based on high-level descriptions to identify those that broadly aligned with GHIT's strategic priorities, balancing scientific innovation with the potential to address high-burden diseases, strengthen pandemic preparedness, improve vaccine development and manufacturing, and enhance equitable access in LMICs. Where information was insufficient to decide, follow-up research was conducted. This process resulted in a long list of candidates that warranted more detailed evaluation.

The long list was evaluated holistically to identify areas of emerging scientific strength or strategic relevance within the Japanese vaccine ecosystem: AI/Computation approaches; Manufacturing/Access; Mucosal Immunity; Pathogen-specific approaches; vaccine platform innovation. Technologies within the long list were then categorized within these 5 thematic areas.

3.5 Short List Creation & Interview Selection

The long list of technologies was next evaluated using a combined quantitative and qualitative assessment framework that was developed based on GHIT priorities. The four dimensions evaluated were:

- Impact: Degree to which the technology targets high-burden diseases or unmet global health needs.
- Innovation: Extent of scientific differentiation and potential to advance beyond existing approaches.
- Access: Feasibility of affordable, scalable deployment in LMIC settings.
- Organization and partnership: Strength of Japanese involvement, institutional capacity and track record, to support development.

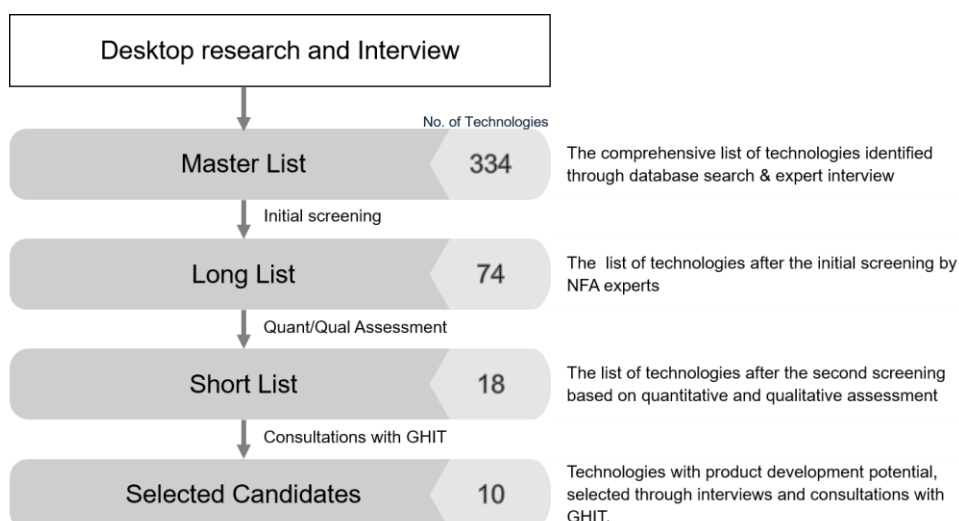
While a structured scoring rubric was applied across predefined criteria, the diversity of technology types and stages of development limited direct, like-for-like quantitative comparison. To address this, quantitative scores were complemented by expert qualitative assessment across the four dimensions to provide a more balanced evaluation of scientific promise, strategic relevance, and potential contribution to GHIT's mission. This approach reduced bias toward more mature technologies with greater publicly available evidence while enabling consistent comparison across a heterogeneous portfolio.

While overall scoring informed the selection process, NFA also sought to ensure representation across the major thematic areas and ensure strategic alignment with GHIT's mission and potential for global health impact.

4. Result

4.1 Results of Screening

Figure shows the selection process in a flowchart. Research of academic database (section 3.2) in conjunction with expert interview yielded a total of 334 technologies, of which 74 technologies were selected for detailed qualitative and quantitative assessment. Based on the findings of the qualitative and quantitative assessment, 18 technologies were selected for inclusion in the Short List, of which 10 technologies were selected as potential technologies for product development based on both scoring and input from internal consultation with GHIT.



4.2 Master List Summary/Analysis

We identified a total of 334 technologies.

- **Technology Type:** within Platforms and Antigen Design, mRNA/DNA technologies are the most common, which is not surprising, given that related technologies have advanced rapidly during the COVID-19 pandemic. Within Adjuvants and Immune Modulators, mucosal or cytokine-based enhancers were most represented, and within Delivery and Expression Systems, oral/nasal/mucosal delivery were the most frequent. Taken together, these patterns may indicate a research trend toward induction of local immunity at target tissues (e.g., the upper respiratory tract, gastrointestinal tract). It could also indicate a trend toward capitalizing on the advantages of needle-free administration and streamlined supply chains.
- **Institutional:** Among the institutions holding the listed technologies, universities account for half, followed by research institutes. We also observe technologies from pharmaceutical companies, startups, and others (e.g., non-pharmaceutical private-sector companies). This make-up reflects the team's concerted effort to ensure this landscape review is comprehensive and not unduly skewed toward any one type of organization. In terms of specific organizations, the most represented is the Japan Institute for Health Security (JIHS), with universities next most prominent.
- **Pathogens:** As for target diseases, SARS-CoV-2 and influenza were most common, which is consistent with the global R&D vaccine pipeline. In addition, diseases that have been a primary focus of GHIT, such as malaria, tuberculosis, and NTDs (e.g., dengue and rabies), also rank relatively high. We also see a trend toward broad vaccine development that is not tied to a specific disease or that targets multiple diseases. Distribution of included technologies can be found in **Appendix 1**.

4.3 Long List Summary/Analysis

We narrowed the list to a total of 74 technologies. Within Platforms and Antigen Design, recombinant protein is the most common, and viral vectors and virus-like particles are also prominent. By contrast, mRNA/DNA also appears frequently but is not dominant, which differs from the Master sheet. In Adjuvants and Immune Modulators, mucosal or cytokine-based enhancers are most frequently observed. In Delivery and Expression Systems, oral, nasal, and other mucosal routes remain the most common, and vector or replicon expression systems and nanoparticle or lipid carriers are also often observed. These patterns are consistent with the Master sheet and suggest that these adjuvant and delivery types are important even when the platform is not mRNA/DNA. The distribution of technology

holders has not changed substantially, although the share of research institutes has increased slightly. The distribution of target diseases does not differ markedly from the Master sheet. Distribution of included technologies can be found in **Appendix 2**.

The long-list was evaluated holistically to identify five thematic areas of emerging scientific strength and strategic relevance within the Japanese vaccine ecosystem: AI/Computation approaches; Manufacturing/Access; Mucosal Immunity; Pathogen-specific approaches; vaccine platform innovation. These areas align with a global trend of increasing investments in these technologies.

4.4 Short List Summary/Analysis

From the Long List, 18 high potential technologies were identified across the five thematic areas to make up the Short List.

- Mucosal Immunity Strategies: Technologies designed to induce protective immune responses at the primary sites of pathogen entry
- Vaccine Platform and Adjuvant Technologies: Systems to enable efficient antigen delivery, expression, and immune activation across multiple diseases.
- Computationally Enabled Vaccine Design: Integration of AI, structural biology, and high-throughput tools to optimize antigen selection and immune targeting.
- Manufacturing and Access Innovation Approaches that improve scalability, affordability, and deployment of vaccines, particularly in LMIC settings
- Vaccines for High-burden and Neglected Diseases

The short list was composed mainly of platform and enabling technologies, rather than conventional single-product vaccine candidates. By primary technology category, the 18 technologies consisted of five mucosal vaccine technologies, five broader vaccine platform technologies, four AI- and computationally enabled vaccine design technologies, three manufacturing and access-related technologies, and one pathogen-specific vaccine candidate. This summary is based on primary categorization, noting that some technologies spanned multiple categories.

Table 1: 18 Shortlisted Technologies

No.	ID ²	Technology	Organization	Category	Stage	Technology Details
1	14	Bacterial Membrane Vesicle (MV/OMV) Vaccine Platform	Japan Institute for Health Security (JIHS)	Mucosal / Platform	Basic research or development	Bacterial membrane vesicles as a broad next-gen mucosal platform.
2	49	Next-generation nanogel spray vaccine targeting respiratory viruses	Chiba University	Mucosal	Preclinical	Cationic nanogel nasal spray driving respiratory IgA and systemic immunity.
3	155	cCHP Nanogel Nasal RSV Vaccine (SHe-PspA)	The University of Tokyo / Chiba University	Mucosal	Preclinical	cCHP nasal nanogel targeting conserved RSV SHe to trigger mucosal IgA.
4	57	Polyplex mRNA Mucosal Vaccine	The University of Tokyo	Mucosal / Platform	Basic research or development	Polymer–mRNA polyplexes delivering antigen to airway mucosa for strong IgA.
5	70	mRNA vaccine (nanoball)	Nagasaki University	Mucosal	Basic research or development	SARS-CoV-2 mRNA in inhaled “nanoballs” for lung and systemic immunity.
6	94	Transgenic rice-based oral vaccine platform (MucoRice).	Chiba University	Mucosal / Platform	Basic research or development	Transgenic rice (M2e/SHe) for oral, cold-chain-free flu and RSV immunity.
7	132	Marker-free rice-based oral vaccine platform (MucoRice line 19A).	Chiba University	Manufacturing / Access	Preclinical	Marker-free rice line for LED-hydroponic, cold-chain-free oral vaccines for Cholera.
8	334	AI-Designed Universal Vaccines for Tropical Diseases (Malaria & Dengue)	NEC OncoImmunity AS / Nagasaki University	AI / Computational / Structural	Basic research or development	AI mines field samples for cross-variant malaria and dengue hotspots.
9	16	Microneedle patch vaccine platform (K3 adjuvant)	The University of Osaka	Manufacturing / Access	Preclinical	Dissolvable microneedle skin patch with the K3 adjuvant, needle-free.
10	170	Intradermal needle-free vaccination device	Kumamoto University	Manufacturing / Access	Basic research or development	PassPort porator with dry antigen patch; dose-

² ID refers to the identification number assigned in the Technology List.

						sparing, room-temp stable.
11	6	CD22-Targeting Precision Immunostimulant (Inflammation-Free Vaccine Adjuvant)	Tokyo Medical and Dental University	Adjuvant	Basic research or development	A novel vaccine adjuvant designed to enhance immunogenicity without inducing inflammation by targeting B lymphocytes through the inhibitory receptor CD22
12	107	Computational / AI-driven vaccine design platform.	NEC Corporation	AI / Computational / Structural	Basic research or development	In-silico epitope prediction designs universal influenza blueprints.
13	123	Computational/AI-driven Epitope Optimization and Rational Antigen Design	JIHS	AI / Computational / Structural	Basic research or development	A next-generation vaccine platform using structure-based computational design (AI/Structural Biology) to optimize Flavivirus antigens (Dengue, etc.).
14	110	Inhalant mRNA vaccine delivered via iPSC-derived respiratory epithelial cell exosomes (HiREC-Ex)	HiLung Inc.	Mucosal	Basic research or development	Utilizing iPSC-derived respiratory epithelial cell exosomes for efficient pulmonary delivery of mRNA vaccines.
15	182	Intranasal BC-PIV/DS-Cav1 RSV Vaccine	Sapporo Medical University / BioComo Inc. / Mie University	Mucosal	Preclinical	BC-PIV vector expressing RSV pre-F antigen to induce robust mucosal and systemic immunity.
16	251	Rhoptry-Associated Membrane Antigen (PvRAMA) Blood-Stage Vaccine	Ehime University	Pathogen Specific	Basic research or development	Rhoptry antigen PvRAMA eliciting long-lasting T-cell and antibody responses against Plasmodium vivax.
17	167	AI-Designed Broadly Protective Betacoronavirus mRNA Vaccine	NEC Corporation / NEC OncoImmunity AS	AI / Computational / Structural	Preclinical	AI finds conserved antigens across SARS, SARS-CoV-2 and MERS for mRNA.

18	186	AlphaVLP Platform	VLP Therapeutics Japan, Inc.	Vaccine Platform	Ready to market entry	Alphavirus VLPs plus self-amplifying RNA; FDA-validated chikungunya VLP.
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Considering GHIT's priority areas and interests, the 18 shortlisted candidates were further narrowed to 10 technologies which were selected for interviews (corresponding to Nos 1-8 in the table above)

4.5 Interview Findings

To complement the desktop research, interviews were conducted with selected researchers and technology developers associated with the shortlisted technologies. The objective was to validate and expand on findings from publicly available sources, identify opportunities and challenges for technology translation, and better understand the potential contribution of these technologies to global health and GHIT's investment priorities. The interviews provided important insights into scientific differentiation, development pathways, partnership needs, and potential applications across a range of infectious diseases. Key findings are summarized below.

Of the 10 candidate technologies, interviews were successfully conducted with 8 (Nos 1-8). The 8 technologies were ultimately consolidated into six technologies, as No.2 and No.3, as well as No.6 and No.7, utilized the same underlying technology despite targeting different disease areas. Summary of interview findings can be found in **Appendix 4**.

Assessment of Final Candidates:

- Alignment with GHIT investment priorities
 - Overall, the shortlisted technologies demonstrated potential applicability to GHIT's investment priorities, including tuberculosis, malaria, neglected tropical diseases, and diseases with pandemic potential, as well as broader infectious disease applications.
 - Several technologies also offer potential advantages relevant to LMIC deployment, such as easier administration and improved storage conditions. As a result, the shortlisted portfolio may have the potential to generate substantial global health impact and appears to be highly aligned with GHIT's objectives.
- Potential areas for GHIT support
 - Financial support for translational development
 - Facilitation of international research collaborations
 - Support for identification and engagement of industry partners

- Risks and consideration
 - Uncertainty regarding whether promising preclinical results can be reproduced in humans
 - Challenges in securing commercial and industry partners
 - Cost and implementation challenges associated with deployment in LMICs

5. Implications for GHIT Fund

A holistic evaluation of data collected across the landscape review, yielded the following key findings.

Key finding 1: Japan's vaccine ecosystem demonstrates particular strength in enabling technologies:

The landscape review identified clusters of innovation in mucosal immunity, manufacturing and access and vaccines for high-burden diseases. These themes suggest that one of Japan's comparative strength lies in the development of enabling technologies that can support vaccine development across multiple pathogens. In particular, the shortlist included a large number of technological approaches targeting mucosal vaccines. Given the promise of mucosal immune induction for improved protection, multiple studies of various pathogens (including influenza, tuberculosis, and COVID-19) are currently underway in various locations. Many of the targeted formulations could be administered needle-free and transported at room temperature, which would likely translate into significant public health impact for disease prevention in LMICs.

Key finding 2: Platform technologies are increasingly being validated through diseases with strong commercial or pandemic relevance:

Many of the innovative technologies identified are being developed for diseases of certain commercial demand, which has established clinical pathways. Interviewees noted that demonstrating feasibility in diseases with established systems are mandatory for new technology to be introduced into market in initial stage, which enables later facilitation of broader application. These technologies may subsequently be adapted to diseases with high public health burden but more limited commercial incentive.

Key Finding 3: Japan's innovation pipeline may extend beyond publicly visible technologies

The technologies identified through this review likely represent only a portion of ongoing innovation activity in Japan. In several stakeholder interviews, developers described technologies that had been under quiet development for a substantial period before reaching the stage of external visibility

captured in this review. And we know that the earlier end of the product development lifecycle is where public visibility (publications, patents, database records) is typically most limited.

This suggests that a pool of relevant Japanese technologies may exist that has not yet surfaced through conventional publication or database channels (and possibly reflecting limitations in connectivity between some Japanese innovators and global health funders).

The "valley of death" dynamic is well documented in translational research: promising technologies can stall for years between initial discovery and the point where they generate the publications, patents, or partnerships that make them externally visible, particularly when they lack a clear commercial pathway. This points to an opportunity for funders willing to invest in proactive, and creative, surveillance (see Recommendation 4), as it can help identify and support promising technologies when investment can have the largest impact.

Key Finding 4: GHIT is well positioned to accelerate the application of enabling technologies to diseases of greatest global health need.

Findings suggest that opportunity lies in supporting enabling technologies with broad applicability and facilitating their translation towards diseases with highest burdens in LMICs. This could include supporting the adaptation of platform technologies to new disease targets, strengthening translational partnerships or addressing barriers to product development.

6. Conclusion & Recommendations

The following recommendations draw on findings from both the landscape review and stakeholder interviews. They reflect our assessment of how GHIT can operationalize key findings to accelerate vaccine development for diseases of greatest global health need.

Recommendation 1: Prioritize investments in technologies that demonstrate potential for cross-pathogen applicability

Platforms continue to remain an important tool achieving broad global health goals. By focusing on platform-based approaches funders leverage investments made across products or disease target, such as mRNA platforms which can deliver a wide range of antigens, or adjuvants which can boost efficacy across vaccines/subpopulations. Many platform technologies were developed for vaccines with significant commercial markets, and this investment can be leveraged to enable highly optimized platforms to address diseases of global health priority. Further, the applicability or impact of a platform may be applied to solve specific disease challenges. For example, Japanese vaccine developers are particularly proficient at the development of platforms that enable the delivery of vaccines that target compartments of the mucosal system (particularly the respiratory or GI tracts) and may enable

development of more effective vaccines against mucosally-targeting pathogens which are a major global health challenge. The expanding toolbox of platforms may offer new avenues to solve challenging R&D problems via funding opportunities that specify specific goals (achieving a desired manufacturing cost or scale, delivery systems achieve anatomical level protection, or effective protection of sub populations), or a portfolio approach to funding that compares the utility of specific platforms to solving a disease challenge.

Recommendation 2: Invest in emerging technologies with transformative potential

GHIT could consider targeted investments in emerging areas such as AI-enabled vaccine design, structural vaccinology and systems immunology. These are sub-disciplines that were relatively under-represented in the landscape review but have the potential to fundamentally reshape vaccine discovery and development in the years ahead. It is not clear if this underrepresentation of AI-based approaches represents a limitation of Japanese R&D and investment, or if such work is occurring outside the purview of this review. Whatever the case, such technologies are rapidly advancing in capacity and have the potential to upend the existing vaccine R&D paradigm enabling more rationally designed products and accelerating product development as a whole. As such, GHIT may want to consider 1) focusing investing in domestic AI-centric approaches either by supporting centers of excellence or requiring the application of AI in new projects, and/or 2) developing funding incentives which foster collaboration between Japanese vaccine developers and groups globally which are at the forefront of the application of AI to enhance vaccine R&D. Such an approach would continue to building the foundation of domestic next-generation technologies, infuse domestic work with cutting-edge approaches and collaborations in the AI-space, and focus such technologies on GHIT priorities.

Recommendation 3: Address translational bottlenecks to ensure that innovation translates to public health impact

Stakeholder interview identified common barriers to translation, including access to disease-specific animal models, clinical validation pathways, manufacturing capabilities, etc. Such bottlenecks are common across vaccine R&D efforts and can slow or prevent promising technologies from progressing to clinical impact. GHIT could consider investment in shared translational capabilities, including advanced disease models, humanized mouse platforms, vaccine manufacturing platforms, assay development and regulatory programs, that can support multiple technologies and disease areas. Strengthening these cross-cutting enablers would increase the likelihood that promising technologies advance through the product development pipeline and deliver improved public health.

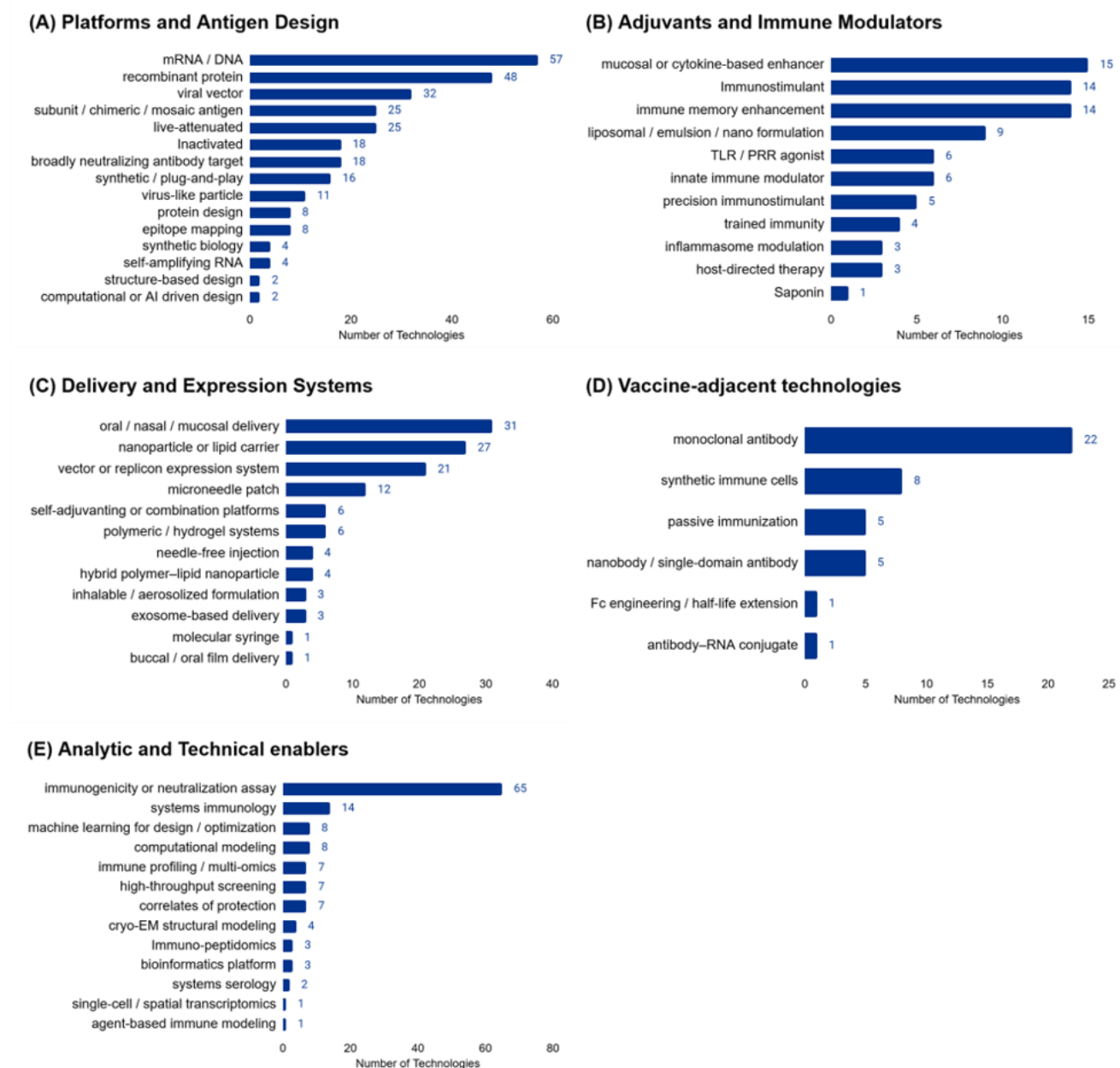
Recommendation 4: Continue to monitor Japan's enabling technology landscape to identify new and emerging technologies

GHIT could consider implementing a structured horizon-scanning process to periodically assess emerging enabling technologies, track changes in technologies of interest flagged within this landscape, identify new partners and partnerships, and evaluate opportunities where Japanese innovation could be applied to high-burden infectious diseases.

Appendix

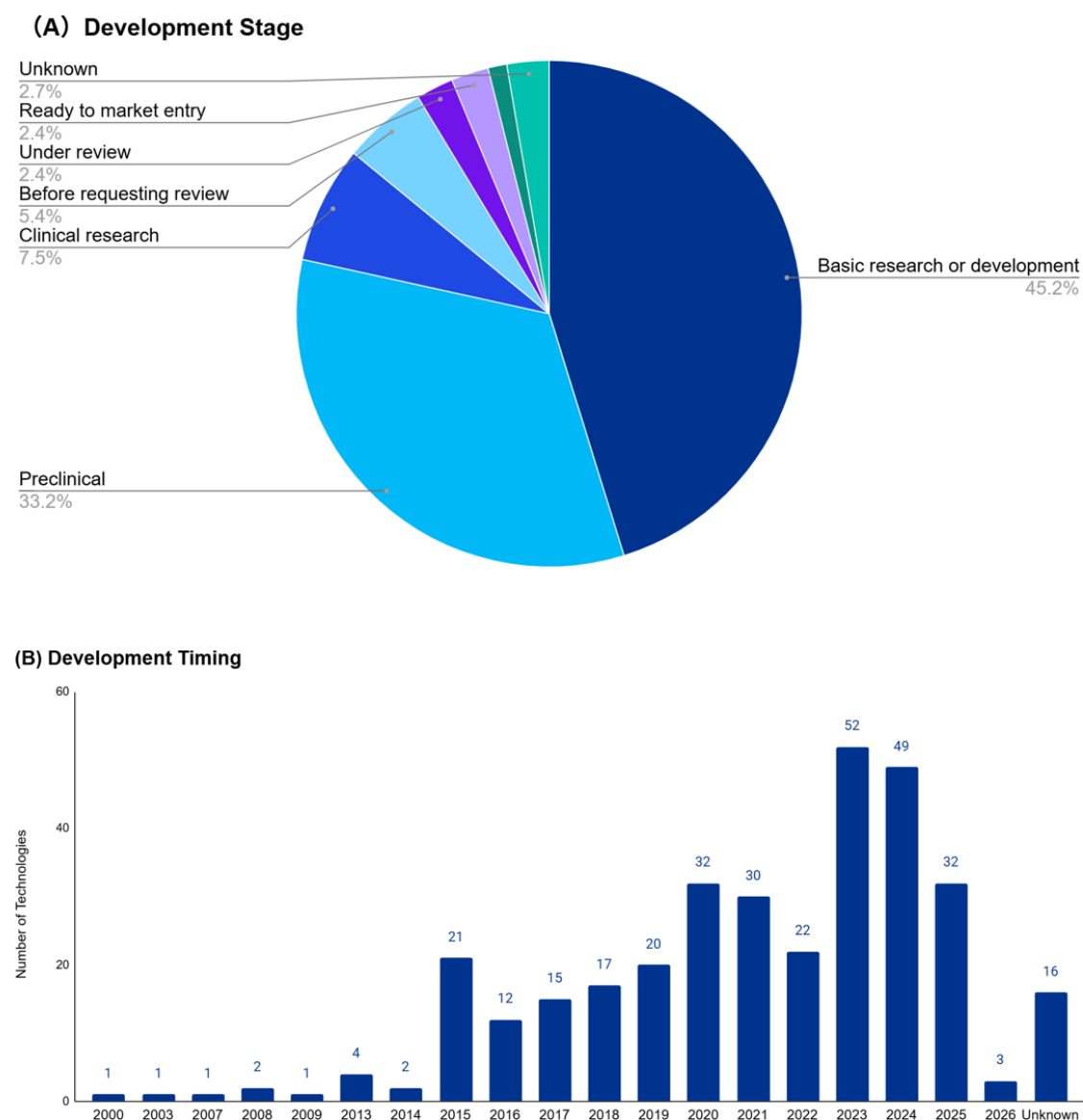
Appendix 1. Master List Analysis

Figure 1-1: Technology Type Distribution



Note: A technology may be classified into multiple technology categories. Counts are therefore not mutually exclusive and may exceed the total number of technologies analyzed.

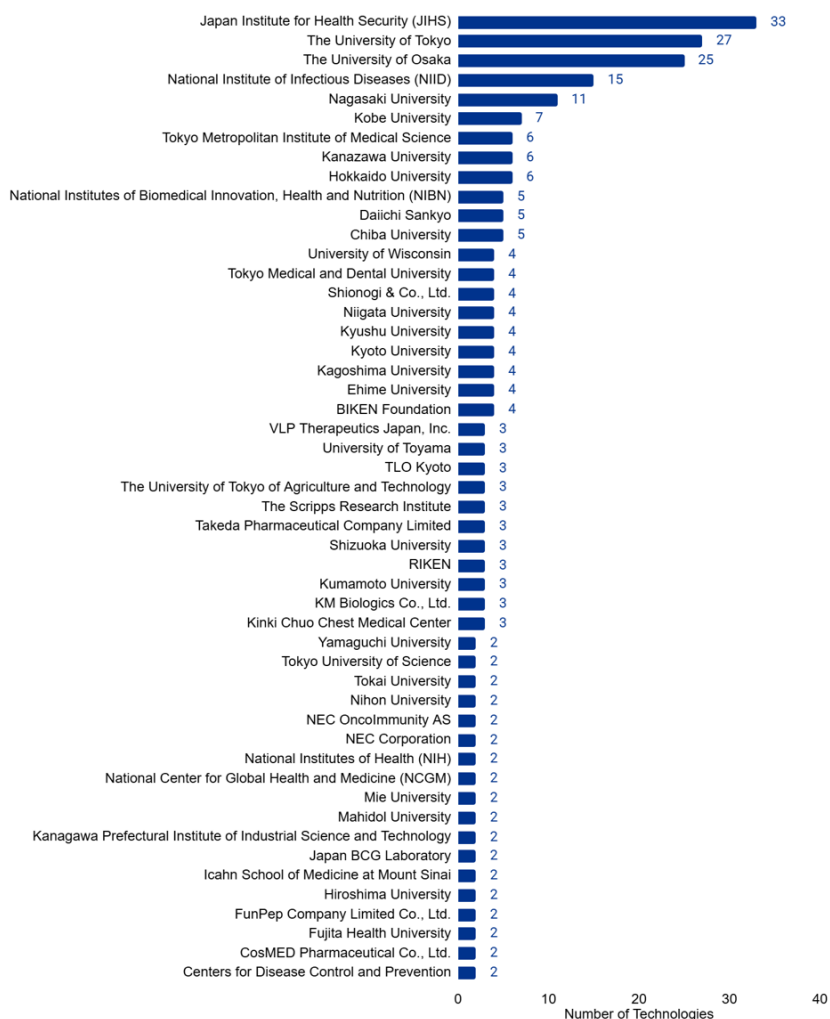
Figure 1-2: Development Stage and Timing



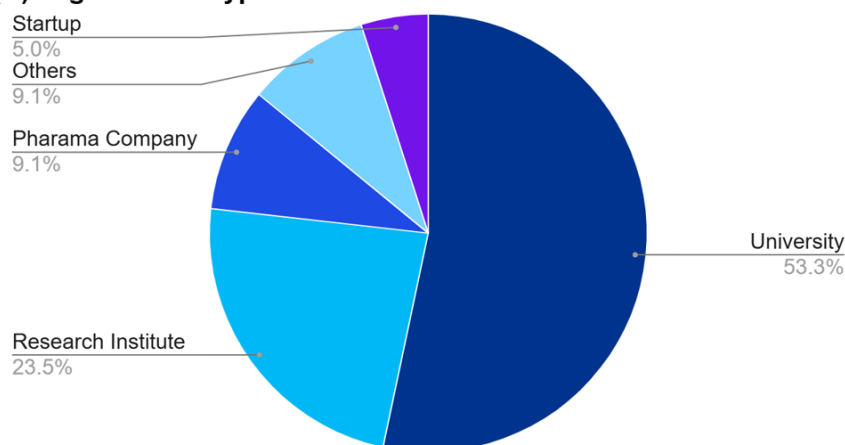
Note: (A) shows the percentage distribution, while (B) shows the count distribution, of technologies included in the Master List (N=334).

Figure 1-3: Organization Type Distribution

(A) Developers / Owners



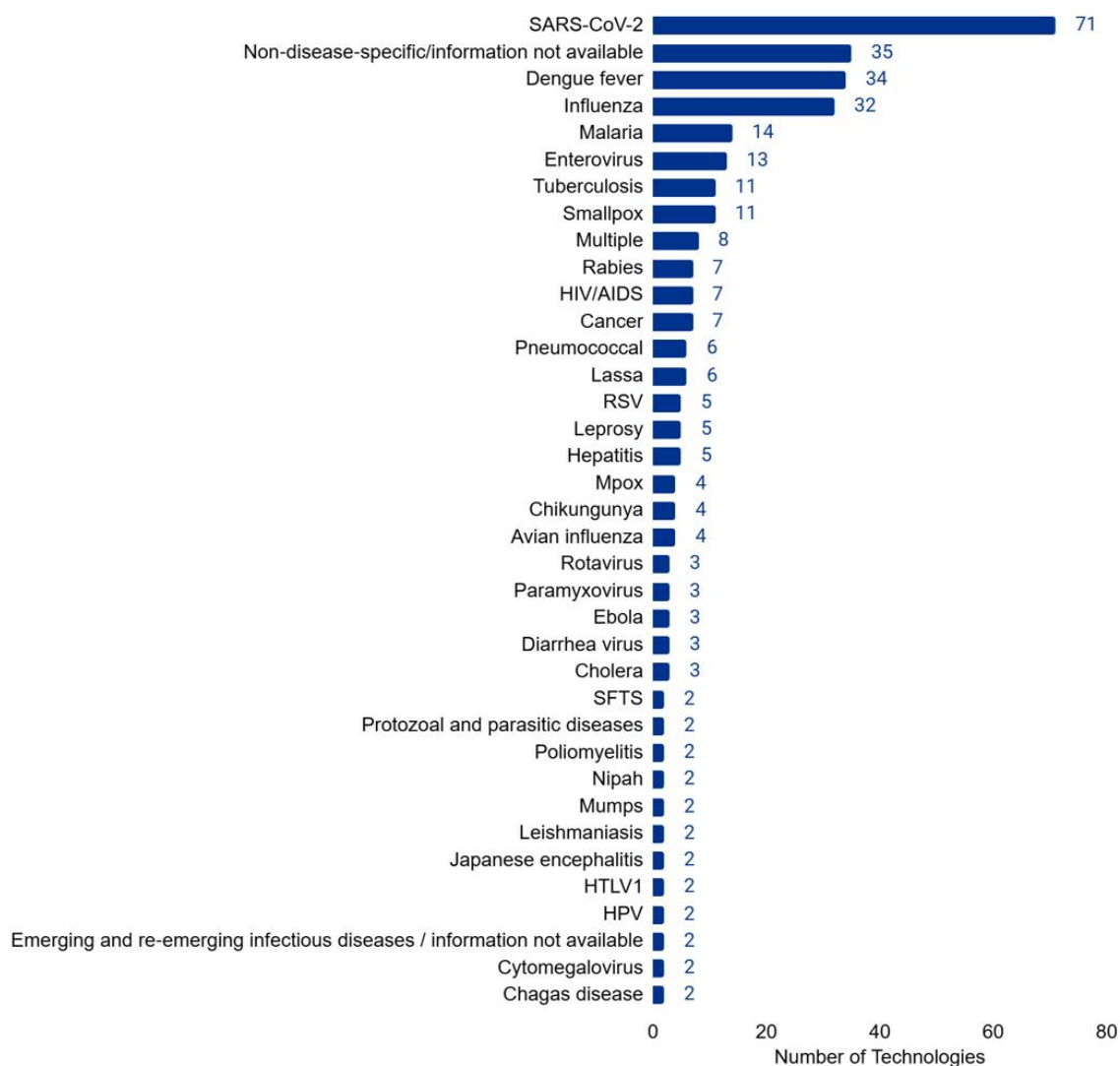
(B) Organization Type



Note: (A) shows the number of technologies associated with each developer/owner, while (B) shows the percentage distribution of technologies by organization type. Technologies may be associated with multiple developers/owners and organization types; therefore, counts and percentages are not mutually exclusive. Only organizations associated with two or more technologies are shown in (A). "Others" in (B) primarily includes technology-oriented companies and other non-academic organizations.

Figure 1-4: Target Disease Distribution

Target Disease



Note: Values represent the number of technologies associated with each target disease. Technologies may be associated with multiple target diseases; therefore, counts are not mutually exclusive.

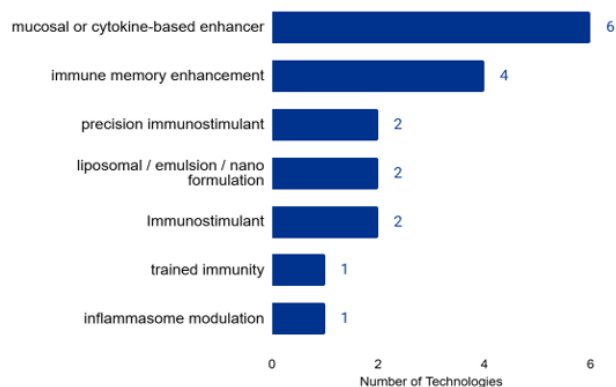
Appendix 2. Long List Analysis

Figure 2-1: Technology Type Distribution

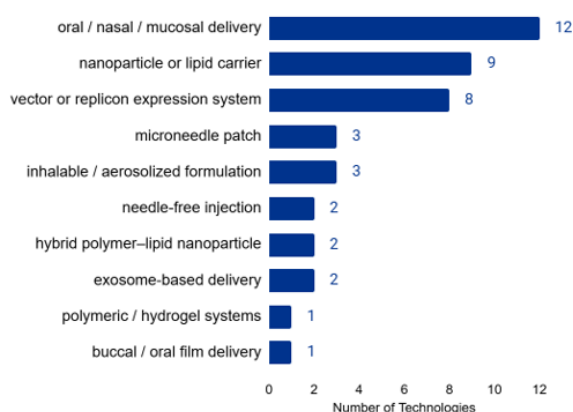
(A) Platforms and Antigen Design



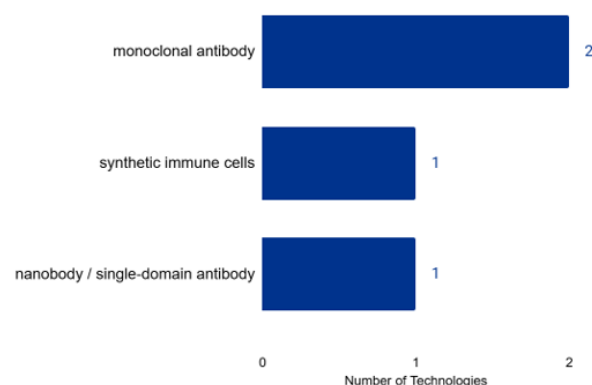
(B) Adjuvants and Immune Modulators



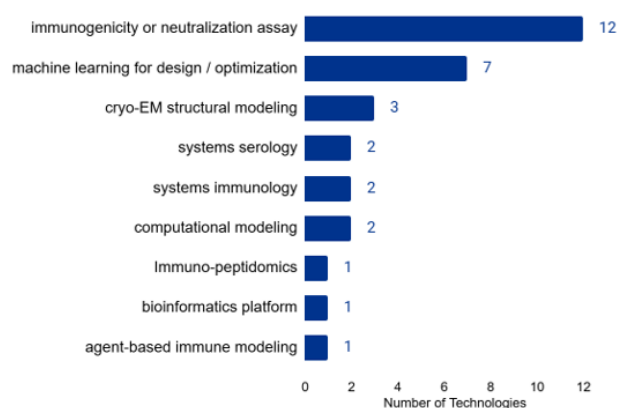
(C) Delivery and Expression Systems



(D) Vaccine-adjacent technologies

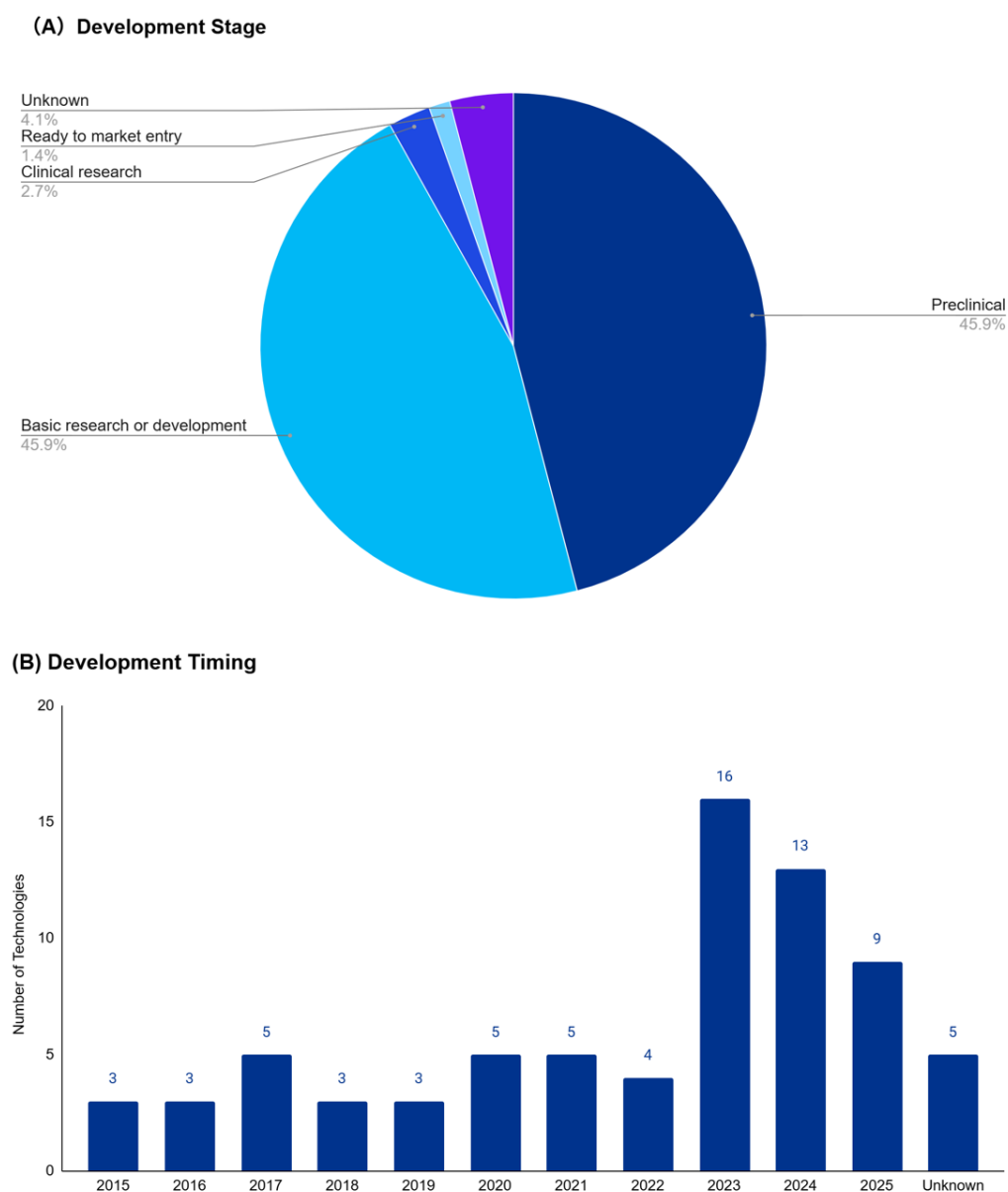


(E) Analytic and Technical enablers



Note: A technology may be classified into multiple technology categories. Counts are therefore not mutually exclusive and may exceed the total number of technologies analyzed.

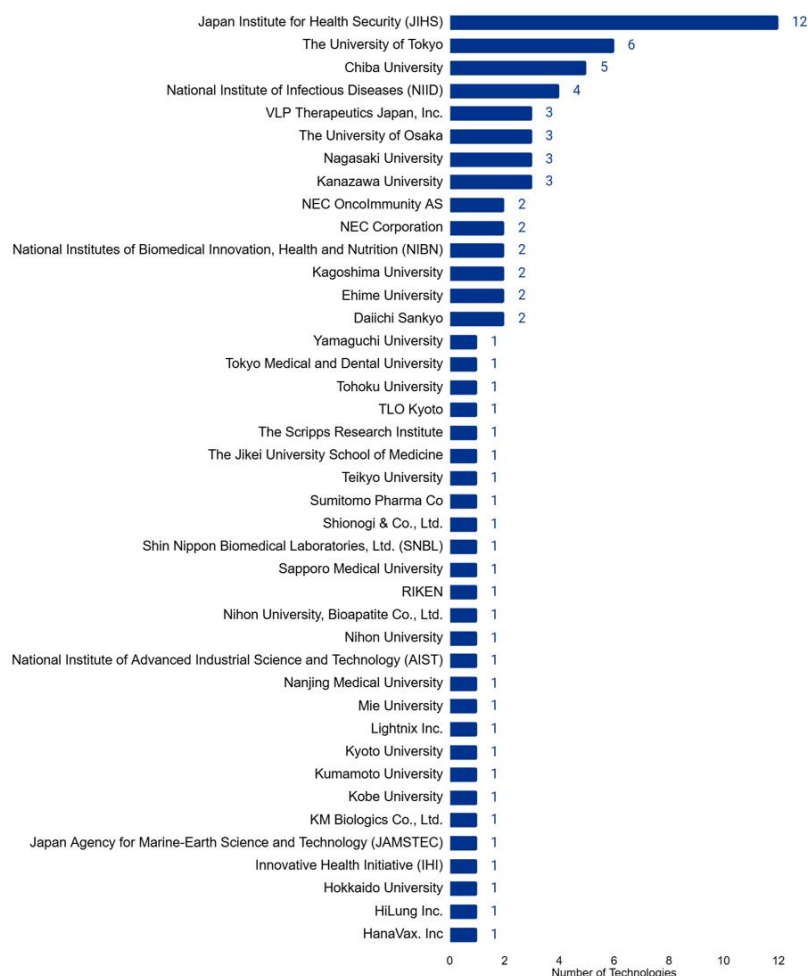
Figure 2-2: Development Stage and Timing



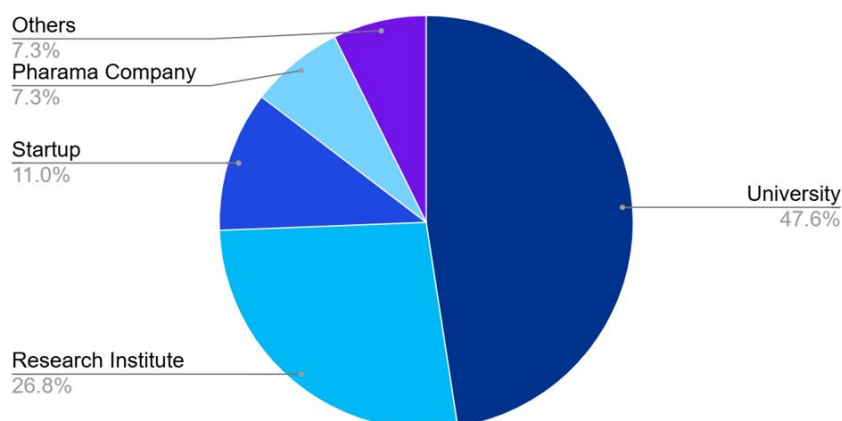
Note: (A) shows the percentage distribution, while (B) shows the count distribution, of technologies included in the Long List (N=74).

Figure 2-3: Organization Type Distribution

(A) Developers / Owners



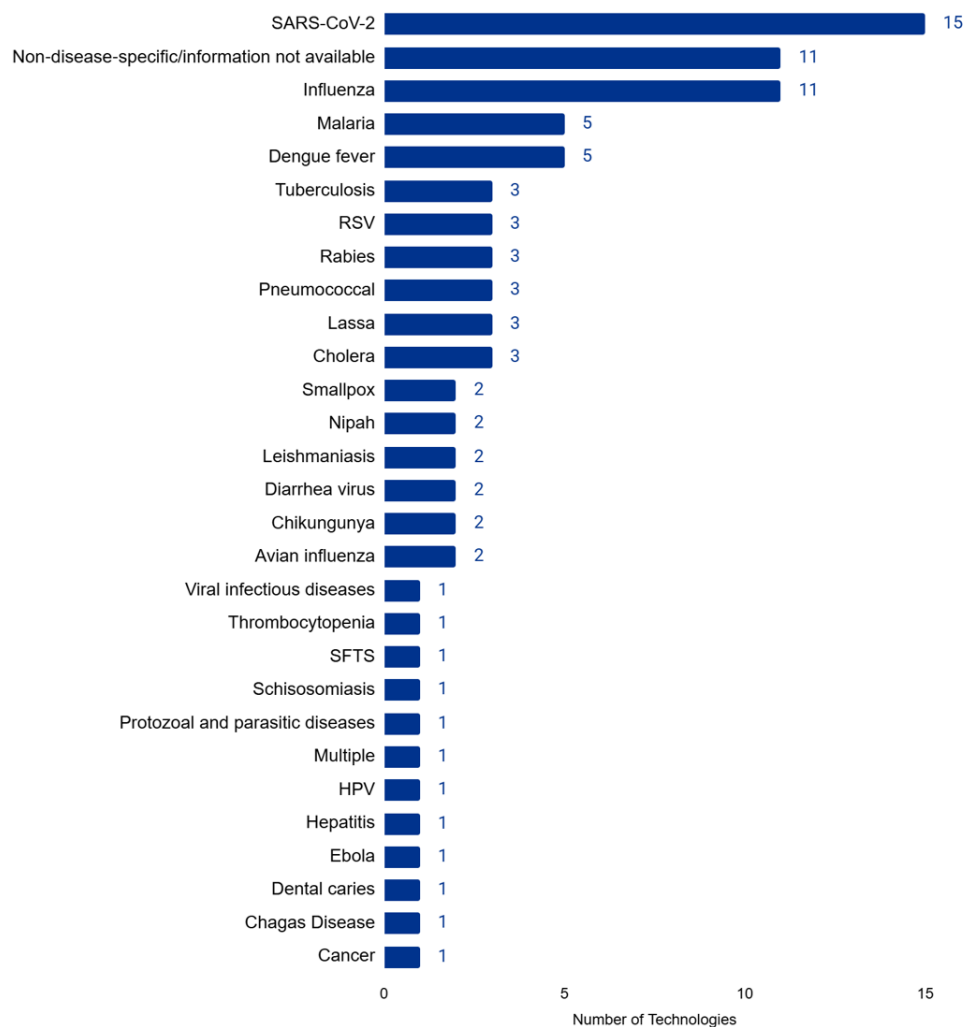
(B) Organization Type



Note: (A) shows the number of technologies associated with each developer/owner, while (B) shows the percentage distribution of technologies by organization type. Technologies may be associated with multiple developers/owners and organization types; therefore, counts and percentages are not mutually exclusive. "Others" in (B) includes NEC Corporation, NEC Oncolmmunity AS, Innovative Health Initiative (IHI), and TLO Kyoto.

Figure 2-4: Target Disease Distribution

Target Disease

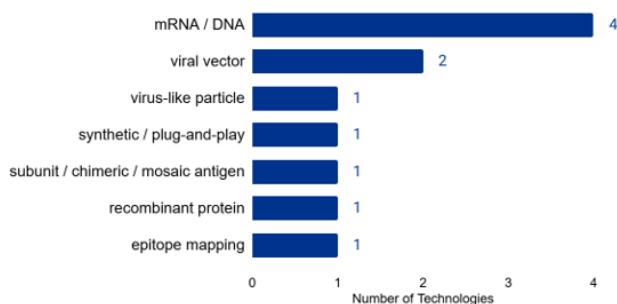


Note: Values represent the number of technologies associated with each target disease. Technologies may be associated with multiple target diseases; therefore, counts are not mutually exclusive.

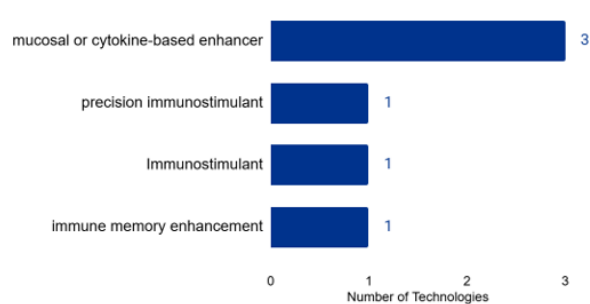
Appendix 3. Short List Analysis

Figure 3-1: Technology Type Distribution

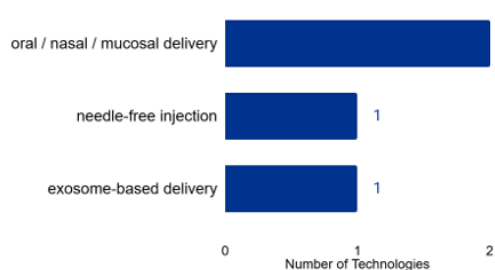
(A) Platforms and Antigen Design



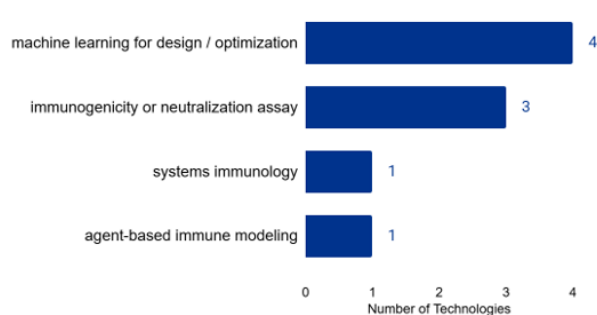
(B) Adjuvants and Immune Modulators



(C) Delivery and Expression Systems

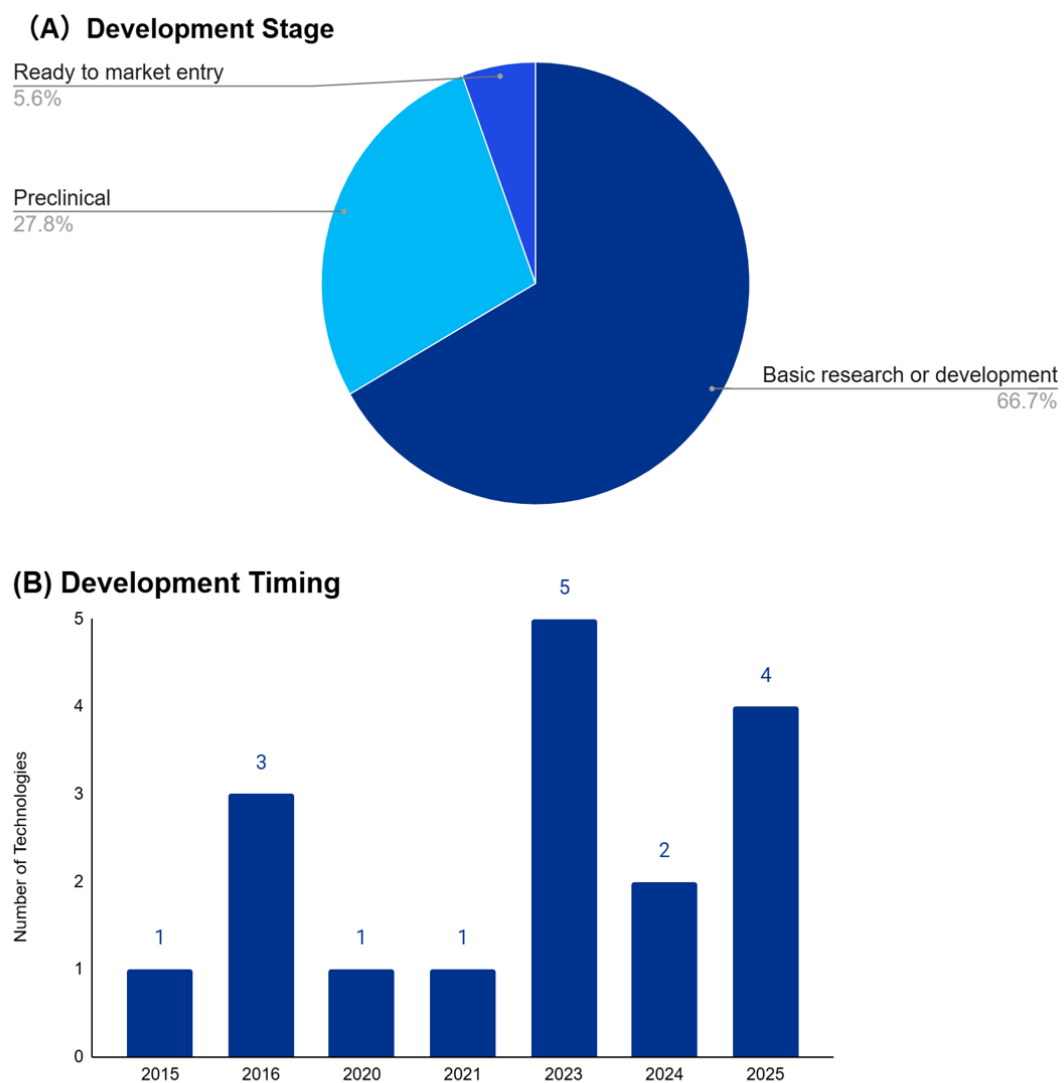


(E) Analytic and Technical enablers



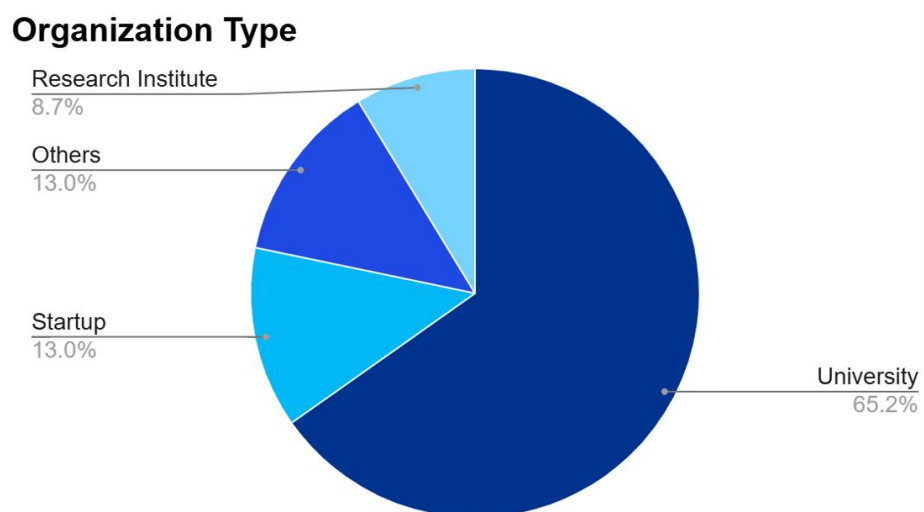
Note: A technology may be classified into multiple technology categories. Counts are therefore not mutually exclusive and may exceed the total number of technologies analyzed.

Figure 3-2: Development Stage and Timing



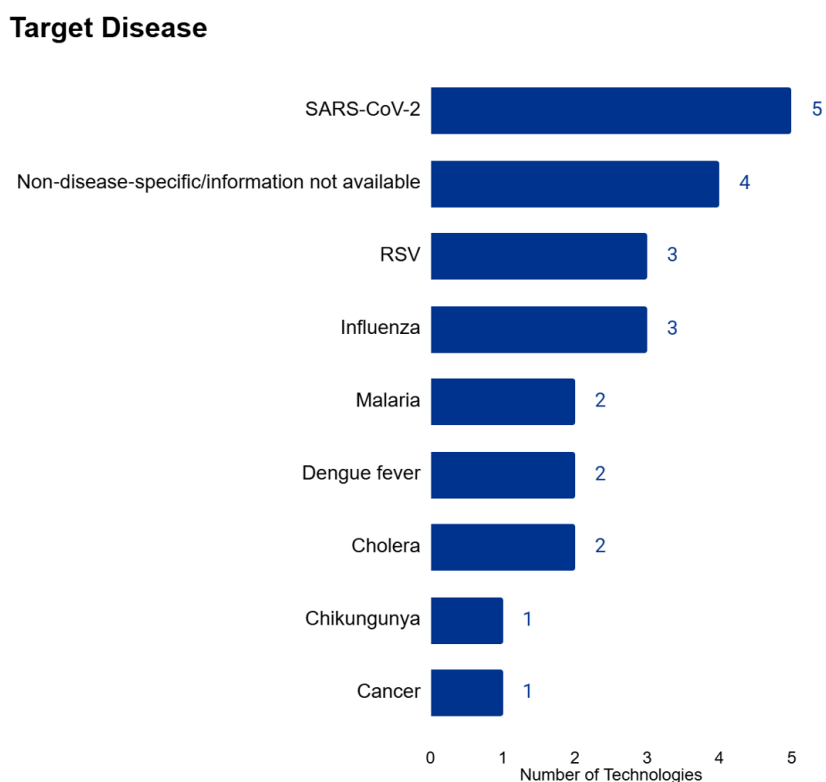
Note: (A) shows the percentage distribution, while (B) shows the count distribution, of technologies included in the Short List (N=18).

Figure 3-3: Organization Type Distribution



Note: Values represent the percentage distribution of technologies by organization type. Technologies may be associated with multiple developers/owners and organization types; therefore, categories are not mutually exclusive. "Others" includes NEC Corporation, NEC Oncolmmunity AS, and other technology-oriented companies and non-academic organizations.

Figure 3-4: Target Disease Distribution



Note: Values represent the number of technologies associated with each target disease. Technologies may be associated with multiple target diseases; therefore, counts are not mutually exclusive.

Appendix 4. Summary of Interview Findings for Each Technology

No	ID	Technology / Platform	Developer / Owner	Interviewee	Technology	Differentiation	Technical Bottlenecks	Non-technical Challenges
1	14	Bacterial Membrane Vesicle (MV/OMV) Vaccine Platform	Japan Institute for Health Security (JIHS) / National Institute of Infectious Diseases (NIID)	Nakao Ryoma, Japan Institute for Health Security (JIHS) – Influenza program lead Yamaguchi Takehiro, JIHS – Tuberculosis program lead	• Bacterial membrane vesicles (MVs/OMVs) possess intrinsic immunogenicity and adjuvant activity and can themselves serve as vaccine candidates. For example, MVs derived from periodontopathic bacteria and BCG have been investigated as vaccine candidates against periodontal disease and tuberculosis, respectively. • MV-based vaccines can be administered through different routes, depending on the desired immune responses, including intranasal administration to induce mucosal immunity and intramuscular administration to induce systemic immunity. • In addition to the direct use of MVs as vaccine candidates, their intrinsic adjuvant properties can be exploited as a vaccine delivery platform. One such approach uses MVs derived from a probiotic <i>Escherichia coli</i> strain as carriers, with target antigens stably displayed on their surface via the SpyTag/SpyCatcher system.	• MV-based vaccines can exploit both the antigenicity of bacterial MVs themselves and their intrinsic adjuvant activity, potentially reducing or eliminating the need for additional adjuvants. • The bioconjugation-based platform enables adaptation to different infectious diseases by exchanging disease-specific antigens displayed on the MV surface. • Intranasal administration has demonstrated immune responses across multiple mucosal sites, suggesting the potential to induce robust mucosal immunity at. • The platform is compatible with lyophilization and may enable room-temperature storage and transportation, offering potential advantages in LMIC settings with limited cold-chain infrastructure. • BCG-derived MVs represent one example of a non-replicating vaccine approach that may offer safety advantages over conventional live vaccines. More broadly, MV-based vaccines could potentially provide alternatives to, or complement, other live bacterial vaccine strategies, particularly for populations in whom live vaccines are contraindicated.	• Across the platform, optimization of manufacturing processes, particularly improving membrane vesicle production yield and scalability, remains an important technical challenge.	• Further funding and development support will likely be required to advance the programs from preclinical evaluation to clinical development.

					• This bioconjugation-based MV vaccine platform is being applied to multiple infectious disease programs, including influenza, plague, and tuberculosis, with intranasal administration being explored as a major route of delivery.			
2&3	49&155	Next-generation Nanogel Spray Vaccine / cCHP Nanogel Nasal RSV Vaccine	The University of Tokyo (IMSUT) / Chiba University	Prof. Hiroshi Kiyono, Dr. Rika Nakahashi, and Dr. Shinichi Sawada, Chiba University	• A nasal vaccine platform based on cationic nanogel technology for mucosal delivery of protein antigens. The platform is being developed for influenza, RSV, and other infectious diseases. The published cationic nanogel technology based patents are now owned by Shionogi, while next-generation cationic nanogel technologies are currently under development.	• The platform can be applied to a broad range of infectious diseases by substituting disease-specific antigens. It enables efficient mucosal delivery of protein antigens and may induce both systemic and mucosal immunity. • Compared with existing live-attenuated mucosal vaccines, the platform may offer an improved safety profile. For RSV, it may provide an alternative to monoclonal antibody-based prevention strategies.	• For the influenza vaccine program, human proof of concept (PoC) has not yet been established, and preparations for clinical trials are currently underway together with Shionogi. For next-generation nanogel technologies, further formulation optimization and evaluation are required.	• Industrial partners will be essential for clinical development and manufacturing. In addition, international collaborations may be required to support expansion into additional disease.
4	57	Polyplex mRNA Mucosal Vaccine	The University of Tokyo, Graduate School of Engineering Lead: Mitsuru Naito	Mitsuru Naito, Lecturer, Department of Materials Science and Technology, Faculty of Advanced Engineering, Tokyo University of Science	• mRNA mucosal vaccine utilizing polyplexes (synthetic polymer-based delivery system), designed for intranasal or inhalation administration.	• Polymer-based polyplex formation stabilizes mRNA and may reduce inflammatory responses and PEG-related risks compared with lipid nanoparticle (LNP) systems. Lyophilized powder formulations enable potential room-temperature storage and transport, improving deplorability in LMICs.	• Manufacturing challenges such as GMP-scale uniformity and post-lyophilization re-dispersibility	• Clinical transition requires GLP-grade preclinical data, GMP manufacturing, and suitable clinical trial design.
5	70	mRNA Vaccine Utilizing Biocompatible "Nanoball" Technology	Nagasaki University (Institute of Tropical Medicine) Hitoshi Sasaki.	Prof. Yasuda: Director, Vaccine Research and Development Center, DEJIMA Infectious Disease Research Alliance, Nagasaki University, and Prof. Kaneko: Administrative Director, Vaccine	• An mRNA vaccine delivery platform that encapsulates antigen-encoding mRNA in biocompatible "nanoball" particles. The platform is not limited to a single route of administration: formulation optimization is currently focused on intramuscular injection, while mucosal routes such as intranasal	• Nanoballs consist of an mRNA-containing cationic core coated with a biocompatible anionic polymer, which gives the particles a net negative surface charge. The anionic coating confers high stability in serum and enables cellular uptake through a pathway distinct from that of conventional LNPs, and the platform can induce both mucosal (local) and systemic immunity. • The platform may have a favourable safety profile and is compatible with lyophilization,	• Ensuring particle uniformity, quality control, and reproducibility upon scale-up. In addition, for intramuscular administration in vitro gene expression does not correlate well with in vivo efficacy, so candidate formulations must be screened in animal	• Current support envisaged from SCARDA / CEPI for non-clinical work, but additional funding will be required for GMP transition, clinical trials, and large-scale production. • Attracting industry and funder interest may be

				Research and Development Center, DEJIMA Infectious Disease Research Alliance Nagasaki University	and pulmonary delivery are also applicable.	which allows storage without an ultra-cold chain and thereby supports stable supply in low- and middle-income countries (LMICs). • Manufacturing may be comparatively less complex because the particles are formed by self-assembly, and the platform may face fewer constraints from existing LNP-related patents, suggesting potential cost advantages.	studies, which limits throughput.	difficult for target diseases with small patient populations (e.g., Ebola, Lassa).
6&7	94&132	MucoRice Line 19A Oral Cholera Vaccine / Transgenic Rice-Based Oral RSV and Influenza Vaccine Platform	Chiba University (Chiba University Future Mucosal Vaccine R&D Synergy Institute - cSIMVa)	Prof. Hiroshi Kiyono and Dr. Yoshikazu Yuki, and Dr. Koji Kashima, Chiba University Dr. Koji Kashima, Asahi Kogyosha, Co., Ltd.	• An oral vaccine platform using transgenic rice to express vaccine antigens. Rice seeds function as natural capsules, enabling room-temperature storage and oral administration. The platform is being developed for cholera and is being expanded to RSV and influenza.	• Rice seeds (e.g., protein bodies) act as natural capsules, enabling oral administration without a cold chain. The platform can be applied to multiple diseases by changing the expressed antigen. • The platform enables self-administration and may induce both mucosal and systemic immunity through oral delivery. • LED-based hydroponic cultivation may support scalable and cost-effective manufacturing. • The MucoRice technology has the potential to facilitate the development of a vaccine that does not require a cold chain and syringe/needle.	• For cholera, progression beyond Phase I will likely require overseas human challenge studies. • For RSV and influenza, the platform remains at the research stage, and further efficacy evaluation is required.	• Human challenge studies are difficult to conduct in Japan. International collaborations and funding support will be important for further development.
8	334	AI-Designed Universal Vaccines for Tropical Diseases	NEC Corporation NEC Oncolmmunity AS / Nagasaki University (Institute of Tropical Medicine)	Prof. Yasuda and Prof. Kaneko	• The program—jointly led by NEC Oncolmmunity and Nagasaki University—utilizes AI (NEC Immune Profiler) to design “universal” vaccines that target conserved epitope hotspots across pathogens such as malaria and dengue.	• Enables vaccine designs effective across diverse genetic backgrounds by targeting conserved epitopes rather than single strains. Utilizes AI to accelerate antigen discovery and optimization, reducing development time and cost.	• While NEC's AI has a track record in oncology, its experience applying this to infectious-disease vaccine design, formulation, and manufacturing processes is limited, creating a practical translation gap from design to productization.	• Underdeveloped regulatory frameworks and trust issues for AI-designed vaccines.