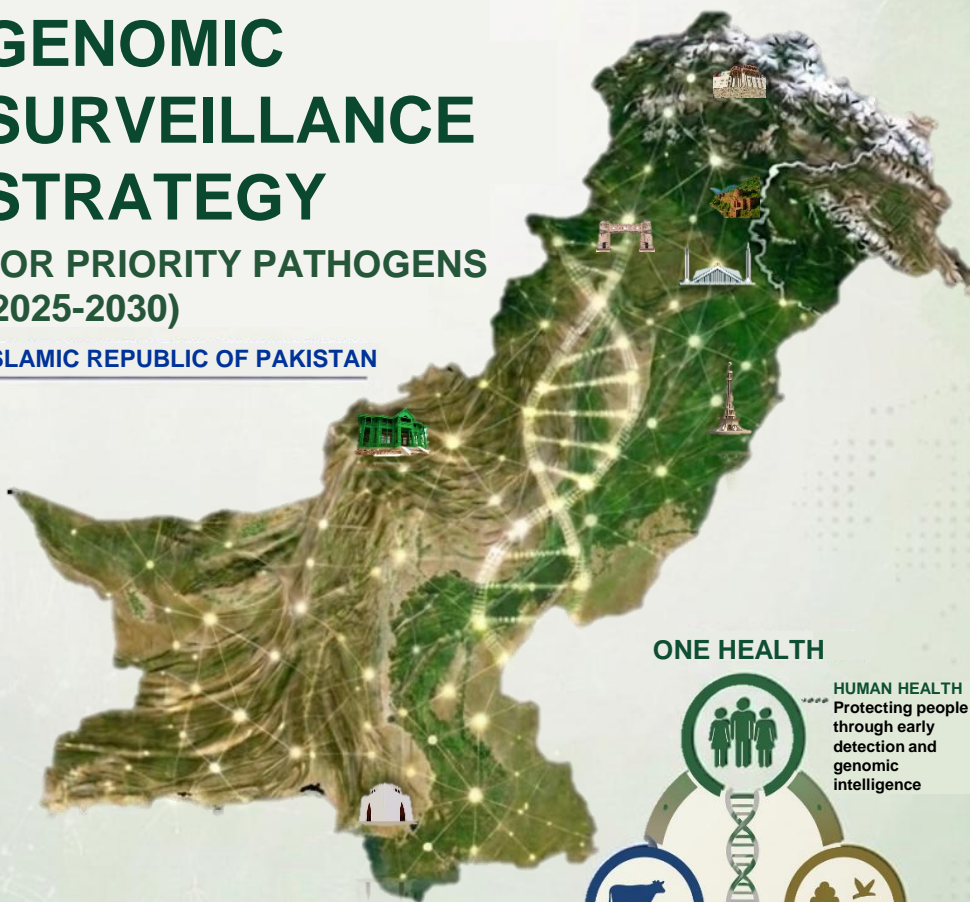




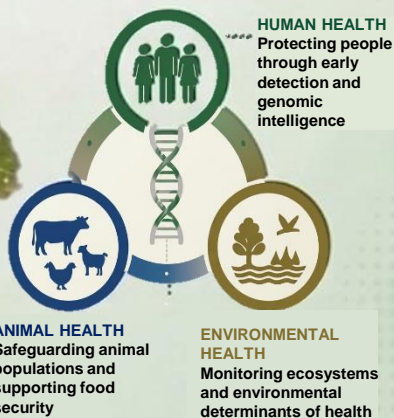

NATIONAL GENOMIC SURVEILLANCE STRATEGY

FOR PRIORITY PATHOGENS (2025-2030)

ISLAMIC REPUBLIC OF PAKISTAN



ONE HEALTH

Genomic intelligence for a healthier, safer and resilient Pakistan



NATIONAL NETWORK



STANDARDIZED LABORATORIES



DATA SHARING & INFORMATICS



SKILLED WORKFORCE



EVIDENCE FOR ACTION

Ministry of National Health Services Regulations & Coordination
Government of Pakistan

National Institute of Health, Pakistan

Version 2.0



NATIONAL GENOMIC SURVEILLANCE STRATEGY FOR PRIORITY PATHOGENS

Islamic Republic of Pakistan

Message

Strengthening the core capacities of Pakistan's health system is an obligation under the International Health Regulations (IHR 2005) and a priority for our Ministry. A crucial pillar of this effort is the systematic integration of pathogen genomics into our public health architecture.

This National Genomic Surveillance Strategy for priority pathogens of Pakistan outlines a comprehensive, multisectoral roadmap for using genomic technologies to track priority diseases. It builds upon lessons from the past while anticipating the threats of the future by ensuring connectivity across provinces, establishing technical standards, enabling data sharing, and building a skilled workforce.

Genomic surveillance is no longer a luxury; it is a national imperative. The Ministry will continue to provide policy leadership, resource advocacy, and inter-ministerial coordination to operationalize this strategy, ensuring that no region or community is left behind.

Dr. Abdul Wali khan

Director General of Health

Ministry of National Health Services Regulations and Coordination
Pakistan

Preface

It is with great commitment to national health security that the National Institute of Health (NIH) presents this revised National Genomic Surveillance Strategy for Priority Pathogens of Pakistan (2025–2030).

Originally developed in 2023, the first version of the strategy laid the groundwork for integrating genomic tools into disease surveillance. However, its implementation remained limited. This revised version builds upon those initial efforts, drawing on insights from recent outbreaks, expanding the scope, and grounding the framework in an inclusive, actionable, and forward-looking approach.

Several transformative enhancements distinguish this updated strategy:

- 1. Prioritization of Pathogens:** For the first time, a structured prioritization exercise has identified high-impact pathogens across human, animal, and environmental health domains ensuring targeted and efficient genomic surveillance.
- 2. One Health Integration:** Unlike the earlier human health-centric version, this strategy embraces the One Health paradigm, fostering multisectoral collaboration across human, animal, and environmental sectors.
- 3. Implementation Roadmap:** This is not merely a policy document; it includes a clear implementation plan, outlining how genomic surveillance can be institutionalized across Pakistan with timelines, stakeholder roles, and measurable milestones.

These advancements make this a truly national strategy, anchored in equity, scientific evidence, and long-term sustainability.

I express my deep appreciation to the Technical Working Group (TWG) and the National Laboratory Working Group (NLWG) for their technical leadership and unwavering dedication to this effort. I also gratefully acknowledge the Aids Health Care Foundation (AHF), US, whose generous support made this revision possible.

As we move forward, I urge all partners and institutions to treat this strategy as a living document one that evolves with the pathogens we face and remains central to building a safer, stronger, and more resilient Pakistan.

Dr. Muhammad Salman

Chief Executive Officer
National Institute of Health (NIH), Pakistan

Acknowledgements

The National Institute of Health (NIH), Pakistan extends its sincere appreciation to all individuals and institutions who contributed to the development of the National Genomic Surveillance Strategy for Priority Pathogens of Pakistan (2025–2030).

This strategy is the product of a national effort to embed genomic intelligence into public health systems guided by the principles of science, equity, and multisectoral collaboration. We particularly recognize the contributions of the Technical Working Group (TWG), which included genomics experts from the NIH, provincial public health laboratories, animal health laboratories, and partner organizations. Their subject-matter expertise in next-generation sequencing, pathogen genomics, and molecular surveillance was central to shaping the technical direction and priorities of this strategy.

We also extend our thanks to the National Laboratory Working Group (NLWG), whose cross-sectoral members reviewed the live draft and provided constructive feedback to enhance the relevance, feasibility, and alignment of this strategy with national laboratory policies and frameworks.

Special acknowledgements are due to the Provincial Health Departments, Public Health Reference Laboratories (PPHRLs), representatives from animal, environmental, and agricultural health sectors, academic institutions, and bioinformatics and data systems experts for their participation in consultations and technical discussions.

We gratefully acknowledge the generous support of the Aids Health Care Foundation (AHF), United States, which enabled the successful revision and finalization of this strategy. We also thank our development and technical partners World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), United States, UK Health Security Agency (UKHSA), DAI Fleming Fund, and Jhpiego for their ongoing contributions to genomic surveillance and health security in Pakistan. Their continued support will be key to the successful implementation of this strategy in the years ahead.

Finally, we acknowledge the leadership of Dr. Massab Umair, Principal Scientific Officer and Head of the Virology Department at NIH, who has led this initiative from its inception, including the development of the original 2023 strategy to the comprehensive revision presented here. His unwavering dedication, technical guidance, and coordination efforts were instrumental in bringing this national strategy to fruition.

This strategy stands as a national milestone and a shared commitment to building a future-ready, genomics-enabled public health system for Pakistan.

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Abbreviations and Acronyms

ADDRS	Animal Disease Data Reporting System
AJ&K	Azad Jammu and Kashmir
AKU	Aga Khan University
AMR	Antimicrobial Resistance
BSL	Biological Safety Level
CDC	Centers for Disease Control and Prevention
CoE	Center of Excellence
COVID-19	Coronavirus disease 2019
DAI	Development Alternatives Inc.,
DHIS2	District Health Information System 2
DRAP	Drug Regulatory Authority of Pakistan
EOC	Emergency Operations Center
EMPRES-i	Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases
EQA	External Quality Assessment
FAO	Food and Agriculture Organization
GAP	Gap Analysis Program
GB	Gilgit Baltistan
GIS	Geographic Information System
GISAID	Global Initiative on Sharing Avian Influenza Data
GLASS	Global Antimicrobial Resistance and Surveillance System
HEC	Higher Education Commission
HIV	Human Immunodeficiency Virus
HR	Human Resource
ICT	Islamabad Capital Territory
IDIMS	Idaho National Engineering and Environmental Laboratory Data Integration Mediation System
IDSR	Integrated Disease Surveillance and Response
IPC	Infection Prevention and Control
ICT	Islamabad
IT	Information Technology
LIMS	Laboratory Information Management System
MB	Molecular Biologist
MeaNS	Measles Nucleotide Surveillance
RubeNS	Rubella Nucleotide Surveillance
MoU	Memorandum of Understanding
NAP	National Action Plan
NCBI	National Center for Biotechnology Information
NCOC	National Command & Operation Center
NGC	National Genomic Center
NGS	Next Generation Sequencing
NIBSC	National Institute for Biological Standards and Control
NVL	National Veterinary Laboratory
MeaNS	Measles Nucleotide Surveillance
MoECC	Ministry of Environment and Climate Change
MoITT	Ministry of Information Technology and Telecommunication

Abbreviations and Acronyms

MoNHSR&C	Ministry of National Health Services Regulations & Coordination
MoU	Memorandum of Understanding
NIBSC	National institute For Biological Standards and Control
NIH	National Institute of Health
NGS	Next-Generation Sequencing
PASS	Pakistan AMR Surveillance System
PCRWR	Pakistan Council of Research in Water Resources
POE	Points of Entry
PMDC	Pakistan Medical and Dental Council
PPHRL	Provincial Public Health Reference Laboratory
PVMC	Pakistan Veterinary Medical Council
RubeNS	Rubella Nucleotide Surveillance
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
SOP	Standard Operating Procedure
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TB	Tuberculosis
TWGs	Technical Working Group
UKHSA	United Kingdom Health Security Agency
UVAS	University of Veterinary and Animal Sciences
WHO	World Health Organization
WOAH	World Organization for Animal Health
WAHIS	World Animal Health Information System

Introduction

Genomic surveillance provides critical evidence on the dynamics of pathogen transmission and introduction patterns in affected populations. It plays a central role in outbreak investigations by enabling the tracking of pathogen evolution and informing response strategies related to virulence, diagnostics, transmissibility, and vaccine effectiveness. For maximum public health impact, genomic surveillance must be timely, efficient, and promote open data sharing to support rapid, evidence-based decision-making.

Pakistan remains endemic for several high-priority infectious diseases. Developing and implementing a National Genomic Surveillance Strategy is essential to strengthening the country's capacity to detect, monitor, and respond to outbreaks, while also preparing for emerging public health threats. The National Institute of Health (NIH) has already established a Genomic Center, which collaborates with the national SARS-CoV-2 Genomic Consortium, comprising laboratories and institutions nationwide, to advance national surveillance efforts.

Building on lessons from the COVID-19 pandemic, Pakistan developed an initial National Genomic Surveillance Strategy¹, guided by the WHO Global Genomic Surveillance Strategy for Pathogens with Pandemic and Epidemic Potential 2022–2032². A SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis was conducted by the Technical Working Group (TWG) at NIH. The initial draft was reviewed by the national SARS-CoV-2 Genomic Consortium, and their feedback was incorporated.

In 2025, the strategy was revised to reflect evolving public health priorities and ensure alignment with global best practices, incorporating a strengthened One Health approach, updated on-site capacity assessments, prioritization of pathogens for genomic surveillance, expanded strategic objectives, and a detailed implementation plan.

The Technical Working Group at NIH conducted on-site assessments of human and animal sector genomic facilities across Pakistan to evaluate institutional capacities, identify system-level gaps, and update the previous SWOT analysis (Annex A). Strategic objectives were refined in collaboration with experts from the human and animal health sectors (Annex B), incorporating the Expanded Strategic Commitments – 2025 Update, and a detailed implementation plan was developed to support operationalization (Annex C). A structured pathogen prioritization exercise (Annex D) was conducted using the Duke-NUS/ASIA Pathogen Genomics Initiative (ASIA-PGI) tool. This process reflected a One Health approach and provided a transparent, evidence-informed framework for selecting priority pathogens for genomic surveillance.

The revised 2025 draft strategy was reviewed by the National Laboratory Working Group (NLWG) and finalized to include updated strategic priorities, a clearly defined implementation roadmap, and provisions for sustainability, costing, and ongoing capacity monitoring. Grounded in the One Health framework, the strategy is designed to be actionable, adaptive, and aligned with national needs and global standards.

1. <https://www.nih.org.pk/wp-content/uploads/2023/04/National-Genomic-Surveillance-Strategy.pdf>
2. <https://www.who.int/initiatives/genomic-surveillance-strategy>

Strategic Objectives

Objective 1: Strengthen and Expand Access to Tools for Equitable Geographic Representation

Statements

1.1. Establish a Legally Mandated National Genomic Consortium (NGC)

The Ministry of National Health Services, Regulations & Coordination (MoNHSR&C), in coordination with provincial health departments and the animal, environment, and agriculture sectors, shall establish and legally mandate a National Genomic Consortium (NGC). The NGC will coordinate genomic surveillance of priority pathogens across the One Health spectrum through a nationally coordinated yet decentralized framework, ensuring representation from all provinces, regions (ICT, AJ&K, GB), and key stakeholders from public and private sectors.

1.2. Define Consortium Composition and Stakeholder Representation

The NGC shall include representatives from the following disciplines and institutions, among others:

- Molecular Biologists, Microbiologists, Pathologists
- Epidemiologists, Biostatisticians, Veterinarians
- Bioinformaticians, Entomologists, IT/GIS Experts
- Academicians, Environmental and Public Health Experts, Agriculturists
- Provincial Public Health Reference Laboratory (PPHRL) experts
- Ministry representatives and donor agencies

1.3. Establish a Technical Working Group for Coordination and Oversight

Dedicated Provincial Technical Working Groups (TWGs) shall be created under the NGC with clearly defined roles and responsibilities. TWGs shall help NGC for implementation of strategy in respective provinces.

1.4. Align Operations with National Biosafety and Laboratory Policies

The consortium shall ensure full alignment with existing National Laboratory Policy and the National Biosafety and Biosecurity.

1.5. Map and Evaluate National Genomic Sequencing Capacity

The NGC shall coordinate comprehensive national mapping of existing and potential sequencing capacities across human, animal, marine, forensic, environmental, and agriculture sectors, including:

- Laboratory infrastructure (e.g., NGS platforms)
- Equipment and bioinformatics tools
- Human resources and sustainability plans
- Data sharing mechanisms and legal frameworks to identify synergies, gaps, and opportunities for resource sharing.

1.6. Recommend Minimum Capacity for Real-Time Surveillance

Based on mapping results, the NGC and TWGs shall define minimum sequencing capacity requirements for real-time surveillance across provinces and regions, ensuring decentralization and geographic equity.

Strategic Objectives

1.7. Develop National Guidelines for Priority Pathogen Surveillance

The NGC and TWGs shall periodically review and where necessary update the list of priority pathogens and develop guidelines for standardized testing volumes and assays required for genomic surveillance in line with evolving health risks.

1.8. Provide Policy and Resource Advocacy to Government Stakeholders

The NGC and TWGs shall advocate for and submit its technical recommendations to MoNHSR&C, Ministry of National Food Security & Research (MoNFSR), and provincial health departments to ensure financial, logistical, and policy-level support for sustainable genomic surveillance.

Expanded Strategic Commitments – 2025 Update

1.9. Infrastructure & Performance Standards

1.9.1. Leverage Public Health Reference Laboratories (PPHRLs) for a Decentralized Genomic Network

NGS facilities in all four PPHRLs shall serve as the foundation of a decentralized genomic surveillance network, enabling real-time detection and reporting from all regions.

1.9.2. Set Minimum Quality Standards for Sequencing Sites

Minimum performance standards (e.g., turnaround time, genome coverage, QC metrics) shall be established for all sequencing centers to ensure consistency and comparability.

1.9.3. Develop a Real-Time National Sequencing Dashboard

An interactive, public health dashboard shall be created to visualize sequencing throughput, coverage, and pathogen data flow in real-time.

1.10. One Health Integration

1.10.1. Formally Integrate Human, Animal and Environmental Surveillance Labs

Human, Animal, and environmental disease laboratories shall be fully integrated into the national genomic surveillance system under a formal One Health framework

1.11. Innovation and Forecasting

1.11.1. Integrate AI Tools for Outbreak Prediction

Artificial Intelligence (AI)-enabled predictive modeling tools shall be adopted to strengthen early warning systems, trend analysis, and outbreak forecasting capabilities.

Strategic Objectives

Objective 2: Strengthen the Workforce to Deliver at Speed, Scale, and Quality

Statements

2.1. Integrate Pathogen Genomics into Academic Curricula

The Higher Education Commission (HEC) and other relevant academic stakeholders shall promote the inclusion of pathogen genomics; including NGS and bioinformatics as a core subject at graduate, post-graduate, and advanced research levels. This effort will be supported by targeted advocacy campaigns to build and retain a skilled national genomics workforce.

2.2. Create Dedicated Workforce Positions in Genomic Surveillance

The Ministry of NHSR&C, PPHRLs, Ministry of National Food Security & Research (MoNFSR), and Provincial Livestock Departments shall allocate dedicated positions, such as bioinformaticians and molecular biologists, in human, animal health and environment sectors to support the operationalization of national genomics initiatives.

2.3. Implement Certified In-Service and Pre-Service Training Programs

All public and private institutions involved in pathogen genomics shall design and implement standardized training programs (pre-service and in-service), ensure mandatory enrollment of relevant staff, and periodically update course modules to maintain technical relevance and alignment with international best practices.

2.4. Develop and Maintain a National HR Database for Genomics

The Ministry of NHSR&C, in collaboration with PPHRLs, Ministry of National Food Security & Research (MoNFSR), and Provincial Livestock Departments, shall maintain and regularly update a federal and provincial-level human resource database capturing training records and staff profiles relevant to NGS, bioinformatics, and pathogen genomics.

2.5. Establish External Quality Assessment (EQA) Programs

National and provincial EQA programs for pathogen genomics shall be developed, with all public and private genomics laboratories required to participate in national and/or international EQA schemes to ensure quality, accuracy, and standardization.

Expanded Strategic Commitments – 2025 Update

2.6. Cross-Sectoral Workforce Development

2.6.1. Launch Multi-Sectoral Workforce Exchange Programs

Structured cross-sectoral workforce exchange programs shall be implemented between human, animal health and environmental laboratories to encourage skill-sharing, harmonization, and collaborative learning.

2.6.2. Collaborate on Joint Fellowships with Academia and Veterinary Institutes

Collaborations shall be established with veterinary and public health academic institutions to offer joint academic fellowships and research opportunities in pathogen genomics.

Strategic Objectives

2.7. Workforce Standards and Institutional Coordination

2.7.1. Implement a National Certification Framework

A national certification or competency framework shall be developed for genomic surveillance professionals, including core and One Health-specific competencies, and accredited by recognized institutions.

2.7.2. Appoint Institutional Focal Points for Workforce Coordination

Each participating institution shall designate a workforce focal person responsible for coordinating training, certification, and human resource development activities.

Strategic Objectives

Objective 3: Enhance Data Sharing and Utility for Streamlined Local-to-Global Public Health Decision-Making and Action

Statements

3.1. Establish Legal Frameworks for Genomic Data Sharing

All public and private institutions engaged in genomic surveillance of priority pathogens shall develop and sign Memoranda of Understanding (MoU) that mandate timely, secure, and standardized data sharing.

3.2. Define Minimum Metadata Requirements and Data Governance Standards

The NGC and TWGs shall define minimum metadata parameters per pathogen, and coordinate the development of legal frameworks, data-sharing agreements, and governance protocols to support secure, ethical, and timely sharing of data with decision-makers through real-time dashboards.

3.3. Develop and Manage a National Genomic Data Repository

A centralized national genomic data repository for all priority pathogens shall be developed and managed by the NIH, ensuring secure storage, controlled access, and integration of genomic data from across the country, guided by cross-sectoral SOPs that define ownership, usage rights, and metadata standards.

3.4. Enable Timely Submission to National and Global Databases

Genomic and associated metadata for all priority pathogens shall be routinely submitted to national and global repositories (e.g., GenBank, GISAID, NCBI, GLASS), in accordance with data-sharing guidelines developed by the NGC and TWG's. These guidelines shall also cover data backup, security, and confidentiality.

Expanded Strategic Commitments – 2025 Update

3.5. Integrated Platforms and Interoperability

3.5.1. Establish an Integrated National Genomic Data Platform

A unified national platform shall be created to aggregate, manage, and visualize genomic data from human, animal health and environment sectors for real-time analysis and action.

3.5.2. Ensure Interoperability with Global Surveillance Systems

The national platform shall support data interoperability with international One Health databases such as WOAH-WAHIS and FAO EMPRES-i to enhance cross-border collaboration and threat detection.

3.6. Cross-Sectoral Collaboration and Governance

3.6.1. Create a One Health Data Governance Framework

A comprehensive governance framework shall be developed to clearly outline the roles, responsibilities, and access levels for all One Health stakeholders involved in genomic data generation and use.

Strategic Objectives

3.7. Data Integration for Public Health Intelligence

3.7.1. Link Genomic Data with Disease Reporting Systems

Genomic data shall be linked to existing national disease reporting platforms such as the District Health Information System 2 (DHIS2) and the Animal Disease Data Reporting System (ADDRS), and relevant platforms to facilitate integrated risk assessments.

3.7.2. Combine Genomic Data with Clinical and Laboratory Information

Genomic surveillance efforts shall be integrated with epidemiological, clinical, serological, neutralization and other relevant assay data to generate deeper insights into pathogen evolution, transmission dynamics, and public health implications.

3.8. Cyber Biosecurity

3.8.1. Implement Cyber Biosecurity Measures for Genomic Systems

Cyber biosecurity protocols shall be developed and implemented to protect genomic databases, sequencing platforms, and bioinformatics systems from cyber threats.

These protocols shall cover:

- Secure data storage and transfer
- Protection of cloud-based bioinformatics pipelines
- User access controls and audit trails
- Regular cybersecurity risk assessments and incident response mechanisms

These measures shall be aligned with national digital security policies and international best practices in bio-risk and cyber threat mitigation.

Strategic Objectives

Objective 4: Maximize Connectivity for Timely Enhance in the Broader Surveillance Architecture

Statements

4.1 Expand National Surveillance Platforms to Include Genomics

Existing public health surveillance platforms and networks shall be expanded to integrate pathogen genomics, ensuring alignment with the broader disease surveillance ecosystem.

4.2. Strengthen and Scale the Integrated Disease Surveillance and Response (IDSR) System

The IDSR system, in conjunction with PPHRLs and relevant laboratories, shall be expanded and operationalized across all levels: federal, provincial, and district, and shall include genomic data contributions from both public and private sector institutions.

4.3. Establish IT Infrastructure for Connectivity and Data Flow

A robust IT system infrastructure shall be developed at all administrative levels to enable the secure transmission, storage, and visualization of genomic surveillance data.

4.4. Build a National Specimen Referral and Transport System

A centralized, efficient specimen referral and transportation mechanism shall be developed to support timely sample collection, route, and delivery to designated genomic reference laboratories.

4.5. Strengthen Surveillance at Points of Entry (POEs)

A coordination mechanism shall be established to link laboratories, Points of Entry (POEs), and other relevant agencies for timely identification of pathogen introduction/importation, using genome-wide identification and bioinformatics analytics.

4.6. Formalize Targeted Collaboration with One Health Partners

Strategic collaboration shall be initiated with One Health stakeholders, facilitating data integration, early warning, and joint risk assessment across sectors.

Expanded Strategic Commitments – 2025 Update

4.7. Operational Connectivity and Outbreak Response

4.7.1. Embed Genomic Outputs into Multisectoral Outbreak Protocols

Genomic surveillance outputs shall be embedded into national and multisectoral outbreak detection and response protocols to enhance early warning systems and enable coordinated, rapid response across human, animal, and environmental health sectors.

4.7.2. Strengthen Real-Time Information Flow Between Surveillance and Response Systems

Operational linkages will be established between genomic data platforms, field surveillance systems, and emergency response teams to ensure real-time data sharing and actionable insights during outbreak scenarios.

Strategic Objectives

4.8. Inter-Ministerial Governance and Policy Alignment

4.8.1. Develop Inter-Ministerial Coordination Mechanisms for Genomic Surveillance

Formal MOUs and coordination mechanisms shall be developed between the Ministry of NHR&C, MoNFSR, Ministry of Climate Change, and relevant ministries for policy alignment, resource sharing, and joint genomic surveillance governance.

Strategic Objectives

Objective 5: Maintain a Readiness Posture for Emergencies

Statements

5.1 Formulate a National Emergency Genomic Surveillance Action Plan

The NGC and TWGs shall lead the development of a national action plan for genomic surveillance in the context of epidemic and pandemic preparedness. This plan shall include:

- Governance and coordination mechanisms
- Infrastructure and HR assessments for surge readiness
- Surge simulation and response planning
- POE integration for outbreak screening (linked to Objective 4)
- Advocacy for dedicated emergency funding at federal and provincial levels
- Stakeholder engagement (e.g., DRAP, Customs, vendors) for rapid approvals and distribution of critical supplies

5.2. Maintain Essential Resources Across Sectors

Laboratories in the human health, animal and environment sectors shall continuously maintain technical and material resources; including reagents, equipment, and trained staff for rapid scale-up of molecular testing and sequencing during public health emergencies.

5.3. Develop and Implement Surge Capacity Plans

Pre-defined surge plans shall be created and regularly updated to ensure rapid expansion of testing and sequencing operations during outbreaks. These plans shall include logistics, human resource deployment, and facility readiness.

5.4. Ensure Reliable Supply Chain Mechanisms for Emergencies

A mechanism shall be established to guarantee the availability of testing materials, including contingency procurement frameworks and supplier agreements, to support emergency deployment and minimize delays.

5.5. Strengthen Early Warning and Alert Systems through Collaboration

Relevant sectors and institutions shall collaborate on joint early warning alert systems, with a focus on building trust, interoperability, and operational readiness for real-time outbreak detection.

5.6. Conduct Periodic Monitoring, Evaluations, and After-Action Reviews

Routine monitoring, evaluation, and after-action reviews (AARs) shall be institutionalized to assess and continuously improve the performance of genomic surveillance in emergency scenarios.

Expanded Strategic Commitments – 2025 Update

5.7. Zoonotic and Cross-Species Outbreak Preparedness

5.7.1. Include Zoonotic Scenarios in Simulation Exercises

Zoonotic and cross-species transmission scenarios shall be incorporated into national surge simulation and outbreak preparedness plans, ensuring alignment with the One Health approach

Strategic Objectives

5.7.2. Institutionalize Joint After-Action Reviews for Zoonotic Events

Joint AARs shall be conducted following zoonotic outbreaks to evaluate multisectoral genomic response and refine future coordination protocols.

5.8. One Health Emergency Response Capacity

5.8.1. Develop One Health Rapid Response Teams

Multisectoral rapid response teams, trained in genomic sampling, sequencing, and data analysis, shall be developed and pre-positioned to respond to high-impact public health threats.

5.8.2. Advocate for Ring-Fenced Emergency Funding

Dedicated, ring-fenced funding streams shall be established to support cross-sectoral genomic emergency preparedness and response capabilities, particularly for zoonotic threats.

5.8.3. Formalize Existing Cross-Sector Research Collaborations

Existing collaborations in zoonotic disease research and response shall be institutionalized under the One Health framework, with clear roles and shared emergency protocols.

Annex - A

SWOT Analysis

Objective 1: Strengthen and Expand Access to Tools for Equitable Geographic Representation

Strengths

- National Laboratory policy available
- National Laboratory Biosafety & Biosecurity policy is available
- National Laboratory Quality Standards are established
- National Strategic Framework for containment of AMR
- Tiered level of labs is defined
- Federal and provincial health care commissions functional
- DRAP is regulating medical devices and testing material
- Availability of genomics/bioinformatics facility at national and at all provincial level (Punjab, Sindh, KPK, and Balochistan), except Gilgit-Baltistan and AJK
- Availability of trained workforce for genomic surveillance at federal and at provincial level
- Genomic data of some priority pathogens is available
- SOPs/Protocols for the genomic surveillance of some priority pathogens available
- Liaison with international collaborators for providing the resources for genomic surveillance of some priority pathogens
- Mobile labs are available to support outbreak investigations in remote areas.
- Strong academic presence (UVAS, AKU) with research capabilities in genomics.
- Presence of advanced NGS platforms (Illumina, Nanopore, IonTorrent) in institutions like NIH, AKU, PPHL Lahore, PPHL Sindh, and UVAS Lahore
- Foundational sequencing capabilities are present at National Veterinary Laboratory (NVL) and all PPHLs across provinces except GB and AJK.

Weaknesses

- No NGC exists for all priority pathogens
- Inventory of Labs (BSL-2 and BSL-3) at federal and provincial level is missing
- Limited trained workforce and facilities at federal and provincial level
- Limited resources/funding available for genomic surveillance at federal and provincial level, heavy reliance on donor funding (Global Fund, international partners)
- Lack of standardized training tool kit for genomic surveillance at federal and provincial level.
- Lack of coordination among stakeholders at federal and provincial level.
- Most labs lack bioinformaticians and computational power (except NIH, AKU and Indus Hospital).
- Uneven Geographic Distribution of Resources, Balochistan has limited sequencing capacity compared to other provinces.
- Most veterinary labs lack sequencing facilities, sending samples abroad with no access to human lab resources.

SWOT ANALYSIS

Objective 1: Strengthen and Expand Access to Tools for Equitable Geographic Representation

Opportunities

- The genomic surveillance system established for COVID-19, Influenza, Polio, Measles, TB, HIV, Hepatitis, and other pathogens can be used as a platform for the genomic surveillance of other priority pathogens
- Political commitment and realization towards pathogen genomic surveillance
- Awareness and willingness of scientific community at national and provincial level on pathogen genomics surveillance
- Funding and technical support available from donors and international organizations for capacity building of HR and infrastructure on genomic surveillance of some priority pathogens
- Potential for integrating human, animal, and environmental health data under a One Health approach
- Opportunities to optimize and expand existing veterinary diagnostic platforms for genomic surveillance
- The sequencing capacity currently available in the human health sector can be leveraged by the veterinary sector until its own dedicated infrastructure is developed

Threats

- Sustainability of human resources and funding for genomic surveillance
- Continued reliance on external sequencing collaborations due to infrastructure and capacity gaps
- Fragmented coordination between sectors (human vs animal health) may delay response efforts

SWOT ANALYSIS

Objective 2: Strengthen the workforce to deliver at speed, scale, and quality

Strengths

- NIH has launched training programs to build genomic surveillance capacity, which can be replicated by provincial labs (e.g., AKU, UVAS, PPHLs) to strengthen workforce skills
- Bioinformatics program for master and PhD is available in curriculum of universities
- Skilled workforce (Molecular Biologists/bioinformaticians/Lab tech) developed during the COVID pandemic
- Research into genomics is being conducted by various private and public institutes
- Staff trained on IPC at provincial/district level
- Master trainers available for bioinformatics and molecular biology (NGS)
- The National EQA program for molecular testing of COVID-19 was developed and rolled out to more than 150 labs by NIH.
- Strong institutional bioinformatics capacity in NIH, AKU and Indus Hospital

Weaknesses

- Partial skilled workforce for bioinformatics and NGS available at district/provincial level
- Limited standardized training delivered on bioinformatics and NGS at all levels
- Lack of national database/inventory of bioinformatician and molecular biologists available in the country
- Lack of training programs at institutional level both for pre-service and in-service at all levels
- No EQA programs available for NGS
- Limited indigenous capacity available to develop the national EQA programs for all priority pathogens
- Retention of skilled staff for NGS and Bioinformatics/Molecular Biology
- Short-term contracts for staff in most labs.
- Lack of dedicated bioinformatics personnel in most provincial and veterinary labs
- Inconsistent or absent structured training programs in bioinformatics and NGS
- Dependency on external institutions for analysis due to in-house skill gaps

SWOT ANALYSIS

Objective 2: Strengthen the workforce to deliver at speed, scale, and quality

Opportunities

- Political commitments and realization towards pathogen genomics
- Awareness and willingness at federal and provincial level on genomics
- Funding and technical support available from donors and international organizations for capacity building of HR on pathogen genomics
- Master trainers available to conduct standardized cascade trainings on pathogen genomics
- Potential to leverage academic institutions (e.g., AKU, UVAS) for national cascade trainings
- Scope to introduce national-level certification programs in genomic bioinformatics
- Opportunities exist to scale national training capacity through institutions like UVAS, AKU, and NIH
- NIH-led NGS training offers an opportunity to strengthen the human and animal health workforce under a unified capacity-building approach
- Inclusion of environmental health (e.g., antimicrobial resistance in water systems)

Threats

- Sustainability of human resources, funding on pathogen genomics
- Conflict of interest among stakeholders
- Reluctance among staff to work in remote areas
- Retention challenges due to lack of incentives and postings in remote areas
- Over-reliance on short-term donor-funded training initiatives
- Short-term contracts lead to loss of trained personnel.
- Lack of career incentives for bioinformaticians in public sector

SWOT ANALYSIS

Objective 3: Enhance data sharing and utility for streamlined local to global public health decision-making and action

Strengths

- Availability of genomic data on international databanks (NCBI, GISAID etc.) for some priority pathogens, representativeness of different geographical locations of the country
- Partial data sharing system exists for some priority pathogens (Influenza, Polio, TB, AMR, Measles, HIV, dengue, and others)
- IDSR for surveillance of some priority pathogens is partially operational
- LIMS functional at some health institutes at federal and provincial levels for some priority pathogens
- Advanced data-sharing workflows exist at institutions like AKU and Indus Hospital
- Regular submission of genomic data to international repositories (e.g., GISAID, NCBI) by key institutions enhances data visibility and global interoperability.
- Proven collaboration in health emergencies, during the SARS-CoV-2 and MPOX emergencies, stakeholders rapidly shared genomic data with EOC and NCOC, aiding national response and demonstrating Pakistan's ability to coordinate data sharing during crises

Weaknesses

- No national genomic database available for priority pathogens
- No integration of metadata and genomic data at national and provincial level
- Limited reporting of genomic surveillance data to health authorities for all priority pathogens
- Lack of timely data sharing from provincial level to federal level and vice versa
- Lack of guidelines for timely sharing of data for all priority pathogens
- Lack of trust and ownership
- Lack of standardized metadata guidelines at provincial and district level
- Unavailability of legal agreements for data sharing at all levels
- Limited resources/HR for data collection, storage, and analysis (including NGS data)
- Unavailability of internet access in remote areas
- Lack of monitoring and evaluation of genetic data quality uploaded to international databanks (GISAID, NCBI)
- No national mechanism for integration of genomic and epidemiological metadata
- Absence of legal frameworks or MoUs for cross-institutional data sharing
- Lack of capacity to monitor the quality of genomic data shared with international databases
- There is currently no unified system or defined minimum metadata parameters across institutions, risking inconsistent data collection and submission

SWOT ANALYSIS

Objective 3: Enhance data sharing and utility for streamlined local to global public health decision-making and action

Opportunities

- Availability of international funding for data sharing
- Availability of international guidelines for data management
- Availability of international public repositories (NCBI, GISAID, MeaNS/ RubeNS etc.)
- Availability of training opportunities for public health related staff and students
- Ongoing collaboration opportunities with academic and international repositories (e.g., AKU, GISAID)
- Training opportunities in genomic data management through WHO and other partners
- Establishing a formal agreement can build trust and create accountability among institutions involved in genomic surveillance.
- The National Genomic Consortium can standardize metadata requirements and data formats, enhancing comparability and interoperability

Threats

- Data security at all levels
- Sustainability of resources
- Risks of data misuse and privacy breaches in the absence of secure IT infrastructure
- Inadequate legal clarity on data ownership and access rights
- Without a dedicated federal and provincial budget, the genomic repository and associated data sharing systems may not be sustainable

SWOT ANALYSIS

Objective 4: Maximize connectivity for timely value-add in the broader surveillance architecture

Strengths

- NCOC/EOC platform is present at national level
- IDSR and IDIMS, PASS, GLASS, for surveillance of some priority pathogens is partially operational
- One Health platform for surveillance of some priority pathogens is partially available
- WHO supported surveillance activities primarily during outbreak situations
- Nation-wide network of vertical programs such as Malaria, TB, HIV etc.
- The laboratory-based surveillance network for some priority diseases including COVID-19, Influenza, Polio, Measles, Rubella, Rotavirus, Typhoid, Cholera, Diphtheria, pertussis, and Hepatitis etc.
- Networking with International Labs/Institutes such as CDC (USA), UKHSA, NIBSC (UK) WHO etc.
- Collaborative opportunities between human, animal, and environmental sectors already exist — particularly in zoonotic disease research
- Cross-sector integration potential demonstrated by academic institutions collaborating across One Health domains

Weaknesses

- Lack of coordination between public and private sector/Institutes
- Limited integration of surveillance data of priority pathogens at national level
- Lack of coordination between Human, Animal, and Environmental sectors
- Lack of coordination between Lab and relevant POE staff
- Specimen referral system
- Limited infrastructure and Internet access in remote areas
- Limited interoperability between human and animal health surveillance systems
- Gaps in communication and reporting pathways across levels (federal/provincial/district)

SWOT ANALYSIS

Objective 4: Maximize connectivity for timely value-add in the broader surveillance architecture

Opportunities

- Expanding IDSR to include genomic data can enhance outbreak detection and tracking of variants and AMR strains
- Connecting data between the existing surveillance systems is more efficient than creating a new one
- Knowledge and experience gained during COVID-19 pandemic can be used to develop strategies for genomic surveillance of other priority pathogens
- Engaging existing healthcare commission at provincial level
- Expand existing collaboration between the Animal and Human sector
- Use of COVID-era digital tools and systems to expand cross-sector genomic surveillance
- Engagement of veterinary and environmental health labs in One Health platforms

Threats

- Sustainability of resources
- Conflict of interest among stakeholders
- Transfer posting of trained workforce
- Information silos due to weak institutional coordination mechanisms
- Loss of continuity due to frequent re-posting of trained staff
- Many district-level and rural labs lack internet connectivity, electricity stability, or trained IT staff, risking exclusion from the national system.
- Establishing and maintaining nationwide IT and referral systems will require sustained political commitment and financial resources, which may be constrained

SWOT ANALYSIS

Objective 5: Maintain a readiness posture for emergencies

Strengths

- National Action Plan for COVID-19
- Pakistan preparedness and Response Plan COVID-19
- Federal and provincial public health reference laboratories are fully functional with genomic testing capacity
- Existing platform of COVID-19 genomic surveillance
- Existing network of laboratory surveillance programs can be utilized for any outbreak/ emergency
- Some experience related to inter-action and after-action reviews gained during COVID-19, pandemic
- Experience in dealing with outbreak/epidemics of some priority pathogens including Dengue, Typhoid, Polio, Measles, pertussis, Cholera, Diphtheria and Influenza
- Trained laboratory staff available
- Established surge capacity in select labs (e.g., PPHL Sindh, AKU) for rapid outbreak response

Weaknesses

- Lack of training modules and preparedness plan for outbreak situations
- Lack of inventory of available resources including infrastructure, workforce, (equipment and reagents)
- Non availability/ delayed adaptation of new technology at the time of emergency at all levels
- No dedicated funds to respond to public health threats (esp. for genomic surveillance)
- Non-functional sequencing units due to budget constraints (e.g., NVL)
- No surge deployment model for bioinformaticians during outbreaks
- Lack of coordination among research, diagnostic and industrial communication

SWOT ANALYSIS

Objective 5: Maintain a readiness posture for emergencies

Opportunities

- Expand existing surveillance network for genomic surveillance
- Polio outbreak simulation model could be adapted for genomic readiness exercises.
- Technical support available from global reference laboratories
- Liaison with local experts in academia/ research institutes and NGOs for surge support in emergency

Threats

- Trained workforce shortage
- Biosafety and biosecurity concern relevant to handling infectious material during emergency
- Delays in approval and procurement processes (e.g., DRAP) during emergencies
- Timely DRAP approval of testing material
- Pre allocation of budget for emergency/ Outbreak response
- Insufficient pre-allocated funding for emergency genomic surveillance operations

Annex - B

List of participants involved in preparing the draft

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Objective 1: Strengthen and Expand Access to Tools for Equitable Geographic Representation

List of strategic Actions	Operational Plan: Sub Activities	Primary responsibility	Secondary responsibility	Timeline
<p>1.1. Establish a Legally Mandated National Genomic Consortium (NGC)</p> <p>1.2. Define Consortium Composition and Stakeholder Representation</p> <p>1.3. Establish a Technical Working Group for Coordination and Oversight</p> <p>1.4 Align Operations with National Biosafety and Laboratory Policies</p>	<p>1. NIH to formally communicate with MoNHSR&C to initiate the formation of the National Genomic Consortium (NGC) ensuring equitable representation.</p> <p>2. Consolidation and formal notification of the National Genomic Consortium (NGC), including development of Terms of Reference (ToRs) and clearly defined roles and responsibilities for all members.</p> <p>3. Provinces to notify Technical Working Groups (TWGs) for genomic surveillance, which will oversee implementation and coordination at the provincial level.</p>	NIH, MoNHSR&C	Provincial/ Regional Health Departments, Director General Offices, Livestock Departments, MNFS&R, HEC, PVMC, MoECC	Q4 2025
1.5. Map and Evaluate National Genomic Sequencing Capacity	<p>1.NGC develops a standardized assessment tool covering infrastructure, equipment, HR, data sharing, sustainability, and legal/regulatory frameworks</p> <p>2.Technical Working Groups (TWGs) collect relevant data from cross sector provincial labs (Human, Animal, marine, forensic and agriculture) institutions, and stakeholders.</p> <p>3.Compile and submit collected data to NGC for consolidation and analysis.</p> <p>4.NGC consolidates and analyzes sequencing capacity data at the national level.</p>	NGC, TWG's	NIH, Provincial/ Regional Health Commission and Livestock Departments	Q1 2026
1.6. Recommend Minimum Capacity for Real-Time Surveillance	<p>1. NGC and TWG's defines the minimum sequencing capacity requirements based on capacity assessment results</p>	NGC, TWG's	NIH	Q1-2 2026
1.7. Develop National Guidelines for Priority Pathogen Surveillance	<p>1. NGC and TWG's to periodically review and where necessary update the list of priority pathogens in Pakistan for Genomic Surveillance.</p> <p>2. Draft and distribute standardized testing volume guidelines required for genomic surveillance.</p>	NGC, TWG's , NIH	Provincial/ Regional Health and Livestock Departments	Periodically and where necessary
1.8. Provide Policy and Resource Advocacy to Government Stakeholders	<p>1.NGC and TWG's advocates and submits its technical recommendations to MoNHSR&C, MNFS&R, and provincial health departments.</p> <p>2.NGC engages government stakeholders for financial and logistical support to sustain genomic surveillance.</p> <p>3.NGC and TWG's advocates for policy-level integration of genomic surveillance in national and provincial frameworks.</p>	NGC, TWG's	NIH, MoNHSR&C, MNFS&R	Q2-4 2026
1.9. Infrastructure & Performance Standards	<p>1. Develop minimum performance benchmarks (e.g., turnaround time, genome coverage, QC metrics) in consultation with experts</p> <p>2. Disseminate and enforce these standards across public and private sequencing laboratories</p> <p>3. Design and develop a national interactive dashboard with modules for sequencing capacity, throughput, geographic spread, and pathogen-specific data.</p> <p>4. Integrate dashboard with global platforms (e.g., GISAID, WHO, etc.) where applicable for outward data sharing.</p>	NGC, MoITTI, TWG, NIH	Provincial/ Regional Health and Livestock department	Q3 2026 – Q3 2027
1.10. One Health Integration	<p>1. TWG to develop Terms of Reference (ToRs) for integration of human, animal, and environmental labs into the national genomic system.</p> <p>2. Identify integration points for data sharing, joint reporting, and surveillance coordination across human-animal-environmental health systems.</p> <p>3. Develop SOPs for sample referral, sequencing, and data sharing between sectors.</p> <p>4. Pilot data integration between selected human and animal/environmental labs to validate interoperability</p>	TWG, NIH, MNFS&R, MoECC	NIH, MNFS&R WHO, UKHSA, CDC, DAL, FAO and others	Q1-4 2026
1.11. Innovation and Forecasting	<p>1. Provinces to develop and train AI-based predictive models tailored to their local disease burden and epidemiological patterns.</p> <p>2. Link provincial AI models with existing surveillance systems (e.g., IDSS, lab data, climate inputs) for real-time outbreak forecasting.</p> <p>3. Build technical capacity at provincial level through training of data analysts, epidemiologists, and IT teams on AI tools and trend modelling.</p>	Provincial Health and Livestock Departments, PPHL	NGC, NIH	Q1 2027 – Q4 2028

Objective 2: Strengthen the workforce to deliver at speed, scale, and quality

List of strategic Actions	Operational Plan, Sub Activities	Primary responsibility	Secondary responsibility	Timeline
<p>2.1. Integrate Pathogen Genomics into Academic Curricula</p> <ol style="list-style-type: none"> Engage with HEC, universities, and professional councils (e.g., PVMC, PMDC) to initiate academic integration dialogue. Establish an academic curriculum working group under the HEC to review existing curricula and identify gaps related to genomics, NGS, and bioinformatics in medical, veterinary, and life sciences programs. Develop standardized curriculum modules (core concepts, lab skills, data analysis, case studies) tailored to each academic level. 		NGC, HEC	PVMC, PMDC, NIH	Q1 2027 – Q4 2028
<p>2.2. Create Dedicated Workforce Positions in Genomic Surveillance</p> <ol style="list-style-type: none"> NGC to develop and share a standardized list of essential genomic workforce roles (e.g., bioinformaticians, molecular biologists, lab data analysts) with all relevant ministries and departments. Ministries and provincial departments to allocate and advertise dedicated positions in human, animal, and environmental health sectors. Develop and approve a service structure and job descriptions to support long-term retention and career progression of genomic professionals. 		NGC, MoNHSR&C, MIFSAR	Provincial/Regional Health and Livestock Departments, Provincial/Regional Healthcare Commissions	Q3 2026 – Q4 2028
<p>2.3. Implement Certified In-Service and Pre-Service Training Programs</p> <ol style="list-style-type: none"> Design and develop standardized training curricula for in-service and pre-service professionals (covering NGS, bioinformatics, lab workflows, data interpretation). Develop a national Training-of-Trainers (ToT) program to create a pool of certified trainers. Allocate dedicated funding and resources for implementation of ToT programs and subsequent roll-out at national and provincial levels. NGC to review and approve training delivery sites (national or international) based on relevance and cost-effectiveness. Roll out in-service training programs for current public/private lab staff and surveillance officers. 		NGC, NIH, MoNHSR&C, MIFSAR	WHO, UKHSA, CDC, DAL, FAO and others	Q3 2026 – Q2 2027
<p>2.4 Develop and Maintain a National HR Database for Genomics</p> <ol style="list-style-type: none"> Provincial and federal TWGs to collect and compile HR data from relevant institutions and then submit it to NGC. Assign focal persons at provincial level to maintain and regularly update HR records. 		NGC, Provincial/Regional Health and Livestock Departments, TWG, NIH	Provincial/Regional Healthcare commissions	Q1 2027 – Q4 2030
<p>2.5. Establish External Quality Assessment (EQA) Programs</p> <ol style="list-style-type: none"> National and Provincial reference labs to develop capacity for designing and implementing EQA programs specific to genomic surveillance (NGS and bioinformatics). Identify and engage with global EQA providers (e.g., WHO, QCMD, INSTAND) for collaboration and capacity-building. Mandate regular participation in EQA programs (minimum annually) for all labs contributing to the national genomic surveillance system. In the interim, all designated genomic laboratories are encouraged to participate in established international External Quality Assessment (EQA) programs. 		NIH, MoNHSR&C, MIFSAR	WHO, UKHSA, CDC, FAO and others	Q3 2027 – Q4 2028
<p>2.6. Cross-Sectoral Workforce Development</p> <ol style="list-style-type: none"> NGC and TWGs to identify priority skill areas and suitable professionals for cross-sectoral exchange (e.g., molecular diagnostics, NGS, bioinformatics, biosafety) Design structured short-term exchange programs (1–3 months) with defined learning objectives, supervision plans, and outcome documentation Coordinate exchange placements and logistical support for selected candidates. Develop and approve fellowship structure and curriculum focused on One Health genomics (sampling, sequencing, analysis) Formalize MoUs or agreements with partner institutions for fellowship implementation Advocate for funding support from HEC, donors, and government sources to sustain fellowships 		NGC, TWG, NIH, MoNHSR&C, MIFSAR	Provincial/Regional Health and Livestock Departments, HEC, PVMC, PMDC	Q1 2028 – Q4 2029
<p>2.7. Workforce Standards and Institutional Coordination</p> <ol style="list-style-type: none"> NGC will lead the development of a national certification and competency framework in consultation with all relevant institutes, ensuring it includes sector-specific skill sets, training standards, and pathways for recognition Participating institutions will nominate focal persons to coordinate training, certification and workforce planning efforts 		NGC, TWG	MoNHSR&C, Provincial/Regional Health and Livestock Departments,	Q1 2027 – Q4 2030

Objective 3: Enhance data sharing and utility for streamlined local to global public health decision-making and action

List of strategic Actions	Operational Plan: Sub Activities	Primary responsibility	Secondary responsibility	Timeline
3.1.1. Establish Legal Frameworks for Genomic Data Sharing	1. NGC to develop national guidelines and a standardized MoU template for genomic data sharing across sectors and share with all relevant stakeholders.	NGC, TWG	WHO, UKHISA, CDC, DAI, FAO and others	Q3-4, 2026
3.2. Define Minimum Metadata Requirements and Data Governance Standards	1. NGC and TWG's to define minimum metadata parameters per pathogen. 2. Ensure the repository includes metadata standards, user access levels, data submission pipelines, and linkage with surveillance systems.	NGC, TWG	NIH	Q3-4, 2026
3.3. Develop and Manage a National Genomic Data Repository	1. NIH to design and develop a secure, interoperable national genomic data repository for priority pathogens 2. Conduct training sessions for lab and surveillance focal persons on repository use and maintenance 3. Establish data backup and long-term sustainability mechanisms 4. Develop cross-sectoral SOPs and data-sharing agreements to define data ownership, access levels, use policies, and metadata standards across human, animal, and environmental health sectors.	NIH, MoNHSR&C, MNFS&R	NGC, TWG, WHO, UKHISA, CDC, DAI, FAO and others	Q1 2027 – Q1 2030
3.4. Enable Timely Submission to National and Global Databases	1. Assign focal person in each sequencing center responsible for timely data submission and quality control. 2. Engage relevant stakeholders to facilitate oversight, compliance, and coordination with data-sharing arrangements. 3. Establish a monitoring mechanism through TWGs to track adherence to terms.	All Labs doing genomic surveillance/se quencing, NGC, TGW	NIH MoNHSR&C, MNFS&R, HEC	Q2 2027 – Q4 2030
3.5. Integrated Platforms and Interoperability	1. Design and develop a centralized dashboard linked with National Genomic Repository. 2. Map data requirements and technical specifications of international systems like VIDA, WAHIS and FAO EMPRES-i. 3. Establish standardized data formats and APIs to enable real-time uploading and retrieval of genomic and metadata across sectors. 4. Collaborate with international partners for validation, testing, and capacity building to ensure compliance with global standards.	NIH, NGC	MNFS&R WHO, UKHISA, CDC, DAI, FAO and others	Q2 2027 – Q4 2030
3.6. Cross-Sectoral Collaboration and Governance	1. NGC and TWGs to coordinate development of the One Health data governance framework. 2. Define roles, responsibilities, and data access levels for all stakeholders involved in genomic data generation and sharing. 3. Draft, review, and disseminate the governance framework in coordination with relevant ministries and departments.	NGC, TWG	NIH, Provincial/ Regional Health and Livestock Departments, MNFS&R	Q1 2027 – Q4 2030
3.7. Data Integration for Public Health Intelligence	1. Convene a national-level consultative meeting with IDSR, DHS2 focal points, ADRS representatives (Punjab), and animal/public health stakeholders to plan integration. 2. Design interoperability framework to enable secure and standardized data flow between platforms. 3. Pilot the national genomic data repository with IDSR and ADRS in Punjab. 4. Based on pilot success, roll out integration plan for other provinces and adapt existing animal health reporting systems where ADRS is not present	MoNHSR&C, MNFS&R	Provincial/ Regional Health and Livestock Authorities	Q1 2028 – Q4 2030
3.8. Cyber Biosecurity	1. Conduct stakeholder consultations to ensure buy-in and alignment with national regulations (e.g., cyber laws, public health data governance) 2. Develop basic cyber biosecurity guidelines tailored for genomic labs and data systems, aligned with national cyber-security policies. 3. Implement strong user authentication and access control protocols for genomic databases and bioinformatics platforms. 4. Conduct routine data backups and establish secure data transfer procedures for all participating labs.5. Train designated focal persons at national and provincial levels on cyber-security hygiene and incident reporting protocols.	MoNHSR&C, MNFS&R, MoITT	NIH, HEC, NGC, WHO, UKHISA, CDC, DAI, FAO and others	Q2 2027 – Q4 2030

Objective 4: Maximize connectivity for timely value-add in the broader surveillance architecture

List of Strategic Actions	Operational Plan: Sub Activities	Primary responsibility	Secondary responsibility	Timeline
4.1. Expand National Surveillance Platforms to Include Genomics	<ol style="list-style-type: none"> 1. Conduct a comprehensive needs assessment of existing platforms (e.g., IDSR, disease-specific programs) to evaluate readiness for genomic data integration. 2. Assess and allocate resources to upgrade infrastructure and expand system capabilities for pathogen genomics. 3. Operate train programs to build capacity of surveillance and lab teams for handling, analyzing, and utilizing genomic data across various pathogens. 4. Expand existing digital platforms to accommodate multiple pathogens and enable seamless data flow between labs, surveillance, and decision-making units 5. Monitor system integration and evaluate improvements in timeliness and quality of outbreak detection and reporting 	MoNHS&RC, UKHSA, NIH, CDC, Provincial Health and Department	NSC, TWG	Q2 2026 - Q4 2028
4.2. Strengthen and Scale the Integrated Disease Surveillance and Response (IDSR) System	<ol style="list-style-type: none"> 1. Assess the status of DHIS2-based IDSR implementation across all provinces and identify coverage gaps. 2. Develop and implement a scale-up roadmap for nationwide DHIS2 rollout, ensuring interoperability with genomic surveillance systems. 3. Upgrade system infrastructure and software tools where DHIS2 is not fully functional. 4. Conduct capacity-building trainings for district and facility-level surveillance staff and lab personnel 	MoNHS&RC, NIH, UKHSA, CDC	Provincial/Regional Health Department and commission, MNFS&R	Q4 2026 - Q4 2027
4.3. Establish IT Infrastructure for Connectivity and Data Flow	<ol style="list-style-type: none"> 1. Allocate dedicated funds to support phased IT infrastructure development. 2. Initiate a pilot project at the national level and selected reference labs to test systems, workflows, and integration models 3. Develop standardized specifications and procurement guidelines for scale-up to provincial and district levels 4. Based on pilot success, roll out nationwide IT infrastructure strengthening plan 	NIH, MoNHS&RC, Provincial/Regional Health Departments, UKHSA, CDC	WHO, UKHSA, CDC, DAI, FAO and others	Q1, 2028-Q4, 2030
4.4. Build a National Specimen Referral and Transport System	<ol style="list-style-type: none"> 1. Develop a centralized specimen referral framework with defined timelines, packaging protocols, and designated hub-and-spoke providers. 2. Identify and formalize agreements with courier agencies for temperature-controlled, biosecure transport of specimens across provinces. 3. Design and implement a training program for courier staff on biosafety, cold chain maintenance, and specimen handling. 4. Allocate dedicated funding for specimen transport to cover routine and emergency needs. 5. Deploy specimen transport kits and tracking tools (barcoding, digital logs) at collection and referral sites.6. Monitor referral system performance, including turnaround time and specimen condition upon arrival 	Provincial/Regional Health Department, NIH, MoNHS&RC	WHO, UKHSA, CDC, DAI, FAO and others	Q3 2026-Q4 2027
4.5. Strengthen Surveillance at Points of Entry (POEs)	<ol style="list-style-type: none"> 1. Conduct consultative meetings and workshops with POE authorities (human and animal), health officers, and reference labs to identify communication and referral barriers. 2. Develop standard operating procedures (SOPs) and referral protocols to link POEs with designated reference labs for rapid sample transport and testing. 3. Designate focal persons at each POE and reference lab for coordination and tracking. 4. Procure and deploy transport and packaging kits for safe and timely sample transfer from POEs to labs 	BHS, Animal Quarantine, Provincial/Regional and Public Health Labs and authorities	MoNHS&RC, MNFS&R, WHO, DAI, FAO and others	Q4, 2026-Q4, 2027
4.6. Formalize Targeted Collaboration with One Health Partners	<ol style="list-style-type: none"> 1. Sign formal collaboration agreements (MoUs) with key One Health partners from human, animal, and environmental sectors to formalize cross-sectoral coordination. 2. Establish routine coordination meetings for early warning and cross-sectoral risk assessment at national and provincial levels. 	NIH, NSC	MoNHS&RC, MNFS&R	Q3 2026-Q4 2027
4.7. Operational Connectivity and Outbreak Response	<ol style="list-style-type: none"> 1. Define triggers and thresholds for initiating genomic investigation during outbreaks (e.g., unusual clusters, vaccine breakthroughs, severe or unexplained cases). 2. Establish protocols for sharing of genomic results during outbreaks. 3. Establish protocols to link genomic data with case-based line lists and field investigation reports. 4. Conduct joint outbreak response meetings to interpret genomic findings and guide public health actions. 	NIH PHIL, NSC, EC, TWG	MoNHS&RC, Provincial Health and livestock surveillance units, WHO, UKHSA, CDC, DAI, FAO and others	Q4 2026-Q3 2027
4.8. Inter-Ministerial Governance and Policy Alignment	<ol style="list-style-type: none"> 1. Convene inter-ministerial consultative meetings to define shared goals, collaboration areas, and data-sharing expectations. 2. Draft and validate a standard Inter-ministerial MoU template outlining roles, responsibilities, and coordination protocols. 3. Sign formal MoUs or Letters of Agreement (LoA) between ministries and national institutions for long-term collaboration. 4. Integrate agreed actions into existing national public health and One Health policies and frameworks. 	MoNHS&RC, MNFS&R, MoCC	Provincial Health Departments	Q1-4 2027

Objective 5: Maintain a readiness posture for emergencies

List of strategic Actions	Operational Plan: Sub Activities	Primary responsibility	Secondary responsibility	Timeline
5.1. Formulate a National Emergency Genomic Surveillance Action Plan	<ol style="list-style-type: none"> 1. NGC to draft a comprehensive preparedness and response plan, covering all core components (governance, surge, POE, etc.) 2. Conduct infrastructure and HR capacity assessments to evaluate readiness for genomic surge response (Linked to Objective 1.5). 3. Define coordination mechanisms and roles across federal, provincial, and One Health partners for outbreak preparedness and response. 4. Engage stakeholders (e.g., DRAP, Customs, vendors) to streamline emergency approvals and supply chain access. 5. Include funding strategies and allocation plans to support implementation. Align plan with national emergency frameworks and health security priorities 	NGC, TWG	NIH, MoNHS&R, MNFS&R, MoCC	Q3 2026 – Q3 2027
5.2. Maintain Essential Resources Across Sectors	<ol style="list-style-type: none"> 1. Maintain a multisectoral buffer stock system of critical supplies (e.g., extraction kits, PCR reagents, sequencing consumables) at Federal and provincial public health labs. 2. Maintain a rapid deployment team roster of trained personnel for emergency field sequencing and support 3. Conduct biannual inventory reviews of reserve stock to ensure readiness and expiry management 	NIH, MNFS&R, Provincial/Regional Public Health Laboratories	Provincial/Regional Health and Livestock Departments	Q1 2027 – Q4 2030
5.3. Develop and Implement Surge Capacity Plans	<ol style="list-style-type: none"> 1. Develop surge testing and sequencing protocols outlining steps for scaling up operations during outbreak scenarios under the National Emergency Genomic Surveillance action plan. 2. Identify and designate surge-capable labs with capacity for rapid expansion across provinces (public, private, veterinary, environmental) 3. Create a standby roster of trained staff (molecular biologists, technicians, data analysts) for emergency deployment 4. Pre-approve emergency procurement channels and logistics support (transport, cold chain) for rapid response 	NGC, TWG, National and Provincial/Regional Public Health Laboratories	Provincial/Regional Health and Livestock departments	Q1-Q4 2028
5.4. Ensure Reliable Supply Chain Mechanisms for Emergencies	<ol style="list-style-type: none"> 1. Engage with PPRA, DRAP, and customs authorities to streamline import and clearance processes for genomic reagents. 2. Establish agreements with multiple pre-qualified vendors to avoid single-source dependency 3. Fix annual procurement rates through framework agreements to ensure timely availability and cost control 4. Ensure dedicated budget allocation for procurement and stock replenishment of sequencing and PCR materials. 5. NGS suppliers operating in Pakistan are encouraged or required to maintain stock within-country. 	Provincial/Regional Health and Livestock Departments	National and Provincial/Regional Public Health Laboratories	Q1-4 2028
5.5. Strengthen Early Warning and Alert Systems through Collaboration	<ol style="list-style-type: none"> 1. Integrate genomic data streams into existing national early warning platforms such as IDSR and ADDRIS. 2. Conduct joint technical meetings among human, animal, and environmental health sectors to align alert thresholds and information-sharing protocols. 3. Develop real-time data exchange mechanisms to enable timely alerts, backed by signed MoUs and trusted communication channels. 	NIH, NGC, TWG	PPHL, MNFS&R	Q3 2028 – Q3 2029
5.6. Conduct Periodic Monitoring, Evaluations, and After-Action Reviews	<ol style="list-style-type: none"> 1. Develop a standardized M&E framework and checklist for periodic assessment of genomic labs (public/private) 2. Conduct regular performance reviews of laboratories: including turnaround time, quality metrics, data submission, and inter-lab result validation through cross-checking mechanisms. 3. Conduct routine after-action reviews (AARs) following major public health emergencies involving genomic investigations. 4. Compile and disseminate review findings to NGC, provincial stakeholders, and partners for continuous system improvement. 	TWG, NGC, PPHL, Animal Genomics Labs	Federal and Provincial/Regional Public Health Laboratories, WHO, UKHSA, CDC, DAI, FAO and others	Q2 2028 – Q3 2029
5.7. Zoonotic and Cross-Species Outbreak Preparedness	<ol style="list-style-type: none"> 1. NGC with the support from all relevant ministries, designs simulation exercises that include zoonotic pathogens and cross-species transmission events in coordination with animal and environmental health sectors. 2. Conduct joint simulation drills at national and provincial levels to test the genomic surveillance response across sectors. 3. Develop a standardized AAR framework for zoonotic outbreaks, aligned with One Health principles. 4. Conduct multisectoral AARs after each zoonotic event to evaluate genomic data usage and coordination gaps. 	NGC, MoNHS&R, MNFS&R, MoCC, WHO, UKHSA, CDC	NIH, Provincial/Regional Health and Livestock Department	Q1-4 2028
5.8. One Health Emergency Response Capacity	<ol style="list-style-type: none"> 1. Form multidisciplinary teams comprising human health, animal health, and environmental professionals 2. Identify joint training modules focused on sample collection, genomic workflows, data sharing, and risk communication. 3. Identify and train multisectoral rapid response teams in genomic sampling, sequencing, and data interpretation. 4. Pre-position genomic sampling kits and PPE at federal and provincial levels for quick deployment during outbreaks. 5. Develop and submit a costed proposal to federal/provincial authorities advocating for ring-fenced emergency genomic funds. 6. Engage planning and finance departments to ensure dedicated budget lines for cross-sectoral genomic preparedness. 7. Formalize existing zoonotic research collaborations through MoUs under a One Health emergency coordination framework 	NIH, MoNHS&R, Provincial/Regional Health and Livestock Department	WHO, UKHSA, CDC, DAI, FAO and others	Q1-4 2028

Implementation Plan

Strategic actions No.	2025				2026				2027				2028				2029				2030					
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
1.1. Establish a Legally Mandated National Genomic Consortium (NCG)																										
1.2. Define Consortium Composition and Stakeholder																										
1.3. Establish a Technical Working Group for Coordination and Oversight																										
1.4. Align Operations with National Biosafety and Laboratory Policies																										
1.5. Map and Evaluate National Genomic Sequencing Capacity																										
1.6. Recommend Minimum Capacity for Real-Time Surveillance																										
1.7. Develop National Guidelines for Priority Pathogen Surveillance																										
1.8. Provide Policy and Resource Advocacy to Government Stakeholders																										
1.9. Infrastructure & Performance Standards																										
1.10. One Health Integration																										
1.11. Innovation and Forecasting																										
2.1. Integrate Pathogen Genomics into Academic Curricula																										
2.2. Create Dedicated Workforce Positions in Genomic Surveillance Programs																										
2.3. Implement Certified In-Service and Pre-Service Training																										
2.4. Develop and Maintain a National HR Database for Genomics																										
2.5. Establish External Quality Assessment (EQA) Programs																										
2.6. Cross-Sectoral Workforce Development																										
2.7. Workforce Standards and Institutional Coordination																										
3.1. Establish Legal Frameworks for Genomic Data Sharing																										
3.2. Define Minimum Metadata Requirements and Data Governance Standards																										
3.3. Develop and Manage a National Genomic Data Repository																										
3.4. Enable Timely Submission to National and Global Databases																										
3.5. Integrated Platforms and Interoperability																										
3.6. Cross-Sectoral Collaboration and Governance																										
3.7. Data Integration for Public Health Intelligence																										
3.8. Cyber Biossecurity																										
4.1. Expand National Surveillance Platforms to Include Genomics																										
4.2. Strengthen and Scale the Integrated Disease Surveillance and Response (IDSR) System																										
4.3. Establish IT Infrastructure for Connectivity and Data Flow																										
4.4. Build a National Specimen Referral and Transport System																										
4.5. Strengthen Surveillance at Points of Entry (POEs)																										
4.6. Formalize Targeted Collaboration with One Health Partners																										
4.7. Operational Connectivity and Outbreak Response																										
4.8. Inter-Ministerial Governance and Policy Alignment																										
5.1. Formulate a National Emergency Genomic Surveillance Action Plan																										
5.2. Maintain Essential Resources Across Sectors																										
5.3. Develop and Implement Surge Capacity Plans																										
5.4. Ensure Reliable Supply Chain Mechanisms for Emergencies																										
5.5. Strengthen Early Warning and Alert Systems through Collaboration																										
5.6. Conduct Periodic Monitoring, Evaluations, and After-Action Reviews																										
5.7. Zoonotic and Cross-Species Outbreak Preparedness																										
5.8. One Health Emergency Response Capacity																										

ANNEX - D

List of Priority Pathogens

Human / Zoonotic

1. *SARS-CoV-2*
2. *Vibrio cholerae*
3. *Mycobacterium tuberculosis*
4. *Crimean-Congo Hemorrhagic Fever*
5. *Poliovirus**
6. *Dengue virus*
7. *Seasonal Influenza*
8. *Corynebacterium diphtheriae*
9. *Neisseria meningitidis*
10. *Salmonella typhi (XDR)*
11. *Measles virus**
12. *HIV*
13. *Hepatitis B and C*
14. *Plasmodium spp.*
15. *Staphylococcus aureus*
16. *Streptococcus pneumoniae*
17. *Chikungunya virus*
18. *Haemophilus influenzae*
19. *Mpox virus*
20. *Rotavirus**
21. *Antimicrobial-resistant fungi (GLASS priority pathogens)*
22. *Respiratory Syncytial Virus**
23. *Norovirus*

Animal / Zoonotic

1. *Foot-and-mouth disease virus (FMDV)*
2. *Avian Influenza (H5N1, etc.)*
3. *Newcastle disease virus (NDV)*
4. *Lumpy Skin Disease Virus (LSDV)*
5. *Peste des petits ruminants (PPRV)*
6. *Rabies virus*
7. *Brucella spp.*
8. *Bacillus anthracis*

Note: *Dedicated genomic/genetic surveillance is already being conducted at the National Institute of Health, Islamabad, with support from WHO and the CDC (USA).



Ministry of NHR&C



ISLAMABAD

**Ministry of National Health Services Regulations
& Coordination Government of Pakistan,
National Institute of Health, Islamabad**