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Next-Gen Global Health 6.0: Integrative Genomics, Nano-Immunotherapies, and AI for Infectious and Chronic Disease Convergence

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Abstract: *The Next-Gen Global Health 6.0 initiative offers an integrative model employing genomics, nano-immunotherapies, and artificial intelligence (AI) to address the escalating complexity of global health issues, particularly the convergence of infectious and chronic diseases. This framework advances precision medicine by integrating real-time genomic surveillance with AI algorithms, enabling timely prediction and response to outbreaks, as well as tailored therapeutic approaches. Nano-immunotherapies play a critical role in modulating immune responses with high specificity, especially in chronic infections and diseases resistant to conventional treatments. Through these synergistic technologies, the Next-Gen Global Health 6.0 approach aims to transcend traditional healthcare boundaries, offering scalable, data-driven interventions that are adaptable to varying resource levels worldwide. Emphasizing accessibility and equity, this framework highlights the necessity for innovative health policies and interdisciplinary collaboration to optimize deployment in underserved regions, ultimately contributing to sustainable, resilient healthcare systems prepared for evolving global health challenges.*

Keywords: *Genomics, Infectious Diseases, Chronic Diseases, Precision Medicine, Global Health.*

1. INTRODUCTION

In contemporary global health, the growing convergence of infectious and chronic diseases demands urgent attention, driven by intricate interactions among environmental, genetic, and socioeconomic factors that complicate prevention, diagnosis, and treatment [1]. Emerging technologies, such as integrative genomics, nano-immunotherapies, and artificial intelligence (AI), have created unprecedented opportunities to address these intertwined health issues more effectively [2]. By leveraging these technologies, including genomic medicine, researchers and healthcare practitioners can enhance the precision and personalization of medical interventions, which are essential to improving outcomes across diverse populations, especially in low-resource settings [3].

Genomic innovations, for instance, allow for in-depth analyses of both pathogens and host responses, facilitating real-time outbreak tracking and the development of targeted treatments [4]. Concurrently, advances in nano-immunotherapies are enabling more precise immune modulation, which is particularly valuable for chronic and persistent infections that evade conventional treatments [5]. Furthermore, AI algorithms are being deployed to interpret massive datasets generated from genomic and immunological research, supporting predictive models that can foresee disease spread and identify effective therapeutic targets [6]. These technologies collectively represent a transformative shift towards an integrated, data-driven approach to global health, aiming to overcome the limitations of traditional methods.

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At a pivotal moment for healthcare, the Next-Gen Global Health 6.0 framework leverages genomics, nanotechnology, and AI to deliver adaptive, scalable solutions to complex, systemic diseases. This approach advances personalized, predictive medicine, promoting accessible, equitable care—especially for underserved regions burdened by global disease.

Modeling of Infectious and Non-Infectious Diseases Using Regenerative Biology and Nanotechnology

Stem cell-derived organoids and nanotechnology have revolutionized the modeling of infectious and non-infectious diseases, offering unprecedented insights into pathogen-host interactions and the progression of non-communicable diseases (NCDs). Organoids, formed by self-organizing stem cells, provide advanced three-dimensional (3D) structures that simulate the complexity of human tissues, thereby enabling detailed studies on cellular mechanisms during infections. By closely mimicking in vivo structures, these organoids have become instrumental in exploring the effects of infections on respiratory, gastrointestinal, and neuronal systems, offering a robust platform for drug screening and therapeutic discovery [7, 8]. This technology is further enhanced through nanotechnology, which introduces nanoparticles capable of targeting specific cellular structures, thereby providing a precision tool for both simulating infection and delivering therapeutic agents to resistant bacteria. This dual approach enhances the efficacy of drug development, allowing for highly targeted and controlled therapeutic simulations [9].

Looking to the future, combining organoid models with nanotechnology promises transformative applications in regenerative medicine and oncology. Induced pluripotent stem cell (iPSC)-derived organoids, for instance, offer the potential for genome editing, such as CRISPR, allowing precise modification of pathogenic genes and providing patient-specific models for personalized therapy. Furthermore, the integration of nanoparticles within organoid cultures can enhance cellular responsiveness and adaptation, potentially improving outcomes in chronic conditions by targeting specific molecular pathways involved in disease progression [10]. As the field advances, these technologies may support the development of adaptive, personalized therapies that respond dynamically to changes in disease state, marking a significant shift toward more effective, individualized medical treatments [11].

Personalized Vaccination and Immunotherapy Based on Genetic Profiling and Nanotechnology

Personalized vaccination and immunotherapy, leveraging genetic profiling and nanotechnology, represent a transformative approach in modern medicine, offering targeted and efficient treatments against both infectious diseases and cancer. The development of mRNA-based vaccines exemplifies this progress, where vaccines are tailored to an individual's genetic makeup, allowing for more precise immune activation and response. In the context of cancer immunotherapy, personalized mRNA vaccines can stimulate T-cells to recognize tumor-specific neoantigens, improving both safety and efficacy. Nanotechnology further enhances these effects by facilitating targeted delivery of mRNA within lipid nanoparticles (LNPs) that can selectively direct immune responses and reduce side effects, as demonstrated in various studies using personalized cancer nano-vaccines [12-14]

The application of nanotechnology in personalized immunotherapy is advancing quickly, particularly through novel materials that enhance antigen presentation and immune activation. For example, α-mannose-functionalized nanoparticles have been developed to selectively target antigen-presenting cells (APCs), thus optimizing the immune response to mRNA vaccines. This specificity not only heightens vaccine efficacy but also reduces unintended interactions with non-target cells. Additionally, advanced carriers like graphene oxide hydrogels have been shown to stabilize and prolong mRNA release, improving the durability of immune responses. These developments pave the way for future personalized vaccines that adapt dynamically to patient-specific disease profiles and immunological needs, making them particularly promising in the treatment of chronic and complex diseases [15, 16].

Genomic Surveillance and Artificial Intelligence Algorithms for Global Outbreak Prediction and Disease Spread

Genomic surveillance and artificial intelligence (AI) are transforming global public health by enabling real-time monitoring and prediction of infectious disease outbreaks and antimicrobial resistance patterns. Genomic surveillance, through whole-genome sequencing (WGS), captures comprehensive data on pathogens, offering insights into resistance mechanisms and transmission pathways essential for outbreak prediction. This technology allows scientists to trace the genetic evolution of pathogens, making it possible to identify and control clusters of antimicrobial-resistant bacteria early in their spread. For instance, the integration of pathogen genomic data with phylogenetic analysis has been

shown to predict and monitor the spread of drug-resistant strains, such as carbapenem-resistant organisms [17]. AI models then process these vast datasets, identifying patterns and trends that inform public health strategies, which is crucial for fast and accurate interventions in combating global health threats like antibiotic-resistant infections [18, 19]

Advances in machine learning (ML) further enhance these surveillance capabilities by enabling sophisticated predictive modeling that adapts to new pathogens and resistance patterns as they emerge [20]. ML models, such as random forest and convolutional neural networks, have demonstrated high accuracy in forecasting antimicrobial resistance (AMR) based on genomic data, even when data is limited or incomplete. These AI-driven systems predict the potential spread of AMR genes across bacterial genomes, helping prioritize regions for surveillance and control efforts [19]. For example, the development of AI-based predictive tools for bacterial pathogens like Vibrio cholerae and Klebsiella pneumoniae has demonstrated significant potential in resource-limited settings, offering fast, in silico alternatives to traditional testing [21]. These integrated genomic and AI frameworks mark a new frontier in global health, enabling scalable and effective responses to infectious disease threats across various regions [22, 23]

CRISPR-Based Therapy and Genetic Editing for Systemic Infectious and Non-Infectious Diseases

CRISPR-based therapies are pioneering a new era in the treatment of systemic infectious and non-infectious diseases, particularly by targeting latent viral reservoirs and correcting genetic immune deficiencies [24, 25]. The CRISPR/Cas9 system enables precise genetic alterations, allowing researchers to disrupt viral genomes integrated within human cells, such as those seen in HIV, or deactivate the hepatitis B virus (HBV) in liver cells, significantly reducing viral replication. This precision also extends to hereditary immune deficiencies, where CRISPR can correct gene mutations that hinder the body's vaccine response, providing a promising avenue to fortify immune resilience against persistent and emerging infections [25, 26]. Moreover, CRISPR can be used to modify immune cells to better recognize and combat infections, enabling a dual approach that both directly attacks pathogens and bolsters immune function [27].

Future applications of CRISPR promise even greater integration with targeted delivery systems, such as nanoparticles and viral vectors, to improve in vivo efficiency and specificity in gene editing [28]. Research is currently focused on refining CRISPR delivery to avoid off-target effects and enhance treatment durability, with advances in non-viral delivery methods such as lipid nanoparticles showing considerable promise [29, 30]. These

methods provide improved control over gene editing within specific cells and tissues, essential for safely addressing chronic diseases like cancer and neurodegenerative disorders. Furthermore, CRISPR's potential in reprogramming cells to produce antiviral proteins or enhance immune memory represents a leap towards creating durable, possibly permanent, defenses against both current and future infectious threats [31, 32]. This robust, evolving technology marks a significant advancement in therapeutic gene editing, with implications that extend beyond infectious disease to complex, systemic conditions.

Immune-Based Interventions and Cell Therapy to Combat Chronic Infections and Systemic Diseases

Immune-based interventions and regenerative cell therapies are emerging as transformative approaches for treating chronic infections and systemic diseases, especially those exacerbated by age-related immune decline. By engineering immune cells, such as mesenchymal stem cells (MSCs), these therapies can address immunosenescence, a gradual deterioration of immune function linked to inflammaging, where chronic low-grade inflammation accelerates tissue damage and organ dysfunction. MSCs, particularly when modified to enhance anti-inflammatory functions, have shown potential in reducing this systemic inflammation and supporting tissue repair. The application of MSCs in diseases like diabetes and cardiovascular disease demonstrates promising results in reducing inflammatory markers and promoting regenerative outcomes [33, 34]. This ability to recalibrate immune responses marks a significant step forward in managing non-communicable diseases (NCDs) and improving quality of life in the elderly population [35].

The future of immune-based cell therapy lies in the integration of cutting-edge bioengineering and nanotechnology. By coupling regenerative cell therapy with nanomaterials designed to enhance cell targeting and therapeutic delivery, researchers aim to develop adaptive treatments that respond to changes in the immune environment, providing dynamic regulation of inflammation and tissue repair. This approach includes the use of bioengineered extracellular vesicles that act as non-coding RNA carriers to modulate immune responses against chronic infections and autoimmune disorders, thereby reducing the need for long-term pharmacological interventions [36]. With the advancement of immune-modifying biomaterials and senotherapeutics, this integrative approach has the potential to extend healthspan by addressing both the underlying inflammation and regenerative needs of aging and chronically diseased tissues [37].

Nano-Biotechnology in Developing Probiotic-Based Therapies and Targeted Drug Delivery

Integrating nano-biotechnology with synthetic biology-designed probiotic therapies has led to advanced solutions in enhancing immune defenses and targeting pathogenic infections. This approach involves engineering probiotics to produce antimicrobial peptides and other bioactive molecules, providing a tailored response against specific pathogens, particularly in high-infection environments. Nanoparticles serve as a vehicle for delivering these therapeutic probiotics effectively, even through challenging barriers such as the gastrointestinal tract, as demonstrated with nano-bio hybrid probiotics engineered for high precision targeting in gastrointestinal applications [38]. These nano-encapsulated probiotics ensure sustained delivery and effective immune support, positioning them as essential tools in environments prone to high pathogen exposure [39].

Further advancements in this field focus on using nano-biotechnology for targeted antibiotic delivery, particularly through bio-inspired nanoparticles that can effectively address resistant bacterial strains. Bioengineered bacterial encapsulins and mesoporous silica nanoparticles with antimicrobial peptides represent a powerful strategy to overcome biofilm defenses and antibiotic resistance [40]. For example, encapsulins have been engineered to carry therapeutic agents directly to infection sites, thereby reducing systemic exposure and enhancing localized treatment efficacy. This technology is evolving towards more precise, responsive systems that release drugs based on environmental triggers, such as pH or microbial presence, thereby improving therapeutic outcomes in difficult-to-treat infections [40, 41]. These innovations underline a shift towards targeted, responsive, and sustainable therapies in infectious disease treatment, aligning with the demands of modern healthcare.

Real-Time Imaging and Sensor Systems for Early Detection and Disease Monitoring

The integration of real-time imaging and advanced sensor systems based on carbon nanotube (CNT) technology has significantly advanced early disease detection and health monitoring capabilities [42]. Wearable devices incorporating CNTs enable continuous, non-invasive tracking of critical health markers, such as metabolic and immunological indicators, facilitating timely responses to early signs of infectious diseases and non-communicable diseases (NCDs) [43, 44]. These sensors are highly sensitive and capable of detecting minimal physiological changes, which is essential for managing chronic diseases and monitoring organ health, as demonstrated by devices that track respiratory rates or even detect cytokine levels, providing early warnings of immune dysregulation [45, 46]. Such

technologies extend to wearable microneedle patches, enabling the real-time, in vivo monitoring of cytokines—key indicators of immune response—which can be crucial in predicting cytokine storms in severe infections [47].

Looking forward, advancements in molecular imaging are expanding to real-time organ monitoring, particularly for vital organs like the liver and lungs. These CNT-based devices are evolving into complex diagnostic platforms that integrate with mobile applications for instant data retrieval, allowing users and healthcare providers to access real-time health information and make informed decisions quickly. Future sensors are expected to incorporate multifunctional capabilities, with options to detect both biochemical and mechanical signals, thereby broadening their application to a range of health conditions from respiratory infections to Alzheimer's disease [48, 49]. This trajectory positions wearable sensor technology as a cornerstone of preventive healthcare and early disease intervention, enabling a future where health monitoring is accessible, proactive, and deeply integrated into daily life.

Genomics and Single-Cell Sequencing Technology in Immune and Pathogen Interaction Studies

Single-cell genomics combined with advanced immunomodulation technologies is transforming the study of pathogen-host interactions, providing granular insights into immune responses at the cellular level [50]. By capturing the gene expression profiles of individual immune cells, researchers can identify how specific cell subtypes contribute to either protective immunity or autoimmunity. For instance, recent studies have utilized single-cell RNA sequencing (scRNA-seq) to track immune cell behavior in diseases like multiple sclerosis (MS), where single-nucleotide polymorphisms (SNPs) associated with MS risk were found to influence the expression of genes in specific immune cell types, such as B cells and CD4+ T cells, in a highly targeted manner [51]. This approach not only allows for the identification of immune pathways that respond to infections but also uncovers mechanisms that may lead to autoimmune disorders when dysregulated [52].

The future of this technology holds promise for developing precision therapies targeting specific cell types involved in disease progression. For example, studies using single-cell approaches have demonstrated how certain gene variants contribute to T cell and B cell dysfunction in MS, paving the way for targeted interventions that can mitigate inflammatory responses without broadly suppressing the immune system [53]. Additionally, the ability to map interactions between immune cells and pathogens at single-cell resolution could enable the development of gene therapies tailored to the immune profiles of

individual patients, offering a new level of customization in treating autoimmune diseases and complex infections [54]. These advancements underscore the potential of single-cell genomics to drive both diagnostic and therapeutic innovations in immune-related diseases.

Advanced Bioinformatics and Machine Learning Algorithms for Integrated Multi-Disease Diagnostics

Advancements in machine learning (ML) algorithms and bioinformatics are revolutionizing the diagnostic landscape for multi-disease detection, especially in cases where non-communicable diseases (NCDs) and infectious diseases co-occur. By utilizing data-driven ML models, researchers can detect complex relationships between different diseases, allowing for more accurate diagnostic clustering and epidemiological predictions. For example, deep neural networks (DNN) and recurrent neural networks (RNN) are increasingly used in analyzing vast clinical datasets, enabling the prediction of disease progression and the identification of shared biomarkers across diseases. This approach significantly enhances predictive accuracy and aids in stratifying patient populations, which is particularly beneficial in tracking comorbidities such as diabetes and tuberculosis, where disease interdependencies complicate treatment plans [55, 56]

Looking forward, the integration of these ML models with bioinformatics tools allows for the dynamic updating of diagnostic algorithms, adapting to new data inputs and providing a real-time snapshot of multi-disease risks. Techniques such as automated feature selection and hyperparameter tuning further optimize these models, allowing for scalable and precise diagnostic tools that can be deployed in diverse healthcare environments. This evolving framework for predictive diagnostics not only enhances clinical outcomes through personalized medicine but also supports global health monitoring by offering scalable solutions that can analyze genetic, proteomic, and environmental data simultaneously, marking a significant leap towards precision health [57, 58]

Integrated Health Policies for Improved Healthcare Access in Developing Countries

Integrating mobile health (mHealth) and telemedicine in developing countries presents transformative possibilities for healthcare access, particularly for rural and underserved communities. Telemedicine platforms facilitate remote diagnostics and treatment, bridging the gap caused by limited healthcare facilities and specialists in remote regions. For example, telemedicine in São Tomé and Príncipe has enabled ongoing connections with Portuguese specialists, providing specialized care for common conditions such as eye and respiratory ailments, which would otherwise require extensive travel for patients [59]. Additionally, mHealth solutions offer accessible self-management tools,

empowering patients to monitor and manage chronic conditions like diabetes and hypertension from their homes, thus reducing the need for frequent hospital visits [60].

The future of integrated health policies in developing regions also emphasizes the need for sustainable infrastructure to support these digital health technologies. Developing countries often face challenges related to inconsistent electricity supply, limited internet connectivity, and insufficient digital literacy, which must be addressed to fully realize the potential of mHealth and telemedicine [61]. By incorporating local needs and contexts into health policy—such as renewable energy sources and affordable mobile data—governments can enhance the reliability of these services. Furthermore, by adopting universal telemedicine guidelines, as seen in Southeast Asia, countries can standardize the quality of care and address privacy, legal, and data security concerns effectively [62]. Such integrative policies are pivotal for ensuring healthcare equity, creating a robust foundation for accessible, tech-enabled healthcare solutions in low-resource settings.

Senescence Research and Molecular Pathways to Prevent Exacerbation of Age-Related Diseases from Infections

Research into (immuno)senescence pathways has illuminated the molecular connections between aging and infection-driven disease progression, especially in non-communicable diseases (NCDs). As cellular senescence leads to an accumulation of damaged cells that contribute to chronic inflammation, this process has been linked with exacerbated health conditions in elderly populations [63-65]. Specifically, the release of pro-inflammatory cytokines from senescent cells—known as the senescence-associated secretory phenotype (SASP)—creates a sustained inflammatory environment. This inflammation can significantly worsen conditions like Alzheimer's disease and cardiovascular disease when coupled with infections, as infections amplify the SASP and promote further immune dysregulation [66, 67]. The potential of targeted therapies, such as microRNA-based interventions, is particularly promising. These therapies can selectively reduce SASP components, thereby decreasing inflammation and mitigating age-related disease exacerbations [68].

Innovative treatments targeting senescence mechanisms have shown potential in reversing age-related inflammation, specifically by modulating pathways like cGAS-STING and NLRP3. The activation of these pathways due to mitochondrial DNA leakage or persistent viral infections accelerates senescence in immune cells, aggravating conditions like viral pneumonia and diabetes [69, 70]. By addressing these pathways, senotherapeutics offer a preventative strategy for diseases triggered or exacerbated by

infections in older populations. Through senolytics and anti-inflammatory therapies, researchers aim to reduce the inflammatory load in aging cells, ultimately promoting healthier aging and potentially expanding the lifespan by protecting against the dual burden of aging and infections [71, 72].

2. CONCLUSION AND RECOMMENDATION

The integration of genomics, nano-immunotherapies, and AI in the Next-Gen Global Health 6.0 framework marks a transformative approach to infectious and chronic disease management. By leveraging genomic surveillance, precision immunotherapies, and predictive AI, it enables real-time monitoring, personalized treatments, and targeted interventions, building resilient, adaptive healthcare systems for diverse global populations.

To maximize impact, future research and policy should prioritize scalable, accessible healthcare technologies adaptable to diverse cultures, with infrastructure and education initiatives for low- and middle-income regions bearing high disease burdens. Interdisciplinary collaboration among genomic scientists, AI experts, and policymakers is essential for aligning technology with real-world needs, fostering sustainable health solutions that enhance global health equity and preparedness.

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REFERENCES

Aghamiri, S., et al., Nanoparticles-mediated CRISPR/Cas9 delivery: Recent advances in cancer treatment. Journal of Drug Delivery Science and Technology, 2020. 56: p. 101533.

Amend, B., et al., Regulation of Immune Checkpoint Antigen CD276 (B7-H3) on Human Placenta-Derived Mesenchymal Stromal Cells in GMP-Compliant Cell Culture Media. International Journal of Molecular Sciences, 2023. 24.

Azar, J., et al., The Use of Stem Cell-Derived Organoids in Disease Modeling: An Update. International Journal of Molecular Sciences, 2021. 22.

Bag, N., et al., Nanoparticle-mediated stimulus-responsive antibacterial therapy. Biomaterials science, 2023.

Bertelli, C., et al., Enabling genomic island prediction and comparison in multiple genomes to investigate bacterial evolution and outbreaks. Microbial Genomics, 2022. 8.

Bhattacharya, S., P. Heidler, and S. Varshney, Incorporating neglected non-communicable diseases into the national health program—A review. Frontiers in Public Health, 2023. 10.

Bianconi, I., R. Aschbacher, and E. Pagani, Current Uses and Future Perspectives of Genomic Technologies in Clinical Microbiology. Antibiotics (Basel), 2023. 12(11).

Bianconi, I., R. Aschbacher, and E. Pagani, Current Uses and Future Perspectives of Genomic Technologies in Clinical Microbiology. Antibiotics, 2023. 12.

Binnie, A., et al., CRISPR-based strategies in infectious disease diagnosis and therapy. Infection, 2021. 49(3): p. 377-385.

Blutt, S.E. and M.K. Estes, Organoid Models for Infectious Disease. Annual review of medicine, 2021.

Bonnechère, B., et al., Mobile health solutions: An opportunity for rehabilitation in low- and middle income countries? Frontiers in Public Health, 2023. 10.

Chafai, N., et al., Emerging applications of machine learning in genomic medicine and healthcare. Critical Reviews in Clinical Laboratory Sciences, 2023. 61: p. 140 - 163.

Chen, H., et al., Aptamer-Functionalized Carbon Nanotube Field-Effect Transistor Biosensors for Alzheimer's Disease Serum Biomarker Detection. ACS Sens, 2022. 7(7): p. 2075-2083.

Clark, I.C., et al., Barcoded viral tracing of single-cell interactions in central nervous system inflammation. Science, 2021. 372.

Dashtian, K., F. Binabaji, and R. Zare-Dorabei, Enhancing On-Skin Analysis: A Microfluidic Device and Smartphone Imaging Module for Real-Time Quantitative Detection of Multianalytes in Sweat. Anal Chem, 2023. 95(44): p. 16315-16326.

Di Minno, G., et al., Next-generation strategies to improve safety and efficacy of adeno-associated virus-based gene therapy for hemophilia: lessons from clinical trials in other gene therapies. Haematologica, 2024.

Ellabaan, M.M.H., et al., Forecasting the dissemination of antibiotic resistance genes across bacterial genomes. Nature Communications, 2021. 12.

El-Safty, S.A. and M.A. Shenashen, Nanoscale dynamic chemical, biological sensor material designs for control monitoring and early detection of advanced diseases. Materials Today Bio, 2020. 5.

Fuesslin, V., et al., Prediction of Antibiotic Susceptibility Profiles of Vibrio cholerae Isolates From Whole Genome Illumina and Nanopore Sequencing Data: CholerAegon. Frontiers in Microbiology, 2022. 13.

Gali, K.V., et al., Surveillance of carbapenem-resistant organisms using next-generation sequencing. Front Public Health, 2023. 11: p. 1184045.

Gohil, S.H., et al., Applying high-dimensional single-cell technologies to the analysis of cancer immunotherapy. Nature Reviews Clinical Oncology, 2020. 18: p. 244-256.

Gonçalves, C., A.d. Mata, and L.V. Lapão, Leveraging technology to reach global health: The case of telemedicine in São Tomé and Príncipe health system. Health policy and technology, 2021. 10: p. 100548.

Guerrero, A., B.D. Strooper, and I.L. Arancibia-Cárcamo, Cellular senescence at the crossroads of inflammation and Alzheimer's disease. Trends in Neurosciences, 2021. 44: p. 714-727.

Guo, M.H., et al., Dissection of multiple sclerosis genetics identifies B and CD4+ T cells as driver cell subsets. Genome Biology, 2021. 23.

Hui, C.Y., et al., Mapping national information and communication technology (ICT) infrastructure to the requirements of potential digital health interventions in low- and middle-income countries. Journal of Global Health, 2022. 12.

Intan Sabrina, M. and I.R. Defi, Telemedicine Guidelines in South East Asia—A Scoping Review. Frontiers in Neurology, 2021. 11.

Irvine, D.J. and E.L. Dane, Enhancing cancer immunotherapy with nanomedicine. Nature Reviews Immunology, 2020. 20: p. 321 - 334.

Kaufmann, M., et al., Identifying CNS-colonizing T cells as potential therapeutic targets to prevent progression of multiple sclerosis. Med (New York, N.y.), 2021. 2: p. 296 - 312.e8.

Khanal, S., et al., Synthetic gRNA/Cas9 Ribonucleoprotein Inhibits HIV Reactivation and Replication. Viruses, 2022. 14.

Kim, J.I., et al., Machine Learning for Antimicrobial Resistance Prediction: Current Practice, Limitations, and Clinical Perspective. Clinical Microbiology Reviews, 2022. 35.

Kim, M.E. and J.S. Lee, Immune Diseases Associated with Aging: Molecular Mechanisms and Treatment Strategies. International Journal of Molecular Sciences, 2023. 24.

Leong, Y.X., et al., Where Nanosensors Meet Machine Learning: Prospects and Challenges in Detecting Disease X. ACS Nano, 2022. 16(9): p. 13279-13293.

Li, D.-f., et al., Nanoparticles for oral delivery: targeted therapy for inflammatory bowel disease. Journal of materials chemistry. B, 2022.

Li, Z., et al., Senotherapeutics: An emerging approach to the treatment of viral infectious diseases in the elderly. Frontiers in Cellular and Infection Microbiology, 2023. 13.

Liu, C., et al., A Machine Learning-Based Analytic Pipeline Applied to Clinical and Serum IgG Immunoproteome Data To Predict Chlamydia trachomatis Genital Tract Ascension and Incident Infection in Women. Microbiology Spectrum, 2023. 11.

Liu, Z., et al., Immunosenescence: molecular mechanisms and diseases. Signal Transduction and Targeted Therapy, 2023. 8(1): p. 200.

Lüftinger, L., et al., Learning From Limited Data: Towards Best Practice Techniques for Antimicrobial Resistance Prediction From Whole Genome Sequencing Data. Frontiers in Cellular and Infection Microbiology, 2021. 11.

Luís, C., et al., Nutritional senolytics and senomorphics: Implications to immune cells metabolism and aging – from theory to practice. Frontiers in Nutrition, 2022. 9.

Lv, N., et al., Dysfunctional telomeres through mitostress-induced cGAS/STING activation to aggravate immune senescence and viral pneumonia. Aging Cell, 2022. 21.

Lynch, S.M., et al., Role of Senescence and Aging in SARS-CoV-2 Infection and COVID-19 Disease. Cells, 2021. 10.

Ma, B., et al., Ovotransferrin Antibacterial Peptide Coupling Mesoporous Silica Nanoparticle as an Effective Antibiotic Delivery System for Treating Bacterial Infection In Vivo. ACS biomaterials science & engineering, 2021.

Marrella, V., A. Facoetti, and B. Cassani, Cellular Senescence in Immunity against Infections. International Journal of Molecular Sciences, 2022. 23(19): p. 11845.

Martinez-Arroyo, O., et al., Mesenchymal Stem Cell-Derived Extracellular Vesicles as Non-Coding RNA Therapeutic Vehicles in Autoimmune Diseases. Pharmaceutics, 2022. 14.

Maslennikova, A. and D. Mazurov, Application of CRISPR/Cas Genomic Editing Tools for HIV Therapy: Toward Precise Modifications and Multilevel Protection. Front Cell Infect Microbiol, 2022. 12: p. 880030.

McCarthy, J.J., H.L. McLeod, and G.S. Ginsburg, Genomic Medicine: A Decade of Successes, Challenges, and Opportunities. Science Translational Medicine, 2013. 5(189): p. 189sr4-189sr4.

Men, L., et al., Multi-disease prediction using LSTM recurrent neural networks. Expert Syst. Appl., 2021. 177: p. 114905.

Molaei, Z., et al., Exploring non-viral methods for the delivery of CRISPR-Cas ribonucleoprotein to hematopoietic stem cells. Stem Cell Res Ther, 2024. 15(1): p. 233.

Mukerjee, N., et al., Revolutionizing Human papillomavirus (HPV)-related cancer therapies: Unveiling the promise of Proteolysis Targeting Chimeras (PROTACs) and Proteolysis Targeting Antibodies (PROTABs) in cancer nano-vaccines. Journal of Medical Virology, 2023. 95.

Nguyen, T.V., et al., A Wearable, Bending-Insensitive Respiration Sensor Using Highly Oriented Carbon Nanotube Film. IEEE Sensors Journal, 2021. 21: p. 7308-7315.

Nikolajević, J., et al., The Role of MicroRNAs in Endothelial Cell Senescence. Cells, 2022. 11.

Ostadhossein, F., et al., Hitchhiking probiotic vectors to deliver ultra-small hafnia nanoparticles for 'Color' gastrointestinal tract photon counting X-ray imaging. Nanoscale horizons, 2022.

Park, D.J., et al., Development of machine learning model for diagnostic disease prediction based on laboratory tests. Sci Rep, 2021. 11(1): p. 7567.

Qaiser, N., et al., A Robust Wearable Point-of-Care CNT-Based Strain Sensor for Wirelessly Monitoring Throat-Related Illnesses. Advanced Functional Materials, 2021. 31.

Qiu, M., et al., Developing Biodegradable Lipid Nanoparticles for Intracellular mRNA Delivery and Genome Editing. Acc Chem Res, 2021. 54(21): p. 4001-4011.

Rdest, M. and D. Janas, Carbon Nanotube Wearable Sensors for Health Diagnostics. Sensors (Basel, Switzerland), 2021. 21.

Reyes, A., et al., Contribution of viral and bacterial infections to senescence and immunosenescence. Frontiers in Cellular and Infection Microbiology, 2023. 13.

Roth-Walter, F., et al., Metabolic pathways in immune senescence and inflammaging: Novel therapeutic strategy for chronic inflammatory lung diseases. An EAACI position paper from the Task Force for Immunopharmacology. Allergy, 2024. 79(5): p. 1089-1122.

Shpichka, A.I., et al., Organoids in modelling infectious diseases. Drug discovery today, 2021.

Taina-González, L. and M. de la Fuente, The Potential of Nanomedicine to Unlock the Limitless Applications of mRNA. Pharmaceutics, 2022. 14(2).

Thevendran, R. and S. Maheswaran, Recognizing CRISPR as the new age disease-modifying drug: Strategies to bioengineer CRISPR/Cas for direct in vivo delivery. Biotechnol J, 2023. 18(9): p. e2300077.

Tsuchida, C.A., et al., Targeted nonviral delivery of genome editors in vivo. Proc Natl Acad Sci U S A, 2024. 121(11): p. e2307796121.

Turhan, A.G., et al., iPSC-Derived Organoids as Therapeutic Models in Regenerative Medicine and Oncology. Frontiers in Medicine, 2021. 8.

Vadapalli, S., et al., Artificial intelligence and machine learning approaches using gene expression and variant data for personalized medicine. Briefings in bioinformatics, 2022.

Xu, J., et al., Real-Time Monitoring and Early Warning of a Cytokine Storm In Vivo Using a Wearable Noninvasive Skin Microneedle Patch. Advanced Healthcare Materials, 2023. 12.

Xu, Z., et al., Merits and challenges of iPSC-derived organoids for clinical applications. Frontiers in Cell and Developmental Biology, 2023. 11.

Yazar, S., et al., Single-cell eQTL mapping identifies cell type–specific genetic control of autoimmune disease. Science, 2022. 376.

Yeo, G.E.C., et al., Potential of Mesenchymal Stem Cells in the Rejuvenation of the Aging Immune System. Int J Mol Sci, 2021. 22(11).

Yi, W., et al., Recent Progress and Perspective of an Evolving Carbon Family From 0D to 3D: Synthesis, Biomedical Applications, and Potential Challenges. ACS applied bio materials, 2023.

Yin, Y., et al., In Situ Transforming RNA Nanovaccines from Polyethylenimine Functionalized Graphene Oxide Hydrogel for Durable Cancer Immunotherapy. Nano letters, 2021.

Zhang, Y. and M. Li, Genome Editing Technologies as Cellular Defense Against Viral Pathogens. Front Cell Dev Biol, 2021. 9: p. 716344.

Zhong, H., et al., Dissecting Tumor Antigens and Immune Subtypes of Glioma to Develop mRNA Vaccine. Front Immunol, 2021. 12: p. 709986.

Zhou, D., M. Borsa, and A.K. Simon, Hallmarks and detection techniques of cellular senescence and cellular ageing in immune cells. Aging Cell, 2021. 20.