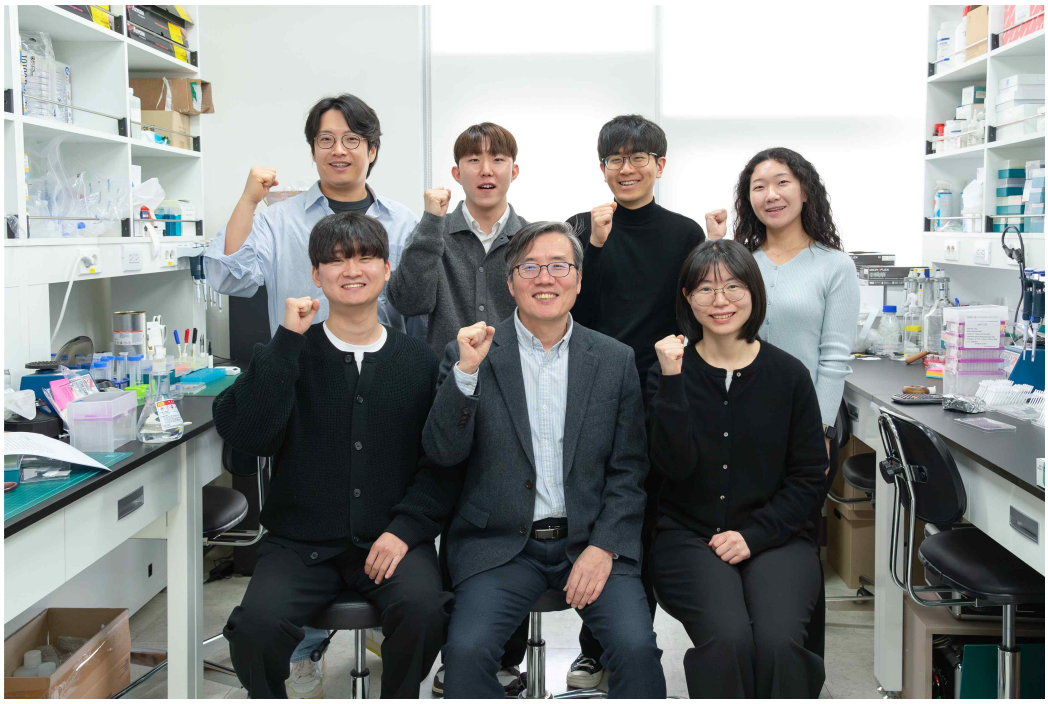
GIST develops universal gene detection technology diagnosing various diseases within 20 minutes… Achieves PCR-level accuracy

- *Professor Min-Gon Kim's team from the Department of Chemistry overcomes limitations in diagnostic design by controlling gene reaction rates*

- *Universal diagnostic technology applicable to various diseases, from infectious diseases to cancer*

- *Published in the international journal* ***Nucleic Acids Research***



▲ (Back row from left) Research Professor Hoyeon Lee (Department of Chemistry), master's student Kyuhan Lee, Ph.D. student Jun Hyeok Park, Ph.D. student Yeo-Jin Park, (front row from left) integrated master's and Ph.D. student Hyungbin Park (first author), Professor Min-Gon Kim (corresponding author), master's student Jiyoung Yun

The Gwangju Institute of Science and Technology (GIST, President Kichul Lim) announced that a research team led by Professor Min-Gon Kim of the Department of Chemistry has presented a next-generation gene diagnostic technology capable of flexibly designing and detecting target genes for various diseases.

This technology allows for the design of customized diagnostic methods targeting specific "target genes" requiring diagnosis, making it applicable to the diagnosis of various diseases, including infectious diseases, cancer, and genetic disorders.

Gene-based diagnostic technology, which diagnoses diseases based on genetic information (DNA or RNA) contained within the body or viruses, is widely used for the diagnosis of various illnesses.

The polymerase chain reaction (PCR) test, currently used as the standard diagnostic method, demonstrates high accuracy and sensitivity but has limitations, such as being time-consuming and requiring specialized equipment and personnel.

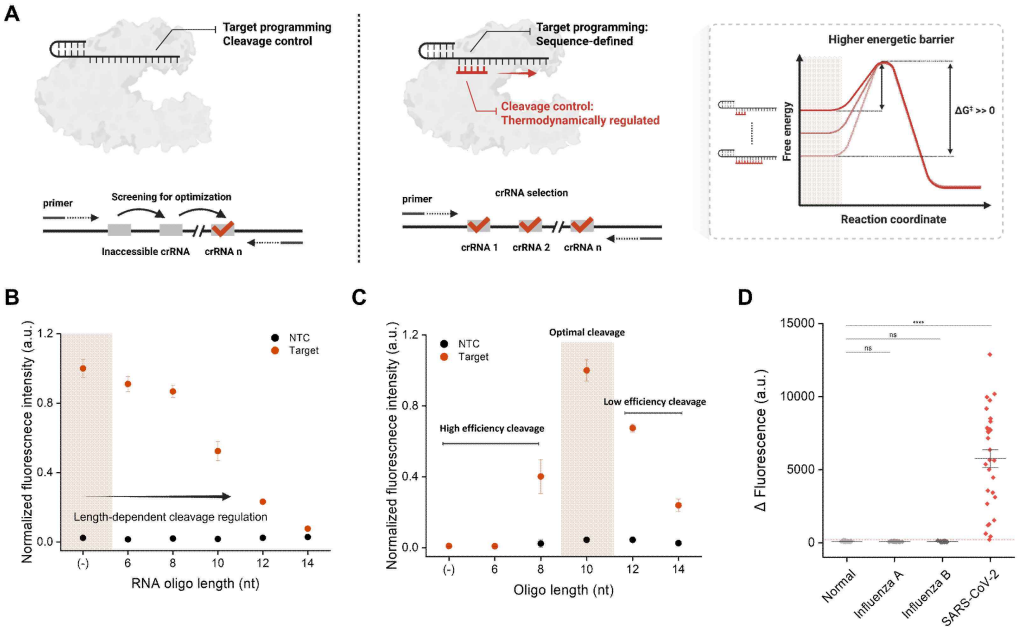
To address these limitations, "one-pot CRISPR" (a combination of CRISPR, which targets specific disease-related genes, and isothermal amplification, which replicates genes rapidly and in large quantities at a constant temperature) is gaining attention.

However, these technologies have limitations in that the reaction speeds for locating genes and emitting signals vary and are difficult to control, making it difficult to find optimal conditions for each gene and restricting design flexibility.

** CRISPR: An enzyme-based technology that recognizes specific gene regions and selectively cuts genetic information (DNA) or genetic information carriers (RNA). Derived from the immune system of bacteria, it functions to target and eliminate invading genetic information; based on high target specificity, it is possible to accurately locate and emit signals only for the desired genes.*

** isothermal amplification: A technology that amplifies molecules (nucleic acids) containing genetic information at a single temperature, without constantly changing the temperature as in conventional genetic testing. One-pot CRISPR diagnostics play a role in increasing sensitivity, but they often result in significant non-specific amplification.*

** one-pot CRISPR: A method in which gene amplification and CRISPR target detection are performed simultaneously in a single test tube. While this technology simplifies the testing process and reduces the risk of contamination, overcoming the challenges of optimizing the amplification and detection processes remains a key challenge.*



▲ ***Next-generation personalized diagnostic platform based on CRISPR. Existing CRISPR technology involves a lot of trial and error as it creates diagnoses by adjusting various conditions; however, the technology proposed by the research team allows for easier design by controlling the gene cutting speed through oligos (A). In particular, the gene cutting speed can be controlled based on the length of the oligo (B), and optimized diagnosis tailored to the situation is possible through length adjustment (C). The research team verified the accuracy by analyzing samples from actual respiratory virus patients (D).***

To overcome these limitations, the research team proposed a new approach that controls gene editing technology to universally detect "target genes" used to diagnose the presence or absence of diseases.

In gene editing technology, much like a navigation system in a vehicle, a guide (RNA, ribonucleic acid) locates a target gene; upon finding it, the engine (Cas protein, which cuts the gene) cuts the gene at that specific location and generates a signal.

The research team introduced short "gene fragments" (oligos) to act as brakes, enabling independent control of the speed of the gene cutting and signal generation processes.

In experiments using gene models and applying oligos of different lengths, the team confirmed that the reaction speed was precisely controlled based on the oligo length—much like how brake strength varies. Based on this, they proposed rules for designing optimal conditions. Furthermore, when the experimental results were applied to 120 samples collected from actual patients, the presence of infection was determined

within approximately 20 minutes. The results demonstrated accuracy and sensitivity comparable to Quantitative PCR (gene amplification test), confirming that rapid and highly reliable diagnosis is possible compared to existing methods. Additionally, the feasibility of clinical application was proven.

This technology is not limited to specific diseases but can be universally applied to various gene targets.

By adjusting the design of the oligo, it can be applied to diverse fields ranging from infectious diseases like COVID-19 to the diagnosis of various types of cancer, allowing for the diagnosis of multiple diseases using a single platform.

Moreover, since there is no need to repeatedly optimize conditions for each gene as in conventional methods, the diagnostic design for diseases can be simplified, and development efficiency can be significantly increased.

Professor Min-Gon Kim stated, "This research is significant in that it presents the potential for a diagnostic platform that can be designed to suit various gene targets, rather than a technology for a single specific disease." He added, "While we have currently verified performance based on samples derived from actual infectious disease patients, we expect it to be applicable to various fields such as cancer and genetic diseases."

This research, supervised by Professor Min-Gon Kim of the Department of Chemistry at GIST and featuring Hyungbin Park, a student in the integrated master's and Ph.D. program, as the first author, was supported by the Ministry of Science and ICT, the National Research Foundation of Korea's Global Research Network Project and the Innovative Research Center (IRC) Project, and the National Science and Technology Council (NST)'s Convergence Research Group Project.

The research results — Functional decoupling of crRNA enables customizable CRISPR diagnostics — were published online on March 3, 2026, in *Nucleic Acids Research*, a prestigious international journal in the fields of biochemistry and molecular biology.

Meanwhile, GIST views this achievement as having not only academic significance but also high potential for industrial application, such as the development of diagnostic technologies. The university stated that discussions regarding technology transfer can be conducted through the Technology Commercialization Office (hgmoon@gist.ac.kr).