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Section of Public Relations	Dongsun Cho Section Chief 062-715-2061	Nayeong Lee Senior Administrator 062-715-2062
Contact Person for this Article	Professor Yunho Lee School of Earth Sciences and Environmental Engineering 062-715-2468	
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Professor Yunho Lee's research team identified the rate and mechanism of antibiotic resistance gene degradation during water treatment and disinfection

- Professor Yunho Lee's team from the School of Earth Sciences and Environmental Engineering at GIST (Gwangju Institute of Science and Technology, President Kiseon Kim) studied the mechanism and speed of degradation of antibiotic resistance genes in various water treatment and disinfection processes through international joint research with the University of Washington, USA.

  - The research team conducted in-depth research on the water treatment process using chlorine, ozone, and ultraviolet light, which is widely used in sewage treatment and disinfection. In particular, the team developed a model which can predict the degree of degradation of antibiotic resistance genes during the water treatment process using ultraviolet light more accurately than before, for the first time.

- Due to the long-time abuse of antibiotics, resistant bacteria with resistance to antibiotics were generated in domestic sewage, hospitals, and livestock wastewater and they spread antibiotic resistance by transferring the antibiotic resistance gene, which stores information on antibiotic resistance, to pathogenic

microorganisms that are dangerous to humans. Thus, antibiotic resistance genes are recognized as a new type of environmental contaminant in terms of public health.

- Treatment of antibiotic-resistant bacteria and resistant genes through appropriate disinfection of sewage or wastewater can effectively block the transmission of antibiotic resistance. However, due to the great scarcity of knowledge on how quickly and in what form the antibiotic resistance gene reacts with water treatment disinfectants, research on whether the currently applied water treatment disinfection method is sufficient is necessary.

- The research team conducted a study with MRSA*, a representative antibiotic-resistant bacteria, and mecA*** gene, which makes MRSA resistant to antibiotics, as representative strains and genes.

  * MRSA(Methicillin-resistant Staphylococcus aureus) : MRSA is a pathogen that can cause skin diseases such as acne and abscess and pneumonia through infection at the surgical site. Unlike general Staphylococcus aureus, it is resistant to Beta-lactam antibiotics, so treatment with antibiotics is difficult. It is known to possibly exist in the skin or nose even for healthy people.

  ** mecA : it is mainly found in Staphylococcus and is a gene related to resistance to Beta-lactam antibiotics. General non-resistant pathogens can also retain resistance to Beta-lactam antibiotics by receiving the gene.

  - Each disinfectant showed its own reaction characteristics with the mecA gene, Chlorine was used as a 'two-stage reaction model', Ozone was used as a 'secondary reaction model', and Ultraviolet Light was used as a 'polymer formation and relaxation reversible reaction model'. It was confirmed that the speed of mecA gene degradation can be well described.

- The reaction model developed in this research is important since it enables to predict the degree of removal of resistant genes due to disinfection treatment by using the information on the sequence information of resistance genes.

  - As a result of using the developed model, it was found that the treatment efficiency of mecA was superior to 99.9% or more under general sewage

treatment and disinfection process conditions. However, when the mecA gene was present inside MRSA, the degradation rate was much slower, which was found to be because the MRSA bacteria formed aggregates and inhibited the reaction with the disinfectant. Therefore, it suggests that the efficiency of treatment of resistant genes may be low under actual water treatment conditions and related follow-up studies are needed.

- Professor Yunho Lee said, "This research is, through understanding the reaction at the molecular level, a new attempt to systematically approach the water treatment efficiency of new environmental contaminant composed of genes ." He said, "In the future, It is expected that it can be applied to a new virus that has recently become a problem in addition to various antibiotic resistance genes."

- This study was the result of a collaboration with Professor Mike C. Dodd's team at the University of Washington, Seattle. Yegyun Choi, a Ph.D. student at GIST, visited Seattle for six months to conduct some experiments. It was carried out with support from the Senior Researcher Project, the National Research Foundation of Korea. The results were published online on January 26, 2021, in *Environmental Science and Technology*, a renowned international academic journal in the field of environmental science.

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