LOCALIZING CHEMICAL AND BIOLOGICAL THREAT DETECTION

Environmental Biomonitoring For Detecting Nefarious Biological Agents

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Environmental biomonitoring can be an effective way to detect next biothreat agents of pandemic potential before it reaches human population. One of the examples of environmental biomonitoring is tracking SARS-CoV-2 from wastewaters for monitoring outbreaks of SARS-CoV-2 at community levels. Although there are now parallel efforts to track other pathogens such as monkeypox and RSVs, they all use PCR based targeted methods and only detect what is targeted. A true surveillance effort should be able to detect broad set of pathogens, including yet to be known pathogens and also pathogens that have been modified for nefarious reasons. Although broad detection of all pathogens including known, unknown, and artificially modified ones is only possibly using sequencing data, to conduct pathogen-agnostic biomonitoring in environmental samples, significant advancements are still required across various aspects of the sequence analysis pipeline. This includes improvements in processing physical samples, refining sequencing methods, and enhancing downstream analytics. Here, we explore these important aspects of environmental biomonitoring in wastewater samples and further expand it to other environments like air and soil. We tested and developed laboratory methods that reduce unwanted sequencing noise at molecular (e.g. rRNA), cellular (e.g. target bacteria or viruses only), and sequencing level (e.g. ReadUntil technologies). In addition, we characterized the overall diversity of wastewater using all publicly available sequencing data to better understand their microbial baseline, diversity, and dynamics that would enable detection of yet to be known, genetically modified, and anomalous pathogens. Using wastewater as a test bed, we show a potential path for setting up broad environmental monitoring framework for detecting all nefarious biological agents from environmental samples.