The Environmental Biotechnology Lab at BGU
Avram and Stella Goldstein-Goren, Department of Biotechnology Engineering

Wastewater Based Epidemiology: SARS-CoV-2 variants of concern detection and quantification in wastewater

Prof. Ariel Kushmaro
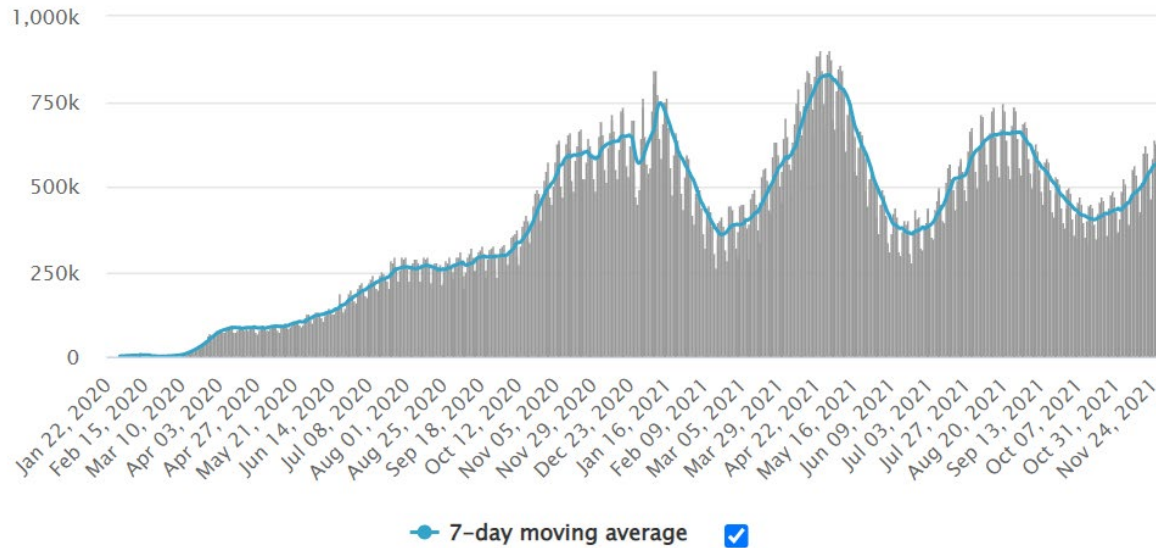
The Environmental Biotechnology Lab at BGU
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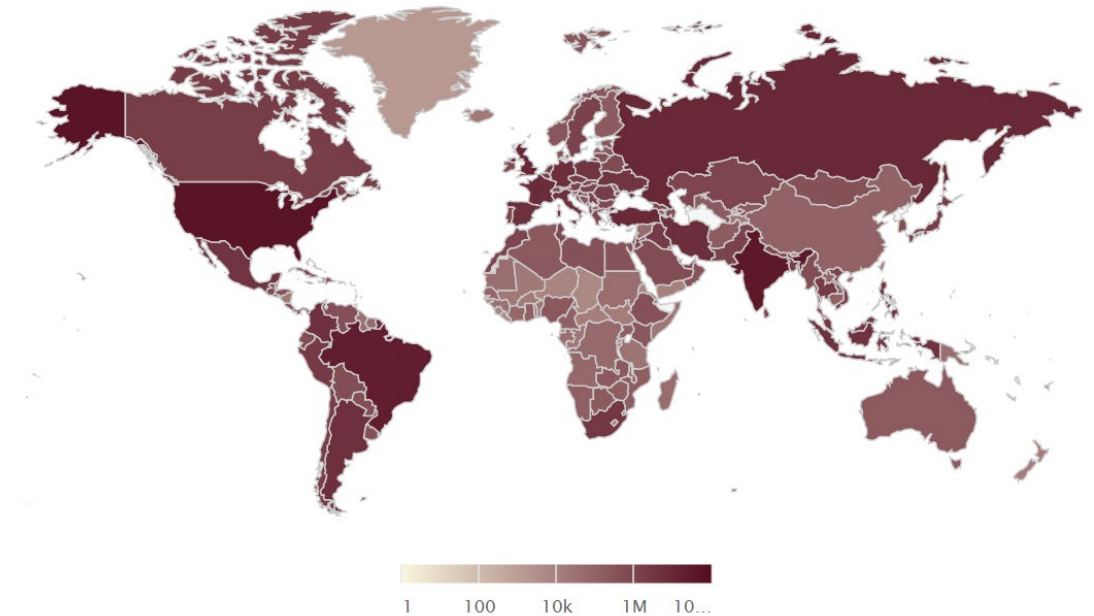
SARS-CoV-2 Pandemic

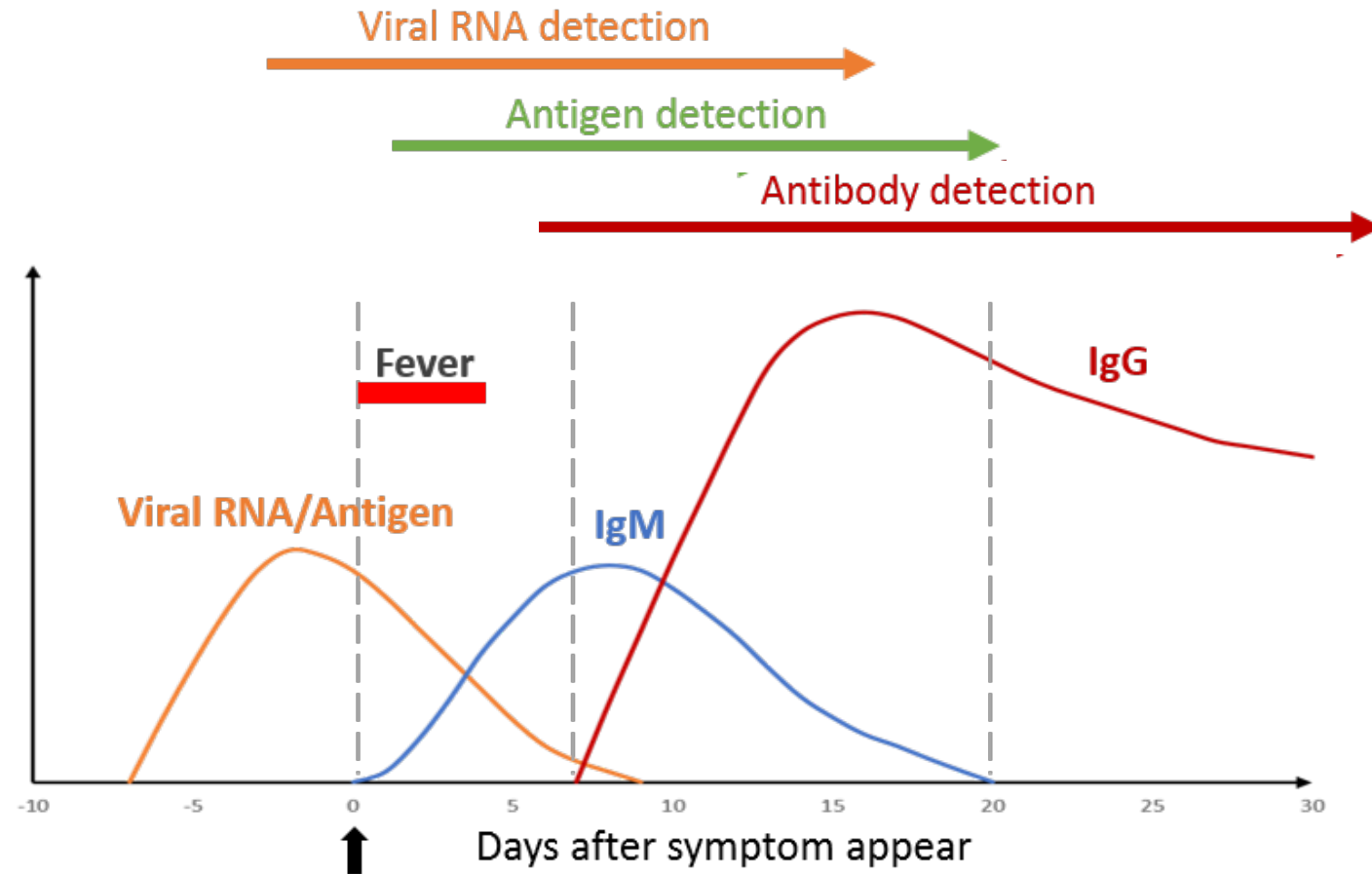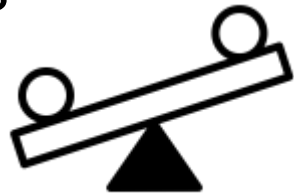*Worldometer, November 30, 2021*

SARS-CoV-2 Pandemic in Israel
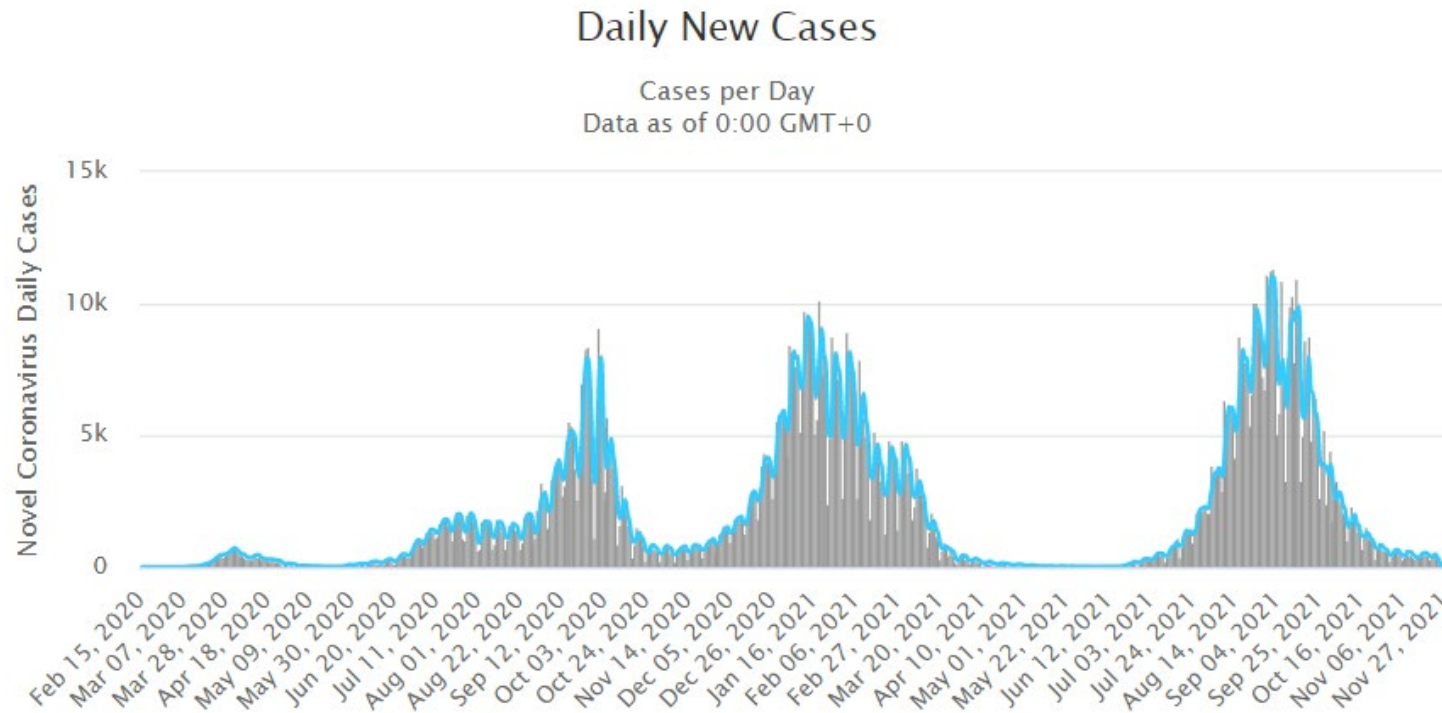
Break the chain of transmission:

The problem

❖ Main detection methodology is through RT-qPCR

❖ <u>Early detection</u> is essential for pandemic containment

❖ Asymptomatic; False Negative; Volunteer bias

Wastewater Based Epidemiology

Rethinking wastewater risks and monitoring in light of the COVID-19 pandemic

Anne Bogler [1] ✉, Aaron Packman[2], Alex Furman [3], Amit Gross [1], Ariel Kushmaro [4,5], Avner Ronen [1,6], Christophe Dagot[7], Colin Hill [8], Dalit Vaizel-Ohayon[9], Eberhard Morgenroth[10,11], Enrico Bertuzzo [12], George Wells[2], Hadas Raanan Kiperwas[9], Harald Horn[13], Ido Negev[9], Ines Zucker [14,15], Itay Bar-Or[16], Jacob Moran-Gilad[17], Jose Luis Balcazar [18,19], Kyle Bibby [20], Menachem Elimelech [21], Noam Weisbrod[1], Oded Nir [1], Oded Sued[9], Osnat Gillor[1], Pedro J. Alvarez [22], Sandra Crameri[23], Shai Arnon [1], Sharon Walker[24], Sima Yaron [25,26], Thanh H. Nguyen[27], Yakir Berchenko[28], Yunxia Hu[29], Zeev Ronen [1] and Edo Bar-Zeev [1] ✉
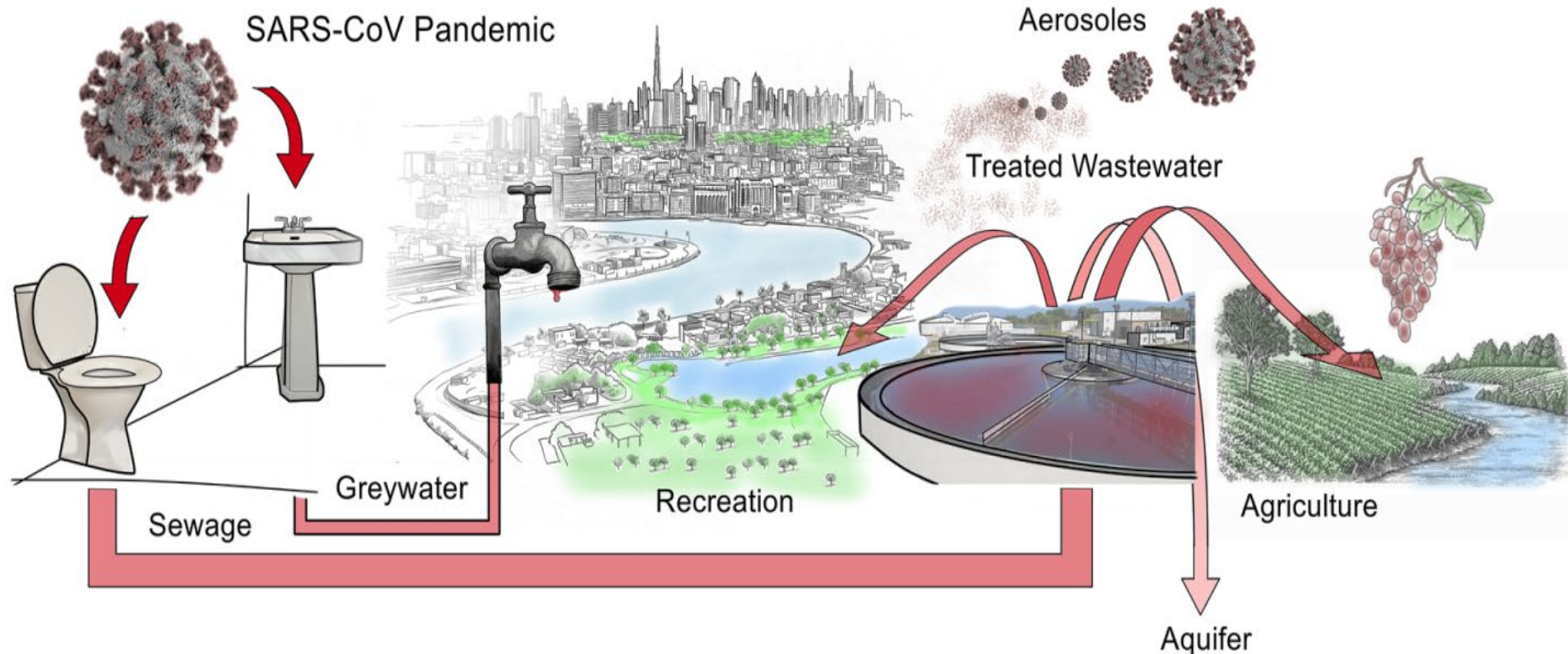
Normalization for SARS-CoV-2 detection
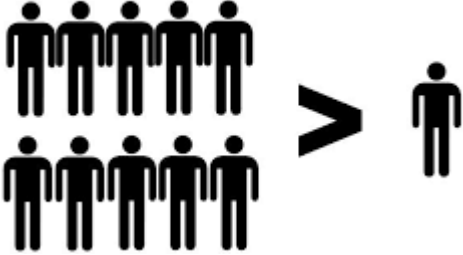
Flow rate

Population size

Secretion rate

Wastewater source

SARS-CoV-2 signal strength

$$Normalized\ Viral\ Load\ (NVL) = \frac{RNA\ copy\ number\ \left(\frac{\#}{L}\right) * Commulative\ sampling\ flow\ (L)}{Population\ size/1000}$$
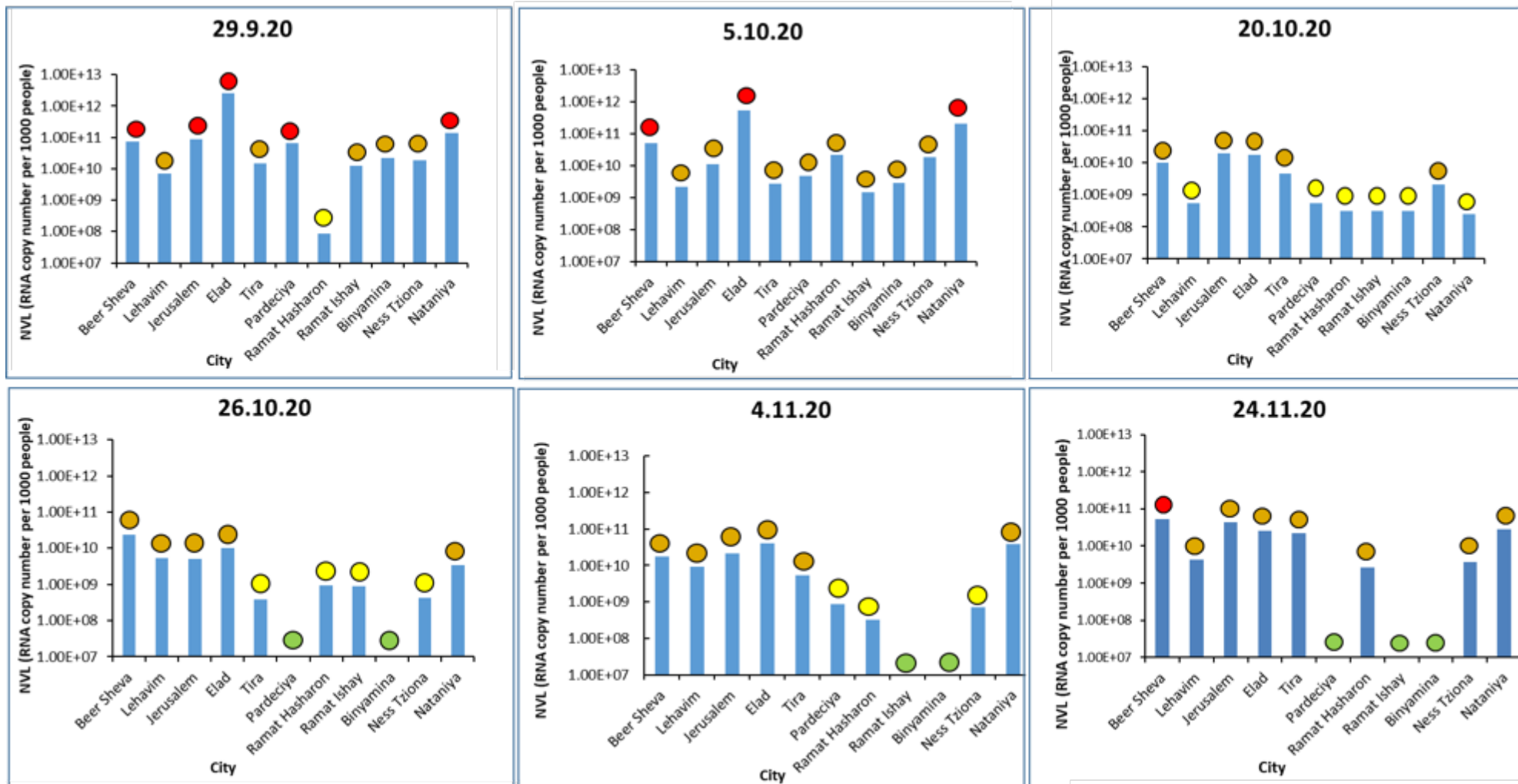
'Traffic' scale for SARS-CoV-2 detection

Variants of Concern vs. Variants of Interest

ALPHA
B.1.1.7
Emerged in UK

DELTA
B.1.617.2
Emerged in India

BETA
B.1.351
Emerged in South Africa

LAMBDA
C.37
Emerged in Peru

GAMMA
P.1.
Emerged in Brazil

ZETA
P.2.
Emerged in Brazil

EPSILON
B.1.429/B.1.427
Emerged in California

ETA
B.1.525
Emerged in NY
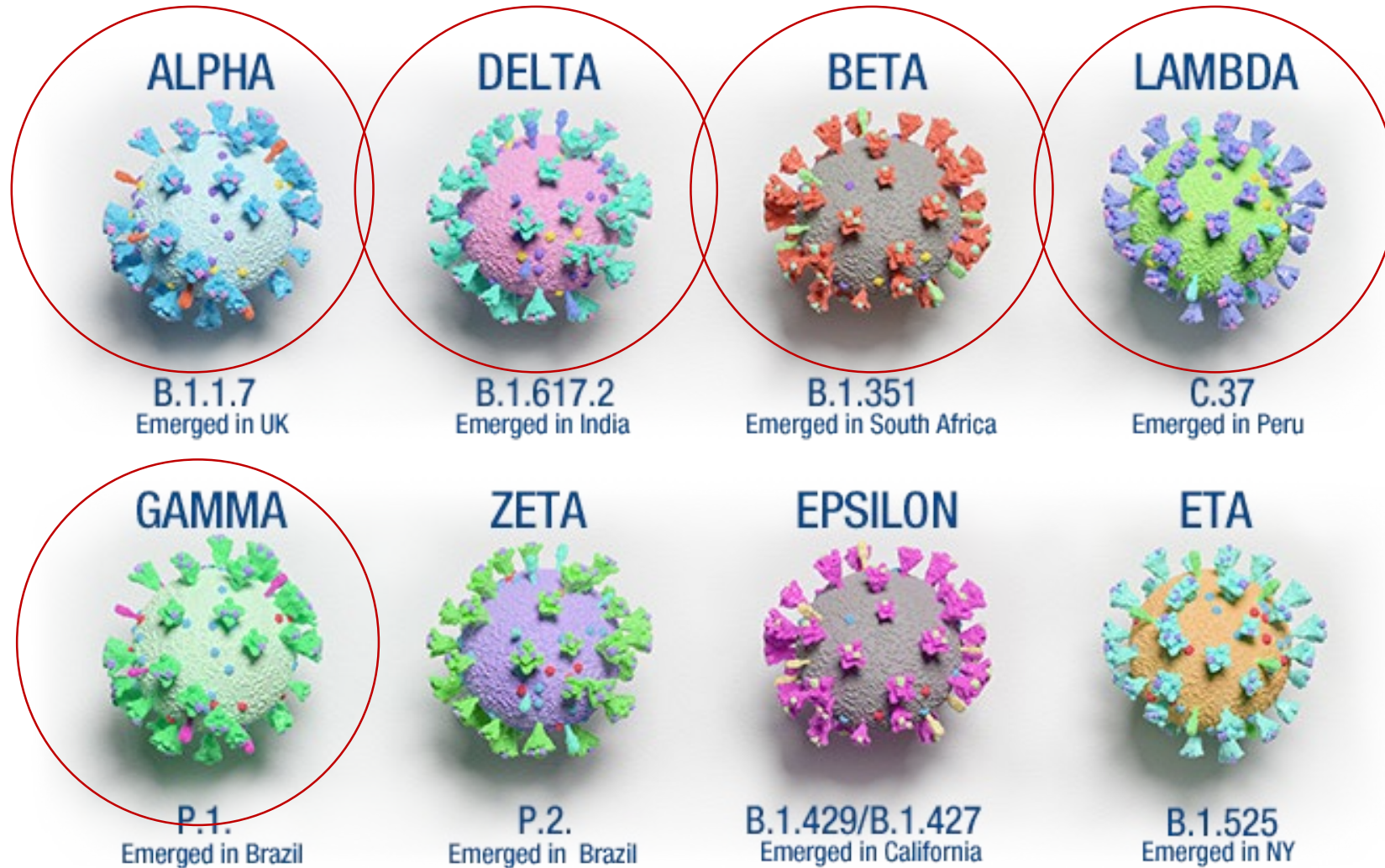
Variants of Concern vs. Variants of Interest

Water Research
Volume 207, 1 December 2021, 117808

RT-qPCR assays for SARS-CoV-2 variants of concern in wastewater reveals compromised vaccination-induced immunity

Karin Yaniv [a, 1], Eden Ozer [b, 1], Yair Lewis [c], Ariel Kushmaro [a, d, e]

Environmental Research
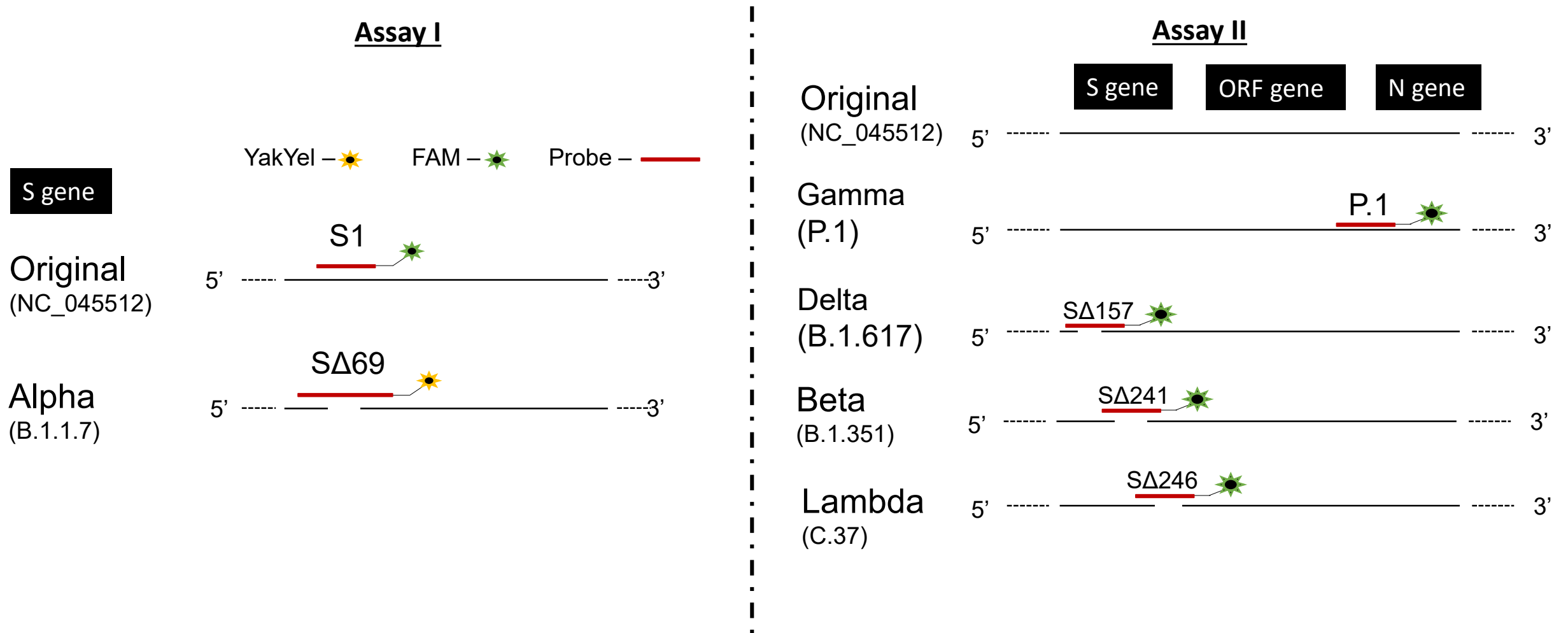Volume 201, October 2021, 111653

Direct RT-qPCR assay for SARS-CoV-2 variants of concern (Alpha, B.1.1.7 and Beta, B.1.351) detection and quantification in wastewater
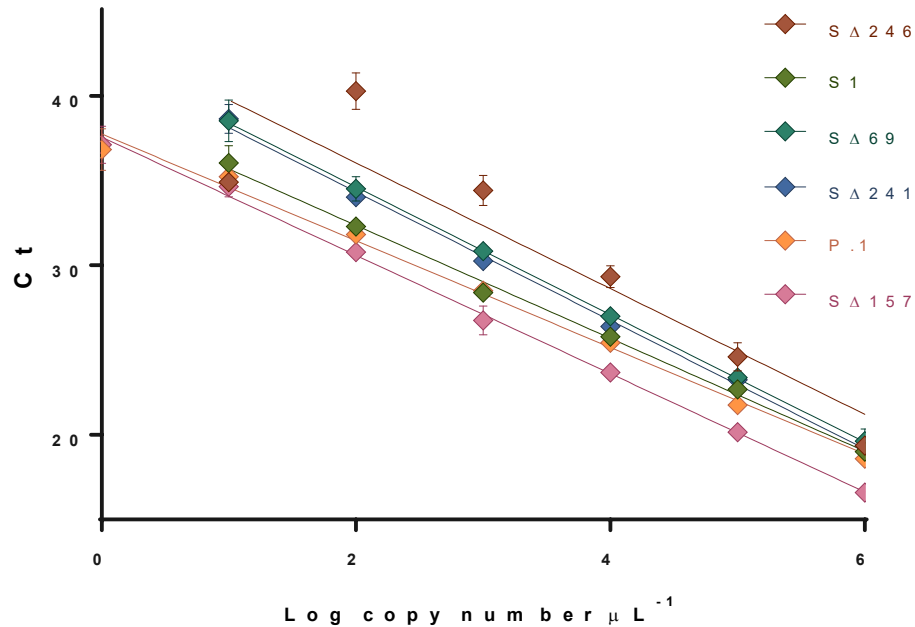
Karin Yaniv [a, 1], Eden Ozer [b, 1], Marilou Shagan [a], Satish Lakkakula [a], Noam Plotkin [a], Nikhil Suresh Bhandarkar [a], Ariel Kushmaro [a, c]
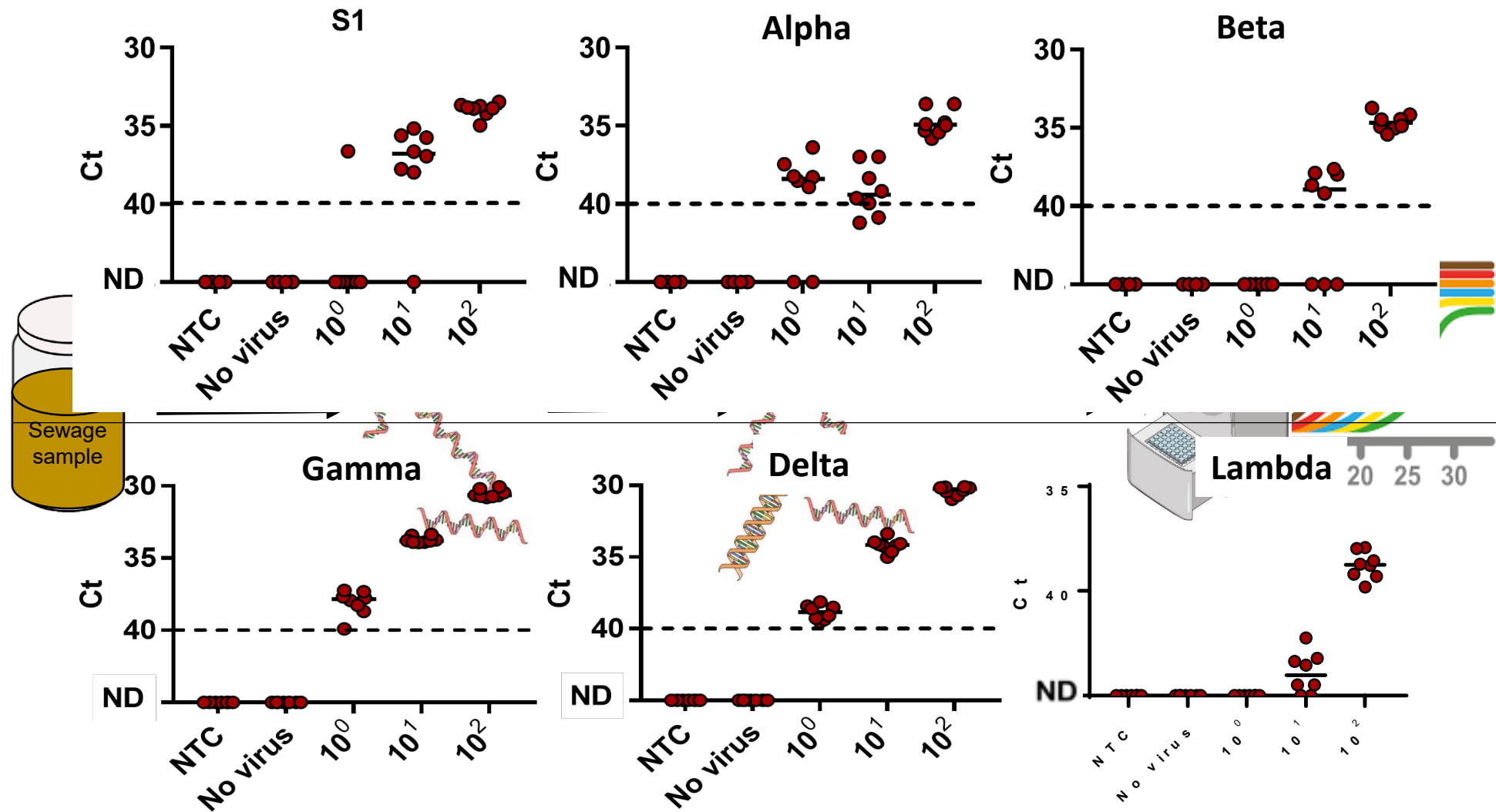
SARS-CoV-2 Mutations detection

SARS-CoV-2 Mutations detection

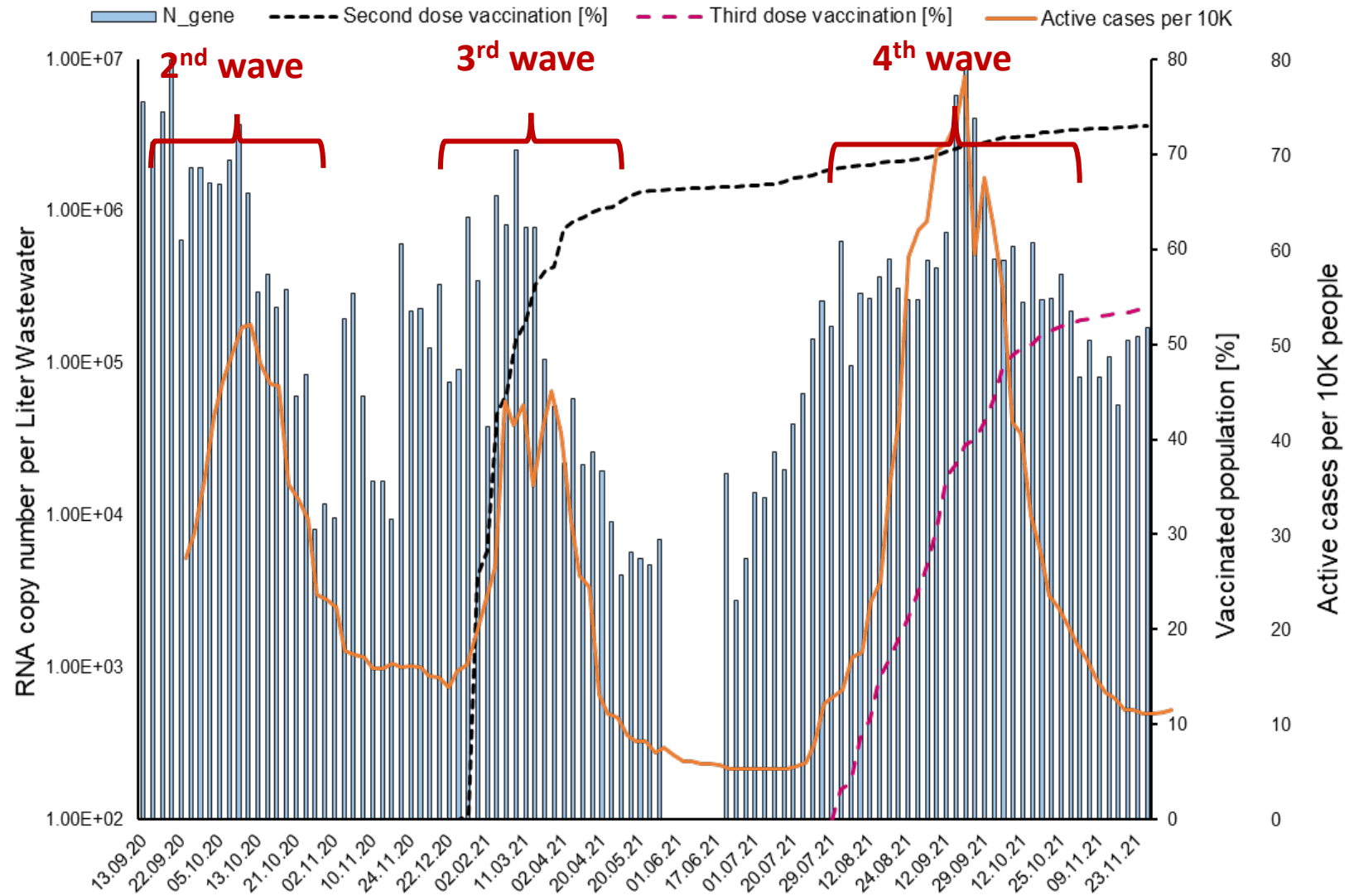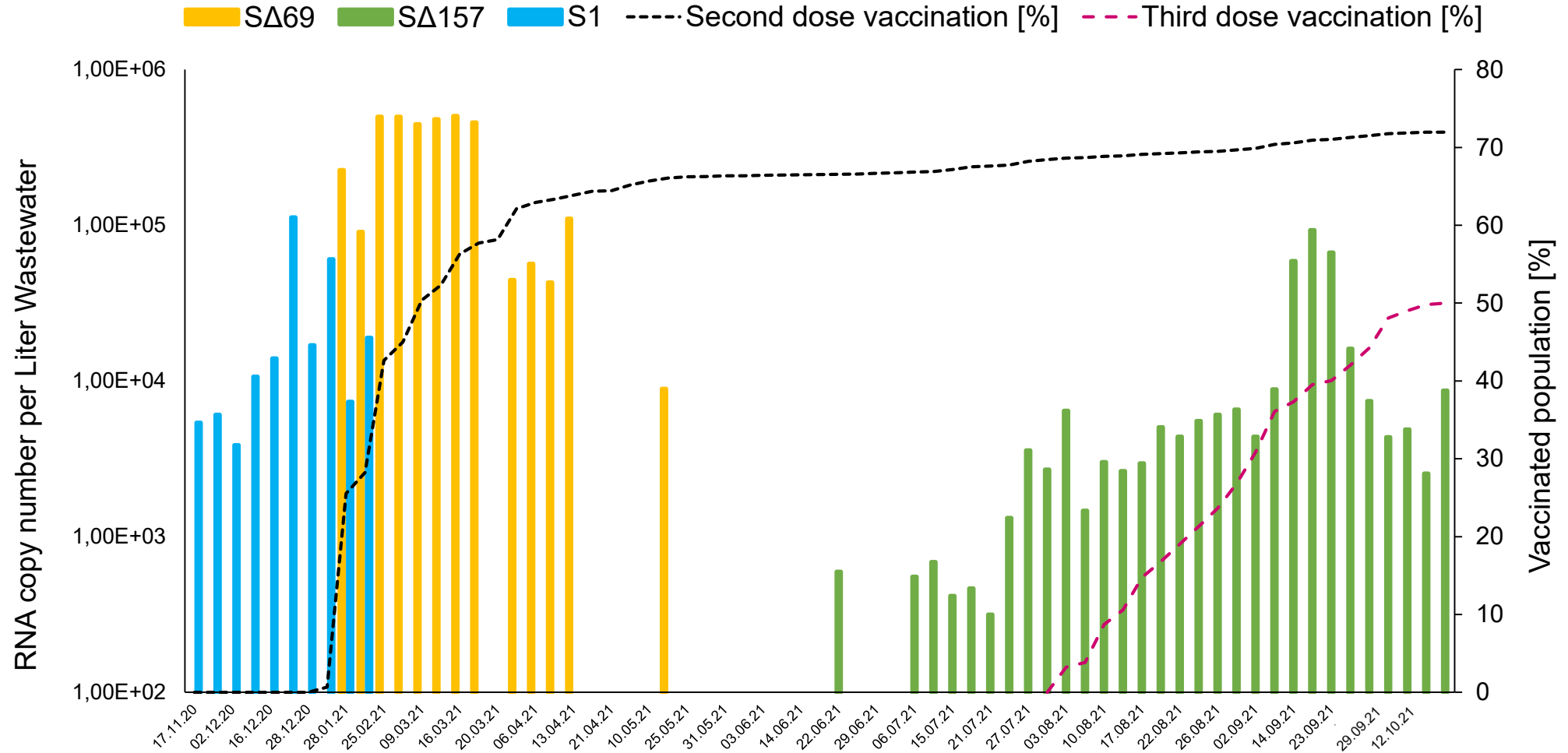| Set	Limit of detection (LOD) [Copy number per µL]	Linear regression R^2	Y intercept
S1	10	0.9977	39.14 ± 0.323
SΔ69	10	0.9998	42.07 ± 0.1132
SΔ241	10	0.9978	41.75 ± 0.3516
P.1	1	0.9942	37.75 ± 0.3865
SΔ157	1	0.9979	37.57 ± 0.2561

SARS-CoV-2 Mutations detection

SARS-CoV-2 Mutations detection in Beer Sheva
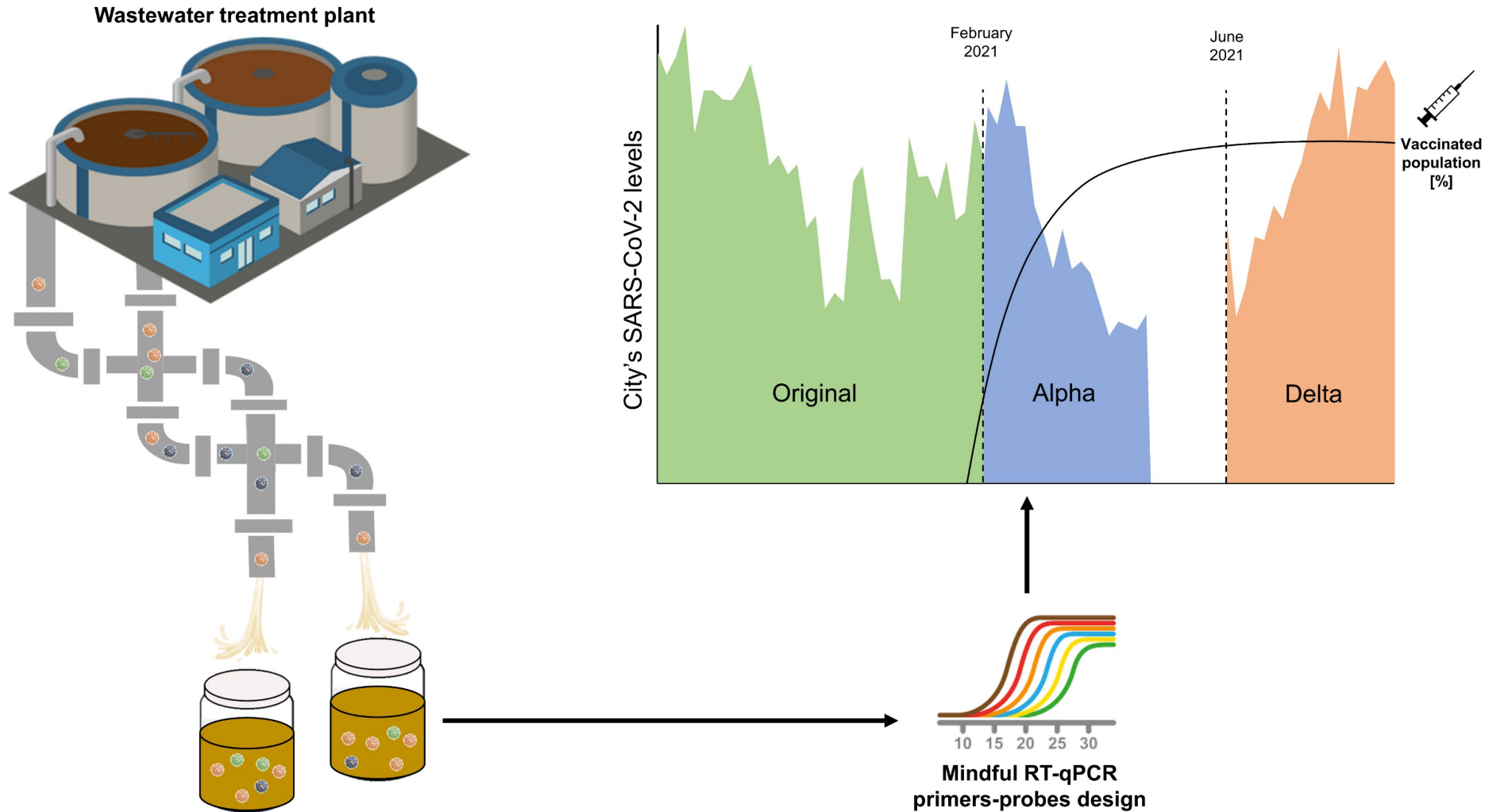
SARS-CoV-2 Mutations detection in Beer Sheva

SARS-CoV-2 Mutations detection in Beer Sheva

Conclusion

❖ **Successful development of direct RT-qPCR assays for Alpha, Beta, Gamma, Delta and Lambda variants of concern.**

❖ **Variants differentiation and quantification was achieved using the developed assays.**

❖ **The describe developments are crucial for early warning and epidemiological population surveillance.**

❖ **The response time for developing specific assays for future variants of interest/concern is relatively short. The presented detection approach is beneficial.**

In the media

Jerusalem Post > Israel News

Israeli tech to hunt for early evidence of coronavirus in sewer systems

Imagine if the world knew that there would be a coronavirus outbreak two weeks before it started spreading, how much better-prepared countries could be in dealing with the pandemic.

By JOSHUA ROBBIN MARKS/THE MEDIA LINE OCTOBER 27, 2020 08:04

Ben-Gurion University Researchers To Monitor Sewage For COVID-19 Outbreaks In 14 Israeli Cities

Ben-Gurion University of the Negev (BGU) has signed an agreement with the Israeli Ministry of Health to detect and monitor for COVID-19 in sewage samples from 14 cities around the country.

Down the tubes: How Israel's poop may help prevent second coronavirus wave

Scientists say analyzing sewage from across the nation can help pinpoint infection areas and nip new cases in the bud

By NATHAN JEFFAY

4 May 2020, 2:00 pm

Using sewage to track coronavirus outbreaks

Ben Gurion University study seeks to use sewage samples to detect increase in coronavirus morbidity before symptoms appear.

& Tags: Coronavirus, Ben Gurion University

Israeli Scientists Hunt COVID-19 Evidence in Sewage Samples

Acknowledgments