Information Item:
Contaminants of Emerging Concern
MCES Research Update

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Environment Committee Meeting, May 12, 2020

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About today’s topic

- Contaminants of Emerging Concern (CECs)
  - Pharmaceuticals and Personal Care Products
  - Microplastics
  - Unknown compounds: Non-targeted analysis
- SARS-CoV-2
- Wastewater-Based Epidemiology
- MCES activities
- Summary

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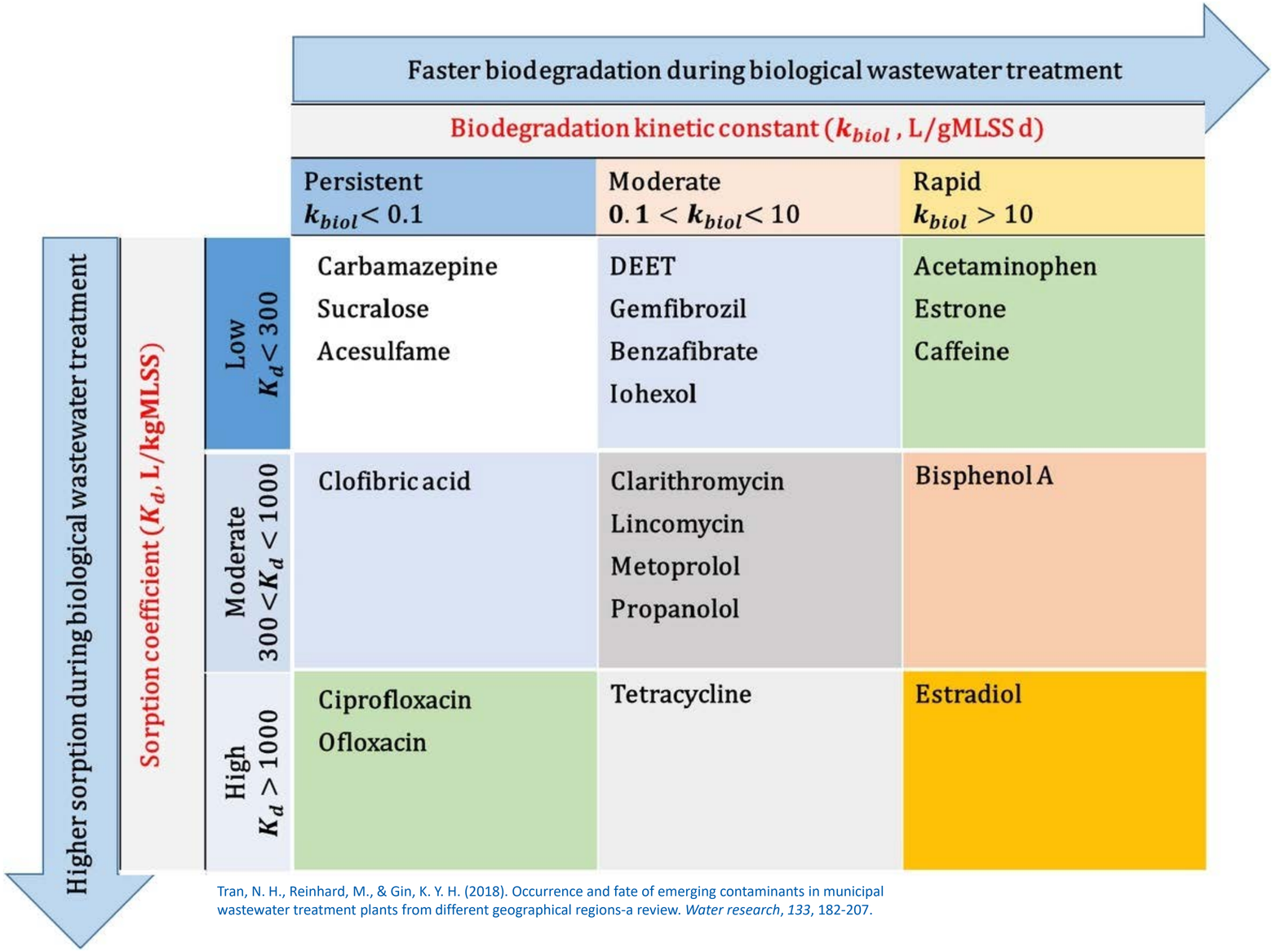
Contaminants of Emerging Concern

- Pharmaceuticals and Personal Care Products



Tran, N. H., Reinhard, M., & Gin, K. Y. H. (2018). Occurrence and fate of emerging contaminants in municipal wastewater treatment plants from different geographical regions-a review. *Water research*, *133*, 182-207.

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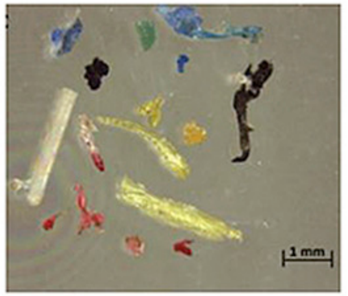
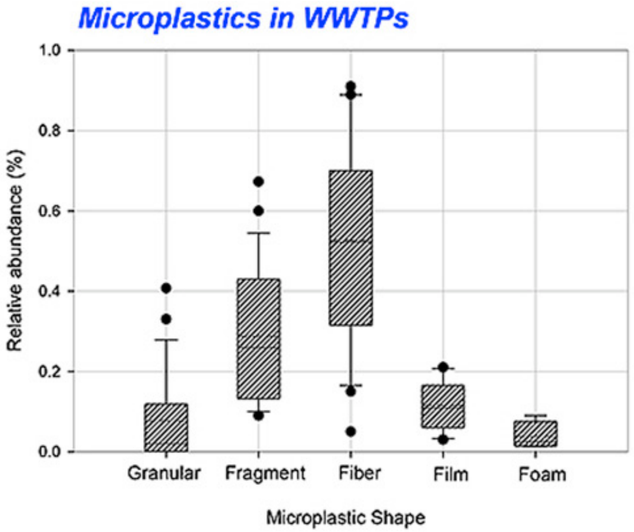
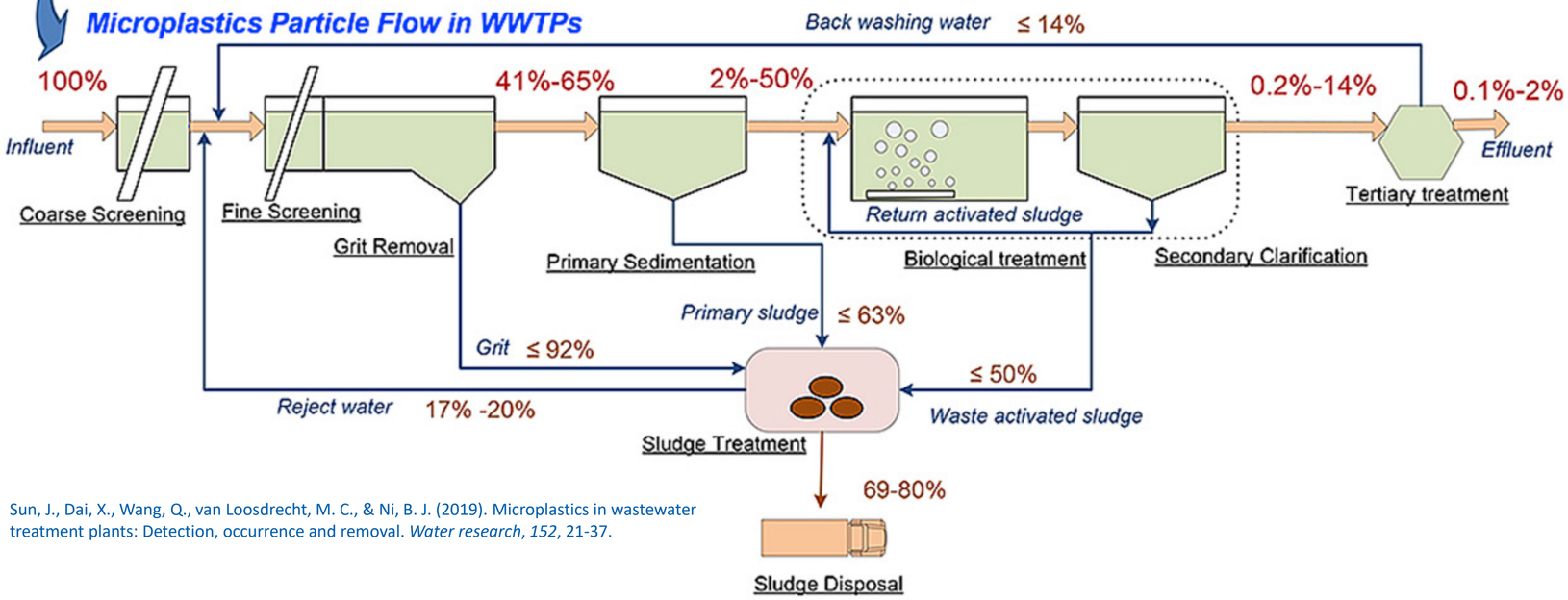
Contaminants of Emerging Concern

- Microplastics







Sun, J., Dai, X., Wang, Q., van Loosdrecht, M. C., & Ni, B. J. (2019). Microplastics in wastewater treatment plants: Detection, occurrence and removal. *Water research*, *152*, 21-37.

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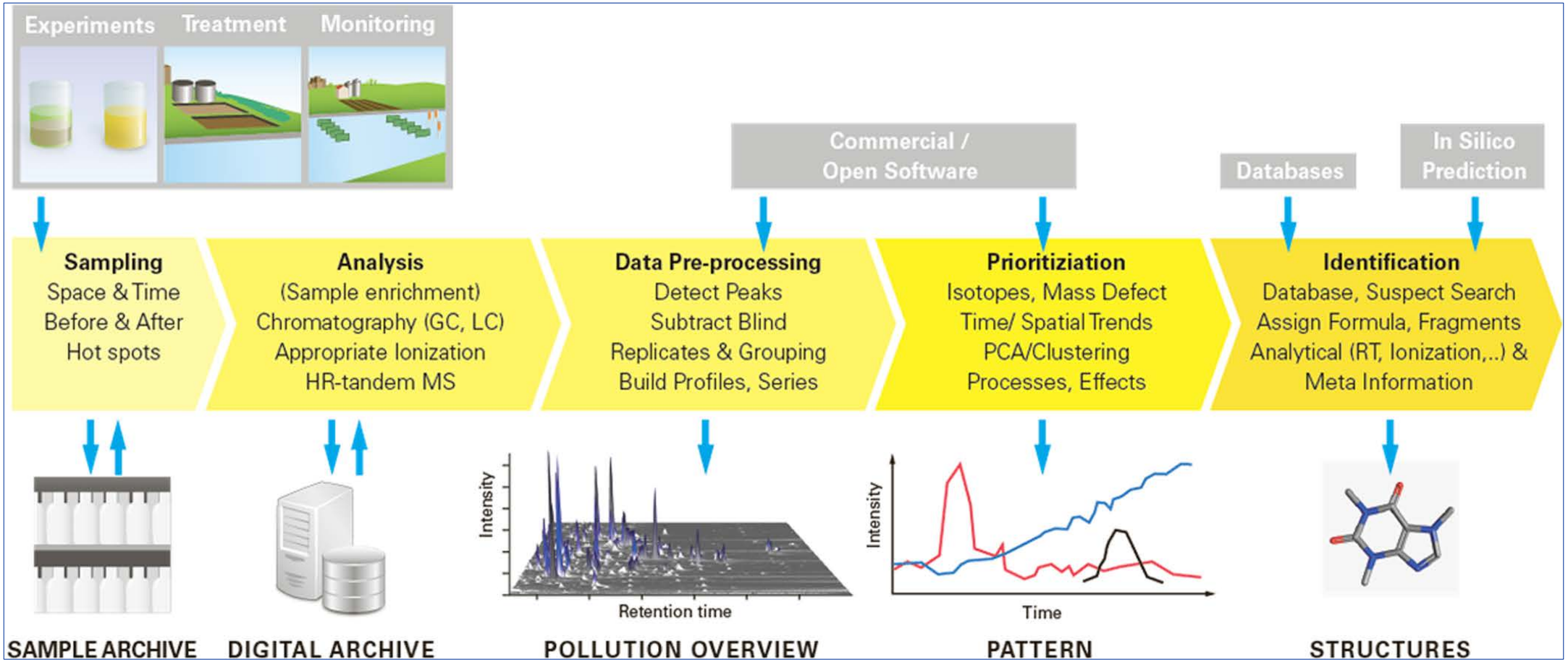
Contaminants of Emerging Concern

- Unknown compounds: Non-targeted analysis



Hollender, J., Schymanski, E. L., Singer, H. P., & Ferguson, P. L. (2017). Nontarget screening with high resolution mass spectrometry in the environment: ready to go?.

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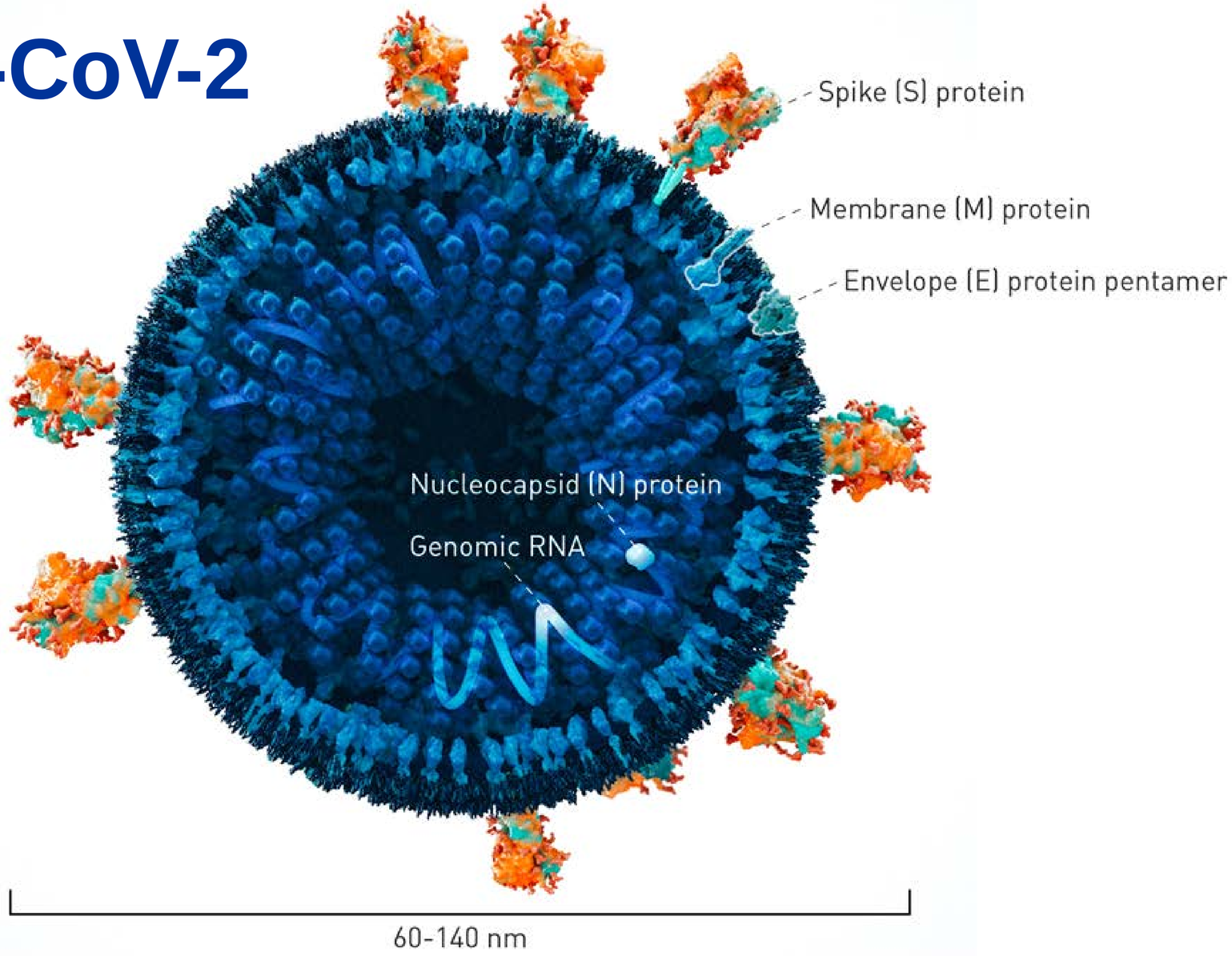
SARS-CoV-2



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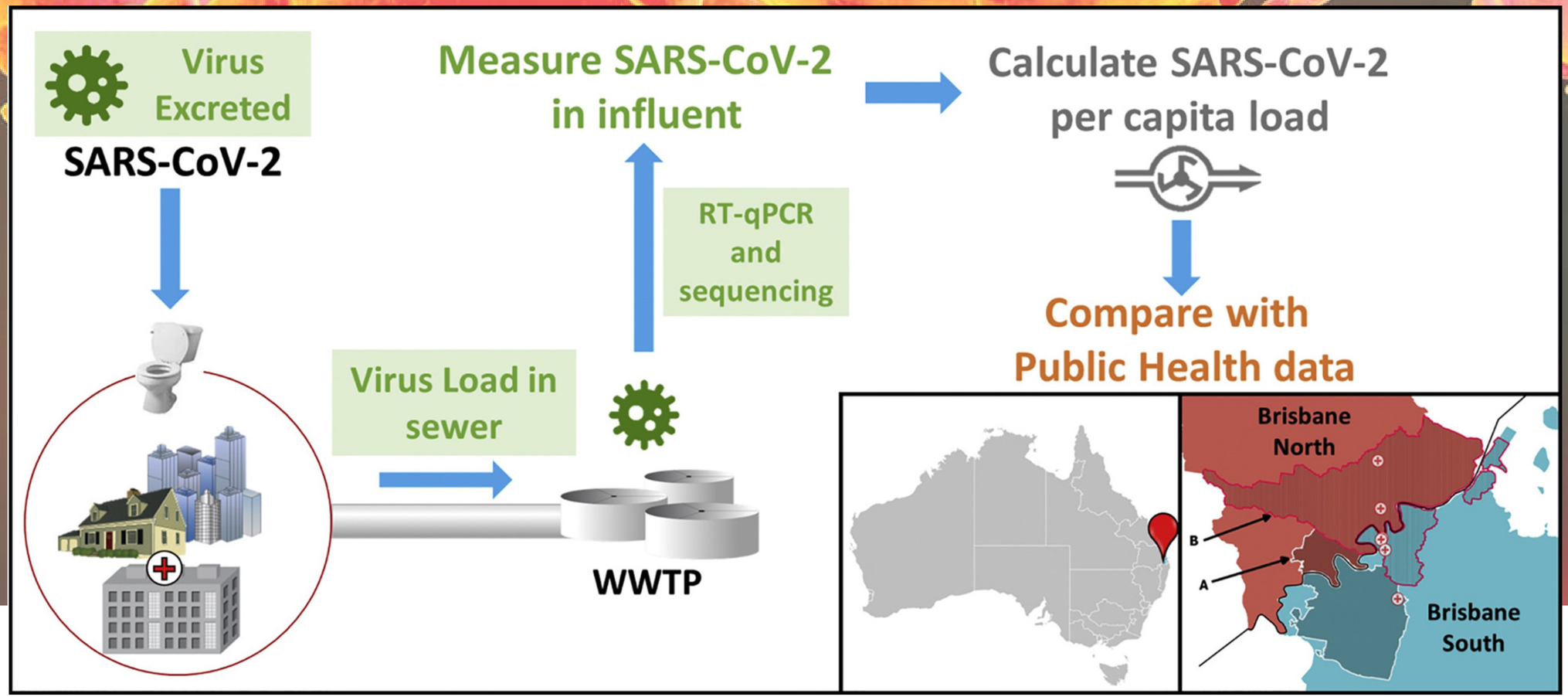
Wastewater-Based Epidemiology – SARS-CoV-2



Ahmed, W., Angel, N., Edson, J., Bibby, K., Bivins, A., O'Brien, J. W., ... & Tscharke, B. (2020). First confirmed detection of SARS-CoV-2 in untreated wastewater in Australia: A proof of concept for the wastewater surveillance of COVID-19 in the community. *Science of The Total Environment*, 138764.

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SEWAGE SURVEILLANCE

Metro WWTP

1 WW SAMPLING

Sample of raw influent WW

2 WW ANALYSIS

% SARS-CoV-2 concentration

Daily flow rate (Q)

3 MASS LOAD

Q X % = Daily mass load of viral RNA

4 INFECTION RATE

= Total number of infected

Daily mass of viral RNA excreted per infected person

1. A representative composite sample of raw influent wastewater is collected at the wastewater treatment plant. (WW Sampling)

2. The concentration of SARS-CoV-2 viral RNA in the sample is measured. (WW analysis)

3. This concentration is multiplied by the daily flow rate of wastewater to obtain the daily mass load of the viral RNA. (Mass load)

4. The daily viral mass load is divided by the daily mass of viral RNA excreted per infected person to estimate the total number of infections in the community served by the treatment plant. (Infection rate)

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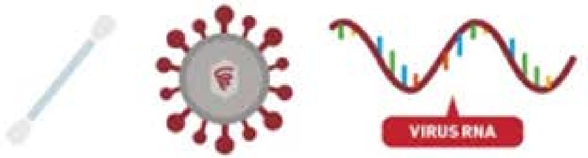
HOW CURRENT TESTS WORK

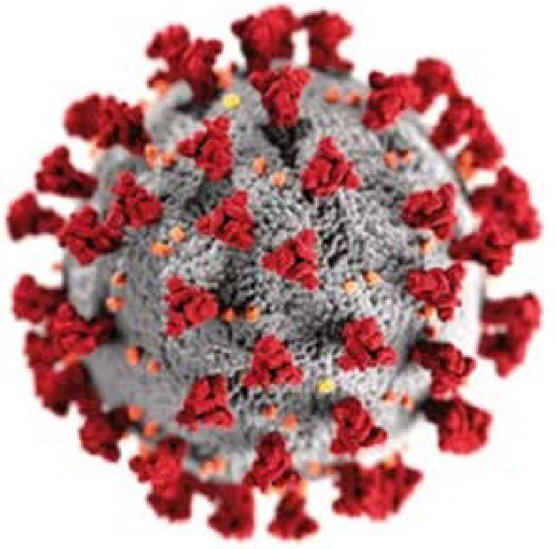
1. A swab is taken of the inside of a patient's nose or the back of their throat. This sample is then sent to a lab to test.



2. The RNA of the virus is extracted and purified. An enzyme, reverse transcriptase, converts the RNA to DNA.

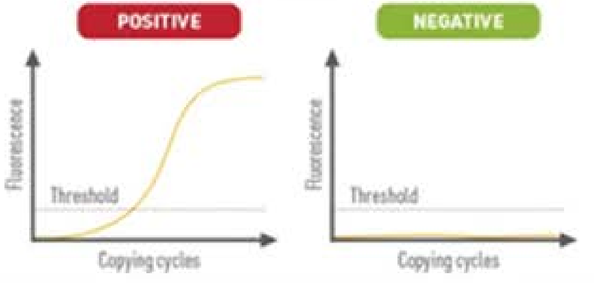
3. The DNA is mixed with primers, sections of DNA designed to bind to characteristic parts of the virus DNA. Repeatedly heating then cooling DNA with these primers and a DNA-building enzyme makes millions of copies of virus DNA.

4. Fluorescent dye molecules bind to the virus DNA as it is copied. Binding makes them give off more light, which is used to confirm the presence of the virus in the sample.



POSITIVE AND NEGATIVE TESTS

The fluorescence increases as more copies of the virus DNA are produced. If it crosses a certain threshold, the test is positive. If the virus isn't present, no DNA copies are made and the threshold isn't reached. In this case, the test is negative.



ISSUES WITH TESTING

REAGENT ISSUES

High demand and issues with reagents have delayed testing in some countries.

TIME-CONSUMING

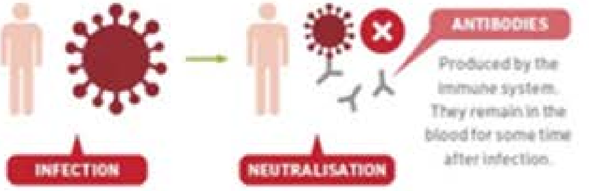
It takes a few hours to get results from the test, limiting how many tests can be done.

FALSE POSITIVES AND NEGATIVES

In some cases sample degradation or contamination can affect the results.

FUTURE TESTS

The current tests are good for diagnosing an infection – but they can't tell us if someone has had it and then recovered. Tests that look for antibodies against the virus can do this.



Tests that look for proteins on the surface of the virus are also in development. These tests are faster, but less accurate.

MCES Activities

1. Biobot/MIT

- Measure SARS-CoV-2 in Metro WWTP influent
- > 150 WWTPs across the US
- Estimate community infection rates

2. University of Minnesota

- Civil, Environmental, and Geo-Engineering Department
- “Monitoring emerging viruses in Minnesota’s urban water cycles”
- Follows previous collaboration to quantify RNA fragments in wastewater
- Builds local skills, facilities, and expertise for future WBE efforts

Summary – Wastewater-Based Epidemiology

URBAN COMMUNITIES

Sampling locations: centralized wastewater utility influent and neighborhood pumping stations

Composite sampling of community wastewater at multiple points in time

RURAL COMMUNITIES

Sampling locations: polluted surface water and point sources

LABORATORY DATA: Viral abundance and genomic diversity

Community wastewater represents a snapshot of the status of public health and allows early detection of outbreaks

OTHER DATA: hydrological, water quality, population biomarker, clinical

MODELING:
Process-based virus fate modeling
Statistical modeling
Data-driven predictive modeling

- Current status of endemic disease
- Early signals for detection of disease outbreaks
- Spatial and temporal variations of viral abundance and diversity and prediction of "critical locations" and "critical times" for future outbreaks.

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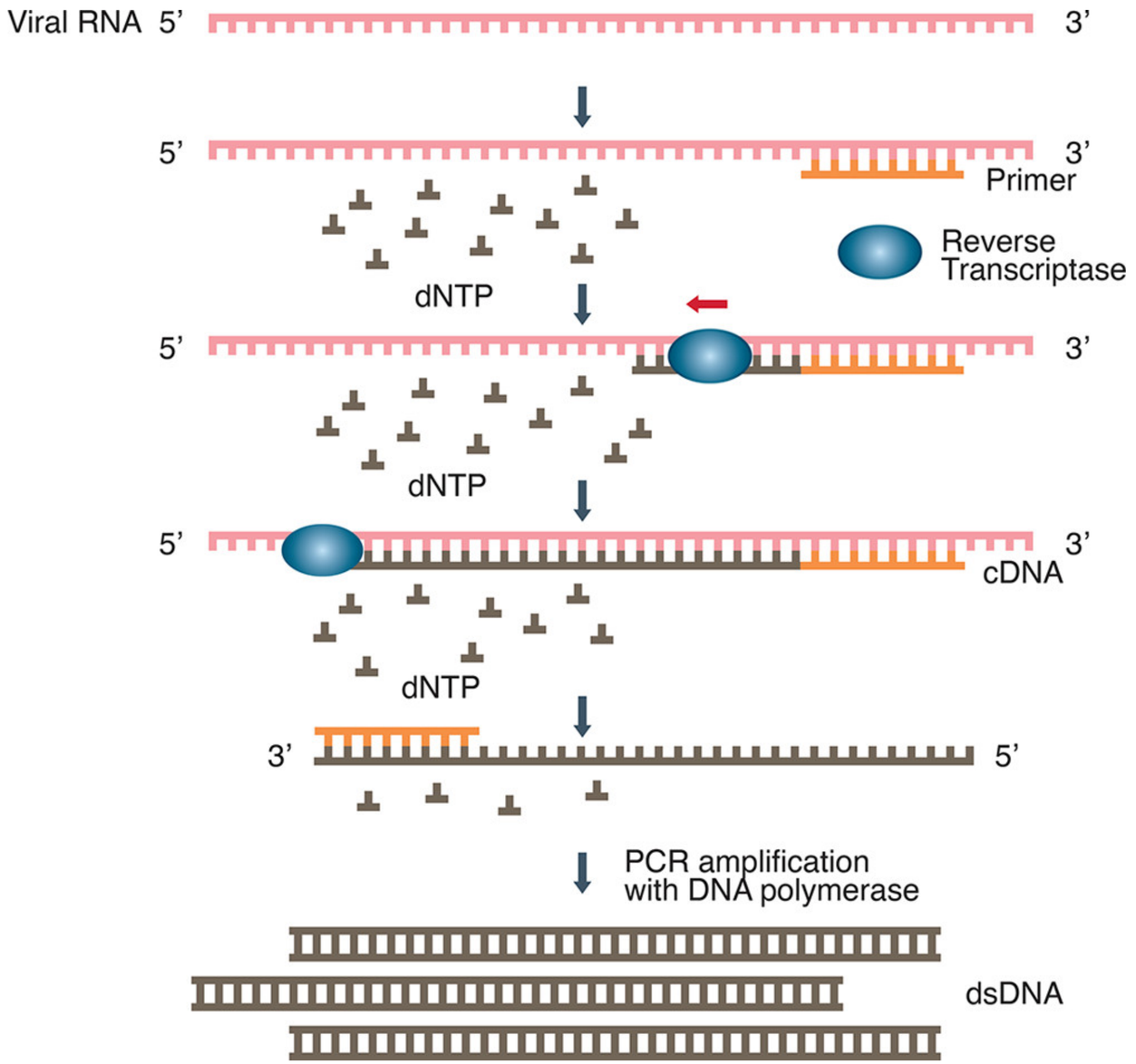
Xagoraraki, I., & O'Brien, E. (2020). Wastewater-Based Epidemiology for Early Detection of Viral Outbreaks. In *Women in Water Quality* (pp. 75-97). Springer, Cham.



RT-qPCR
- measuring SARS-CoV-2 RNA

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Questions

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