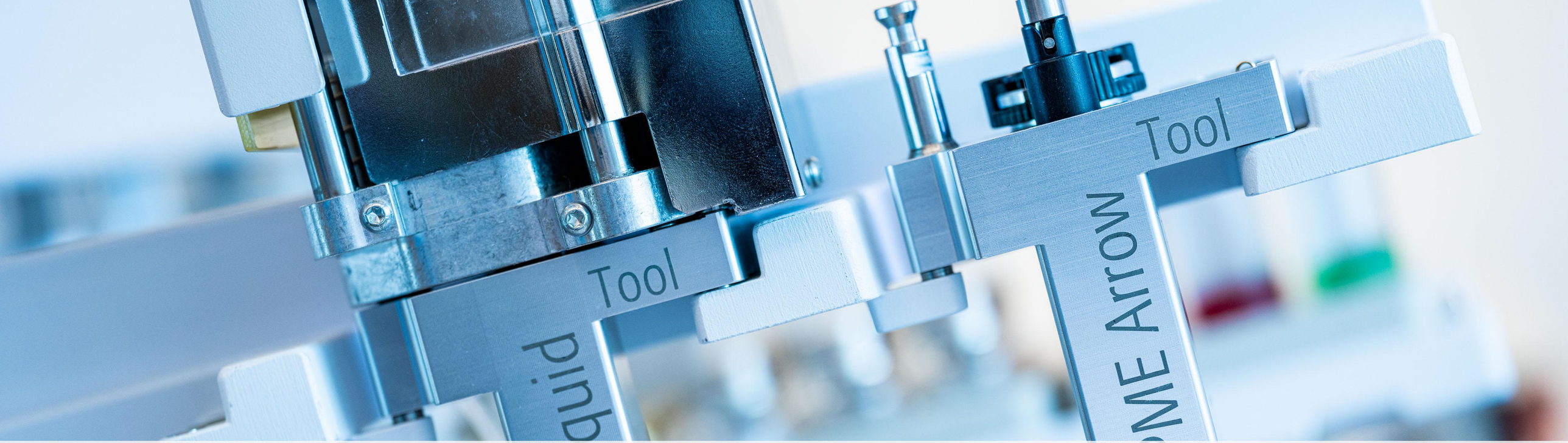

A PFAS Overview

Forever Chemicals, Forever Challenges?

Part 1 of the Webinar Series

PAL SYSTEM
Ingenious sample handling

Webinar Maintenance

Yes, you are in webinar!

Microphone and webcam are **turned off**

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Additional information can be found in the Q&A window

Recording in progress

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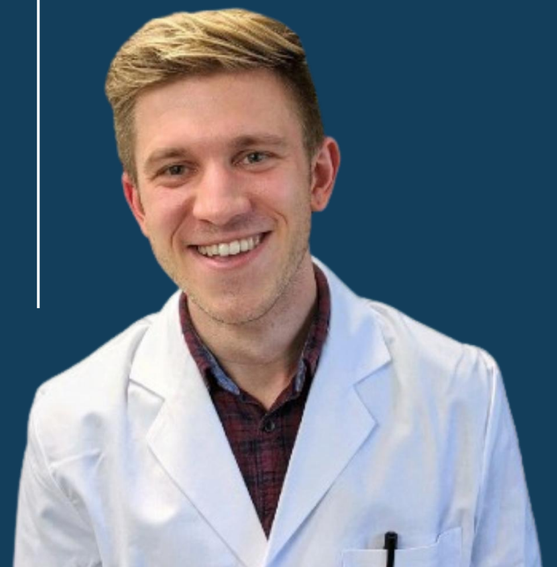
Webinar Maintenance

A webinar series around PFAS – Part 1

Hagen M. Gegner, PhD

Scientific Communications and Projects, CTC Analytics AG

- Background in clinical metabolomics
- Method development in LC-MS and study design
- Focused on sample preparation and quality control



PFAS an Overview

Agenda

What are PFAS?

The Chemistry, Family & Persistence

Where are they found?

Ubiquity in the Environment & Food Chain

Why is it a problem?

Health Concerns & The Regulatory Squeeze

The Analyst's Dilemma in the Lab

Overcoming Key Challenges in the Lab

The Solution

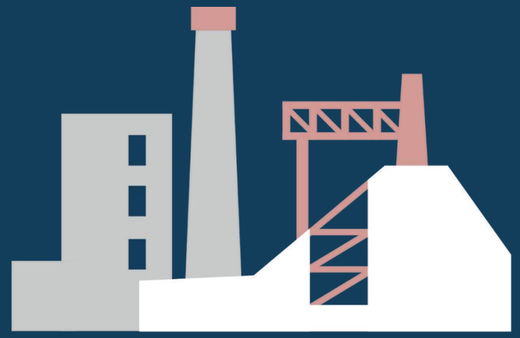
An Overview of Automated Sample Preparation

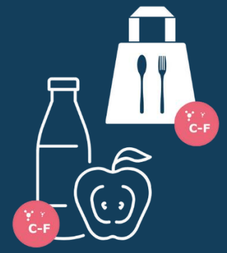
Conclusion & Q&A

What are "Forever Chemicals"

The extreme persistence of PFAS earned them the nickname "forever chemicals".

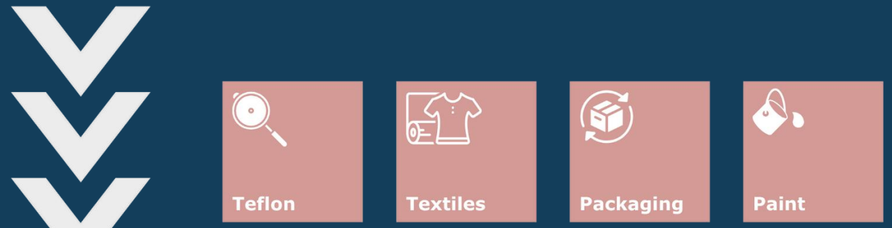
Wee, S. Y., & Aris, A. Z. (2023). Revisiting the “forever chemicals”, PFOA and PFOS exposure in drinking water. In npj Clean Water (Vol. 6, Issue 1). Nature Research. https://doi.org/10.1038/s41545-023-00274-6



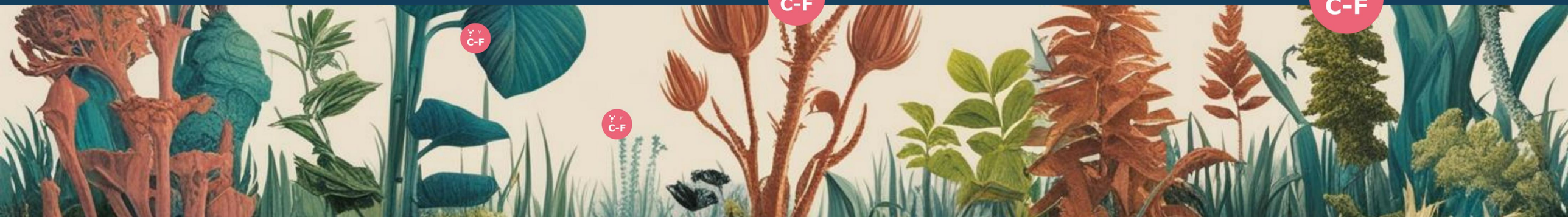


PFAS

(Per- and polyfluoroalkyl substances) are a class of over 4,700 synthetic chemicals used since the 1940s.



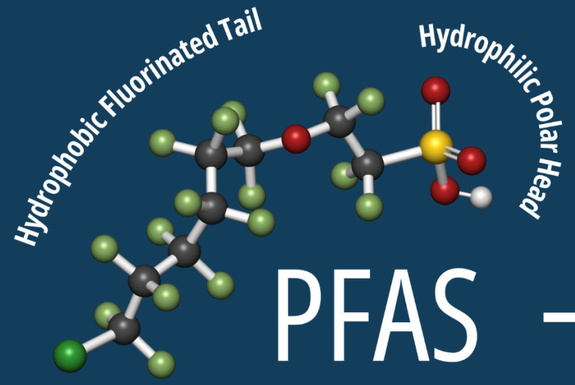
The strength of the Carbon-Fluorine (C-F) bond makes them extremely resistant to heat, chemical, and biological degradation.



The Chemistry Behind the "Forever" Nickname

A (Very) Large and Complicated Family

Brunn, H., Arnold, G., Körner, W., Rippen, G., Steinhäuser, K. G., & Valentin, I. (2023). PFAS: forever chemicals-persistent, bioaccumulative and mobile. Reviewing the status and the need for their phase out and remediation of contaminated sites. Environmental Sciences Europe, 35(1), 20



PFAS

Chain length

- **Legacy PFAs (C9-C12)**
- **Gen X PFAs (C3-C6)**

Polymeric

- Fluro polymers (**PTFE**)
- Side chain fluorinated polymer (textile finishes)

used to produce / may degrade to

Non-Polymeric

Poly-Fluorinated

- Fluoropolymers (**PFA**),
- Fluorotelomers (FTO, FTOH)

Per-Fluorinated

- Perfluorooctanoic acids (**PFOA**)
- Perfluorooctane sulfonate (**PFOS**)

The Chemistry Behind the "Forever" Nickname

Ubiquitous Contamination: From Industry to Your Plate

Industrial & Consumer Use

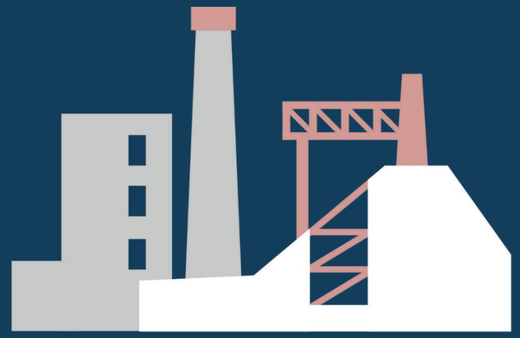
PFAS are released from manufacturing sites and are key ingredients in firefighting foams (AFFF), non-stick coatings, waterproof textiles, and food packaging.

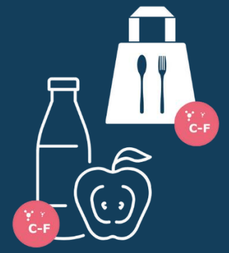
Environmental Pathways

They contaminate soil, air, and water sources globally.

Food Chain Contamination

PFAS bioaccumulate in the food chain, especially in aquatic foods, and are taken up by agricultural crops from contaminated soil and water.





Teflon

Textiles

Packaging

Paint

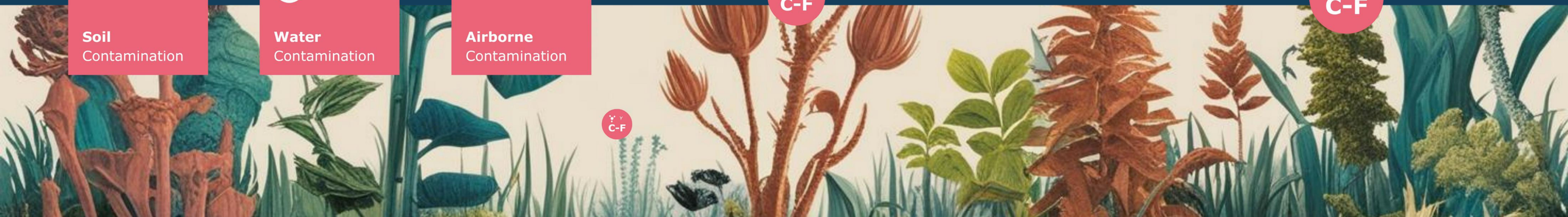
C-F

C-F

Soil Contamination

Water Contamination

Airborne Contamination



A Global Concern for Human Health

PFAS exposure is linked to a wide range of adverse health effects, making them a significant public health concern

Immune System Disruption

Liver Damage & Developmental Effects

Endocrine (Thyroid) Disruption

Increased Cancer Risk (Kidney & Testicular)

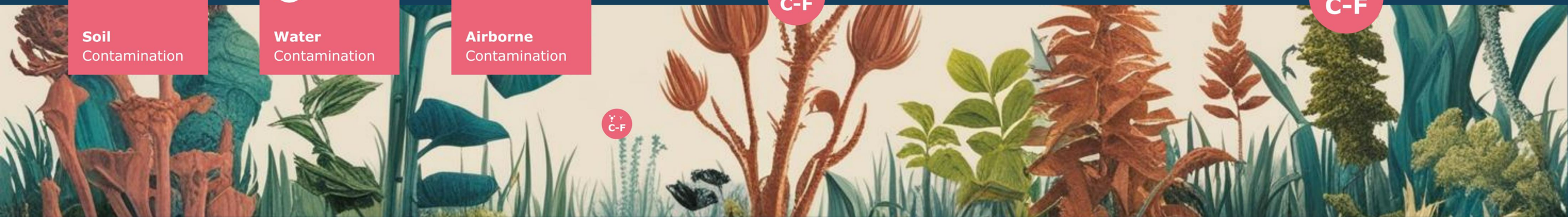
Di Giorgi, A., La Maida, N., Taoussi, O., Pichini, S., Busardò, F. P., Tini, A., & Di Trana, A. (2023). Analysis of perfluoroalkyl substances (PFAS) in conventional and unconventional matrices: Clinical outcomes. *Journal of Pharmaceutical and Biomedical Analysis Open*, *1*, 100002.

Decades of research have linked PFAS exposure to a range of serious health outcomes. **However, the synergistic or sex specific effects remain elusive.**

Soil Contamination

Water Contamination

Airborne Contamination

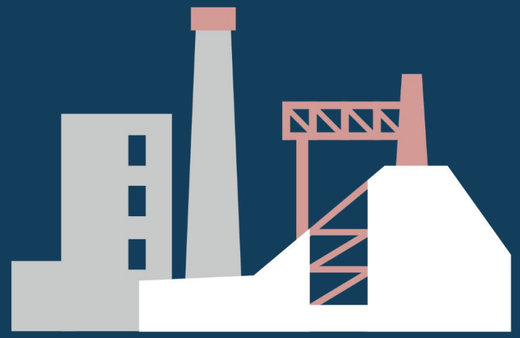


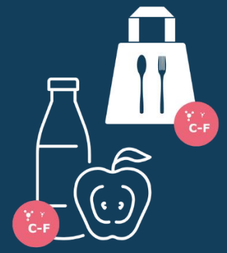
The Regulatory Squeeze is On

A global trend: more compounds are being monitored at ever-lower concentration limits.

European Union

The Drinking Water Directive (EU 2020/2184) sets a limit of 100 ng/L for the sum of 20 specified PFAS.





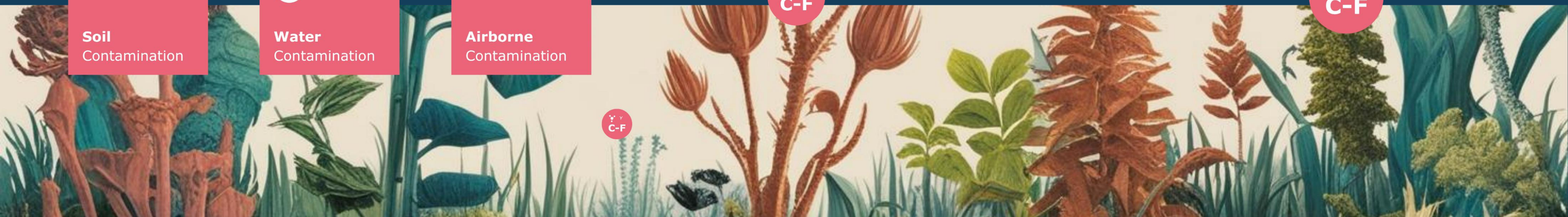
European Union

Regulation 2023/915 sets maximum levels for four key PFAS in specific foods like eggs, fish, and meat.

Soil Contamination

Water Contamination

Airborne Contamination



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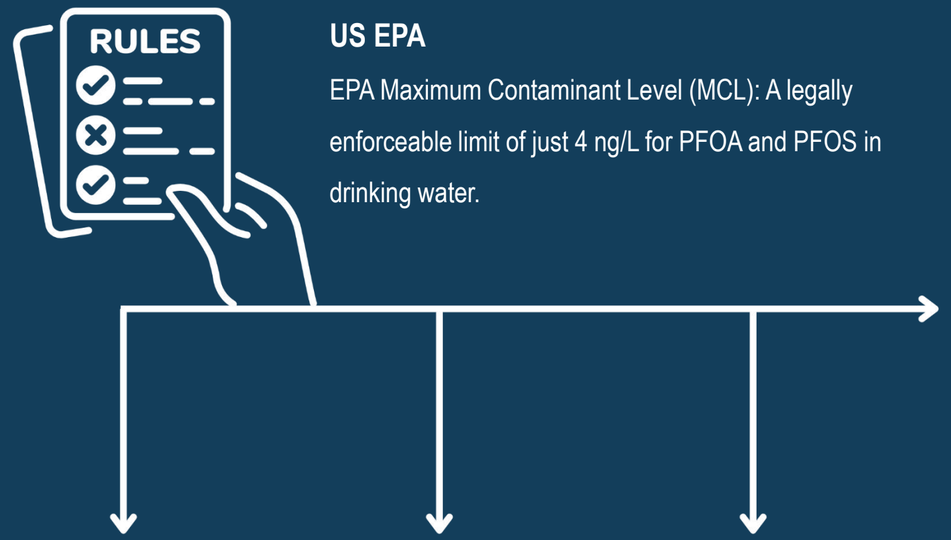
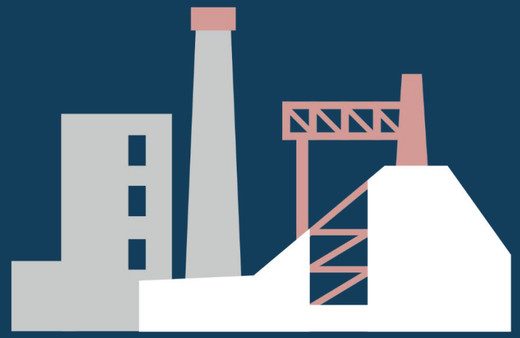
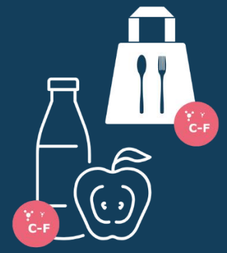


US EPA

EPA Maximum Contaminant Level (MCL): A legally enforceable limit of just 4 ng/L for PFOA and PFOS in drinking water.





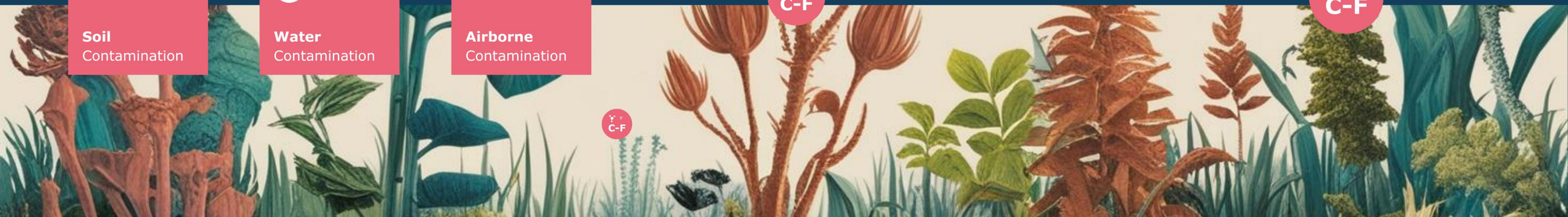
US

- No federal limits/bans for Food or Packaging; relies on voluntary phase-outs (FDA) and diverse state laws.
- FDA: Foods Program Compendium of Analytical Laboratory Methods with MDLs and LOQs

Soil Contamination

Water Contamination

Airborne Contamination



The Analyst's Dilemma

Garbage In, Garbage Out

Major
Challenges

Matrix Effects
Complex food and biological samples contain interferences that can suppress or enhance the analytical signal, causing inaccurate results.

Background Contamination
PFAS are present in many common laboratory materials (vials, tubing, solvents), posing a high risk of false-positive results.

Manual Inconsistency
An estimated 60-70% of lab errors occur during pre-analytical sample handling, introducing variability.

Perovani, I. S., Barbetta, M. F. S., Duarte, L. O., & de Oliveira, A. R. M. (2023). Determination of polyfluoroalkyl substances in biological matrices by chromatography techniques: A review focused on the sample preparation techniques - Review. Journal of Chromatography Open, 3, 100082.

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The Analyst's Dilemma

Tackling these challenges with automation

Major **Challenges**

Focus on clean-up and extraction: Use multi-step methods like Solid Phase Extraction (SPE) to remove interferences.

Mass-labeled internal standards for isotope dilution effectively compensate for matrix effects.

Tame the Matrix

Use PFAS-free consumables to avoid contamination.

Choose hardware designed to reduce carryover, like an autosampler with a sample loop and multi-solvent wash station.

Fight the Noise

Robotic automation is the solution, ensuring every sample is processed with identical timing and precision.

This leads to better consistency, higher throughput, and fully traceable results for robust quality control.

Automate for Consistency

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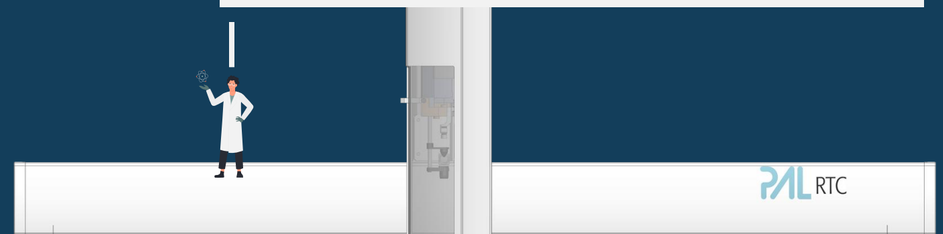
Sample preparation options

Across sample types and fields

Environmental	Dilute and Shoot	SPME
	Direct Headspace	SPME or ITEX
Food and Food Safety	SPE	
	QuEChERS + SPE	
Biological	dSPE	LLE LLE + SPE

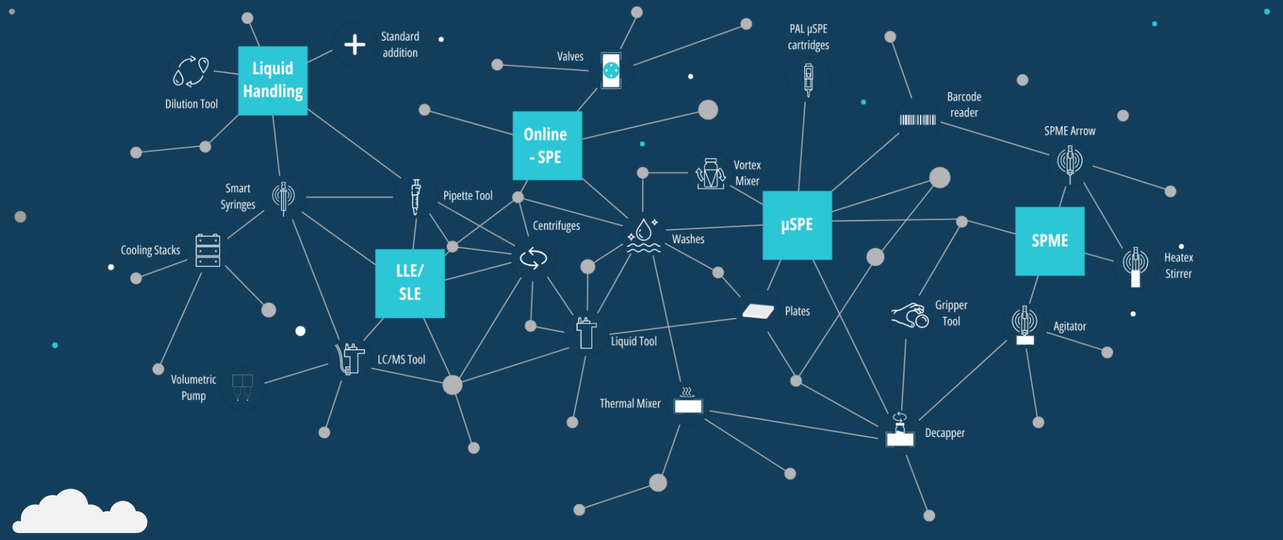
Based on a recent review across PFAS analysis, most scientists use:

Offline SPE in combination with LC/MS as a platform.



Automated sample prep

From liquid handling to complex methods



Account for contamination sources
There are upgrade kits available for PFAS Analysis.
They focus on the tubing, LC/MS Tool, vials and syringes.

Always run blanks for your QC/QA strategies.

Liquid/Solid Extraction (LLE/SLE)

Basic partitioning of PFAS between the sample (or its homogenate) and an extraction solvent (e.g., acetonitrile, methanol) → Dispersive Liquid-Liquid Micro Extraction (automated).

QuEChERS (Quick, Easy, Cheap, Effective, Rugged, Safe)

A streamlined approach combining solvent extraction with a "salting-out" phase separation, followed by dispersive SPE (dSPE) cleanup (shaking extract with loose sorbents).

Solid Phase Extraction (SPE)

Selectively retaining PFAS on a solid sorbent material (in a cartridge, column or well plate) while matrix interferences are washed away, followed by elution of PFAS.

- Manual SPE
- Online SPE
- Micro-SPE (µSPE)
- Dispersive-SPE

SPME (Solid Phase Micro Extraction)

Adsorption of analytes onto a coated Fiber or Arrow device, typically from sample headspace (for volatiles) or direct immersion.

Key Takeaways & The Journey Ahead

A focus on automated sample preparation

PFAS are a persistent, global contaminant with tightening regulations that demand exceptional analytical performance from every lab.

The primary hurdles are not the instruments, but the sample preparation—specifically, background contamination and manual inconsistency.

A systematic approach using robotic automation and PFAS-free workflows is the key to achieving reliable, reproducible results.

Key Takeaways & The Journey Ahead

A focus on automated sample preparation

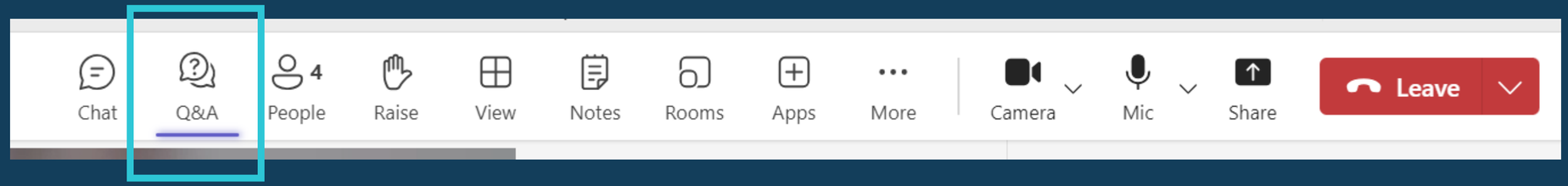
PFAS are a persistent, global contaminant with tightening regulations that demand exceptional analytical performance from every lab.

The primary hurdles are not the instruments, but the sample preparation—specifically, background contamination and manual inconsistency.

Next time (Sept 3): We'll tackle cosmetics with **Automated SPME**.
On Sept 9: We'll dive into seafood analysis with **Automated µSPE**.
On Sept 10: We'll explore ultimate sensitivity in water with **Online SPE**.

A systematic approach using robotic automation and PFAS-free workflows is the key to achieving reliable, reproducible results.

Q&A



Ask your question in the **Q & A window** right now

Use the form linked in the pinned message

Send us an email **info@palsystem.com**

References

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PFAS Analysis PAL System

PFAS Analysis - Equip your PAL System for PFAS Analysis