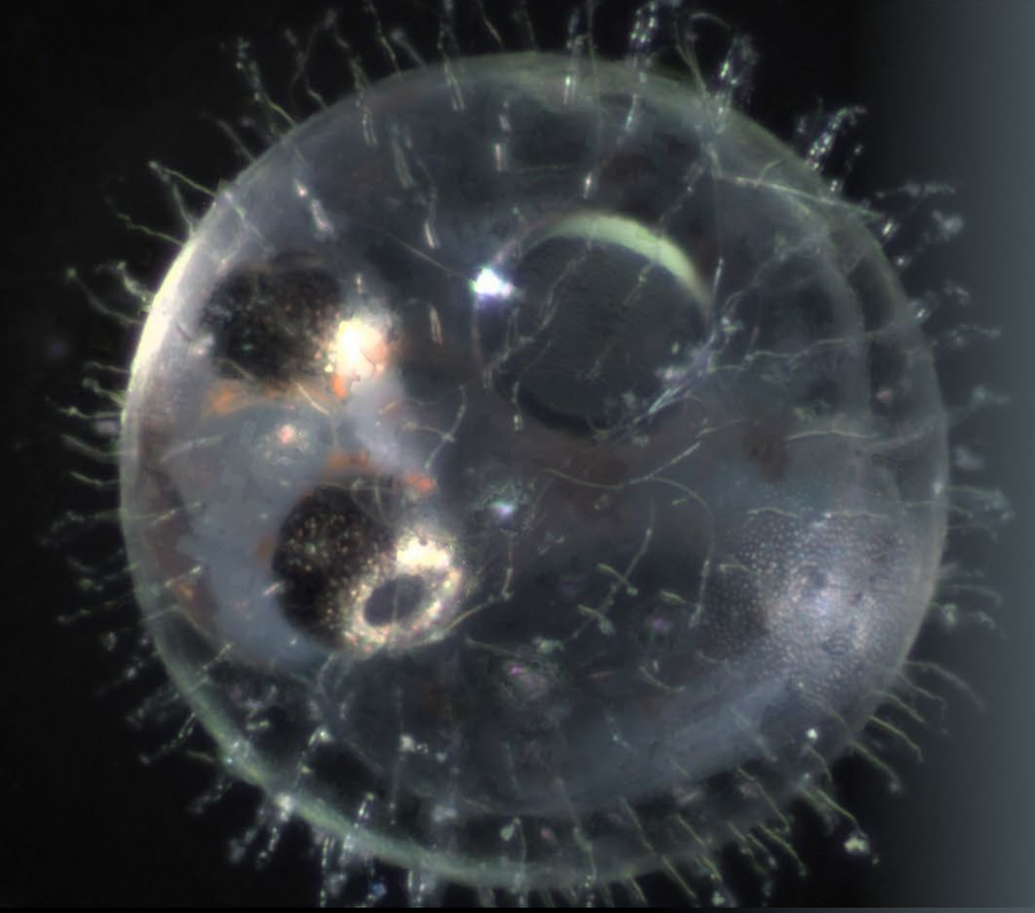


PFAS in our waters: why it matters for community health

TEXAS A&M UNIVERSITY
CORPUS CHRISTI

Frauke Seemann
Texas A&M University-Corpus Christi

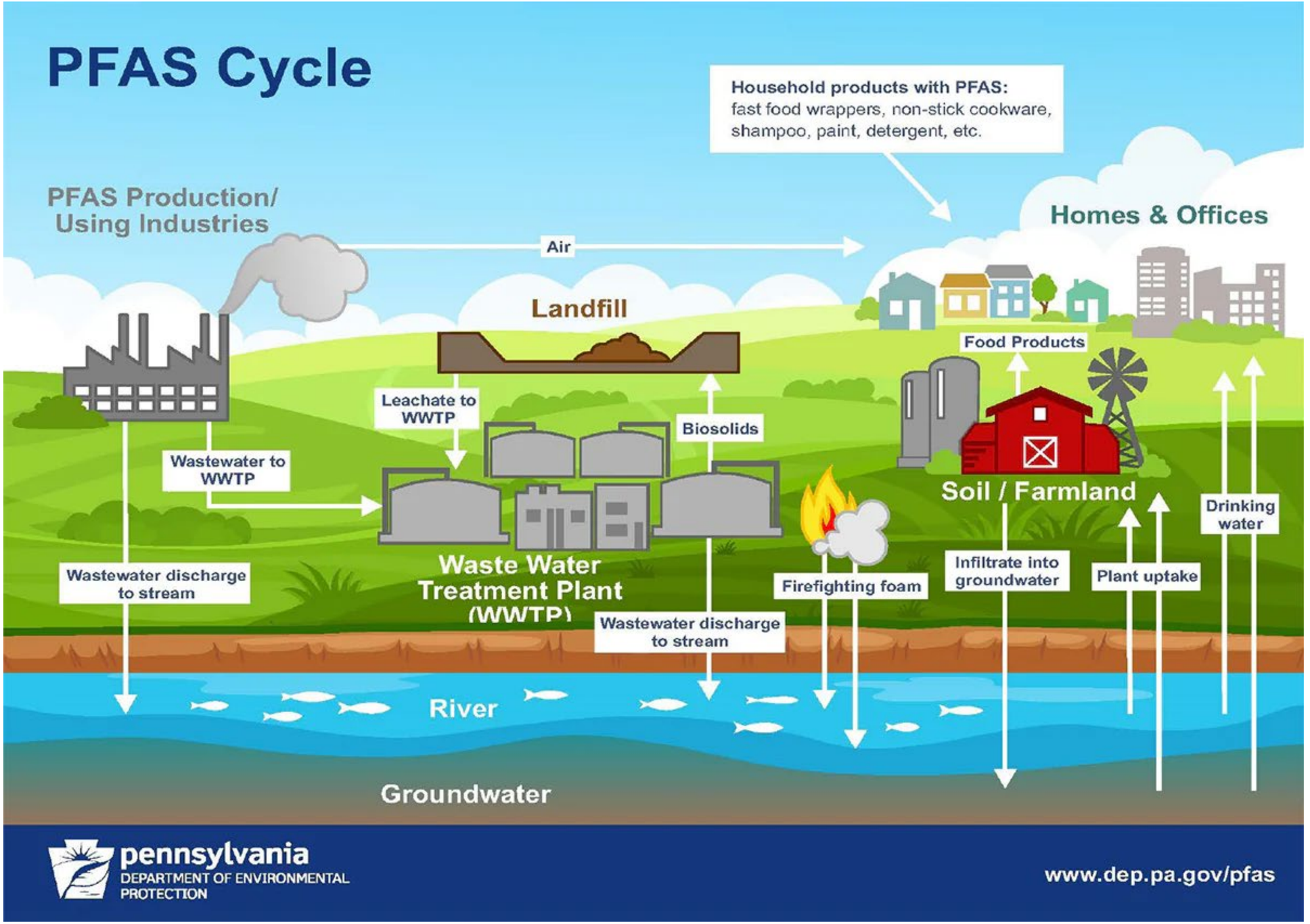
Frauke.seemann@tamucc.edu

Per- polyfluoroalkyl substances (PFAS)

- Ubiquitous in environment
- Estimated over 12,000 substances
  - 4,700 with CAS Registry numbers
  - 50-60 detectable & identified

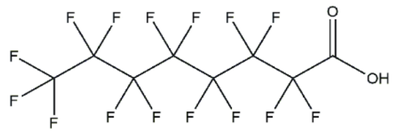
https://www.progressive-charlestown.com/2022/07/what-weve-learned-about-pfas.html

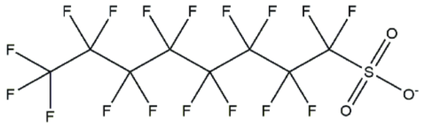
How PFAS travel

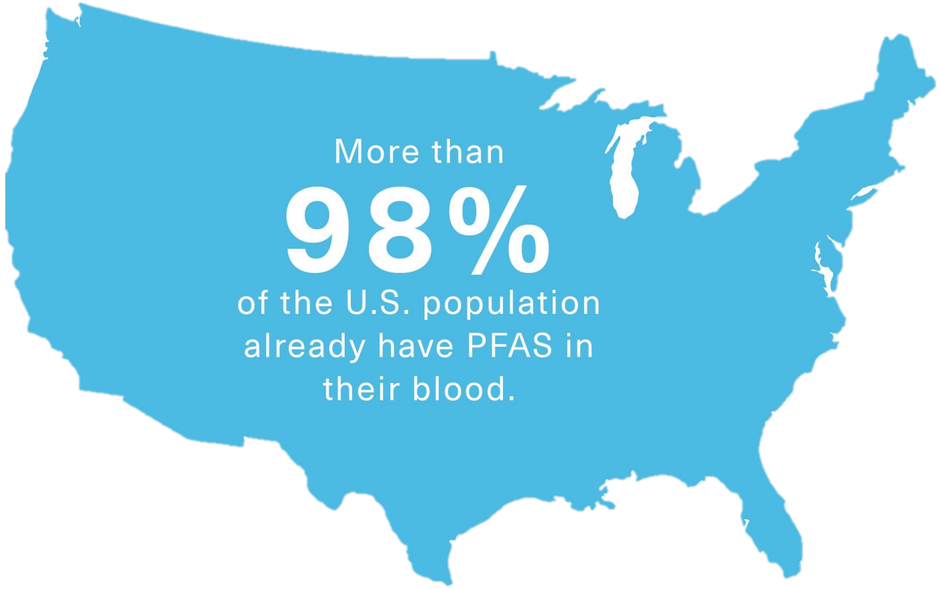


Prenatal and postnatal PFAS exposure

Created in https://BioRender.com







Concentrations of PFAS in blood serum (ng/mL)						
	PFOS	**PFOA**	**PFHxS**	**PFHxA**	**PFBS**	**GenX**
Mother	1 - 11	0.2 - 3	<0.05 - 5	0.01 - 0.05	0.02-0.23	N/A
Infant/young child	3 - 13	0.6 - 3	0.3 - 18	<0.05 - 0.3	<0.10 - 0.2	<LOD
EPA drinking water limits (MCL)	0.004 (4 ng/L)	0.004 (4 ng/L)	0.01 (10 ng/L)	N/A	N/A (HI = 1)	0.01 (10 ng/L)

(Cai 2020; Glynn 2020; Granum 2013; Harris 2018; Liu 2020; Mamsen 2019; Manzano-Salgado 2019; Schulz 2020; Wikstrom 2020; Zhang 2022)

LOD: level of detection

MCL: maximum contaminant level (enforceable)

HI: Hazard index (used for mixtures of two or more PFAS including PFHxS, PFNA< PFBS, and GenX)

PFAS toxicities: potential mechanisms

- Immunosuppression (Pennings et al., 2015)
- Reduced antibody responses (Anderson et al., 2023; Granum et al., 2013)
- Altered gene expression (Giorgi et al., 2023; Pennings et al., 2015)
- Disruption immune cell function (Meléndex et al., 2024; Rockwell et al., 2017)

- Activate PPARs (Szilagyi et al., 2020; Takacs & Abbott, 2007; Yang et al., 2023)

  Lipid dysregulation

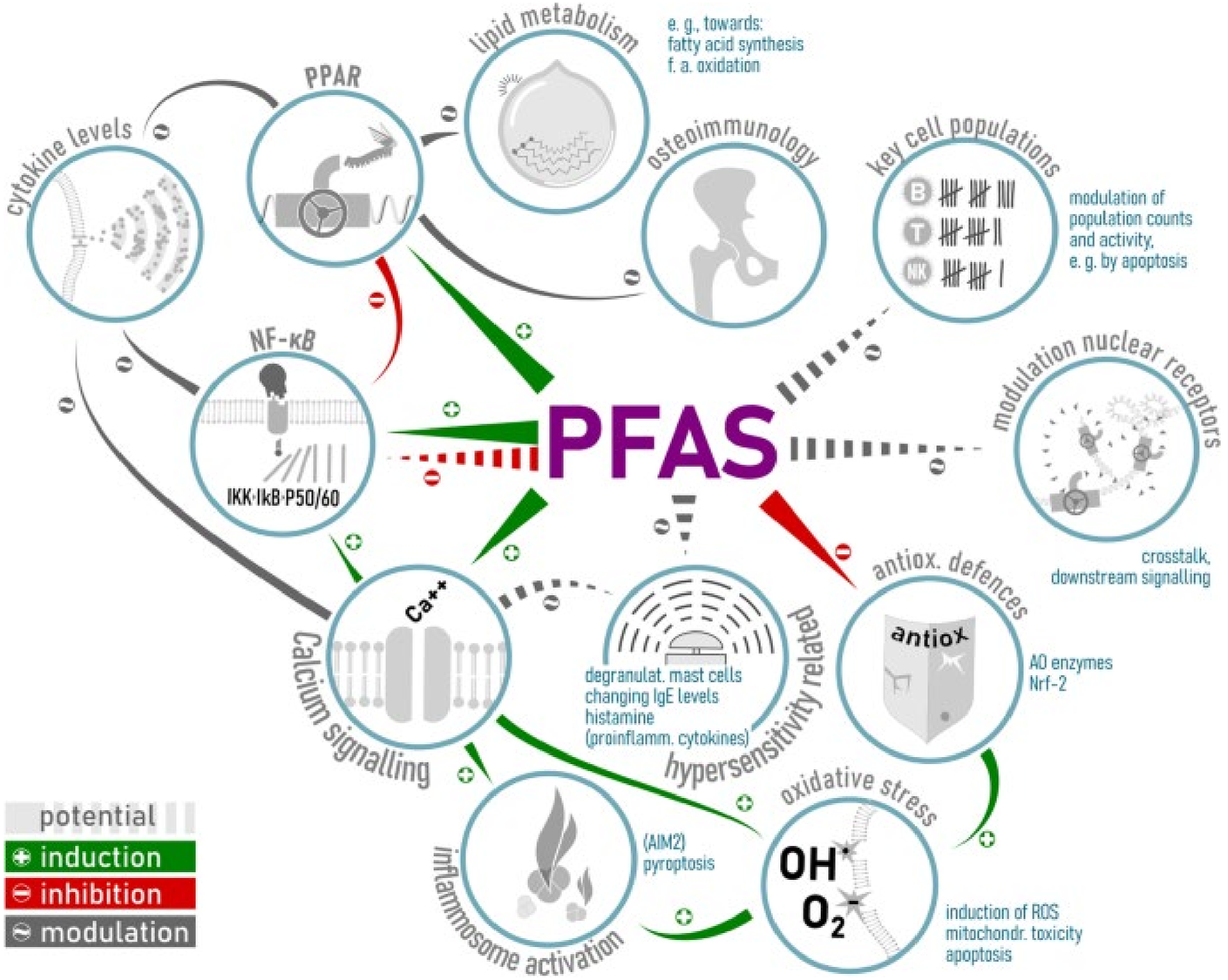
- Low birth weight (Blake and Fenton, 2020; Wikström et al., 2020)
- Developmental delays (Harris et al., 2018)
- Reproductive disruptions (Lemasters et al., 2000; Mokra, 2021)

- Thyroid hormone levels (Coperchini et al., 2021; Freire et al., 2023)

- Metabolic disruptions (Alderete et al., 2019; Alijagic et al., 2024; Chen et al., 2020)

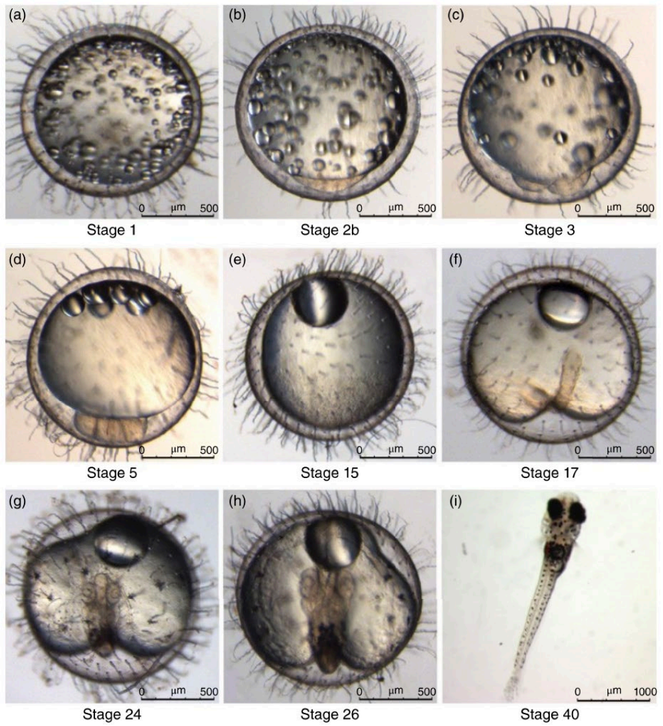
  Glucose metabolism

  Short-chain fatty acid production



Ehrlich et al., 2023

Marine Medaka (*Oryzias melastigma*)

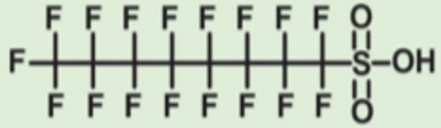
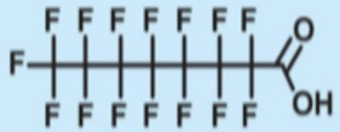
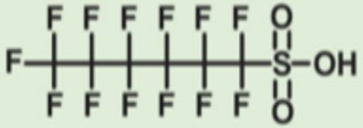
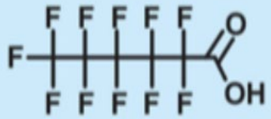
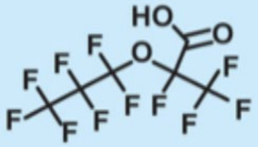


Model for toxicological studies

- Short generation time
- Small size
- High fecundity
- Transparent embryos
- Sexually distinct morphology
- Sequenced and annotated genome

Bajoghli et al., 2019; Bo et al., 2011; Bo et al., 2012; Kasahara et al., 2007; Kim et al., 2016; Kim et al., 2018; Kinoshita et al., 2020; Seemann et al., 2017; Ye et al., 2017

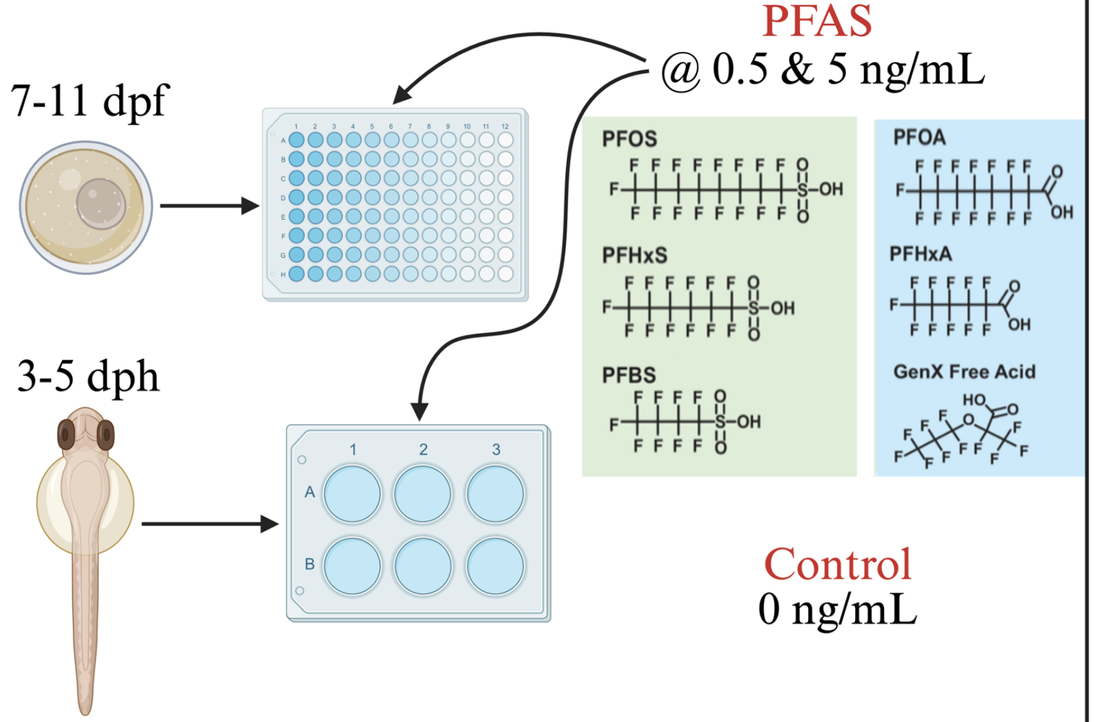
Legacy & replacement compounds

Sulfonic acids	Carboxylic acids
Perfluorooctane sulfonic acid (PFOS) 	**Perfluorooctanoic acid (PFOA)** 
Perfluorohexane sulfonic acid (PFHxS) 	**Perfluorohexanoic acid (PFHxA)** 
Perfluorobutane sulfonic acid (PFHxS) 	**Hexafluoropropylene oxide-dimer acid (HFPO-DA or GenX)** 

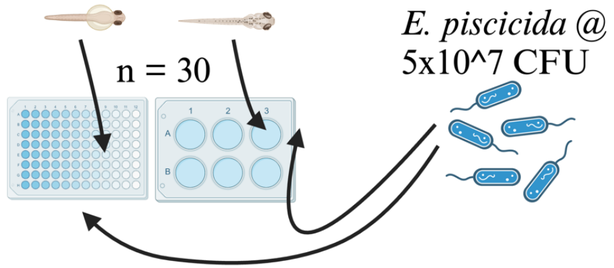
The strong carbon-fluorine bond makes them highly resistant to breakdown, resulting in **persistent environmental pollutants**

Immediate effects of PFAS exposure

Developmental PFAS Exposure

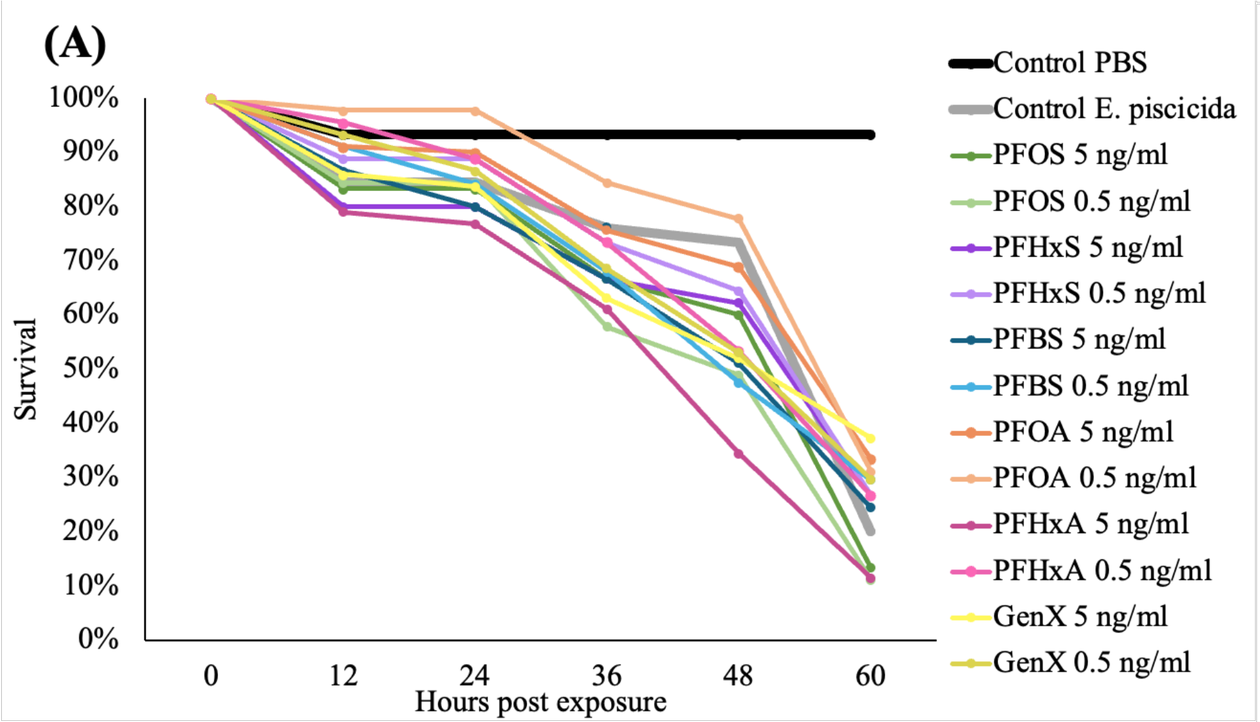


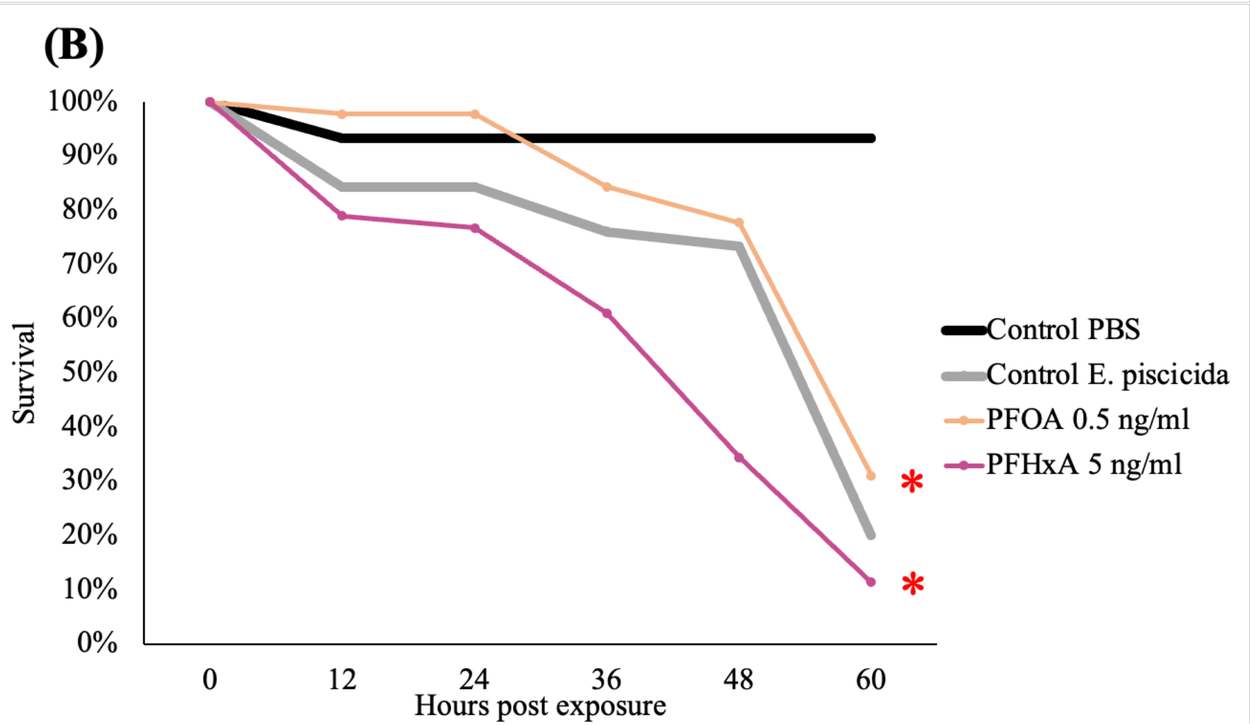
1) Immune Competence (HRA)



- **Moribundity** monitored every 12 hours
- **Survival Analysis** was performed through "survival" package in R version 4.3.1.
- **P-values** indicate significant changes in survival rate over time.

Reduced immune competence at 7-11 dpf

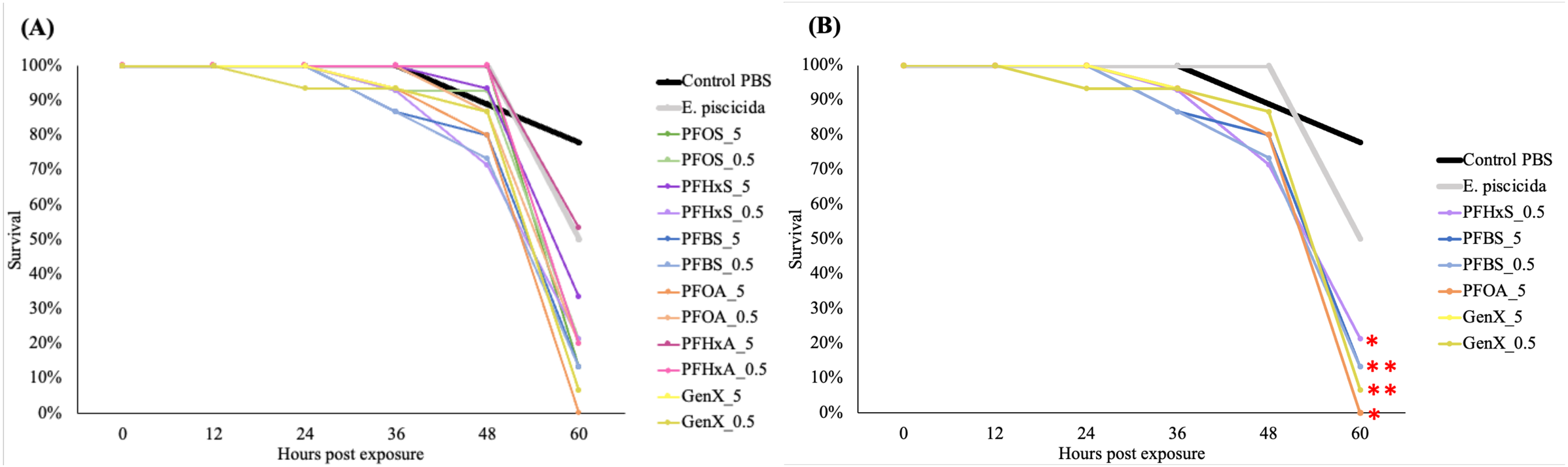




- 7-11 dpf window vulnerable to PFHxA and PFOA
  - Reduced survival after high dose PFHxA exposure %%
  - Altered survival after low dose PFOA exposure %%

n=30; Pairwise LogRank Comparison; R version 4.3.1, “survival” package, *p<0.05

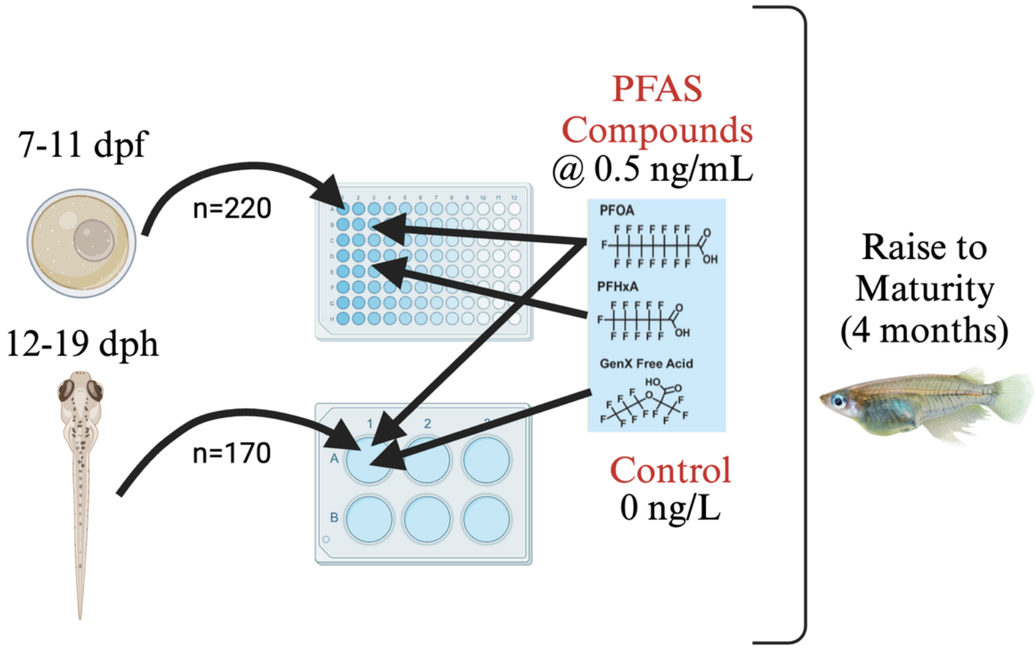
Reduced immune competence 12-19 dph



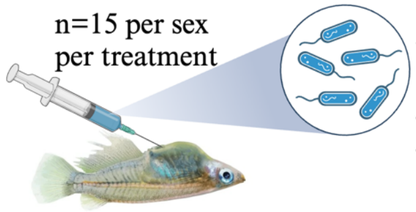
- 12-19 dph window vulnerable to specific PFAS
  - PFHxS, PFBS, PFOA, GenX (75-100% mortality)

n=30; Pairwise LogRank Comparison; R version 4.3.1, “survival” package, *p<0.05

Long-Term consequences of developmental PFAS exposure

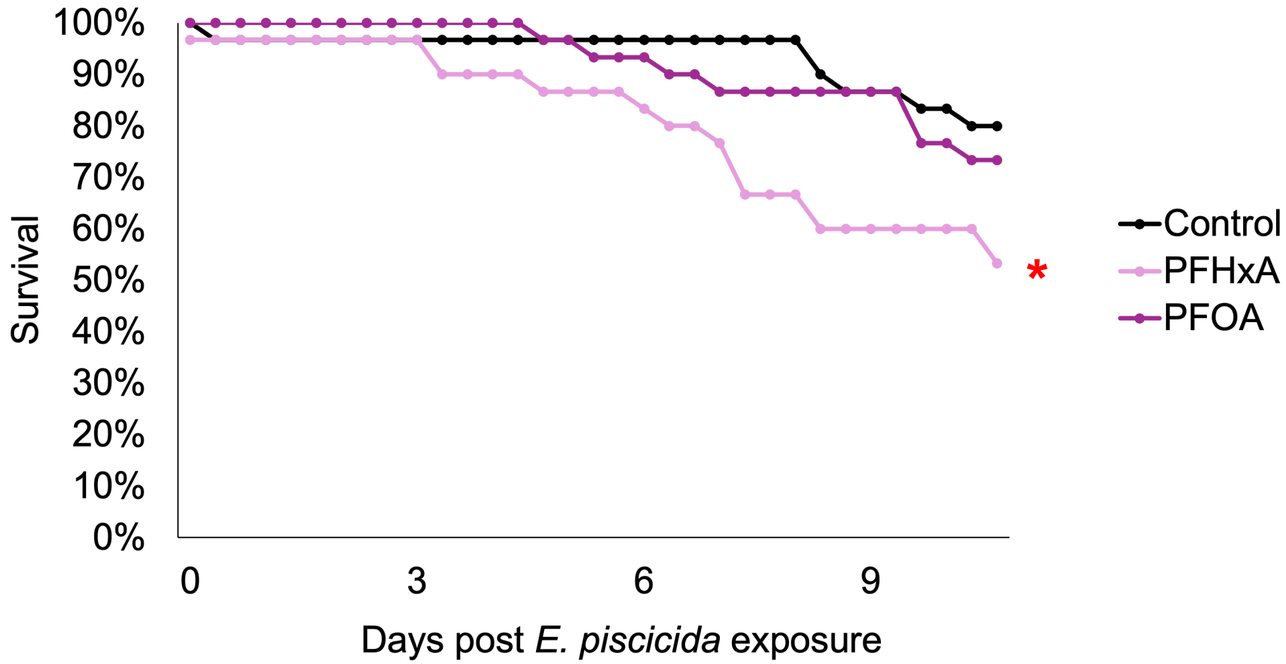


1) Immune Competence (HRA)



- **Moribundity** monitored every 12 hours
- **Survival Analysis** was performed through "survival" package in R version 4.3.1.
- **P-values** indicate significant changes in survival rate over time.

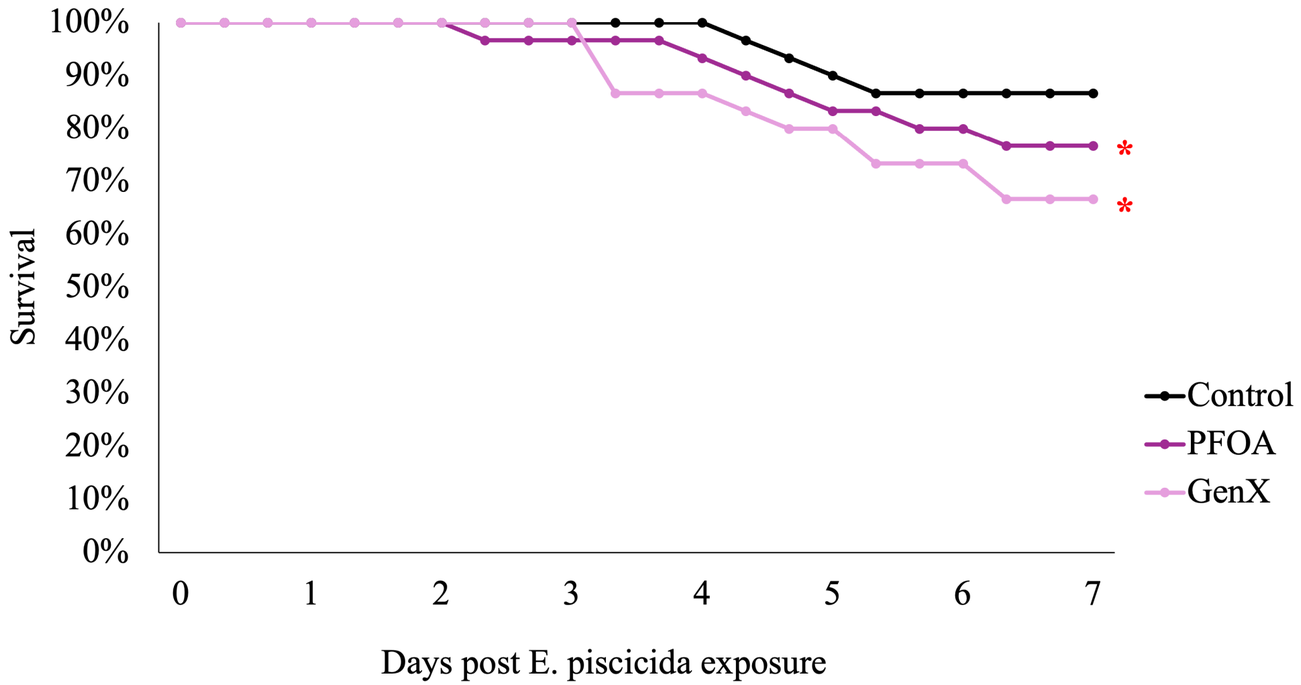
Sex-specific effects on survival after PFAS exposure 7-11 dpf



- Adult **FEMALES** (4 months) who experienced 0.5 ng/mL PFAS (PFOA or PFHxA) exposure from 7-11dpf
  - Trend for PFOA to effect survival, not sig.
  - PFHxA negatively impacted survival by 30%

n=15; Pairwise LogRank Comparison; R version 4.3.1, “survival” package, *p<0.05

Adult Females Exposed 12-19 dph to Both PFOA & GenX have impaired immune competence

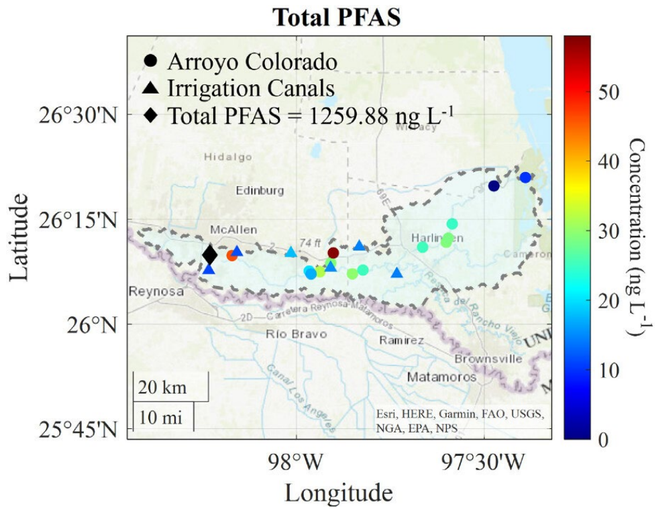


- Adults **FEMALES** (4 months) who experienced 0.5 ng/mL PFAS (PFOA or GenX) exposure from 12-19 dph
  - PFOA negatively impacted survival by 10%
  - GenX negatively impacted survival by 20%

n=15; Pairwise LogRank Comparison; R version 4.3.1, "survival" package, *p<0.05

Take home from the marine medaka experiments

1. PFAS may stress the body's cells, making it harder for the immune system to work normally.
2. These chemicals may increase cell damage and inflammation, which could affect how the body fights infection and stays healthy.
3. PFHxA and GenX, a newer replacement PFAS, affected more biological pathways, showing that newer PFAS may also pose health risks.
4. Developmental exposure can have life-long health impacts

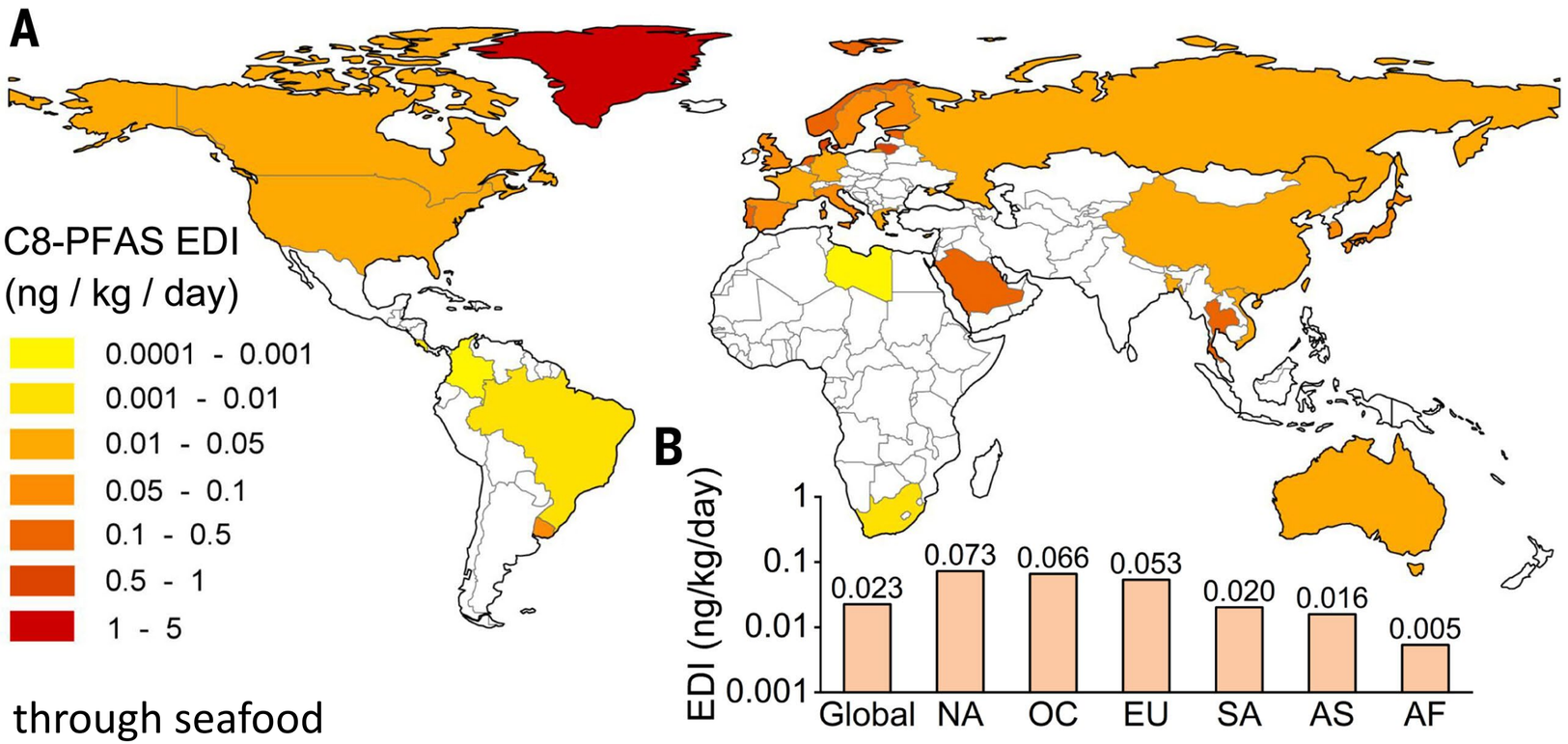


Why should we care?

Liu, Y., et al. (2024), Distribution of Per- and Polyfluoroalkyl Substances in the Rapidly Urbanizing Arroyo Colorado Watershed, Texas. Journal of Contemporary Water Research & Education, 180: 23-36. https://doi.org/10.1111/j.1936-704X.2024.3405.x

	PFCA								PFSA					
	PFBA	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	ΣPFCA	PFBS	PFPeS	PFHxS	PFHpS	PFOS	ΣPFSA
This study														
Arroyo Colorado (n = 15)	7.39	19.21	17.13	22.92	12.13	N.D.	N.D.	78.78	7.81	32.01	140.17	3.42	17.18	200.59
Irrigation Canals (n = 6)	4.68	4.70	4.23	N.D.	N.D.	N.D.	N.D.	13.61	N.D.	N.D.	N.D.	N.D.	3.59	3.59
Scott et al. 2009														
Canadian Rivers and Creeks	N.A.	N.A.	1.03	1.08	1.65	0.51	0.13	4.39	0.21	N.A.	0.72	0.13	2.15	3.21
Gebbink et al. 2017 (n = 18)														
Downstream of a fluorochemical production plant (n = 13)	7.78	4.82	5.34	1.85	4.62	0.67	0.41	25.50	21.00	N.A.	1.97	0.14	3.40	26.51
Upstream of a fluorochemical production plant (n = 3)	6.37	6.17	6.17	1.90	3.00	0.75	0.56	24.91	19.67	N.A.	2.10	0.16	4.77	26.70
Moller et al. 2010														
Rhine upstream Leverkusen (n = 27)	1.44	3.65	2.00	0.43	2.13	N.A.	N.A.	9.65	3.19	N.A.	3.04	N.A.	3.70	9.93
Rhine downstream Leverkusen (n = 9)	117.00	4.28	2.86	0.49	3.11	N.A.	N.A.	127.74	45.40	N.A.	1.93	N.A.	4.13	51.46
River Ruhr (n = 3)	16.60	21.35	8.74	0.99	14.30	N.A.	N.A.	61.98	7.08	N.A.	0.18	N.A.	4.21	11.47
River Moehne (n = 1)	115.00	59.30	49.90	5.78	42.10	N.A.	N.A.	272.08	31.10	N.A.	1.03	N.A.	3.11	35.24
Bai and Son 2021														
Truckee River (n = 8)	N.D.	5.80	18.00	1.70	6.90	N.D.	N.D.	32.40	5.20	0.70	6.40	N.D.	2.20	14.50
Las Vagas Wash (n = 10)	2.60	52.30	80.70	11.60	27.30	N.D.	N.D.	174.50	17.70	2.30	11.20	N.D.	12.90	44.10

Why should we care?



through seafood

European Food Safety Authority:

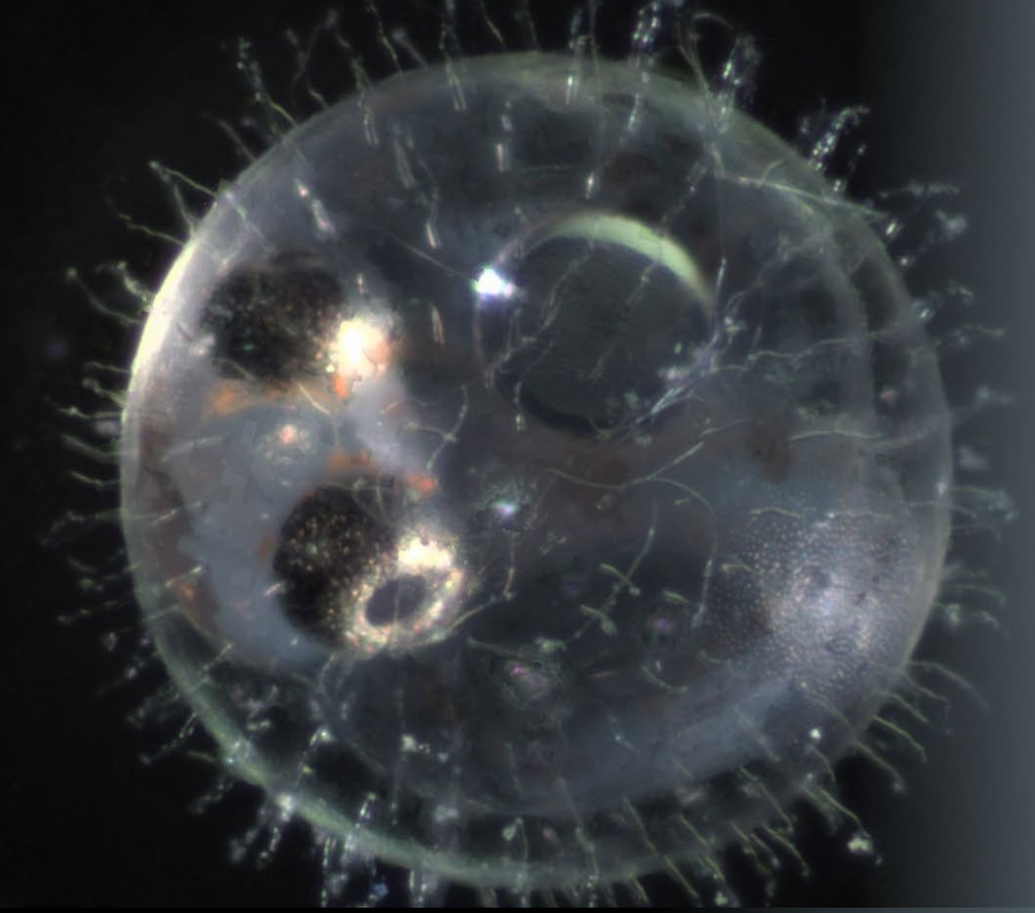
- tolerable daily intake 0.6 ng/kg/day
- identified fish and other seafood as primary contributors to PFAS exposure

Oiu et al., 2025, Science

What will we do?

Sea Grant
TEXAS
AT TEXAS A&M UNIVERSITY

GC-Orbitrap-MS
For targeted and untargeted organic contaminants



QUESTIONS?

Additional EPA Resources

https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas