

# Assessing the impact of pharmaceutical compounds on freshwater ecosystems

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AVEC LE SOUTIEN DU FONDS EUROPÉEN DE DÉVELOPPEMENT RÉGIONAL

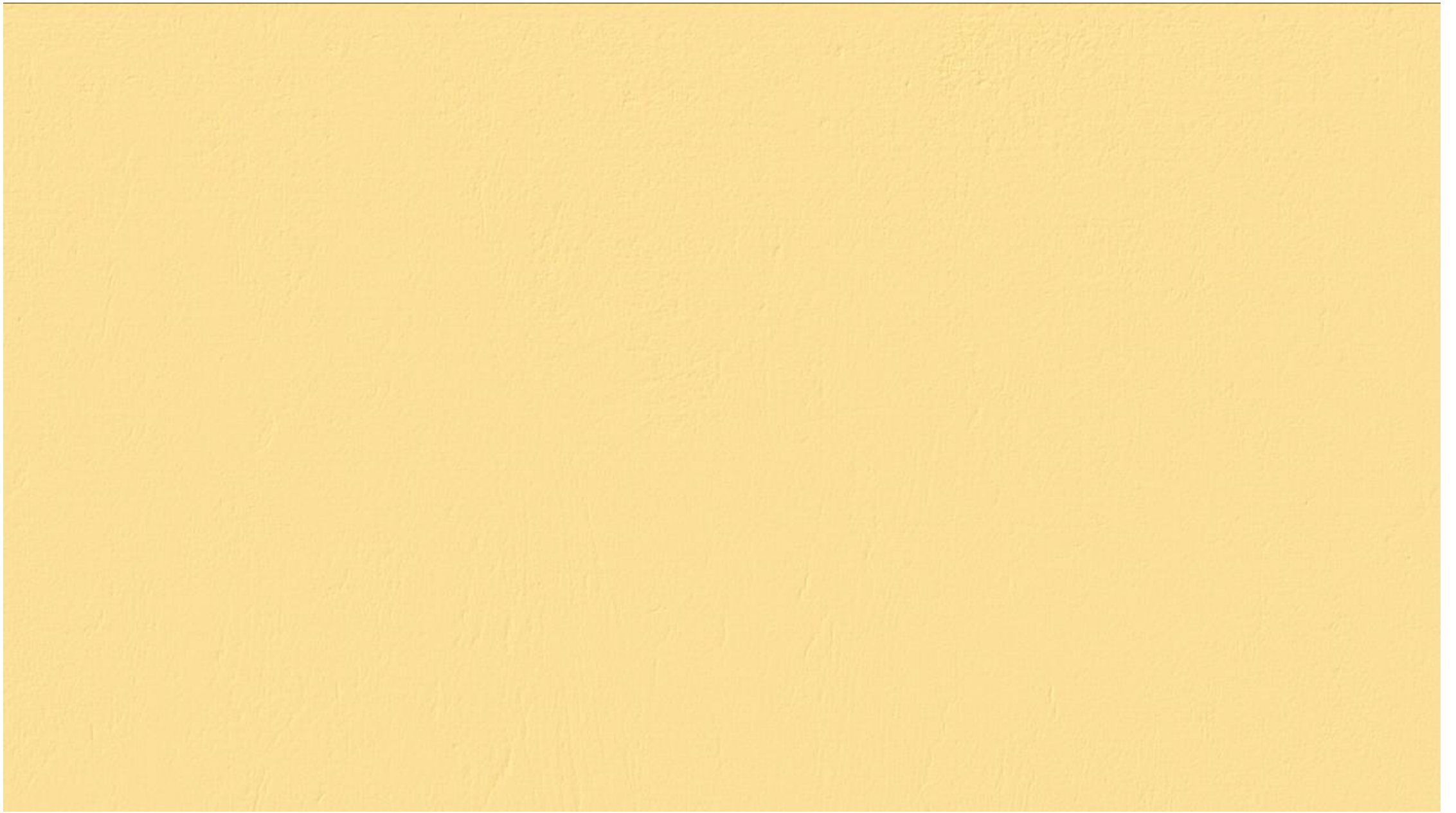


UNION EUROPÉENNE



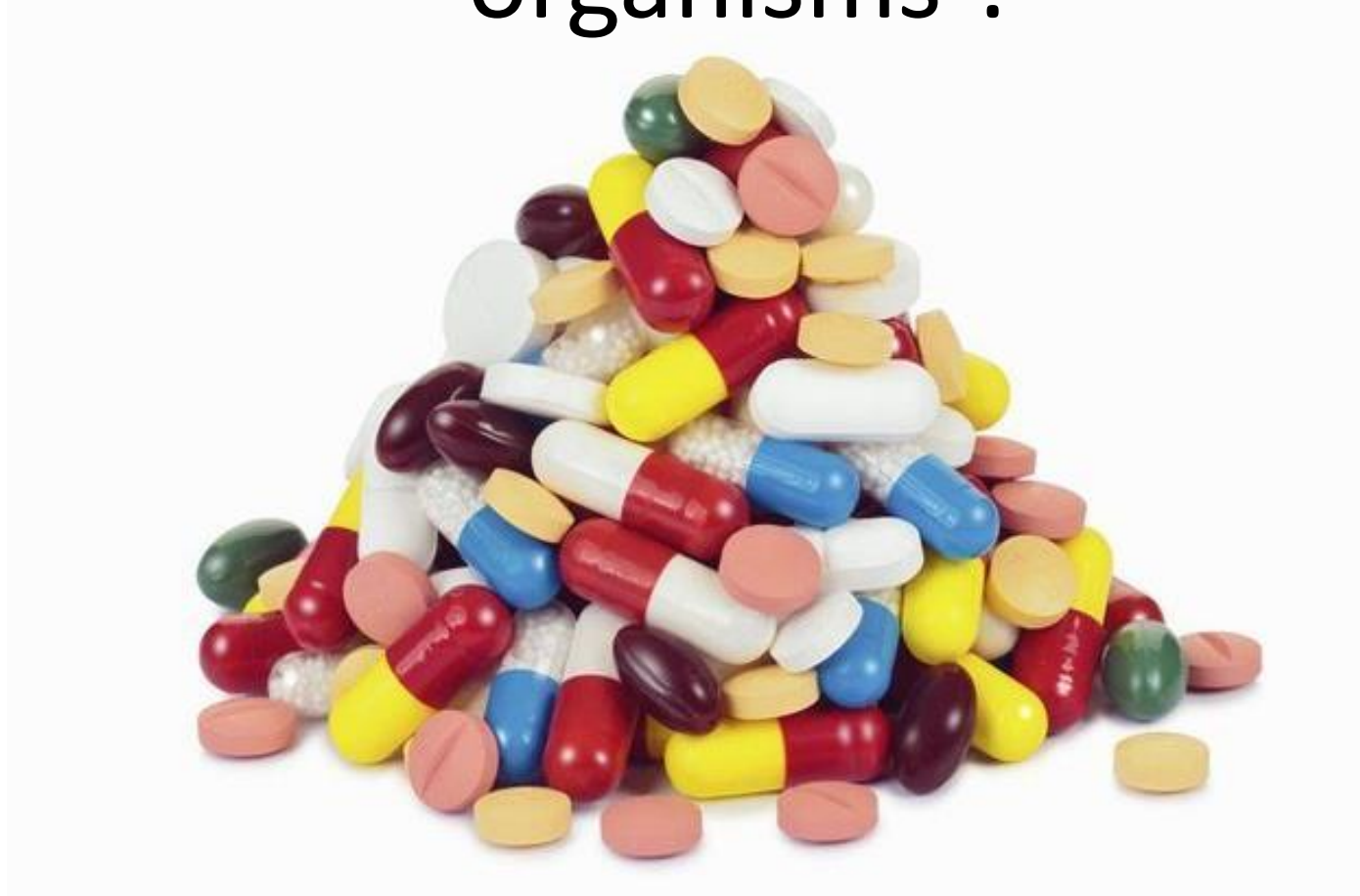
# What happened to the pharmaceuticals after being consumed ?

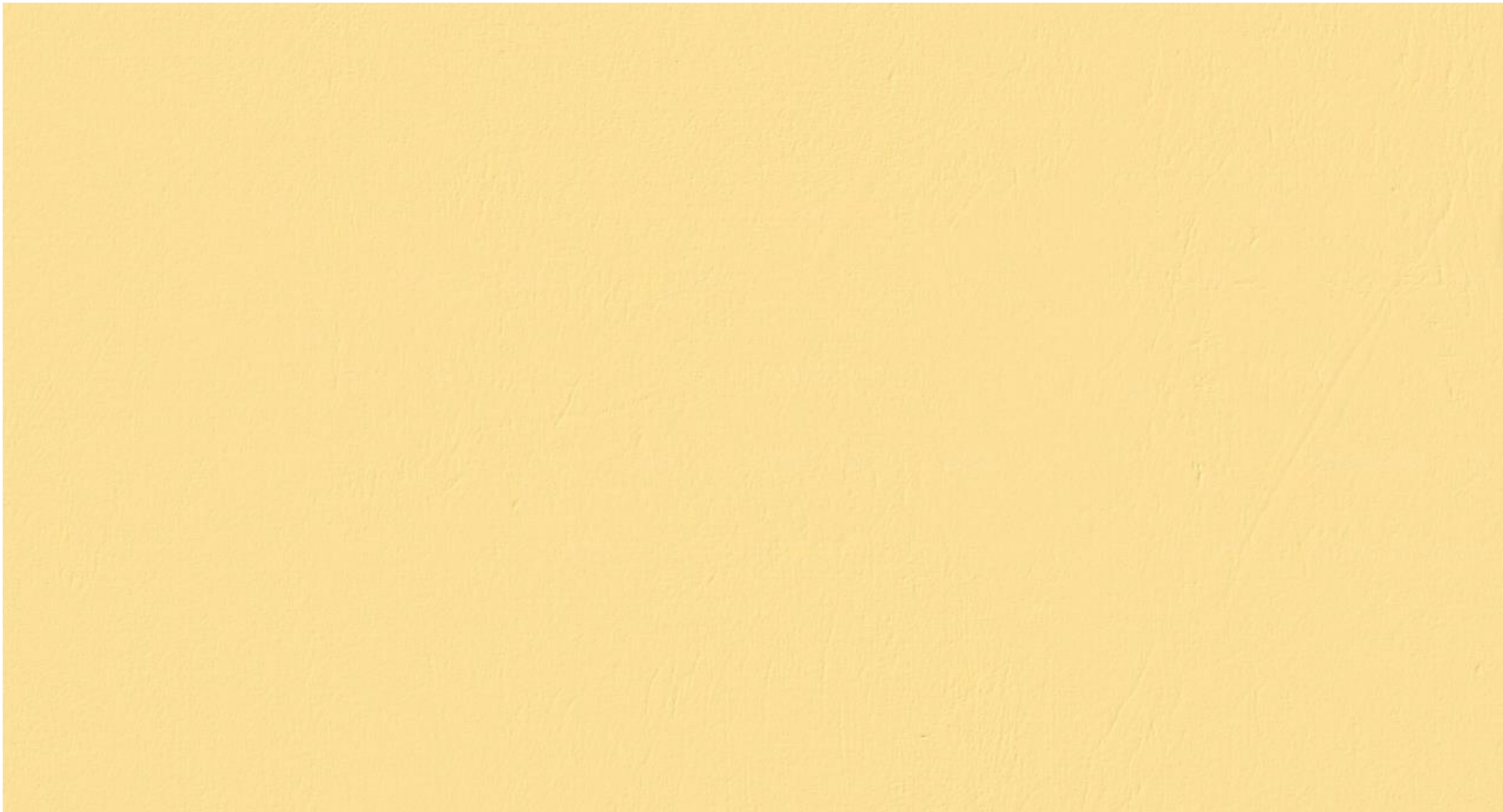




(Overturf et al. 2015, Pal et al. 2010, Petrie et al. 2014)

# What are the consequences for aquatic organisms ?





(Imhoff et al. 2004, Tyler & Jobling 2008; Kestemont & Depiereux 2013).

# How to evaluate pharmaceuticals' environmental risk ?

➤ European regulation since 2006  
Occurrence - biaccumulation - toxicity

- PEC (Predicted environmental concentration)
- PNEC (Predicted non effect concentration)

$$\frac{PEC}{PNEC} > 1 \text{ RISK!}$$



Algae, growth inhibition test

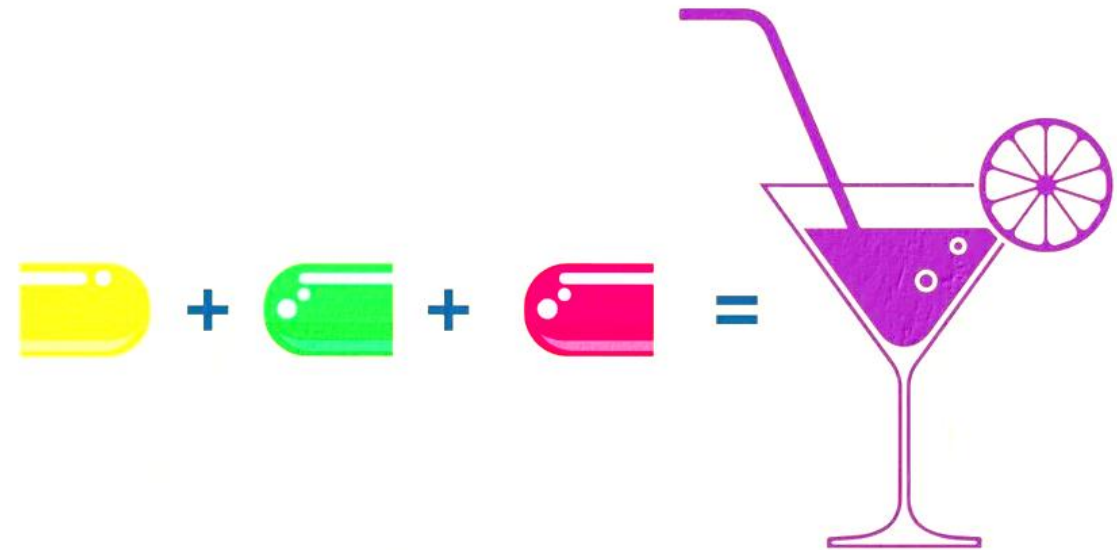
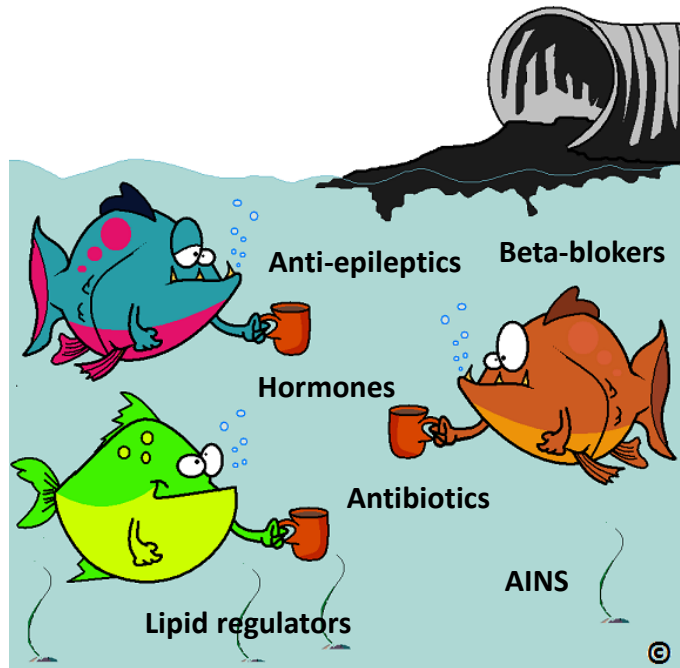


Daphnia , reproduction test



Fish , early life stage acute test

# Mixture toxicity



## DIADeM



## Development of an integrated approach for the diagnostic of the water quality in Meuse river

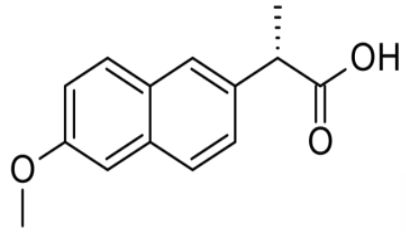
### Aims:

- Diagnostic tools for chemical quality of water
- Better understanding of the impact of pharmaceutical contamination

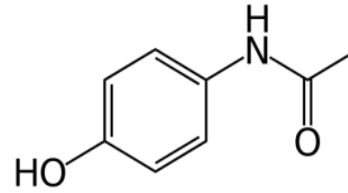




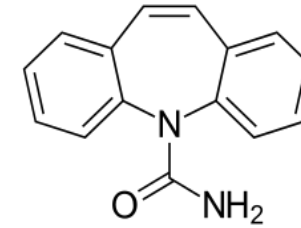
# Mixture toxicity



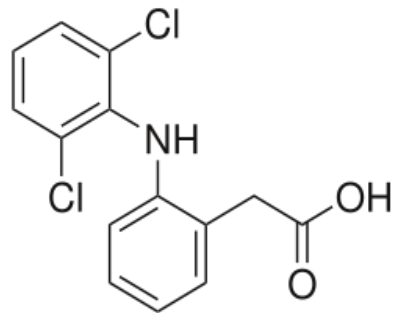
**Naproxen**  
NSAID



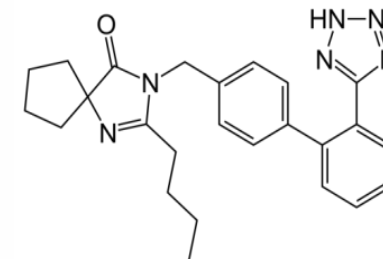
**Paracetamol**  
Analgesic



**Carbamazepine**  
Neuroleptic

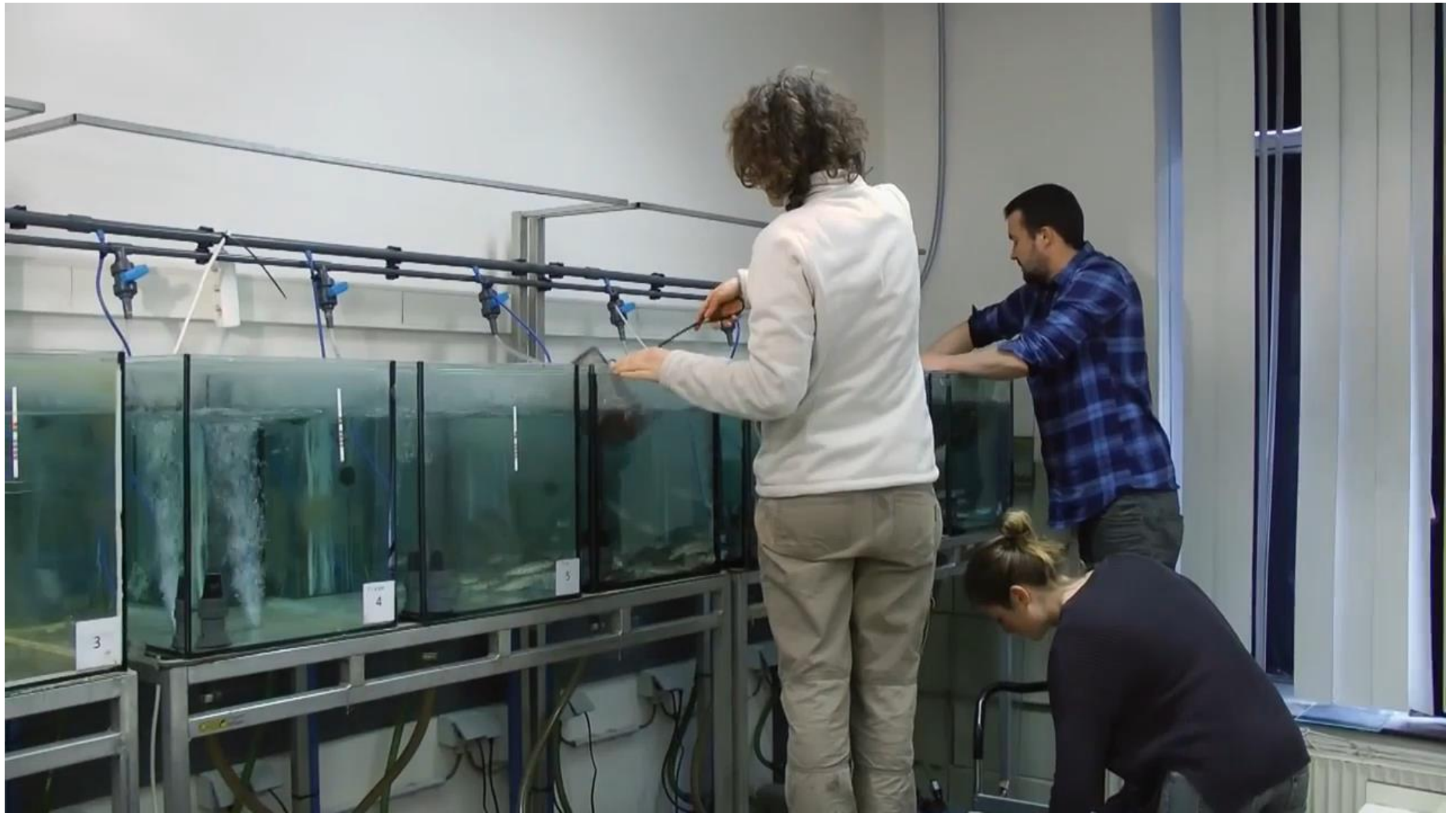


**Diclofenac**  
NSAID



**Irbesartan**  
Antihypertensive





# Multi-biomarker approach

A biochemical, cellular, physiological or behavioral variation that provides evidence of exposure to chemical pollutants

# Multi-biomarker approach

Bioaccumulation ?

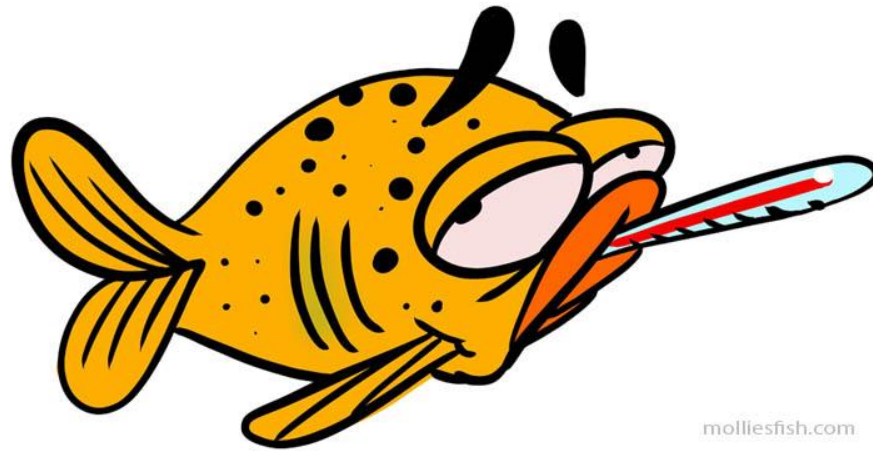


# Multi-biomarker approach

Bioaccumulation ?



Immunotoxicity ?



molliesfish.com

# Multi-biomarker approach

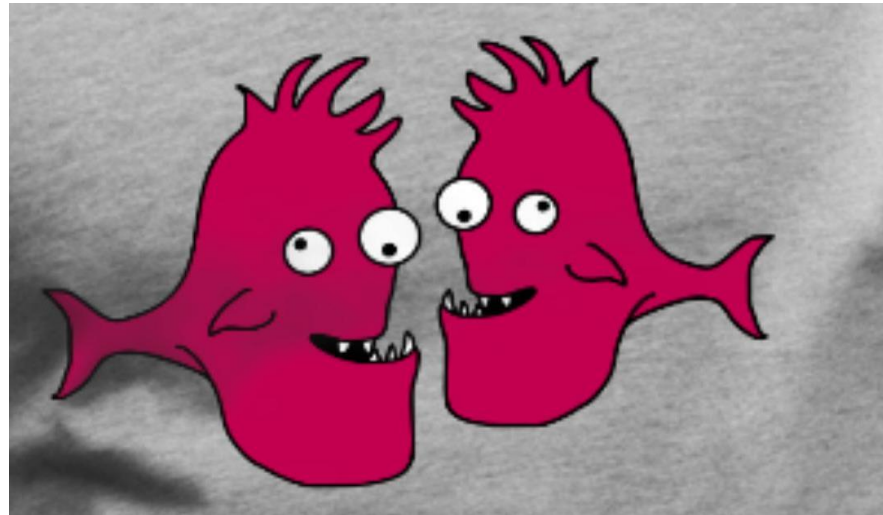
Bioaccumulation ?



Immunotoxicity ?



Neurotoxicity ?



# Multi-biomarker approach

Bioaccumulation ?



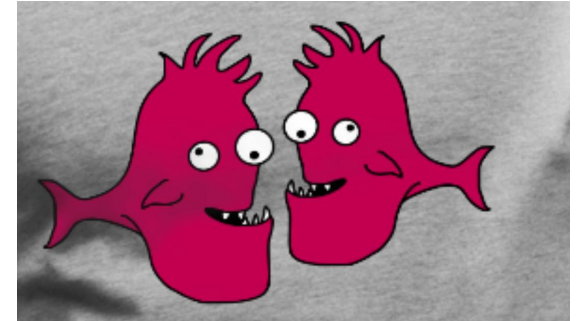
Immunotoxicity ?



Reprotoxicity ?



Neurotoxicity ?

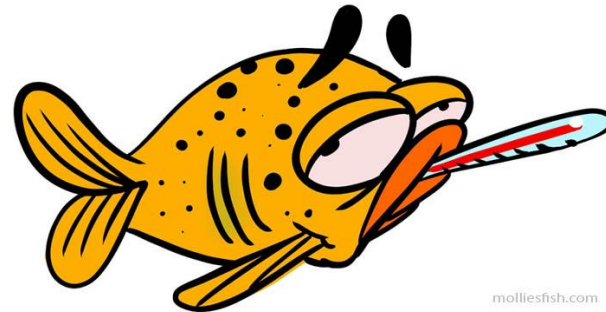


# Multi-biomarker approach

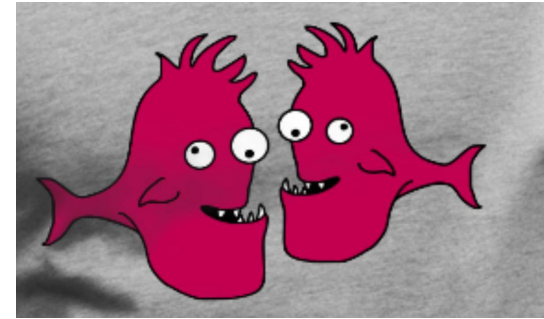
Bioaccumulation ?



Immunotoxicity ?



Neurotoxicity ?



Reprotoxicity ?



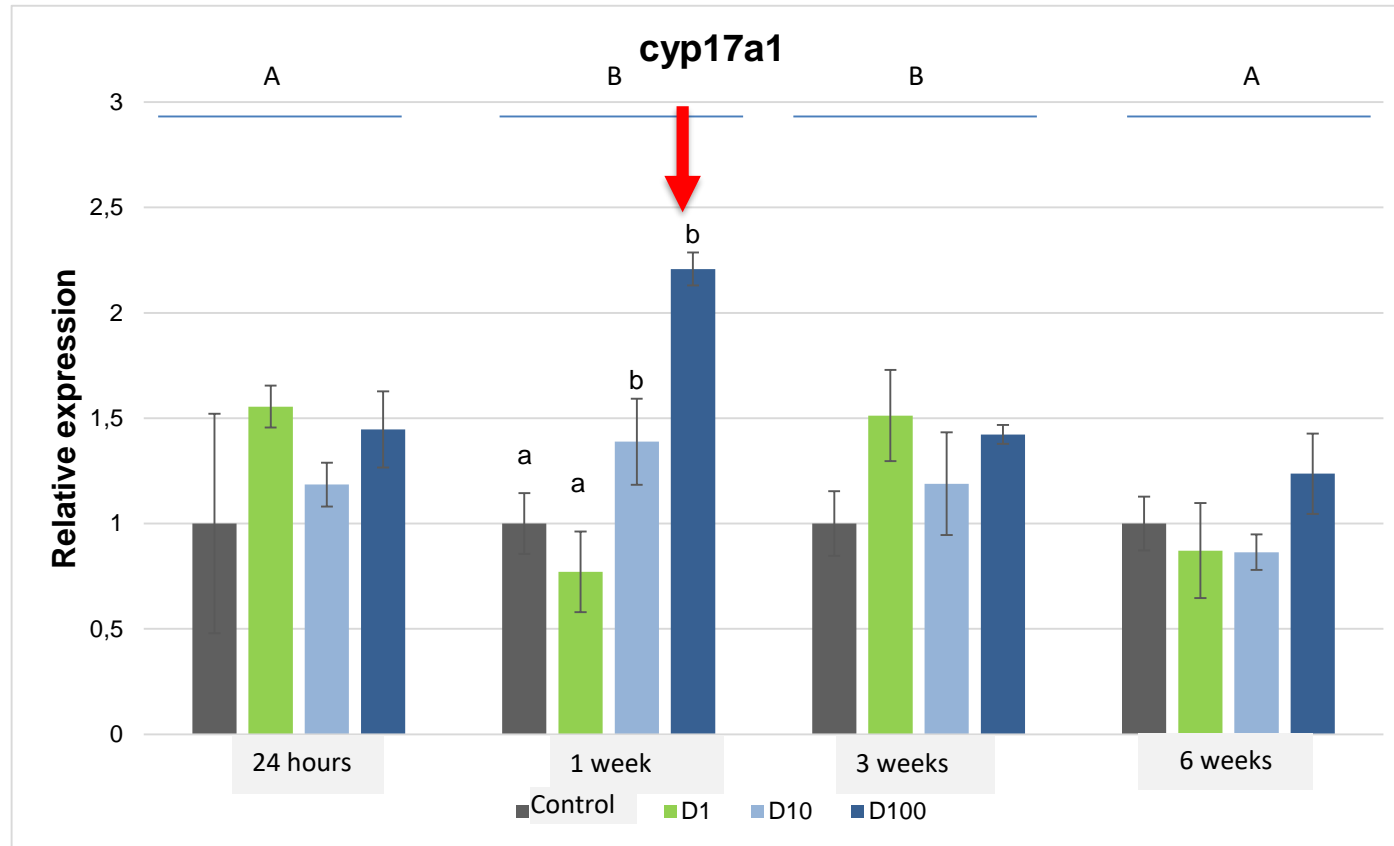
- endocrine-disrupting effects
- Effects unreported for individual compounds

(Guiloski et al., 2007 ,Galus et al., 2013, Gröner et al., 2017)



# Results

## ➤ Sexual steroid hormones synthesis

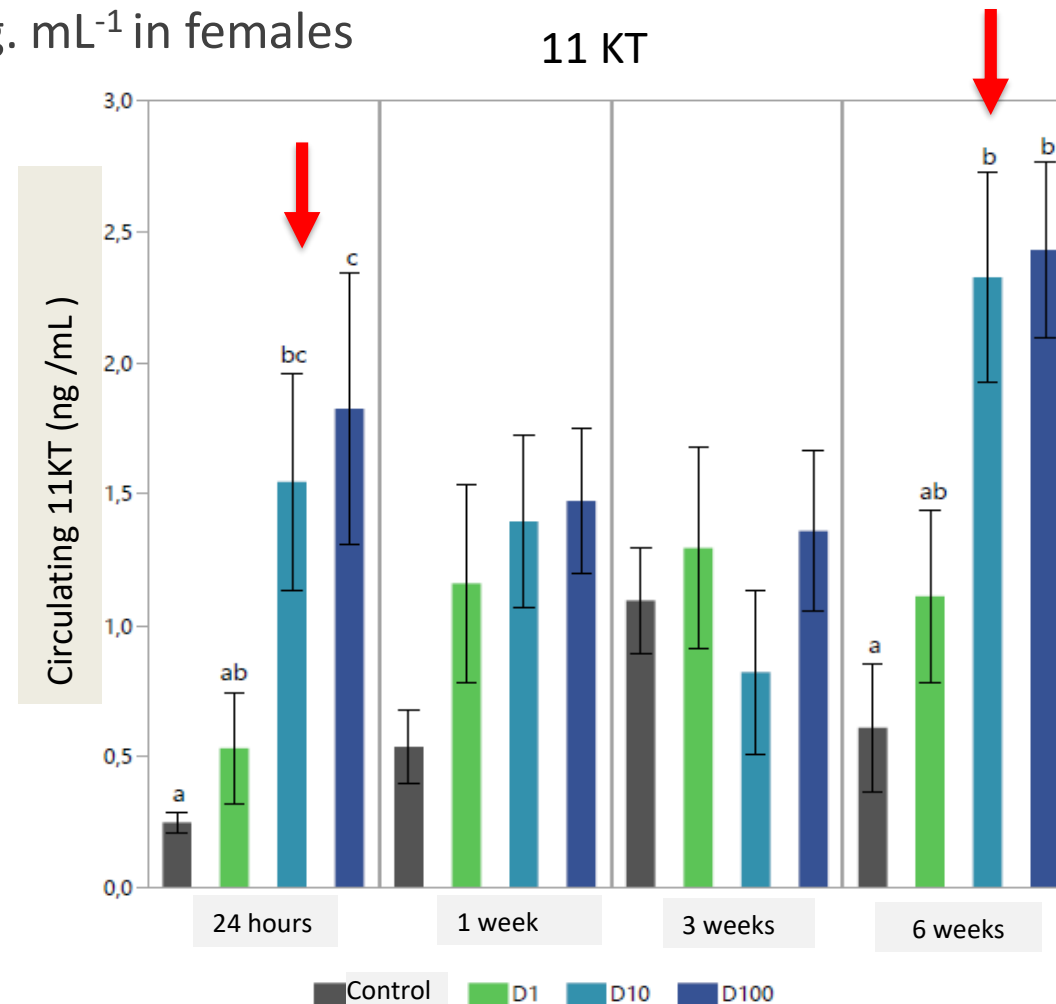


## ➤ Dehydroepiandrosterone (DHEA) synthesis

(Canton et al. 2006)

# Multi-biomarker approach

- Main androgen in fish
- Natural concentrations < 1ng. mL<sup>-1</sup> in females



- Stimulation of eggs production

(Le Bail et al. 1983, Kortner et al. 2009)

# Field caging experiment



Rainbow trout  
(*Oncorhynchus mykiss*)



Three spined stickleback  
(*Gasterosteus aculeatus* L.)



Zebra mussel (*Dreissena polymorpha*)



Gammarus (*Gammarus fossarum*)



Fontinalis moss (*Fontinalis antipyretica*)

# Field caging experiment



Upstream  
(control)

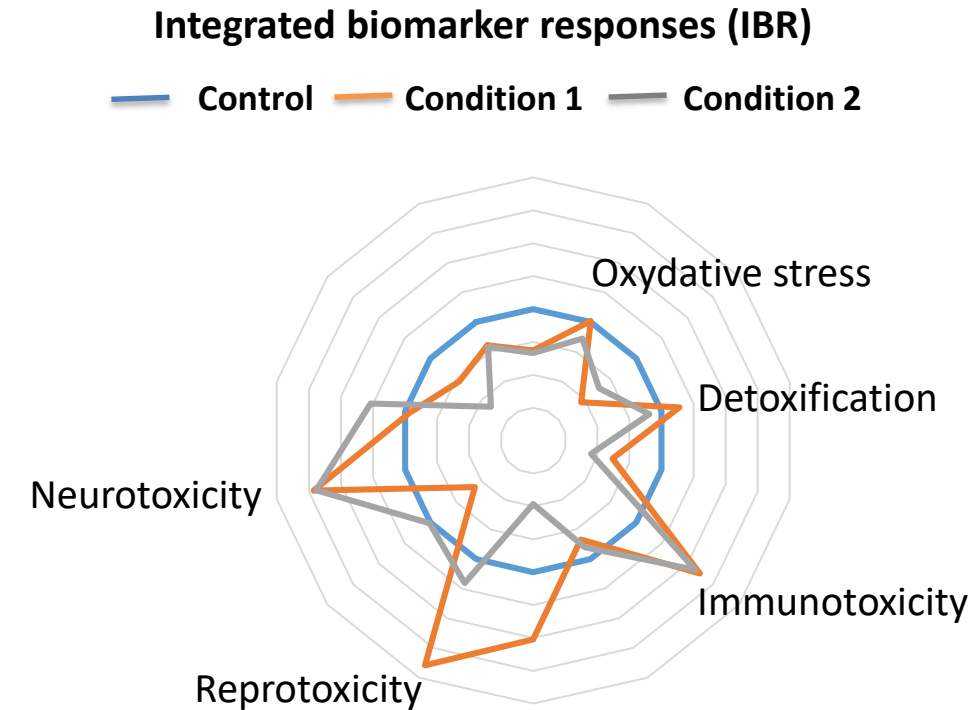


Downstream



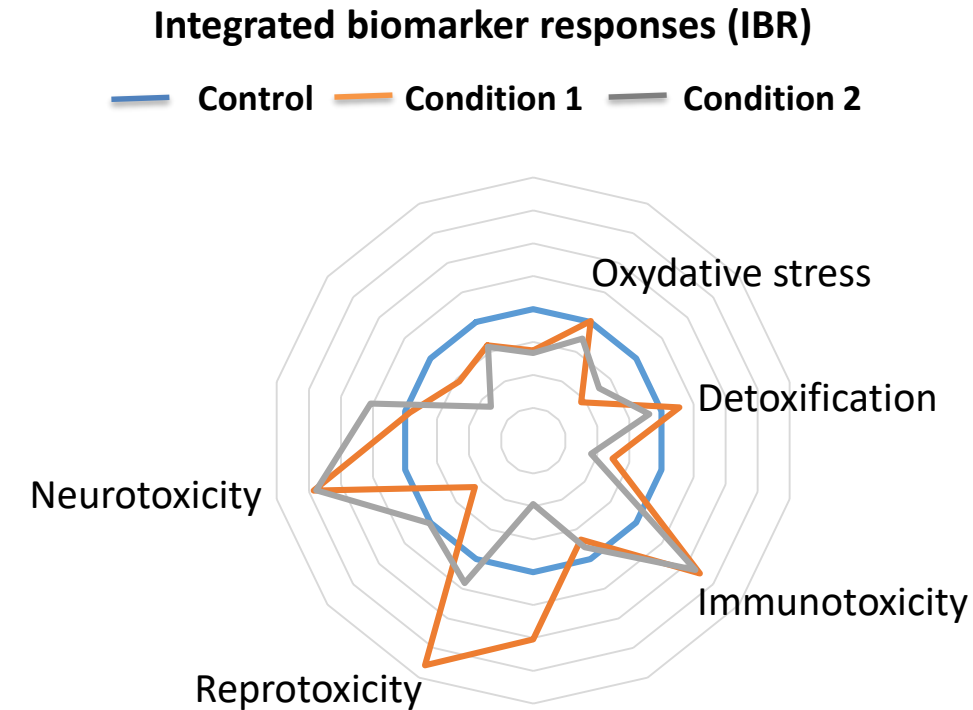
# Conclusion and prospects

- Pharmaceuticals can affect aquatic organisms
- Mixture effects  $\neq$  Individual compounds  
=> Lack of information on mixture
- Possible utilization of IBR



# Conclusion and prospects

- Pharmaceuticals can affect aquatic organisms
- Mixture effects  $><$  Individual compounds  
=> Lack of information on mixture
- Possible utilization of IBR
- Accuracy of laboratory mixture toxicity assessment
- Effects of seasonal variations and distance to the treatment plant



# Thank you for your attention !



# Links to video

Médicaments dans l'eau, une vie insoupçonnée.

<https://www.youtube.com/watch?v=TOwP7ijKGdA>

Le rejet de médicaments, un risque pour nos rivières ?

<https://www.youtube.com/watch?v=2x3yrf7HBTg>



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