Emerging chemicals in food packaging materials

- toxicological profiling of knowns and unknowns

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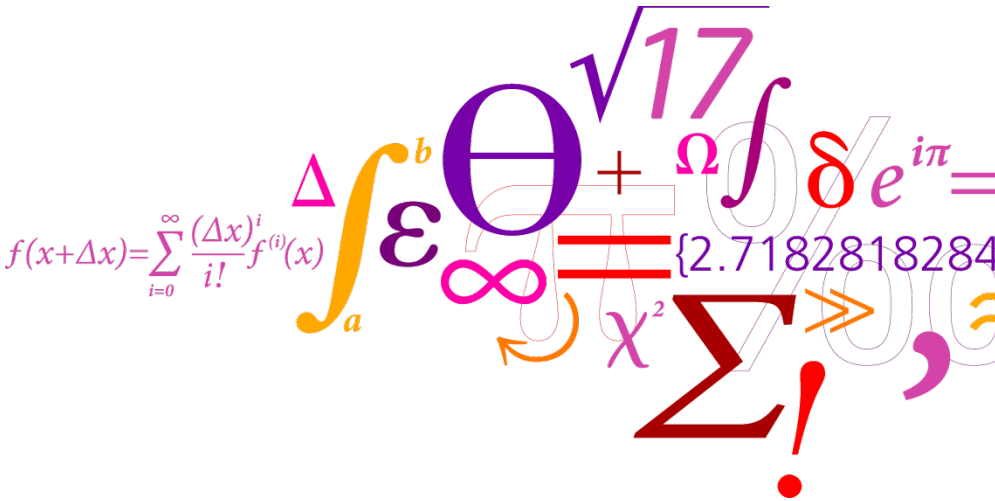
Technical University of Denmark

TED talk, Jan 18 2018



DTU Food
National Food Institute


EveryDay
SALT
Maggi
2 Minute Noodles


Weetabix
Purina
Bakers
Complete
Rabbit & Duck
flavour with vegetables
Capri-Sun
WALKERS
Friskies
CoCat
Mars
Twirl
DEEP & CRISPY
Cheese and onion flan
Chicken and mushroom flan
FIVE CHEESE & PEPPERONI
TGESTIVE

Toxicological profiling
in silico and in vitro

Known chemicals in food packaging with **unknown** effects

- *Bisphenol A analogues*
- *Fluorochemicals*

Unknowns in food packaging

Effect-directed analysis & analytical chemistry

BPA FREE!

Made with 100% BPS

A

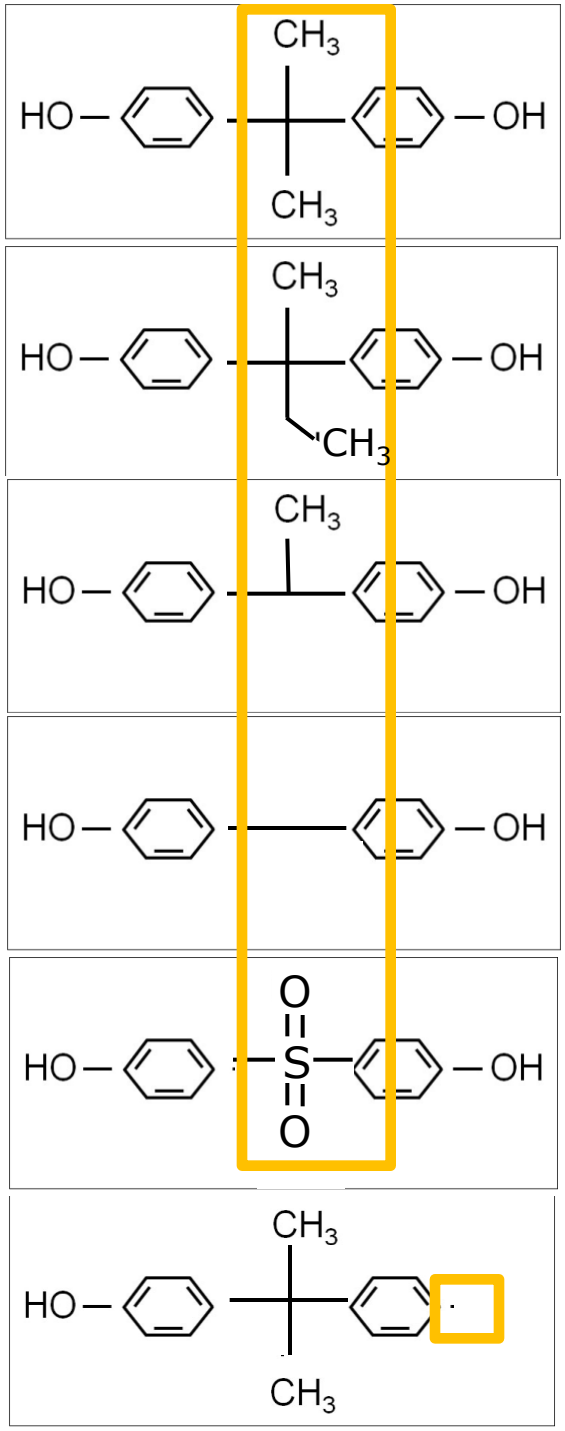
B

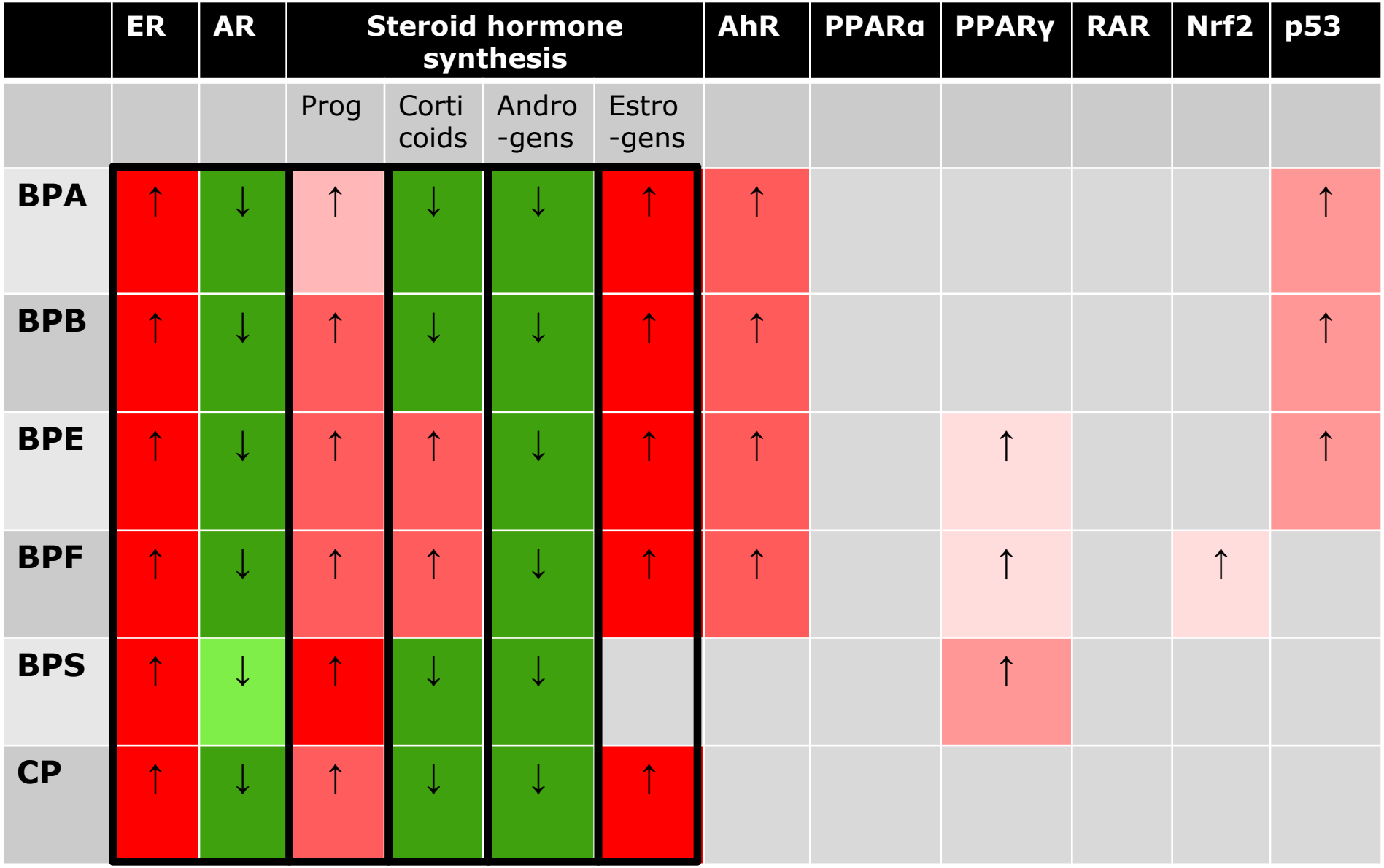
E

F

S

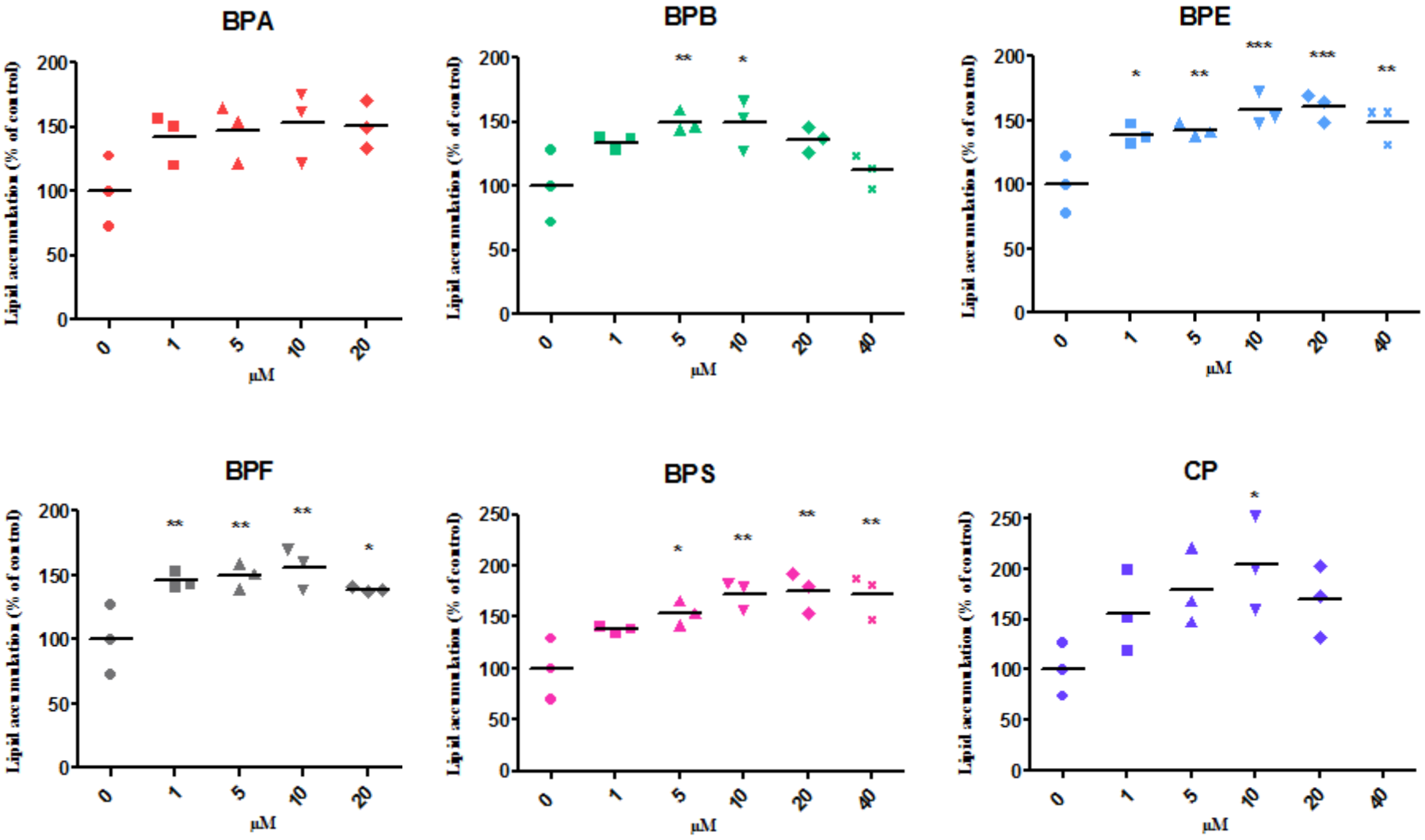
CP





Rosenmai et al. ToxSci 139, 35, 2014

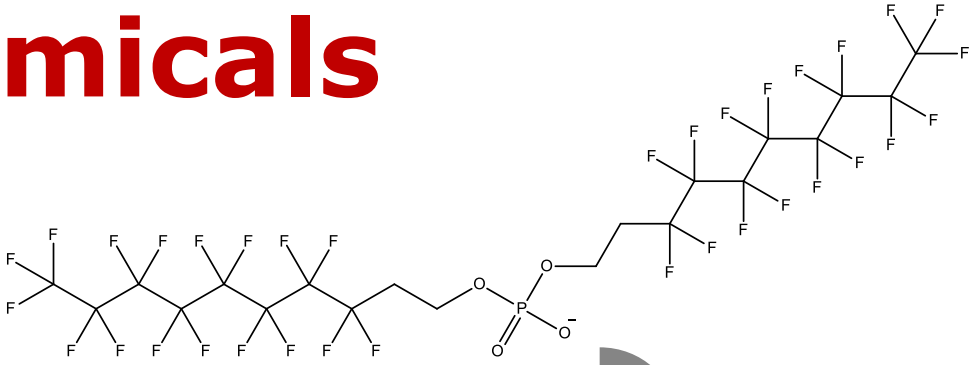
Bisphenols increase lipid accumulation in adipocyte



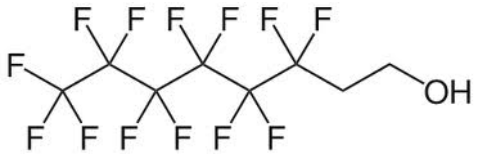
Ramskov-Andersen et al., *in prep*.

Fluorochemicals

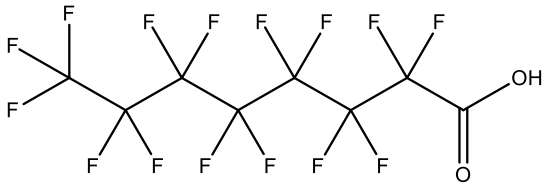
4 PAPs



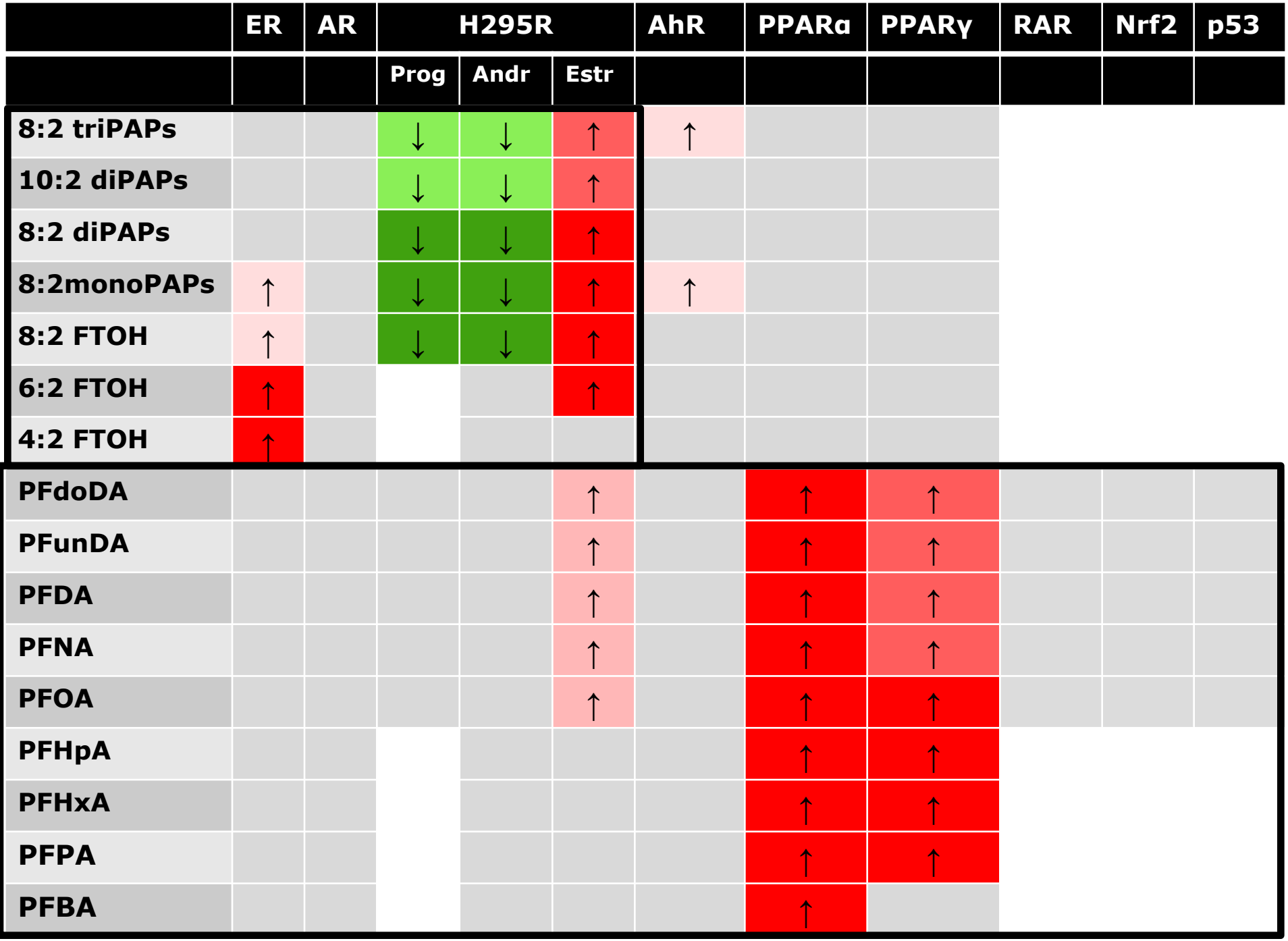
3 FTOHs



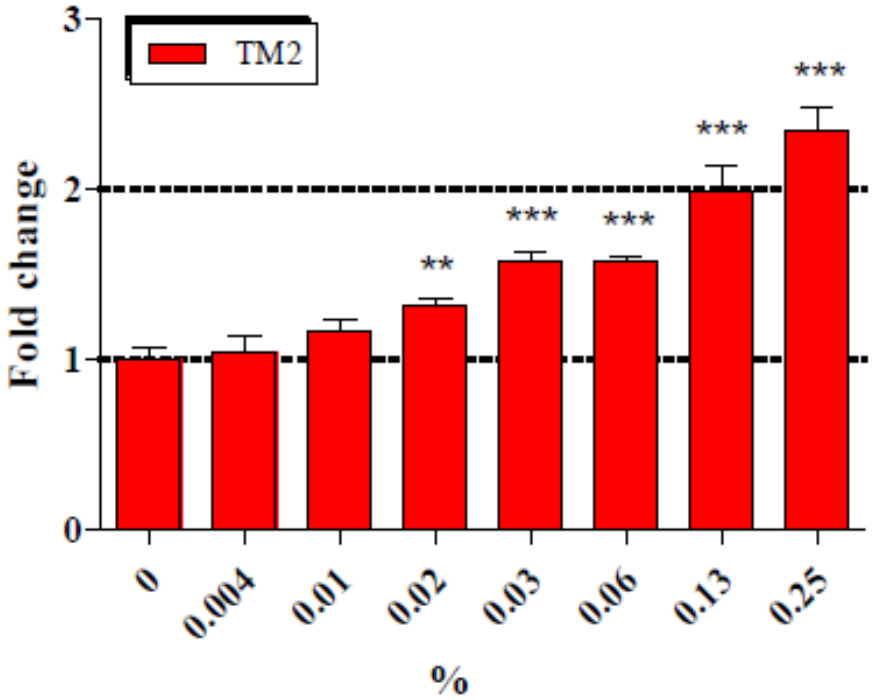
9 PFCAs



3 Technical mixtures


ER
AR
H295R
Prog
Andr
Estr
AhR
PPARα
PPARγ
RAR
Nrf2
p53
8:2 triPAPs
10:2 diPAPs
8:2 diPAPs
8:2monoPAPs
8:2 FTOH
6:2 FTOH
4:2 FTOH
PFdoDA
PFunDA
PFDA
PFNA
PFOA
PFHpA
PFHxA
PFPA
PFBA

	ER	AR	H295R			AhR	PPARα	PPARγ
			Prog	Andr	Estro			
Technical Mixture 1								
Technical Mixture 2	↑				↑			
Technical Mixture 3	↑							



Toxicological profiling
in silico and in vitro

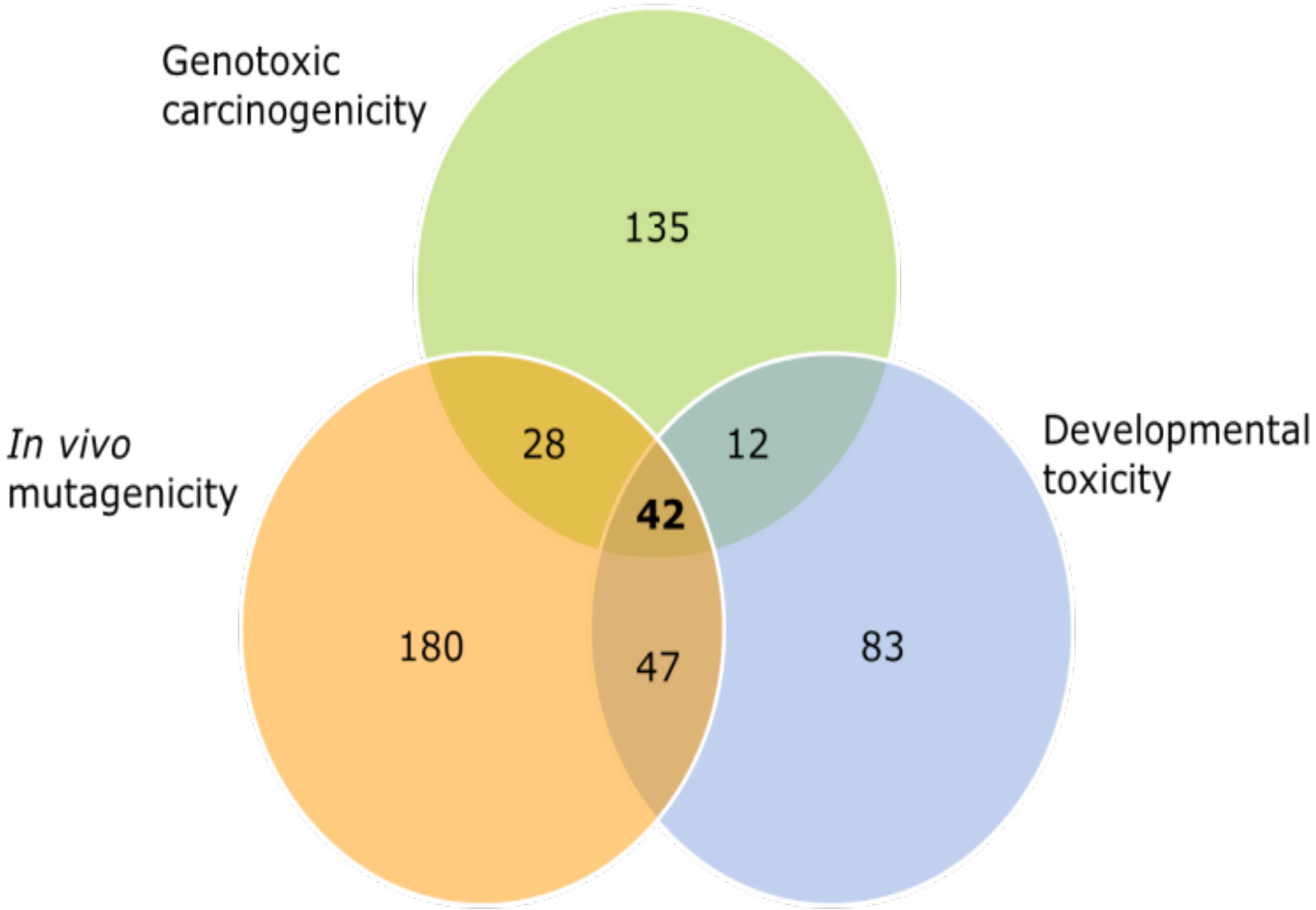
Known chemicals in food packaging with **unknown** effects

- *Bisphenol analogues*
- *Fluorochemicals*

Unknowns in food packaging

Effect-directed analysis & analytical chemistry

QSAR predictions for 2,076 substances used in food packaging



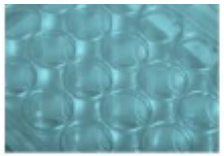
Food packaging test strategy

1

FP extraction

2

Effect-directed analysis



ASSAYS

ER

AR

AhR

GR

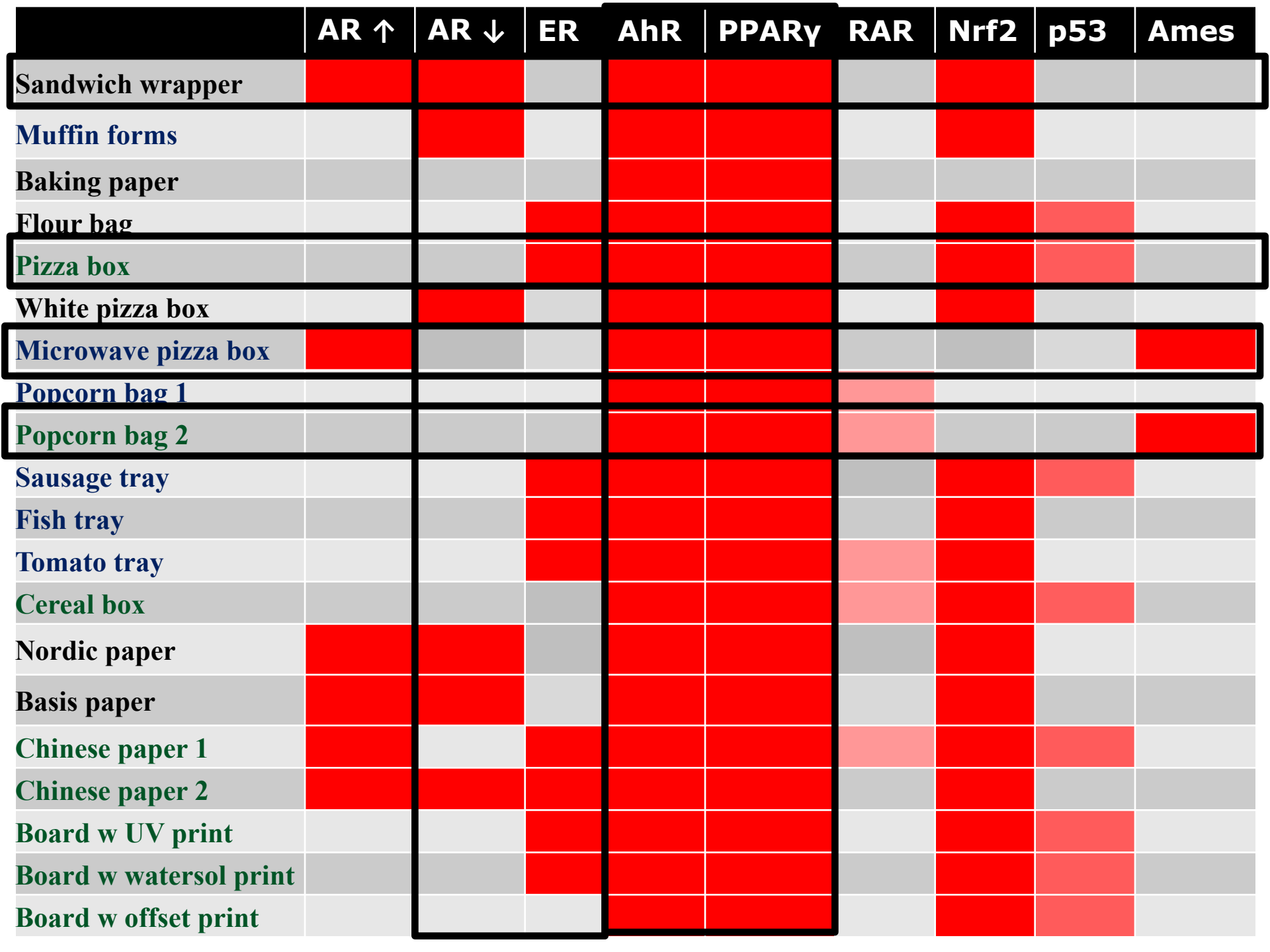
RAR

PPARγ

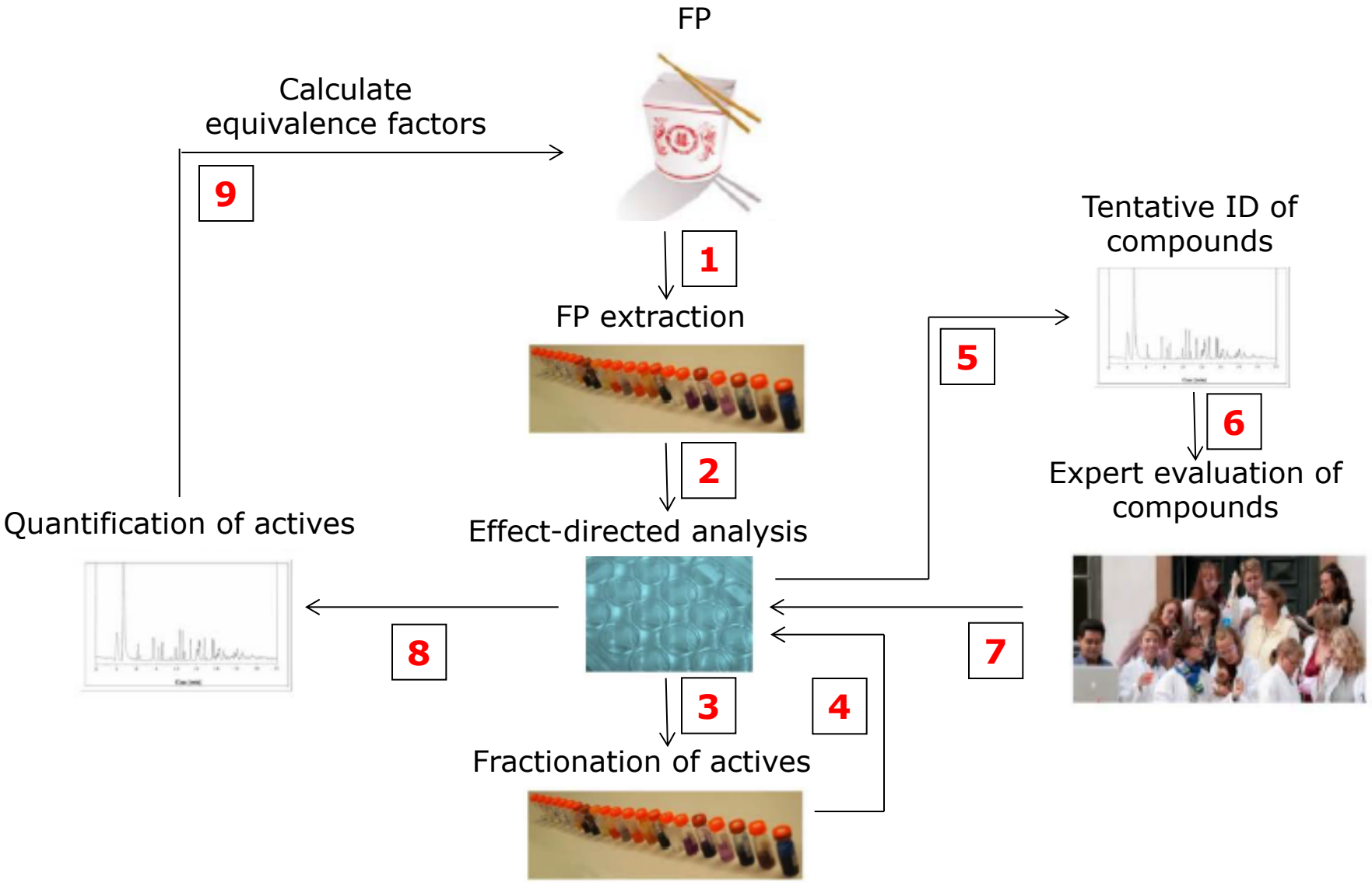
Nrf2

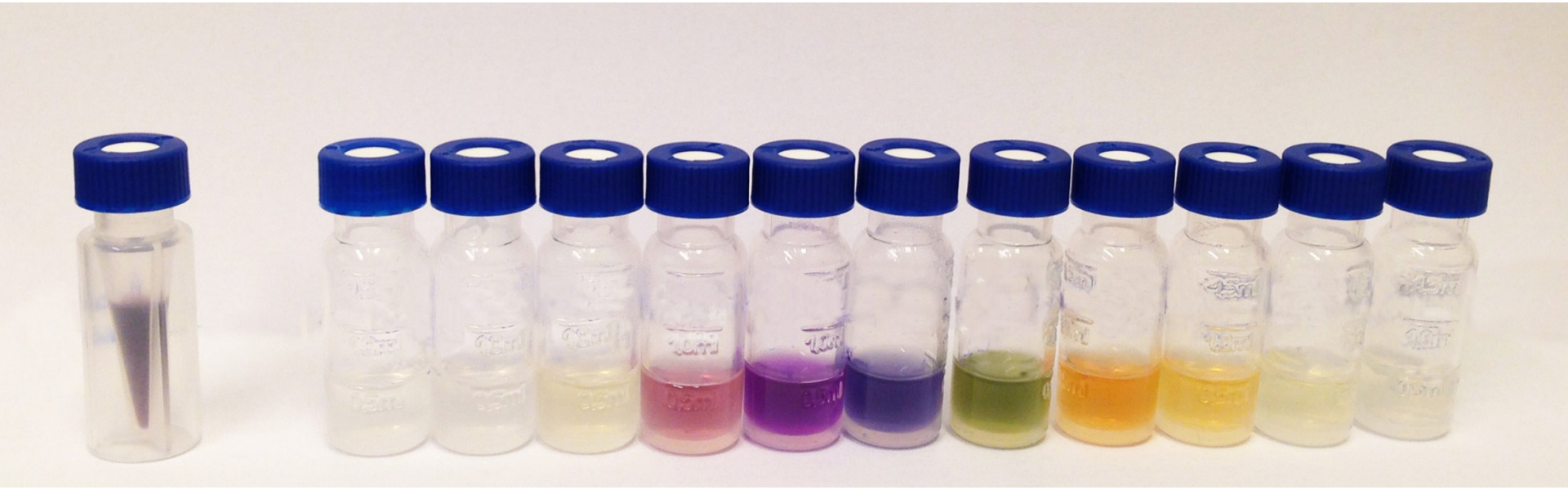
p53

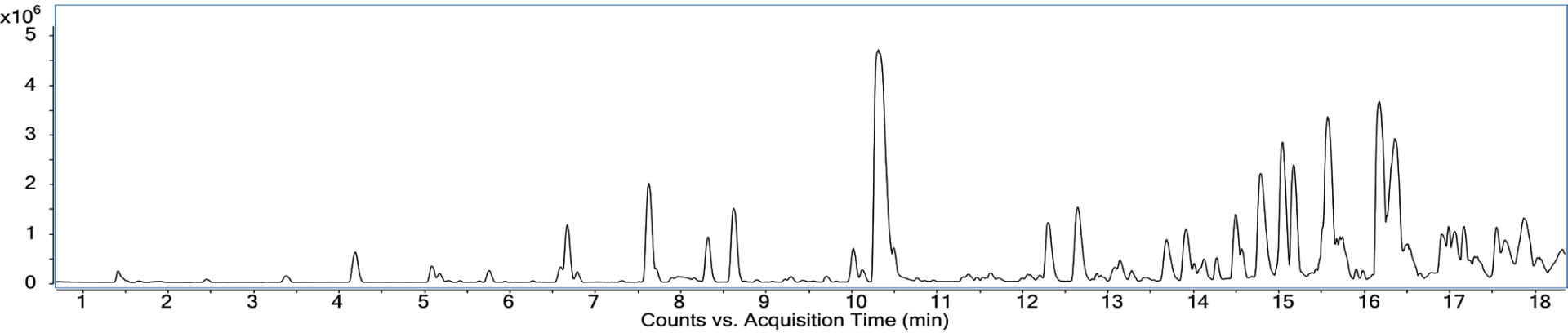
Ames


AR ↑
AR ↓
ER
AhR
PPARγ
RAR
Nrf2
p53
Ames
Sandwich wrapper
Muffin forms
Baking paper
Flour bag
Pizza box
White pizza box
Microwave pizza box
Popcorn bag 1
Popcorn bag 2
Sausage tray
Fish tray
Tomato tray
Cereal box
Nordic paper
Basis paper
Chinese paper 1
Chinese paper 2
Board w UV print
Board w watersol print
Board w offset print

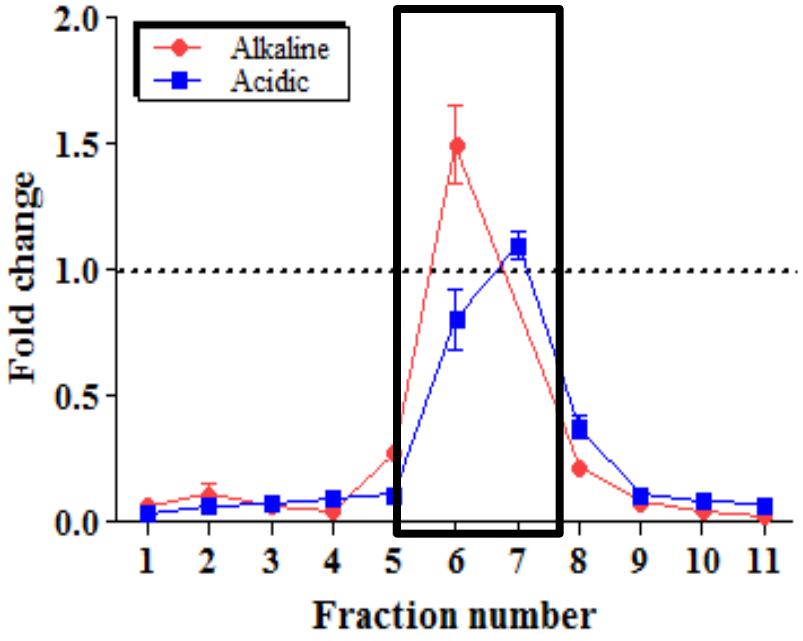
FP test strategy

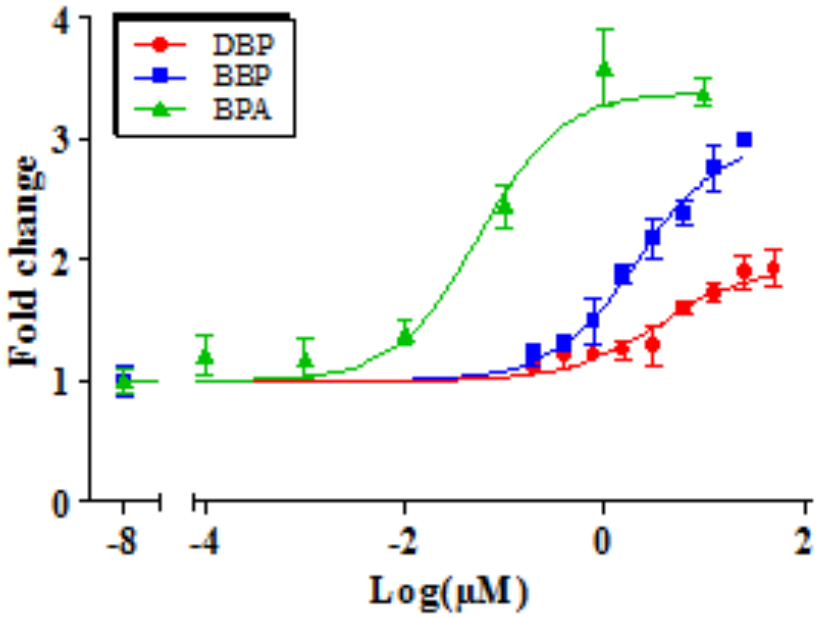





x10^6
5
4
3
2
1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Counts vs. Acquisition Time (min)

Estrogenic activity in pizza box

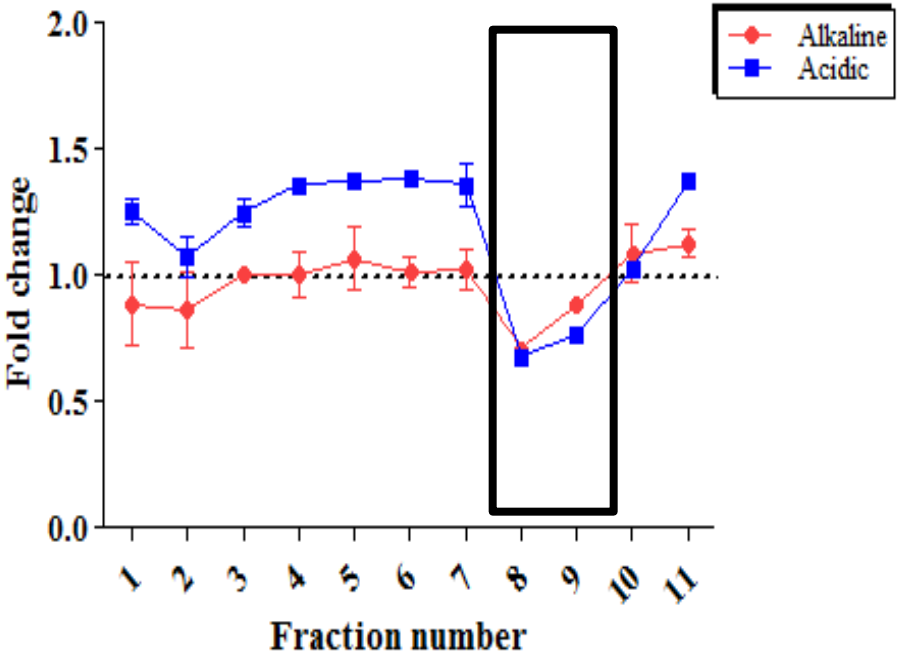


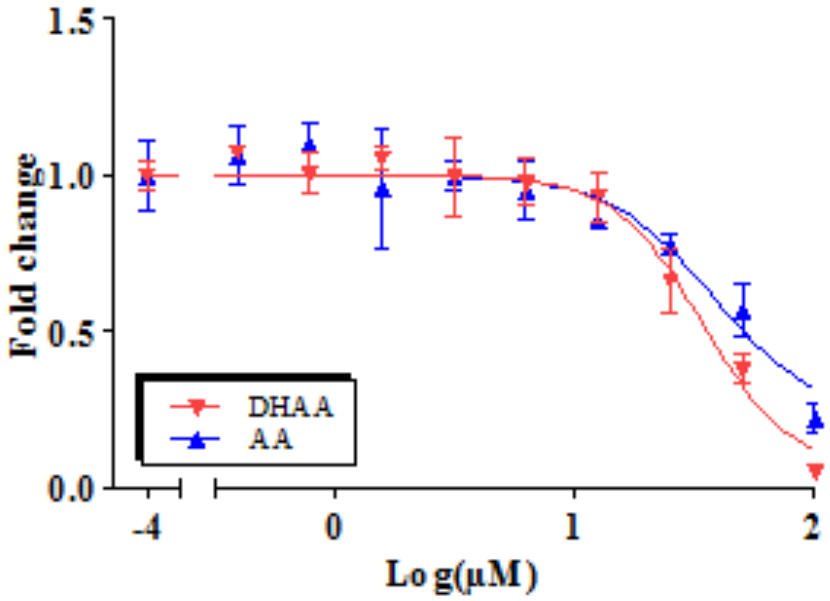


BPA, DBP & BBP responsible for estrogenic activity

BPA			DBP			BBP			EEQ	
Ex-tract µM	EC_{50} µM	EEQ	Extract µM	EC_{50}	EEQ	Extract µM	EC_{50}	EEQ	Predic-ted	Obser-ved
0.08	0.1	$1x10^{-5}$	0.19	3.6	$2x10^{-7}$	0.07	2.1	$2x10^{-7}$	$14x10^{-6}$	$2x10^{-6}$

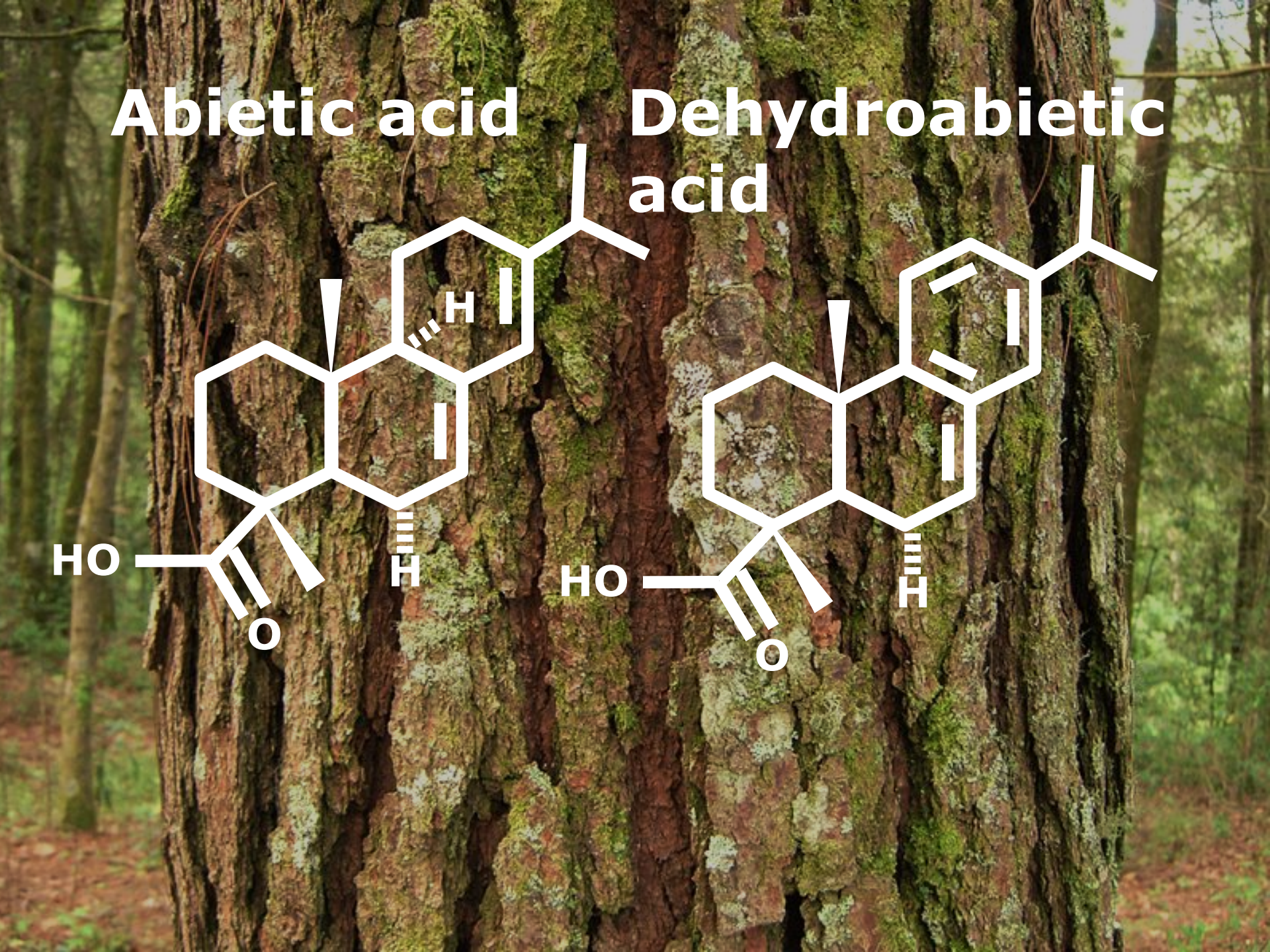
AR antagonistic activity in sandwich wrapper





Abietic acid & dehydroabietic acid responsible for activity

Abietic acid			Dehydroabietic acid			AAEQ	
Extract, µM	EC_{50} µM	AAEQ	Extract, µM	EC_{50}	AAEQ	Predic-ted	Obser-ved
485	38	$1x10^{-1}$	3.9	34	$2x10^{-4}$	$15x10^{-2}$	$9x10^{-2}$


Abietic acid
Dehydroabietic acid
HO
O
H
HO
O
H

Take home message

- More focus on FP is needed as it is a significant source of human exposure to EDCs, especially concerning the use of persistent compounds in FP
- A new paradigm is needed for risk assessing FPs
- Our FP strategy is effect-based covering ED, cyto- and genotoxicity, it's quantitative and valuable for identification of emerging chemicals
- AA and DHAA identified as AR antagonists in sandwich wrapper
- Alternative BPs have similar ED profile as BPA. Substitution of BPA with BP analogues should be reconsidered