Συσσωρευτική έκθεση σε χημικά και δημόσια υγεία. Μια νέα πρόκληση για τη βιομηχανία του 21ου αιώνα

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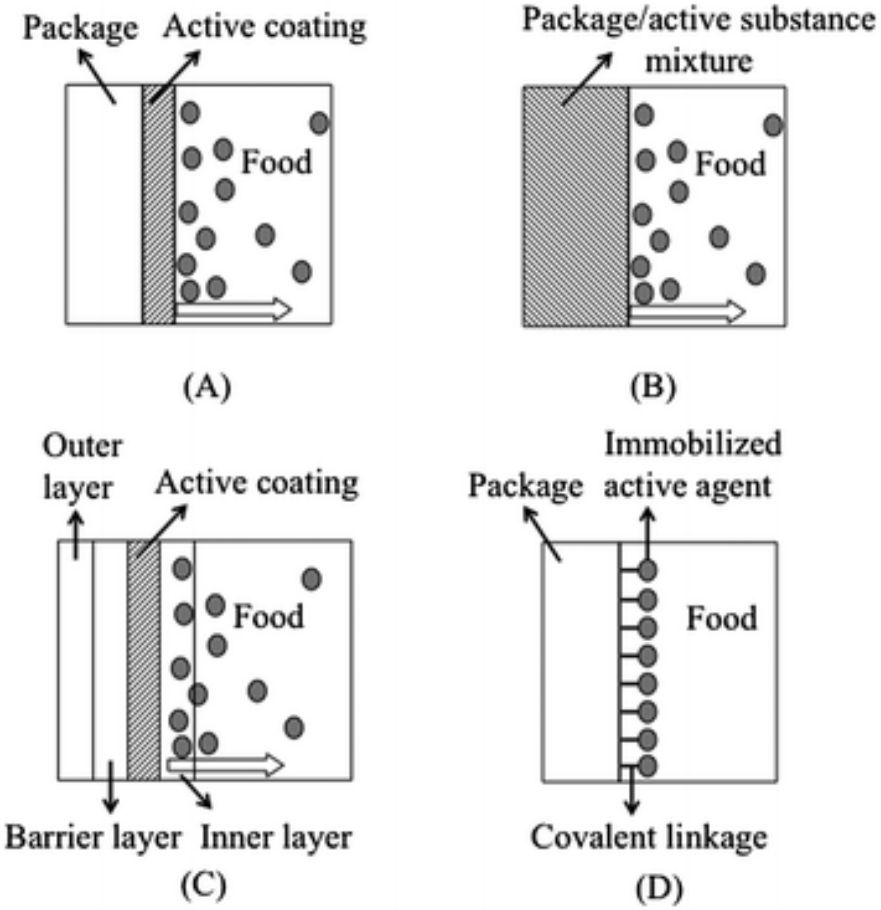
FCM

Types and regulation status

Regulated	Not regulated	Not regulated, high priority
Ceramics	Cork	Paper and Board
Regenerated Cellulose Film	Adhesives	Varnishes & Coatings
Active & Intelligent Materials	Silicones	Printing inks
Plastics	Elastomers & Rubbers	
Recycled Plastics	Glass	
	Metal & Alloys	
	Ion Exchange Resins	
	Wood	
	Textiles	
	Waxes	

What is migration



Migration is a diffusion and partitioning process depending on:

- The nature of the food contact material (FCM)
- The nature and concentration of the migrating substance
- The nature of the foodstuff
- The nature, the extent and the type of contact between the food contact material/article and the foodstuff

Factors affecting migration

- The mass transfer from an external source into food by sub-microscopic processes

- May impact food in two ways
  - Safety – migration of harmful substances
  - Quality – migration of substances which impart taint or odour

- Migration occurs from:
  - Food packaging
  - Materials and articles used in food manufacture, transport and storage
  - Materials and articles used in food preparation and consumption

Food simulants

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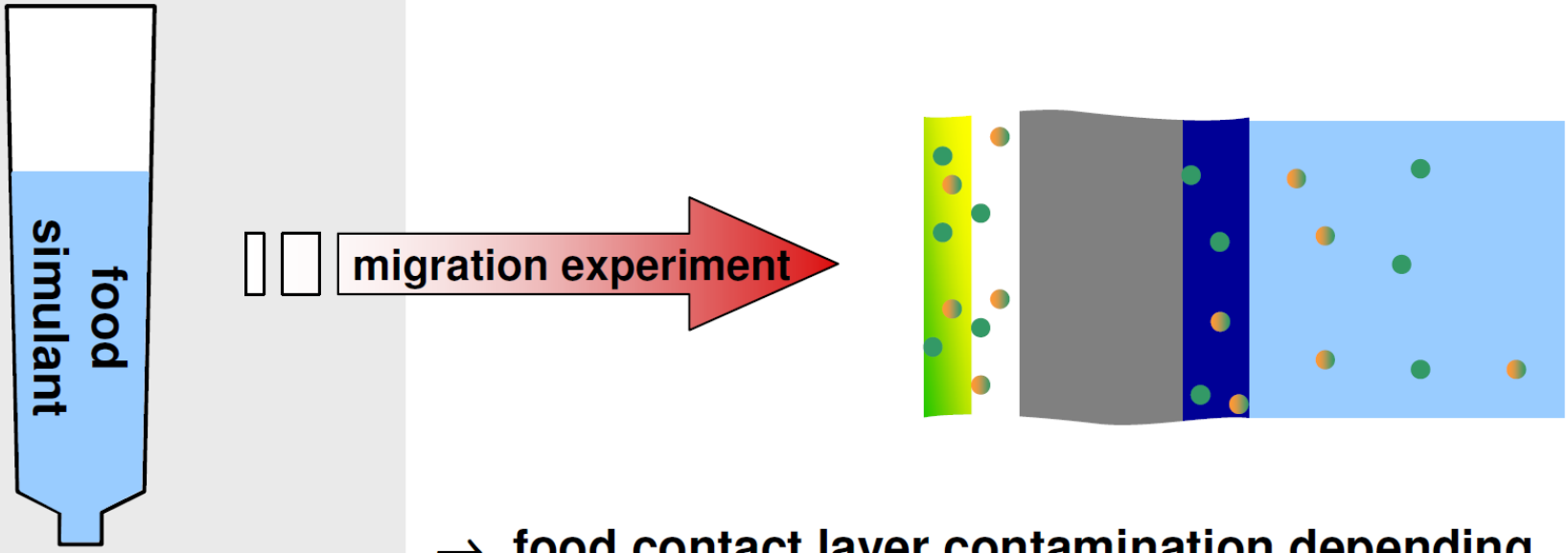
Migration assessment experimentally



→ food contact layer contamination depending on sample history

→ detectable migration of authorised and permitted substances

→ must comply with Article 3 of the framework regulation (EC) 1935/2004

Food simulants

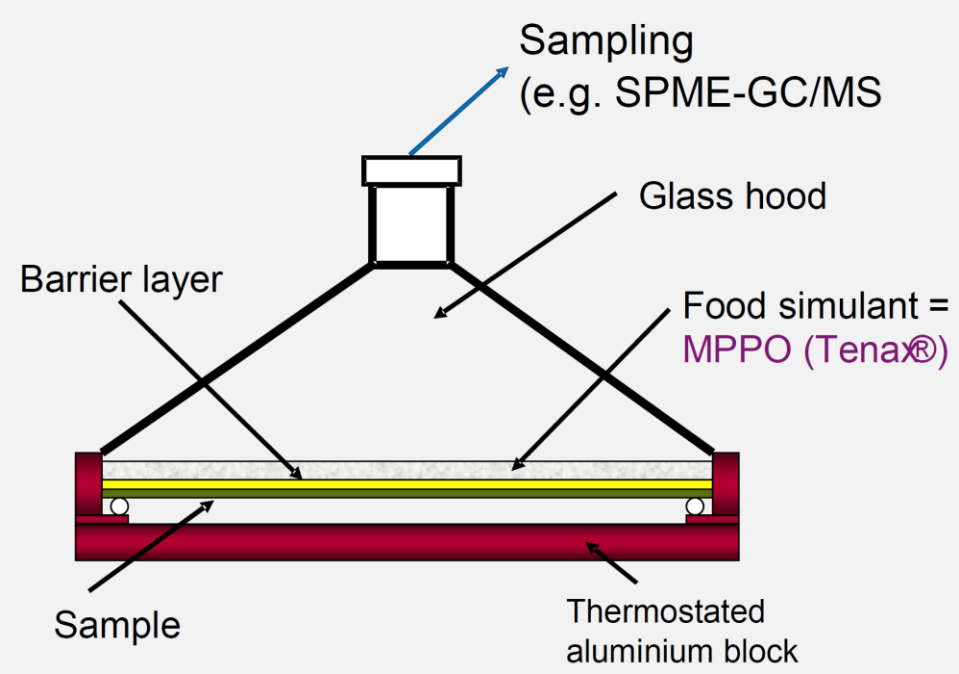
Migration assessment experimentally

Simulant	Abbreviation	Food type
Ethanol 10% (v/v)	Simulant A	Aqueous foods pH > 4,5
Acetic acid 3% (w/v)	Simulant B	Acidic foods pH ≤ 4,5
Ethanol 20% (v/v)	Simulant C	Alcoholic foods
Ethanol 50% (v/v)	Simulant D1	milk / milk products
Vegetable Oil	Simulant D2	Fatty foods
Modified polyphenylene oxides, particle size 60-80 mesh, pore size 200 nm	Simulant E	Dry foods

- Select simulant based on food type
- Select exposure type
- Select exposure conditions – time and temperature

Food simulants

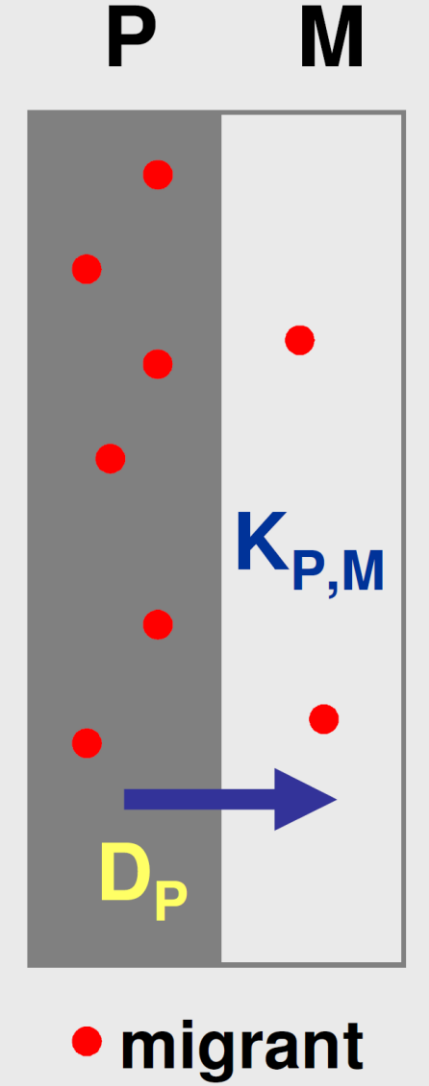
Migration assessment experimentally



- Formaldehyde and glyoxal in water extract
- Metals in water extract
- Pentachlorophenol (PCP)
- Polychlorinated biphenyls (PCBs)
- Diisopropylnaphthalens (DIPN)
- Michlers ketone and Bensophenone
- Monochlorpropanediol (MCPD)
- Dichloropropanol (DCP)
- Primary aromatic amines (PAA)
- MOSH/MOAH
- Bisphenol A
- Phthalates and adipates
- Terephthalic acid
- Irganox
- BADGE
- BHT
- Vinylacetate

Migration modeling

Migration assessment computationally



Fick's 2nd law of diffusion (one dimensional):

$$\frac{\partial C}{\partial t} = D_p \frac{\partial^2 C}{\partial x^2}$$

c - concentration
t - time
x - distance
D - diffusion coefficient

P - polymeric material
M - contacting medium

The Future is Now

Concept, methods and applications

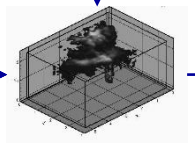
Connectivity

workflow for exposome studies

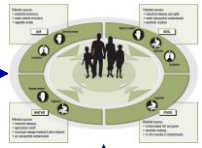
Environmental sensors

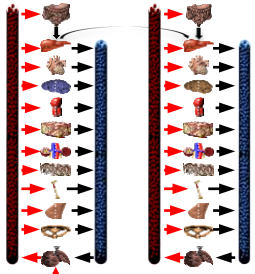
Remote sensing

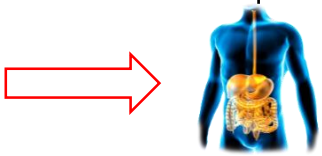
Exposure modelling



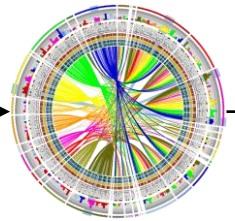
Environmental modeling / data management







Systems Effects / Individual exposome



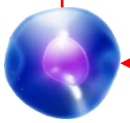
EWAS

Community Effects / Cohorts

Environmental analysis

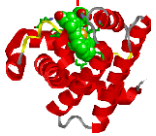
Human biosampling

Epigenetics

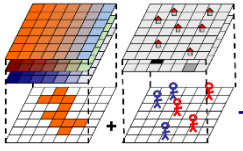


Cellular/tissue effects

Genetic polymorphisms

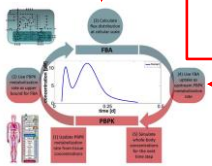


Molecular initiating events

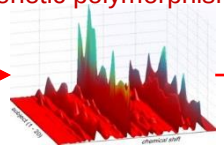


Agent based modelling

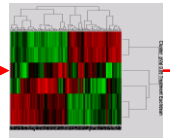
Ubiquitous personal sensors



Fluxomics (dynamic flux balance analysis)

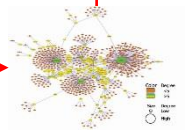


Metabolomics



Transcriptomics

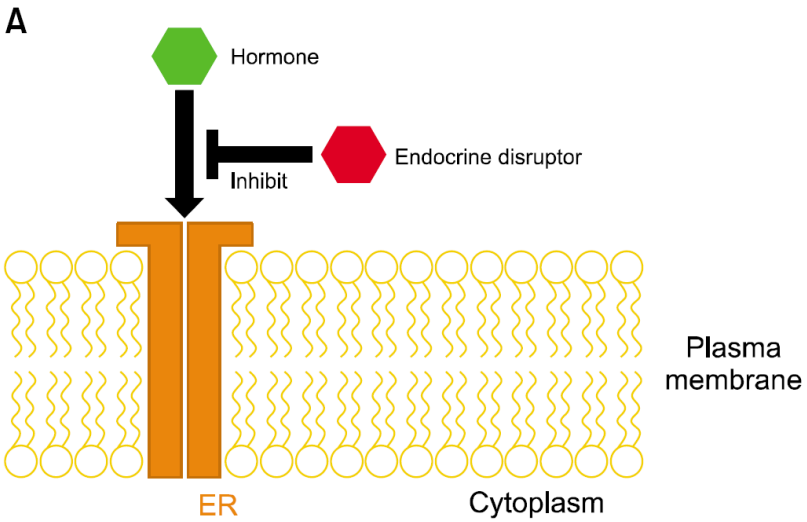
Bioinformatics / systems biology

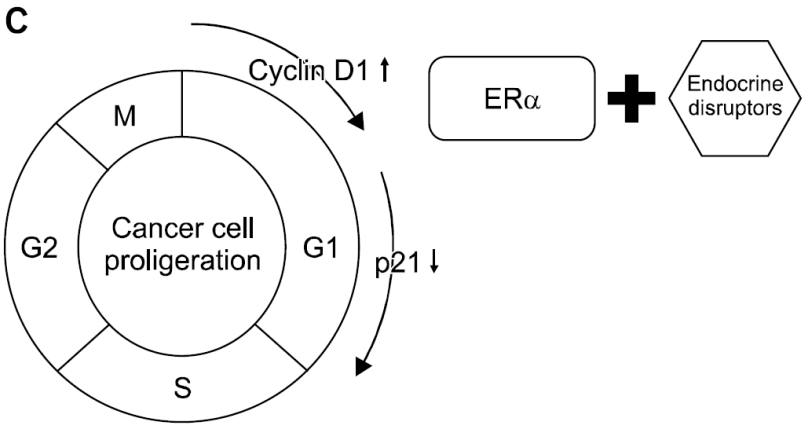


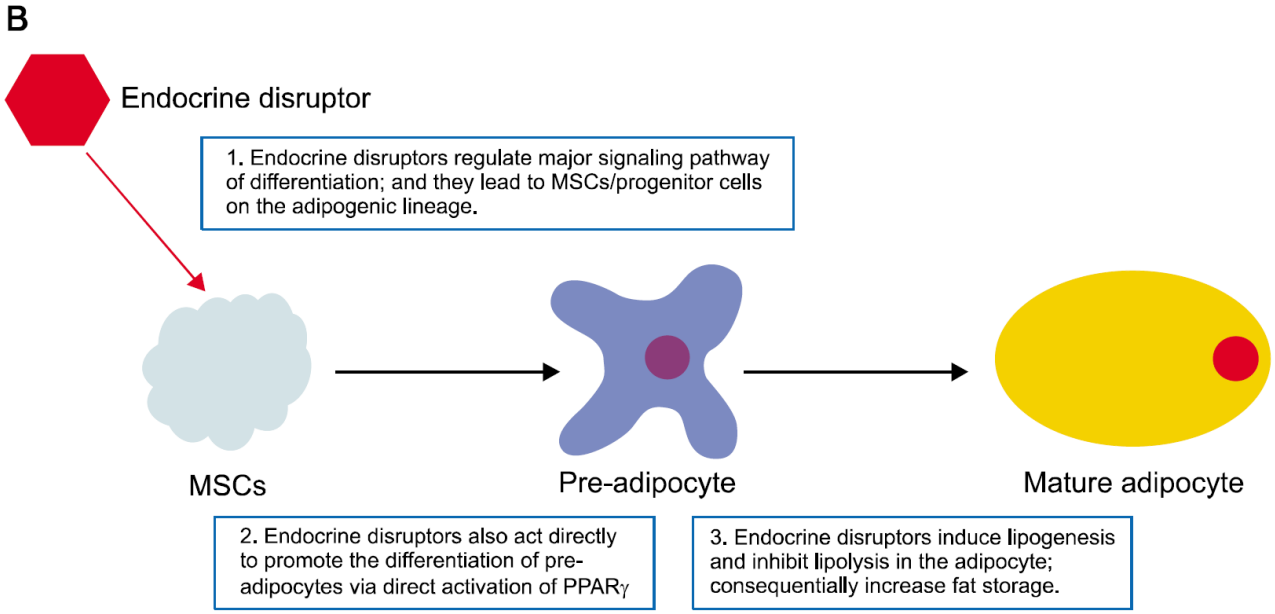
Pathway analysis

EDCs from FCM

Cancer effects

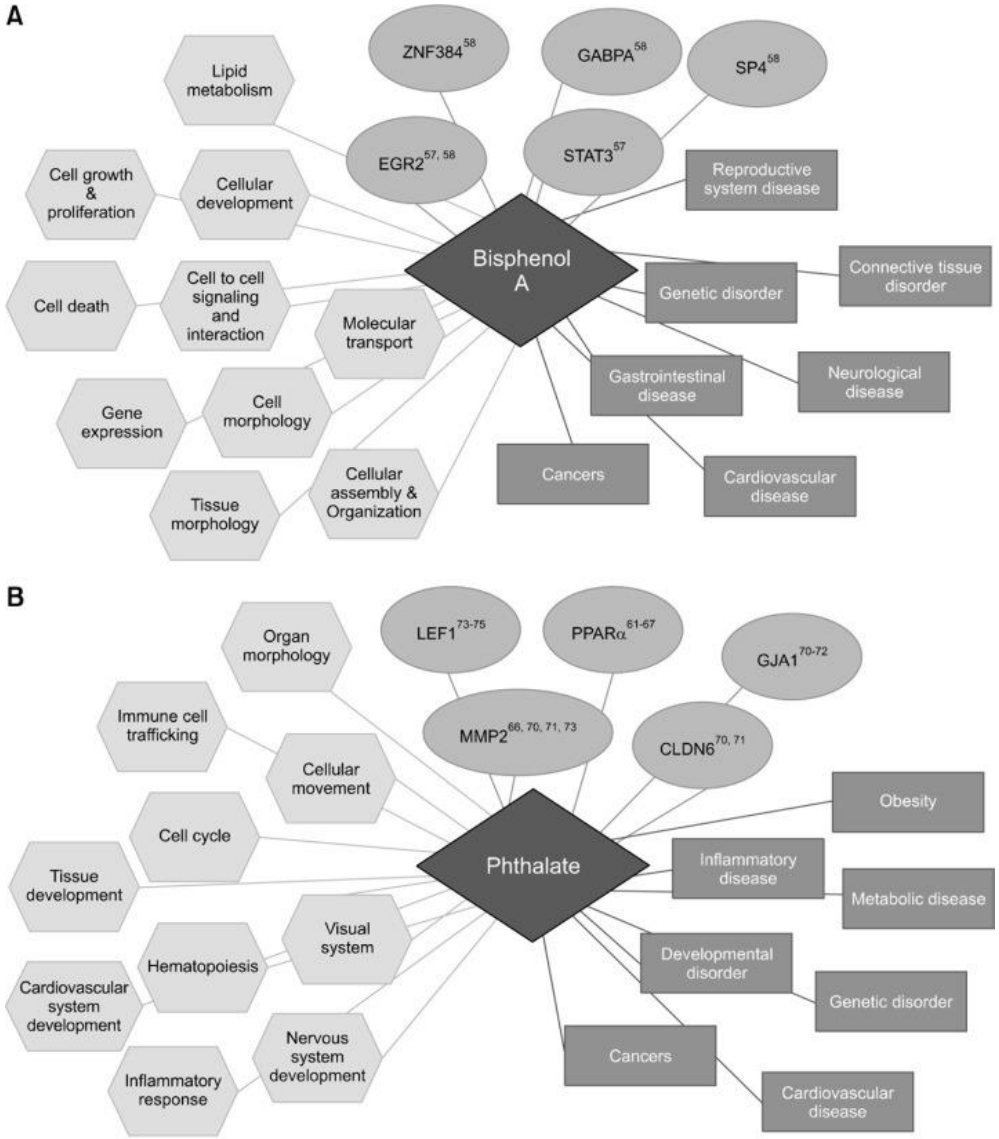






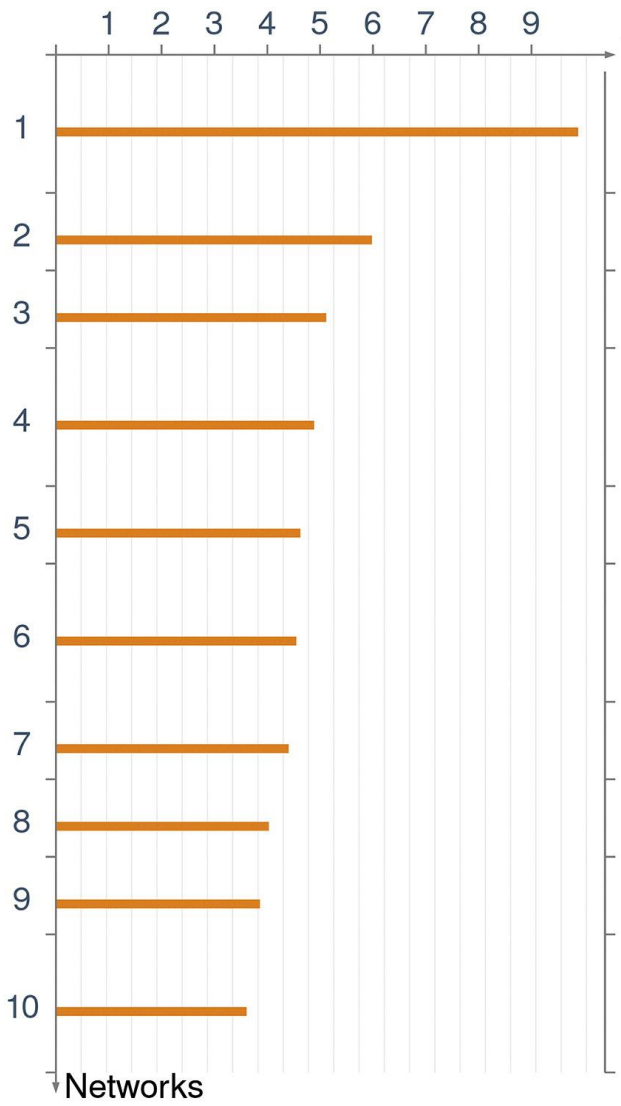
BPA and PAEs

molecular/cellular process and disease/disorder



BPA and PAEs

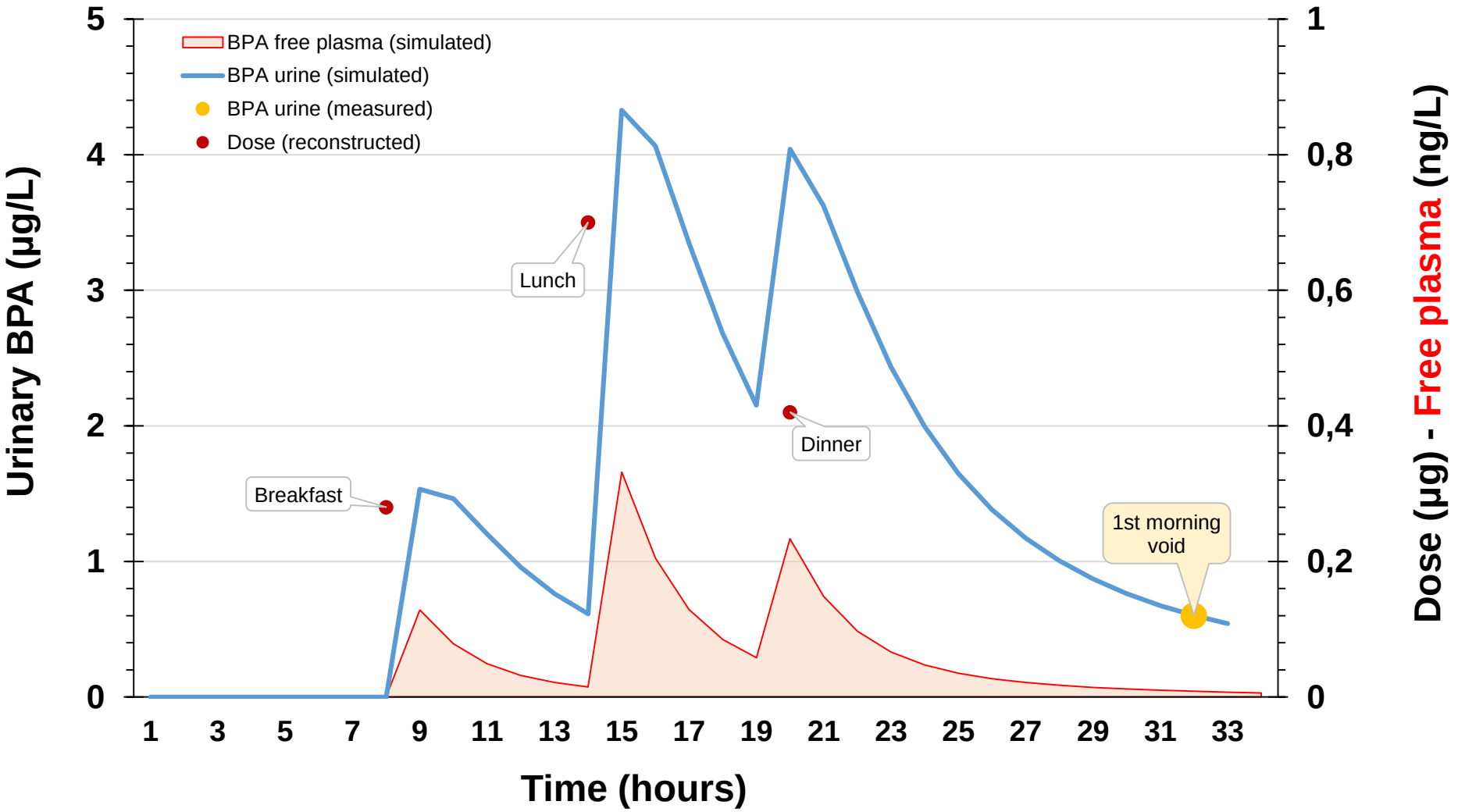
common genes/proteins



1. Inflammation_IL-6 signaling through gp130
2. Inflammation_MAPK signaling
3. Apoptosis_MAPK cascade (MAPK9)
4. Metabolism_CYP's and Fanconi anemia group proteins
5. Inflammation_IL-1 alpha signaling
6. Inflammation_IL-1 signaling, AP-1, NF-kB regulation
7. Chemotaxis_LBP signaling
8. Oxidative stress_HNF4 regulation
9. Chemotaxis_Ceruloplasmin
10. Inflammation_IL-1 beta, IL-1 alpha signaling, AP-1, NF-kB regulation

FCM EDCs exposure

BPA from spot samples



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FCM EDCs exposure

HBM4EU - biomonitoring platform

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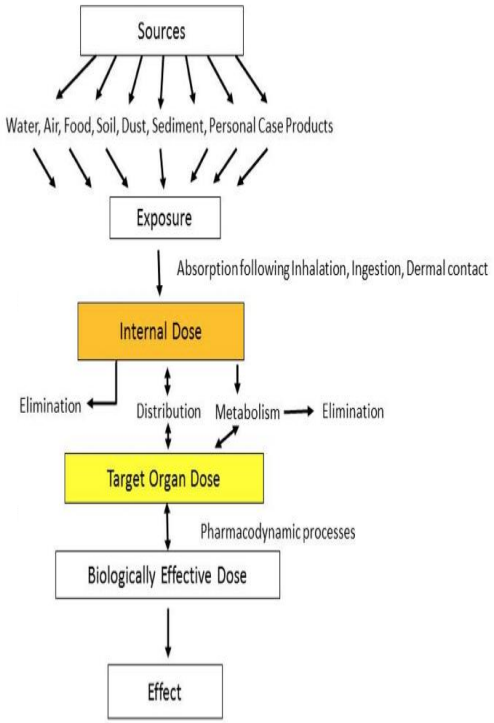
HBM4EU partners



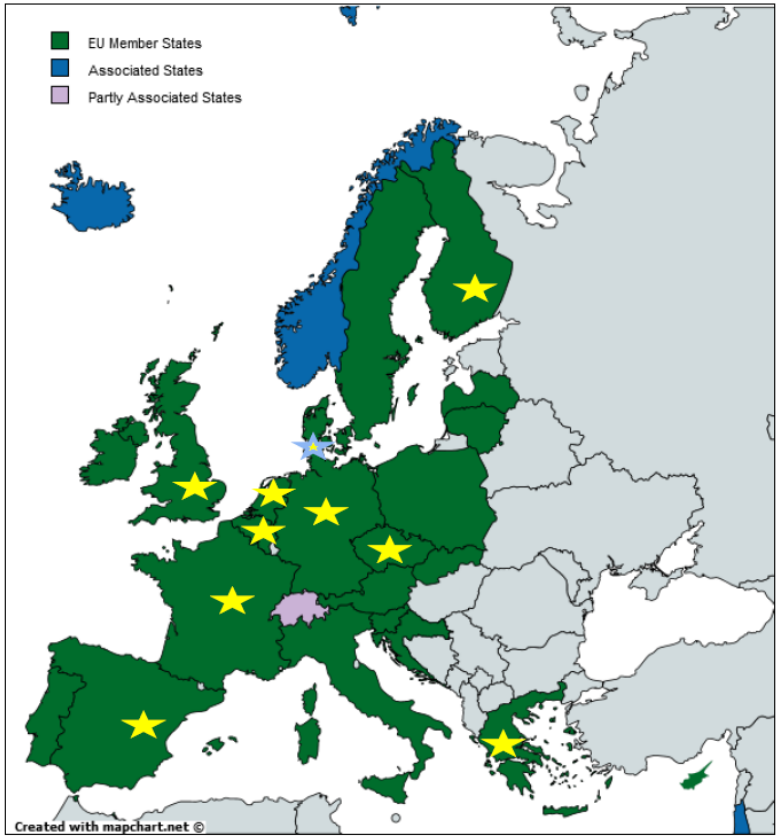
22 EU Member States
3 Associated States
1 Partly Associated State

(3 candidates to join in later)

109 Partners
41 Participants

Financial volume: ~ 73 M €

★ Management Board Member



HBM4EU science and policy for a healthy future

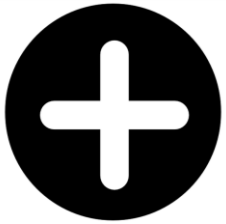
Omics and pathway analysis for real-life mixtures

Exposome analysis starting from biomonitoring data

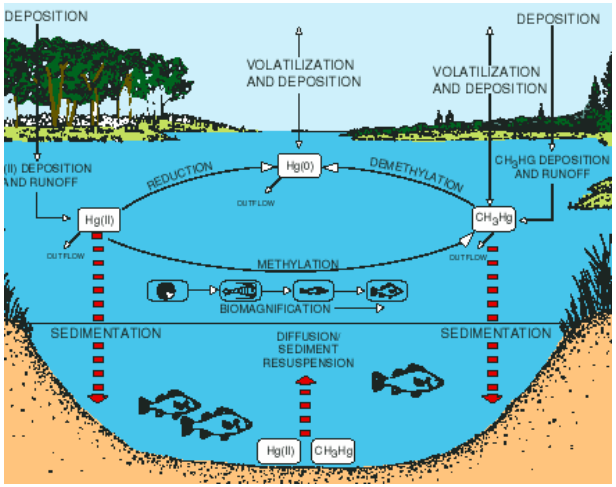
Real-life mixture

Phthalates and mercury

Plasticizer



Plasticizer & mercury



Mercury

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Real-life mixture

Phthalates and mercury

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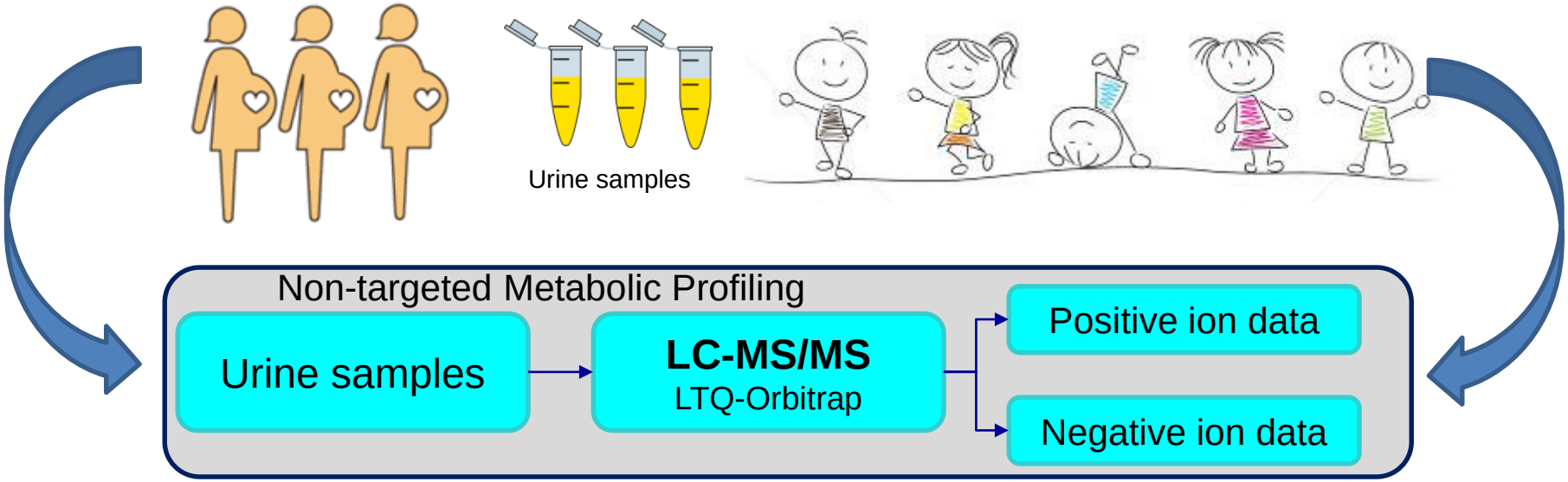
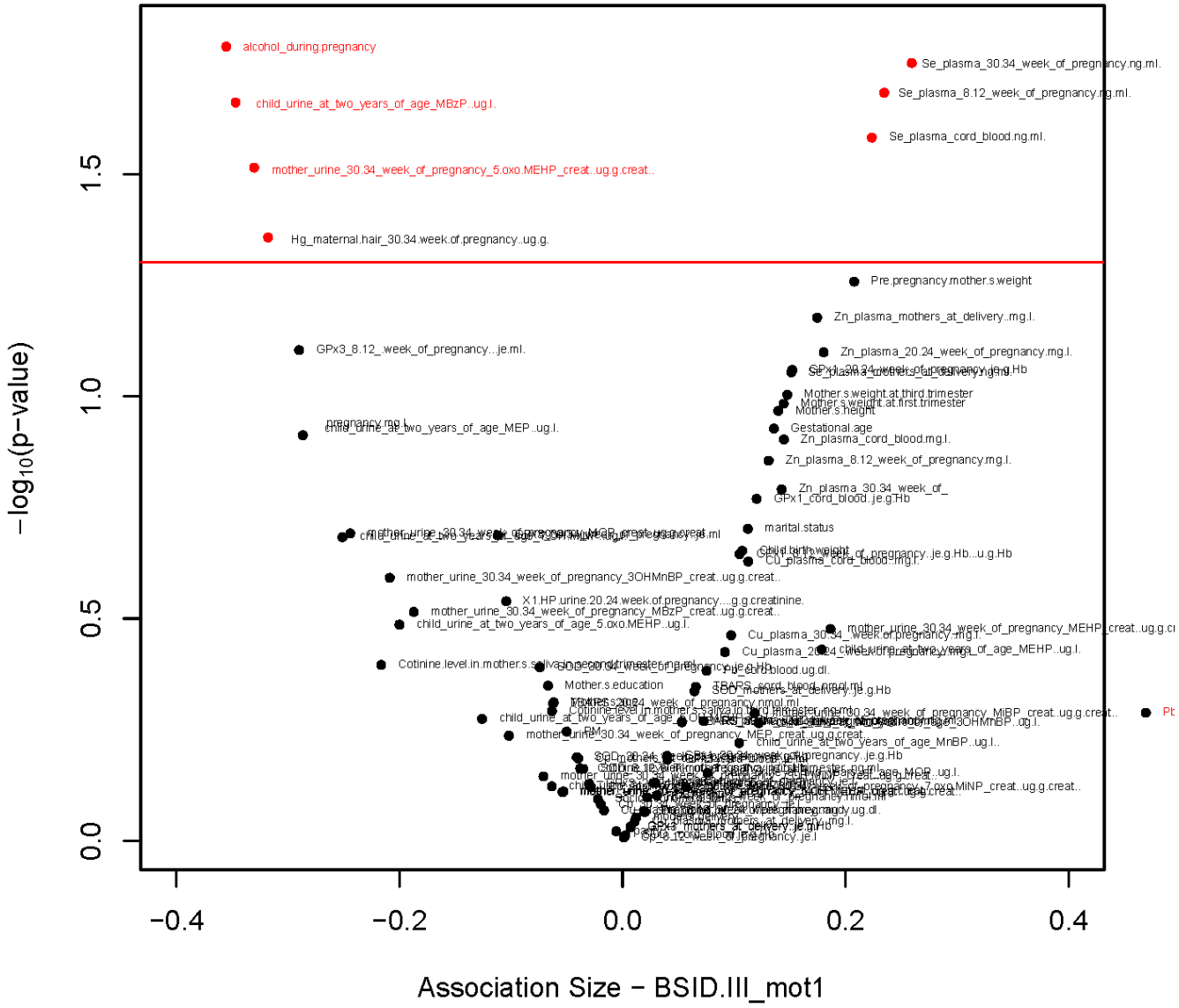
- **Urine** and **cord blood** samples of pregnant women exposed to FCM and environmental contaminants (phthalates and Hg)
  - Urinary concentrations of phthalates
  - Hair Hg
- LC MS/MS (Thermo Orbitrap) for metabolites identification
- EWAS analysis
- Agilent Genespring / Mass Profiler Pro for pathway identification



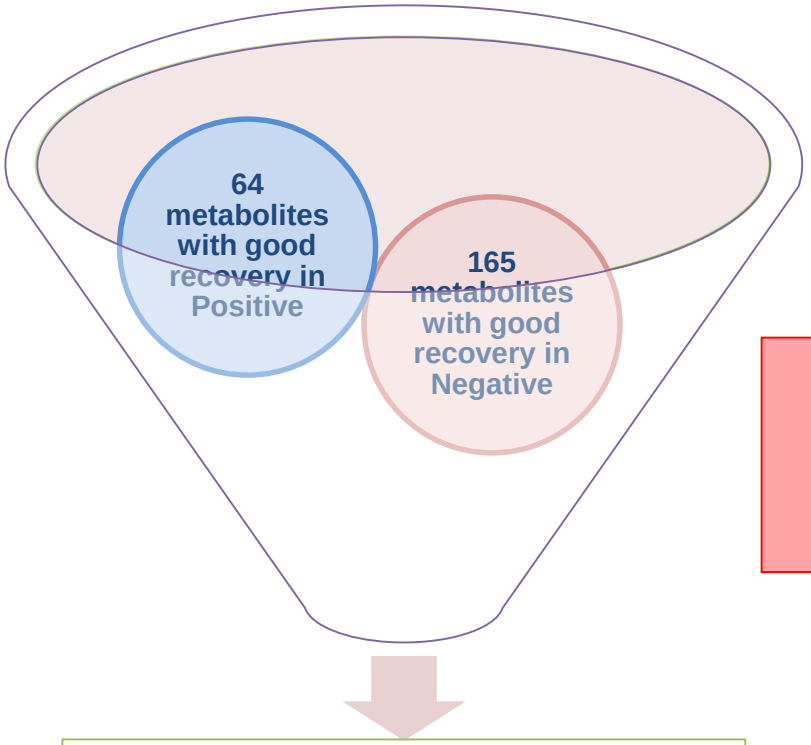
Real-life mixture

EWAS – motor development

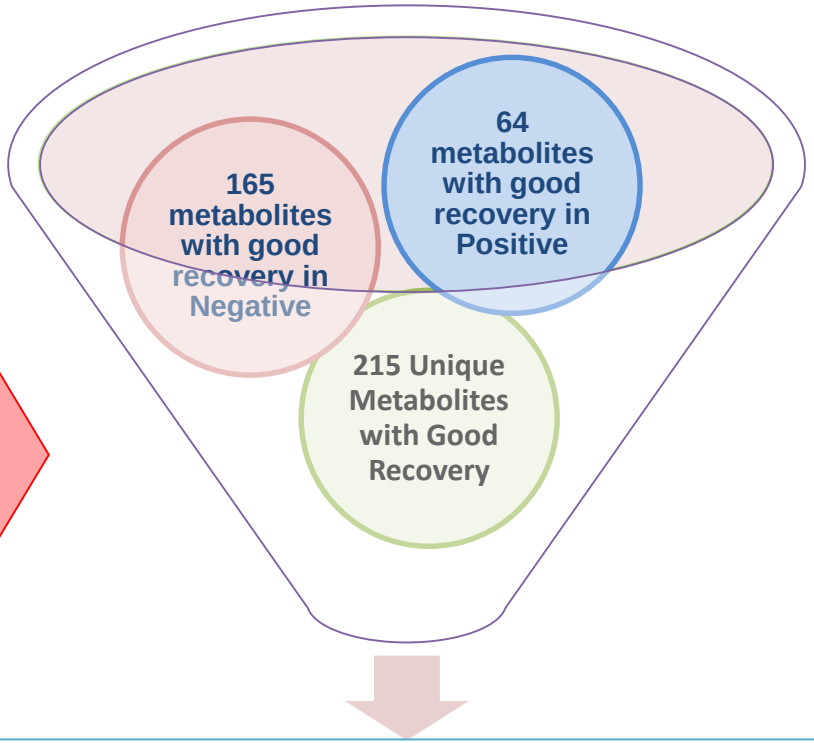


Real-life mixture

Metabolite identification



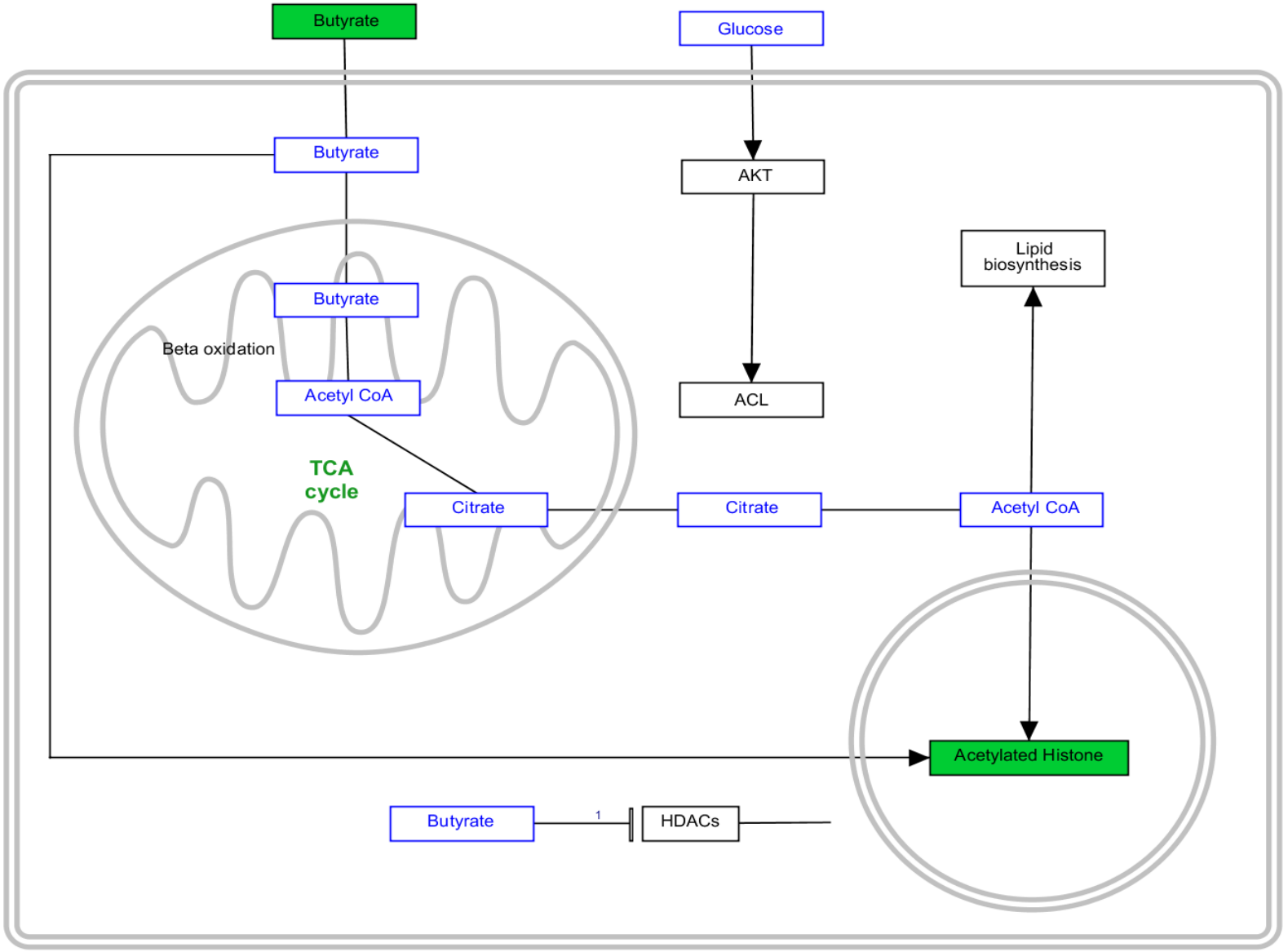
215 Unique Metabolites with Good Recovery



31 Unique Metabolites with Good Recovery and RSD ≥ 300%

Real-life mixture

Pathway identification - phthalates



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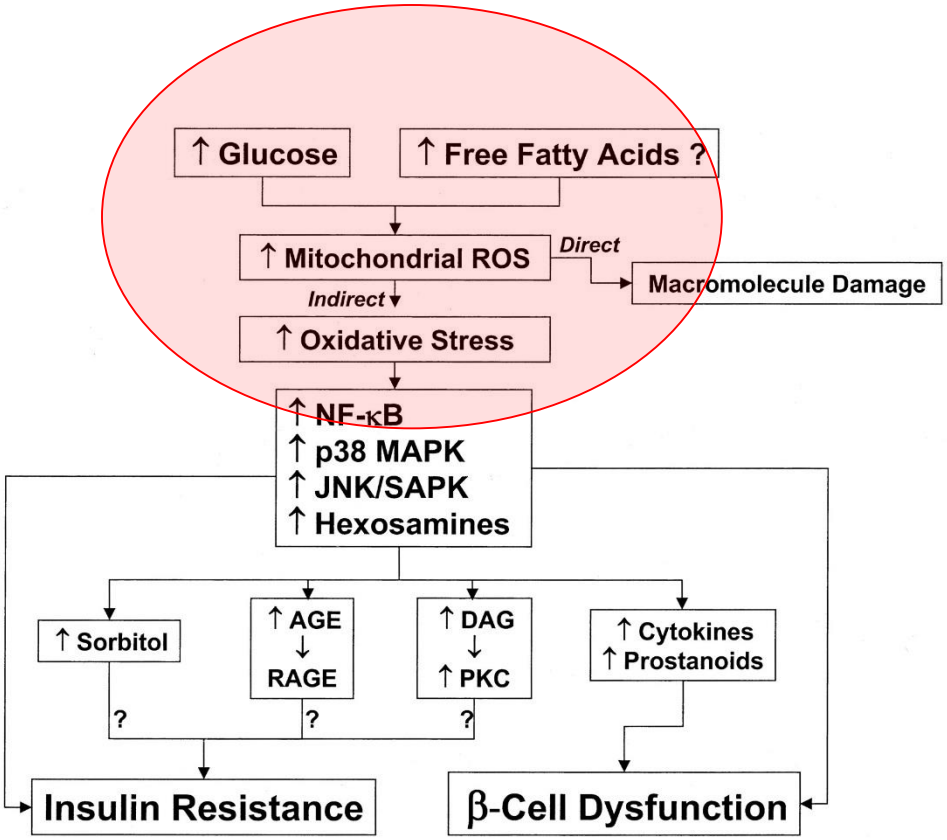
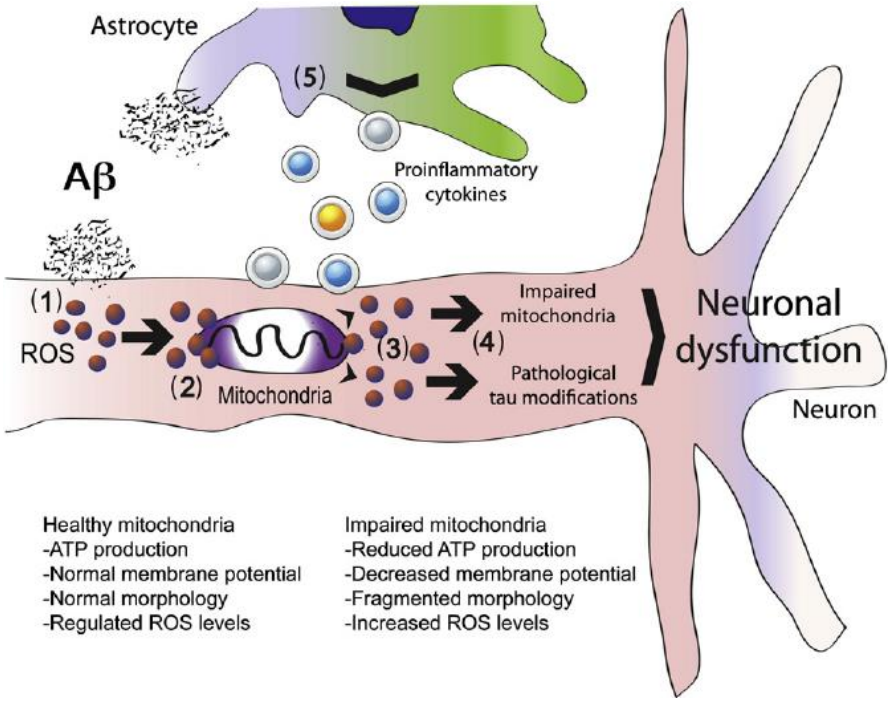
Real-life mixture

Pathway identification – Hg





Conclusions

- FCM may be a source of exposure to multiple compounds
- Migration from FCM varies depending on various parameters
- Exposome science can overhaul the current environmental health risk assessment paradigm and facilitate assessment of risk due to exposure to chemical mixtures
- High dimension biological connectivity permits the identification of molecular paths and biological processes (multi-omics platforms)
- Real-life chemical mixtures should account for the joint effect of FCM and compounds of environmental origin

Bertold Brecht's *Life of Galileo*:

"*The main objective of science is not to open the door to infinite wisdom but to roll back the boundaries of infinite error*"

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A connectivity perspective to environmental health