Anthropogenic chemicals & nanomaterials: Persistent Concerns in Oceans and Human Health.

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Boston University Superfund Research Program

US-NIEHS

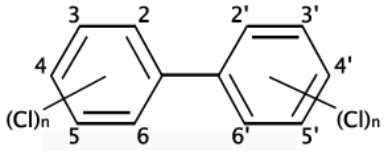
US-NSF

US-NIH Superfund

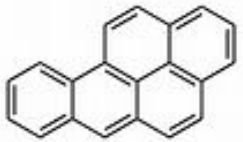
A Few Examples:

Legacy Pollutants

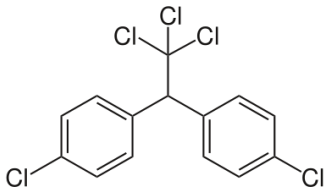
- PCBs



- PAHS

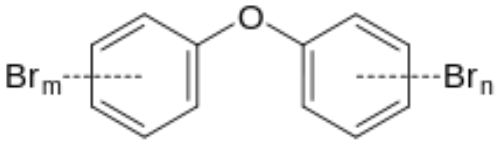


- Metals e.g. MeHg
- Pesticides e.g. DDTs

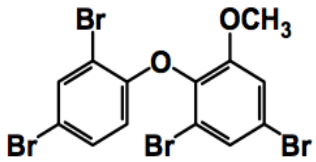


Recent Concerns

- PBDEs



- Nanomaterials
- Personal Care Products
- Natural Products



Total numbers of chemicals are staggering.

Abundance and Implications?

- Globally distributed
- More abundant in coastal areas.
- Variable levels depending on input source.
- Vectored to humans mostly in seafood
- *Neural development/function are susceptible.*

Fundulus heteroclitus

Zebrafish
Danio rerio

Molecular Mechanisms

Global and Ocean issues

Toxins and toxicants

Biomedical Insight and use

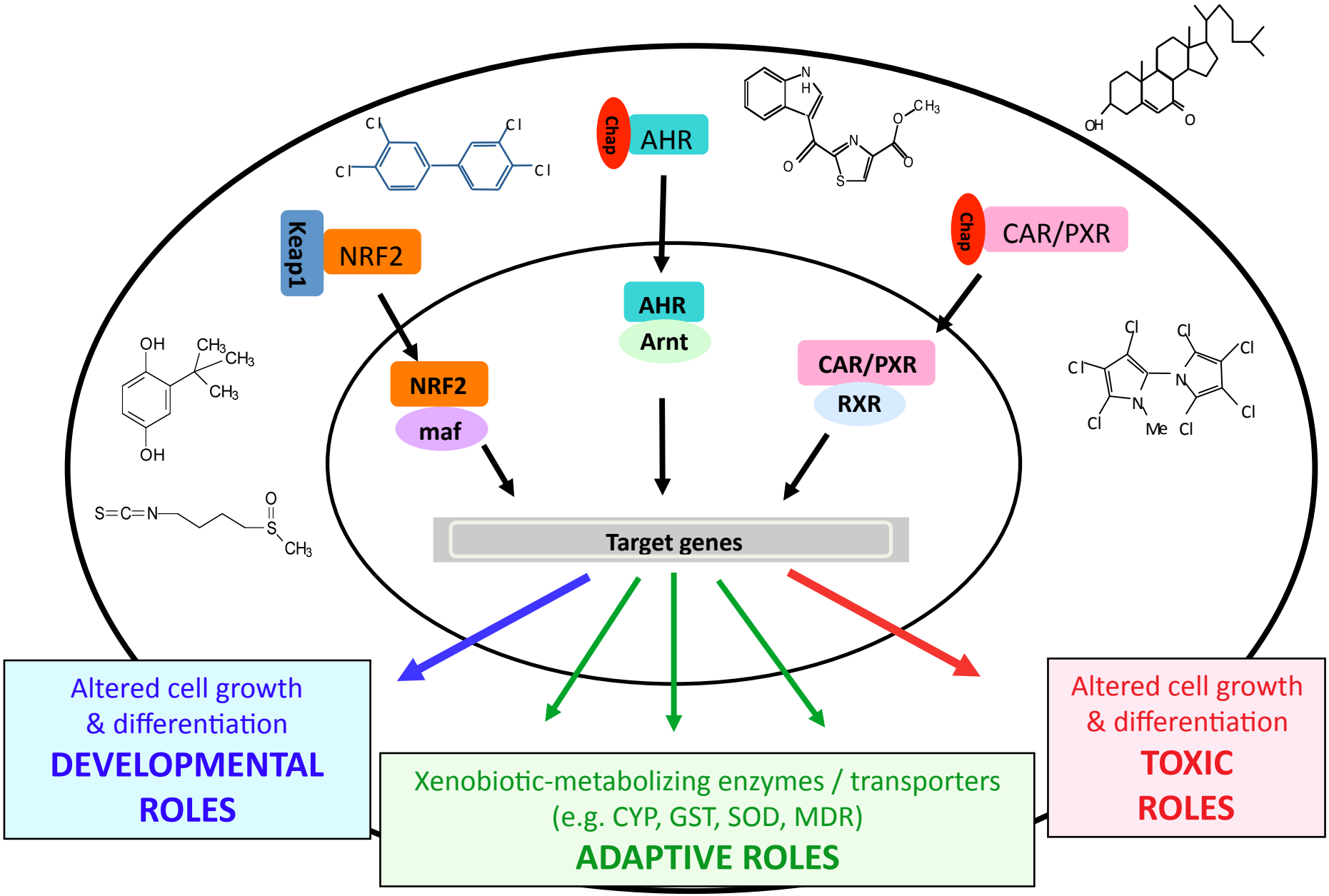
Deep sea

Evolution & Diversity

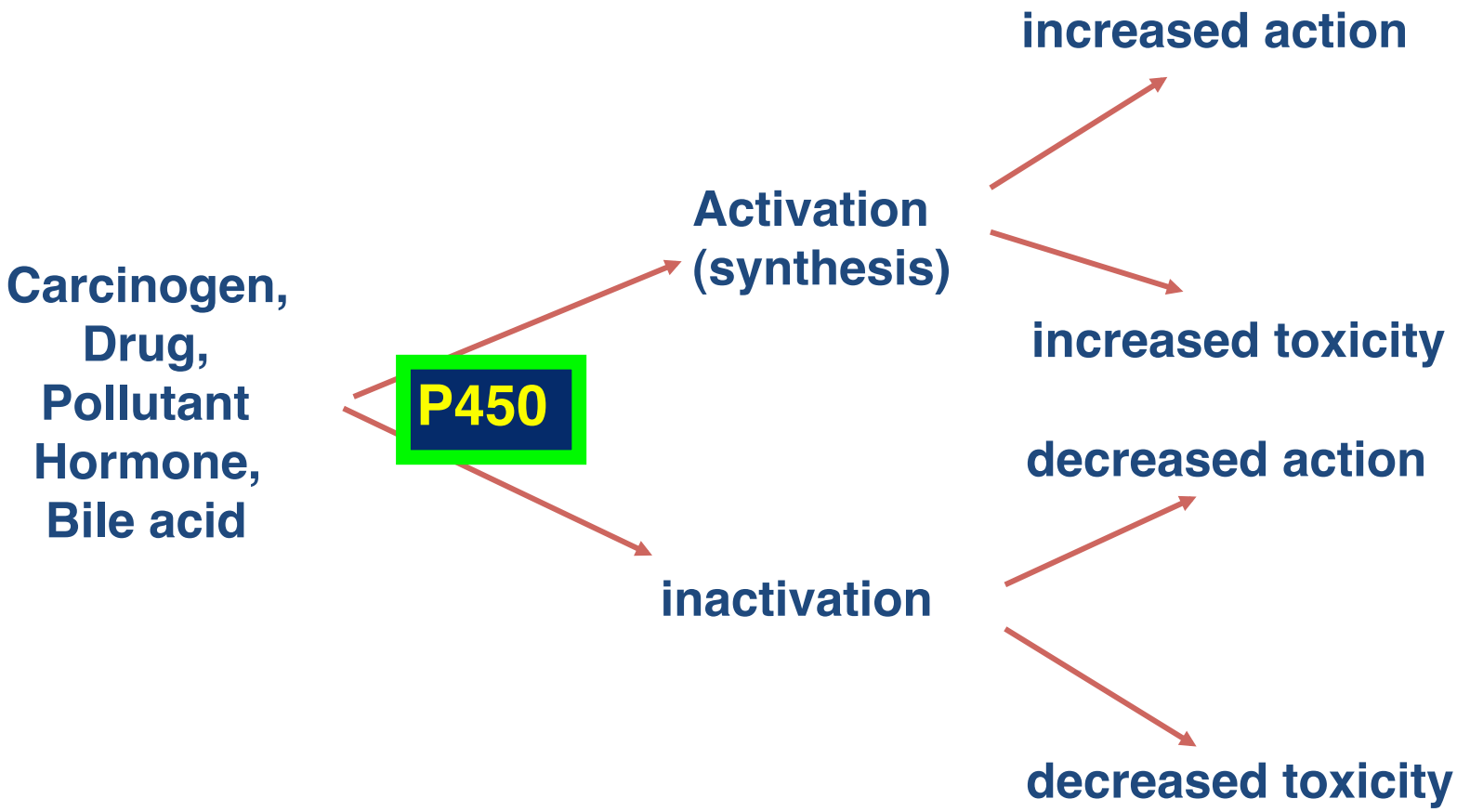
sea urchin

coelacanth

Conditional (ligand-activated) transcription factors

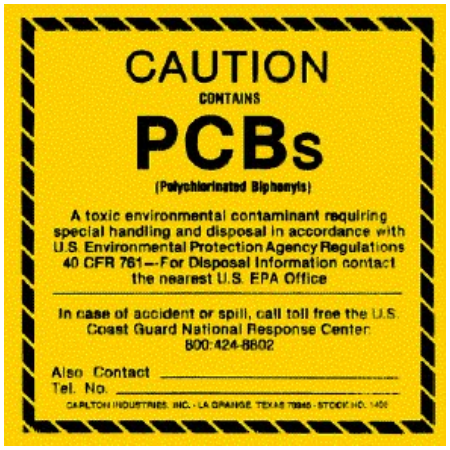


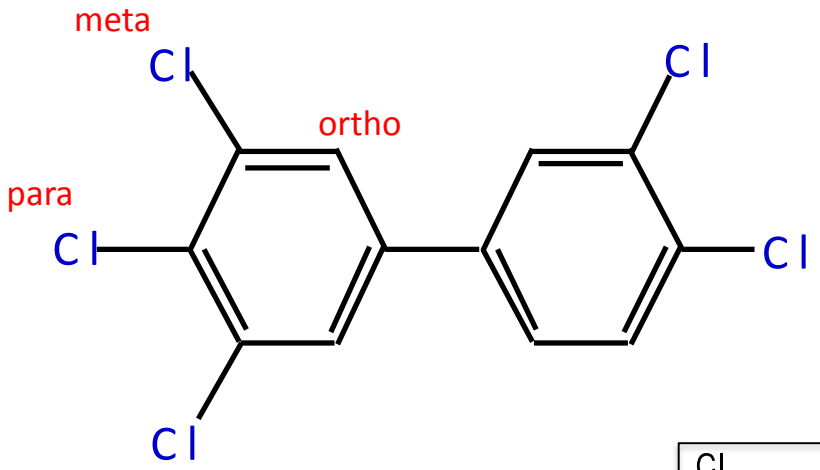
Metabolism of chemicals



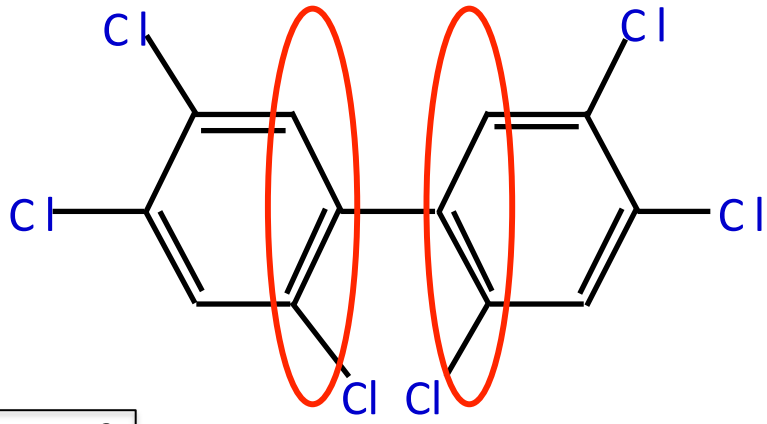
Cytochrome P450 (CYP) 1 - A - 1

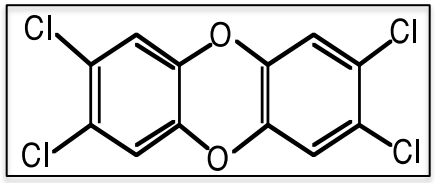
Example of structural diversity: Polychlorinated biphenyls (PCBs)





TCDD





non-*ortho* PCB

3,3',4,4',5-pentachlorobiphenyl (PCB-126)

***Di-ortho* PCB**

2,2',4,4',5,5'-hexachlorobiphenyl (PCB-153)

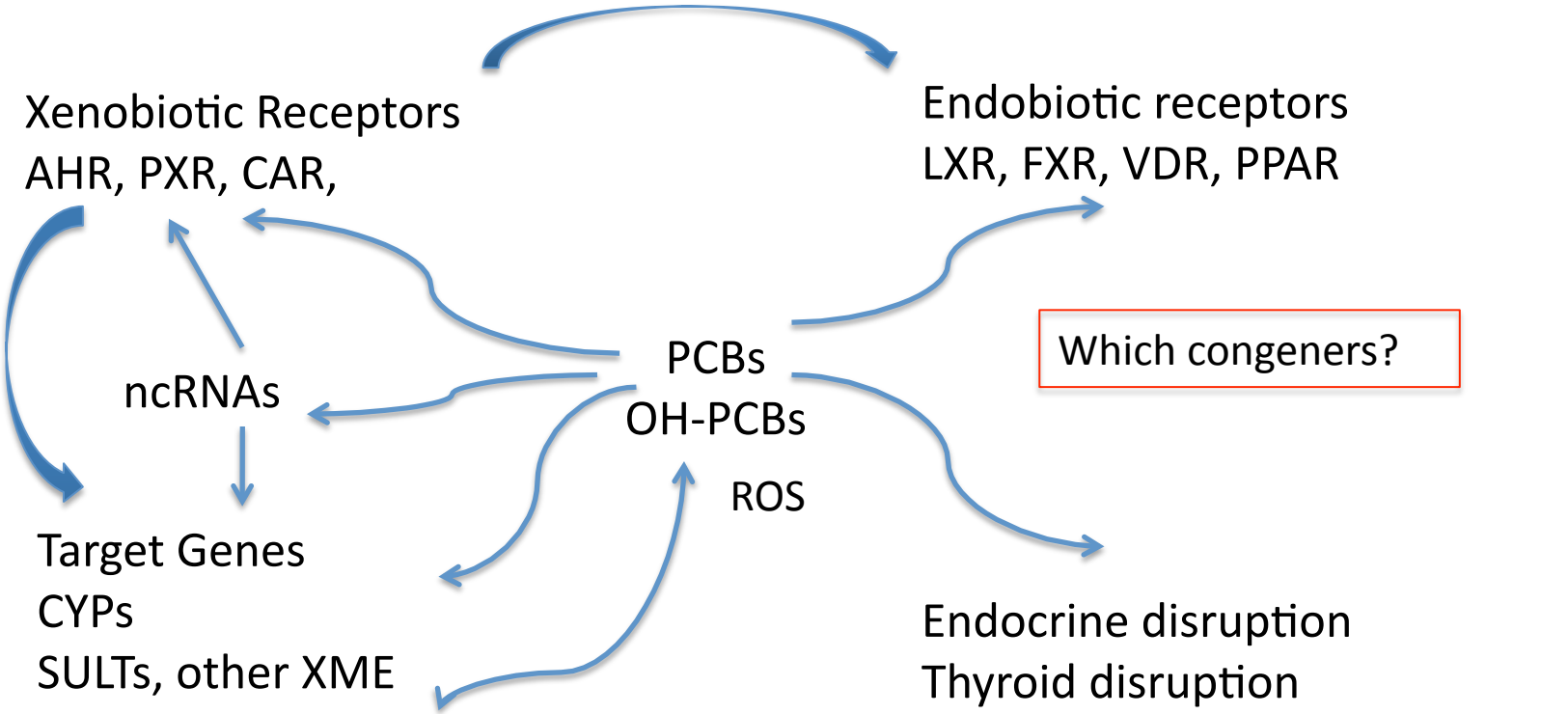
Complexities

- Multiple Structures

  e.g., 209 possible congeners of PCBs & PBDEs
- Diverse Structure-activity relationships
- Biotransformation
- Multiple mechanisms of toxicity

  (plus, species/allelic variation in proteins involved)
- Poorly known interactive effects

Complexities of PCB mechanisms



Examples of variation in response:

Species differences

– 5,000-fold variation among mammals in molecular response to dioxin.

Allelic differences

– 20-fold variation among strains of zebrafish in activation of PXR by an agonist.*

*Collaboration with Goksoyr et al

The Challenges

Global change includes chemical change !

Needs: Identify toxicants and establish exposure levels

Understand mechanisms

Determine significance of low level exposures

Distinguish adaptive and adverse responses

Areas of more recent concern:

Developmental origins of health & disease

Neurological defects (ADHD, cognitive issues)

Epigenetic effects

OA influences on state and bioavailability, & PoP

(The same ***challenges apply to HAB toxins.)***