ISDE treviso

SERATE VERDI 2021

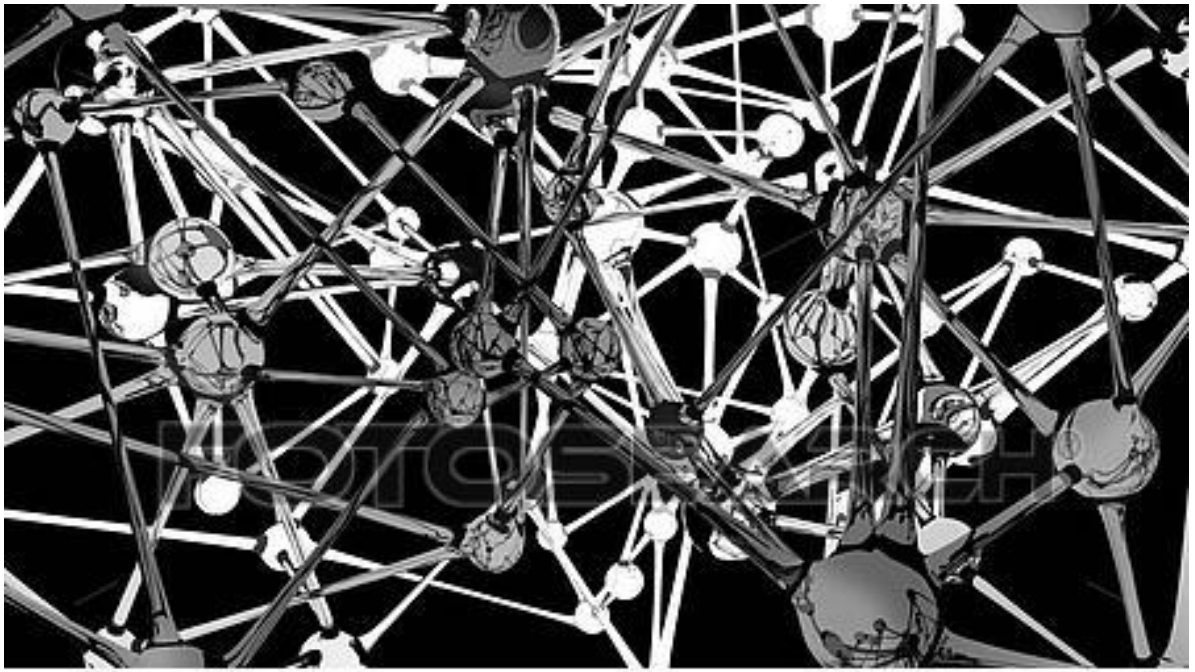
A cura dell'Associazione Medici per l'Ambiente

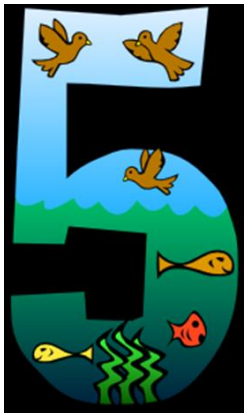
Inquinamento chimico, interferenti endocrini e rischio feto-materno

SERGIO BERNASCONI
PROF. ORDINARIO DI PEDIATRIA
UNIVERSITA' DI PARMA

25 MAGGIO 2021

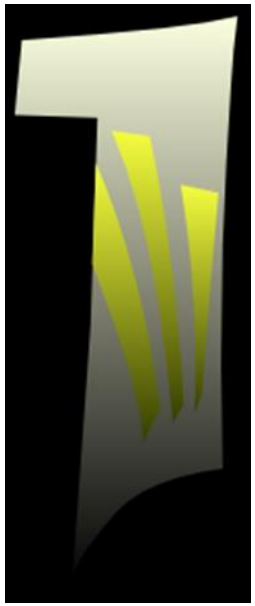
PROBLEMA COMPLESSO E AMPIAMENTE DISCUSSO





PUNTI FONDAMENTALI

1. SOSTANZE CHIMICHE NELL'AMBIENTE



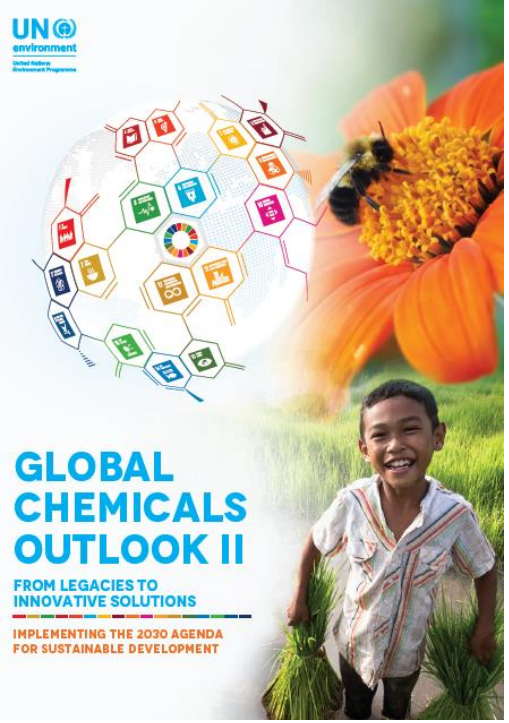
Review

Children's Environmental Health: A Systems Approach for Anticipating Impacts from Chemicals

Elaine A. Cohen Hubal [1,*], David M. Reif [2], Rachel Slover [1], Ashley Mullikin [1] and John C. Little [3]

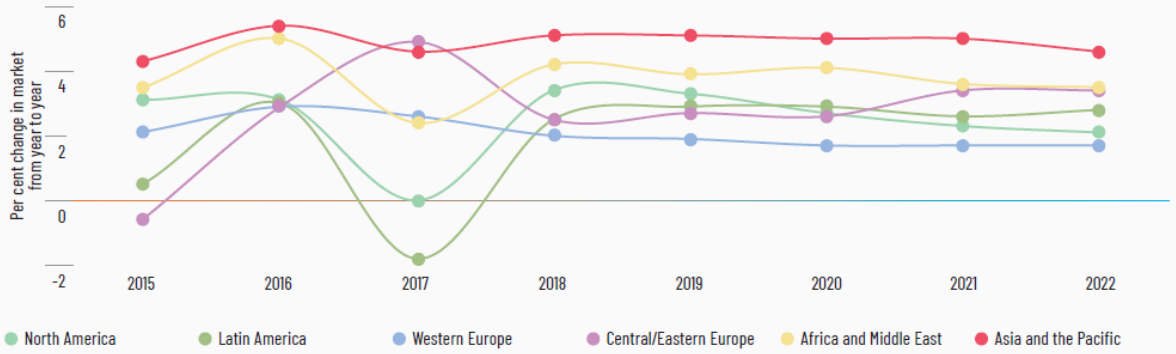
Int. J. Environ. Res. Public Health **2020**, *17*, 8337

The volume and total number of chemicals manufactured and used in consumer products has increased dramatically over the last 50 years [1,2]. Organizations around the world are continuously curating lists of chemicals in commerce [3]. The number of chemicals ranges from approximately 23,000 to greater than 68,000 and may include substances that are no longer manufactured but may still occur in the environment. Despite the promise of product and chemical innovations, challenges of evaluating and predicting impacts remain formidable, and only a small number of chemicals have been well studied for environmental health impacts [4–7]. The gap between the increasing reliance on chemicals in consumer products and our knowledge of the associated human health impacts is growing [8].



Between 2000 and 2017, the global chemical industry's production capacity (excluding pharmaceuticals) almost doubled, from about 1.2 to 2.3 billion tonnes. If pharmaceuticals are included, global sales totalled US dollars 5.68 trillion in 2017, making the chemical industry the world's second largest manufacturing industry.

Figure 5 Projection of annual production growth in the chemical industry by region, 2015-2022 (per cent change per year) (adapted from American Chemistry Council 2017)



While production of chemicals is projected to grow in each region, annual growth rates are highest in regions with developing countries and emerging economies, in particular in Asia-Pacific, Africa and the Middle East.

MICROBIOME Research Hub

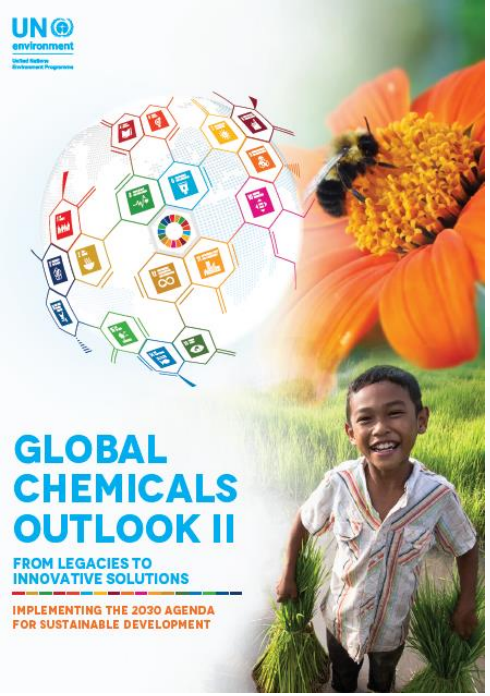
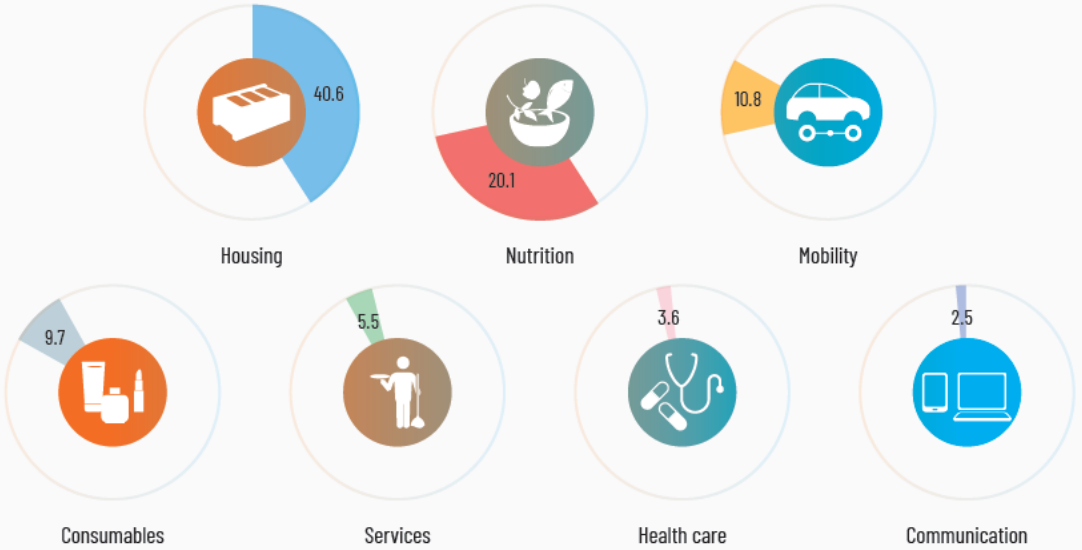


Figure 1.10 The global material footprint: extracted resources by key societal needs and consumables, 2015 (billion tonnes) (based on de Wit *et al.* 2019, p. 19)



Six key societal needs and consumables represent the largest material footprint globally: housing and infrastructure (ca. 44 per cent), nutrition (ca. 22 per cent), mobility (ca. 12 per cent), consumables (ca. 11 per cent), services (ca. 6 per cent), health care (ca. 4 per cent) and communication (ca. 3 per cent). Each of these sectors is chemical-intensive in terms of both production processes and products, which range from asbestos used in steel beams, to pesticides in agriculture, to heavy metals in batteries, to parabens in cosmetics.

High-performance metabolic profiling of plasma from seven mammalian species for simultaneous environmental chemical surveillance and bioeffect monitoring

Toxicology. 2012 May 16; 295(1-3): 47–55

Youngja H. Park[a,b], Kichun Lee[a,b], Quinlyn A. Soltow[a,b], Frederick H. Strobel[d], Kenneth L. Brigham[b,e], Richard E. Parker[b,e], Mark E. Wilson[f], Roy L. Sutliff[b,g], Keith G. Mansfield[h], Lynn M. Wachtman[h], Thomas R. Ziegler[c,e], and Dean P. Jones[a,b,e]

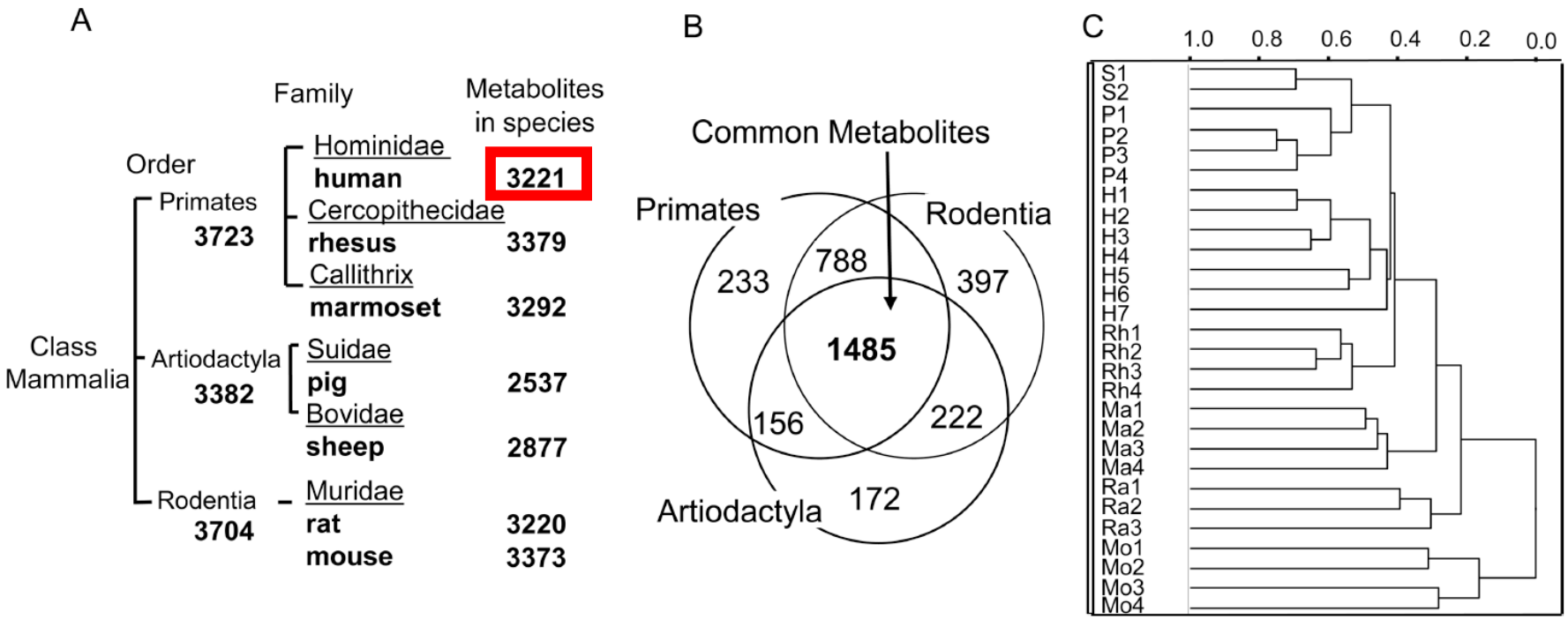


Figure 1.

A. Phylogenetic relationship of 7 mammalian species with associated number of chemicals detected by HPMP for each order, family and species. B. Venn diagram of the chemicals common among families. C. Hierarchical clustering analysis (HCA) of plasma metabolic profiles after variance scaling shows similarity of individuals of the same species.

Bisphenol A concentrations in human urine, human intakes across six continents, and annual trends of average intakes in adult and child populations worldwide: A thorough literature review

Science of the Total Environment 626 (2018) 971–981

Ri-ping Huang [a], Ze-hua Liu [a,b,c,d,*], Hua Yin [a], Zhi Dang [a], Ping-xiao Wu [a], Neng-wu Zhu [a], Zhang Lin [a]

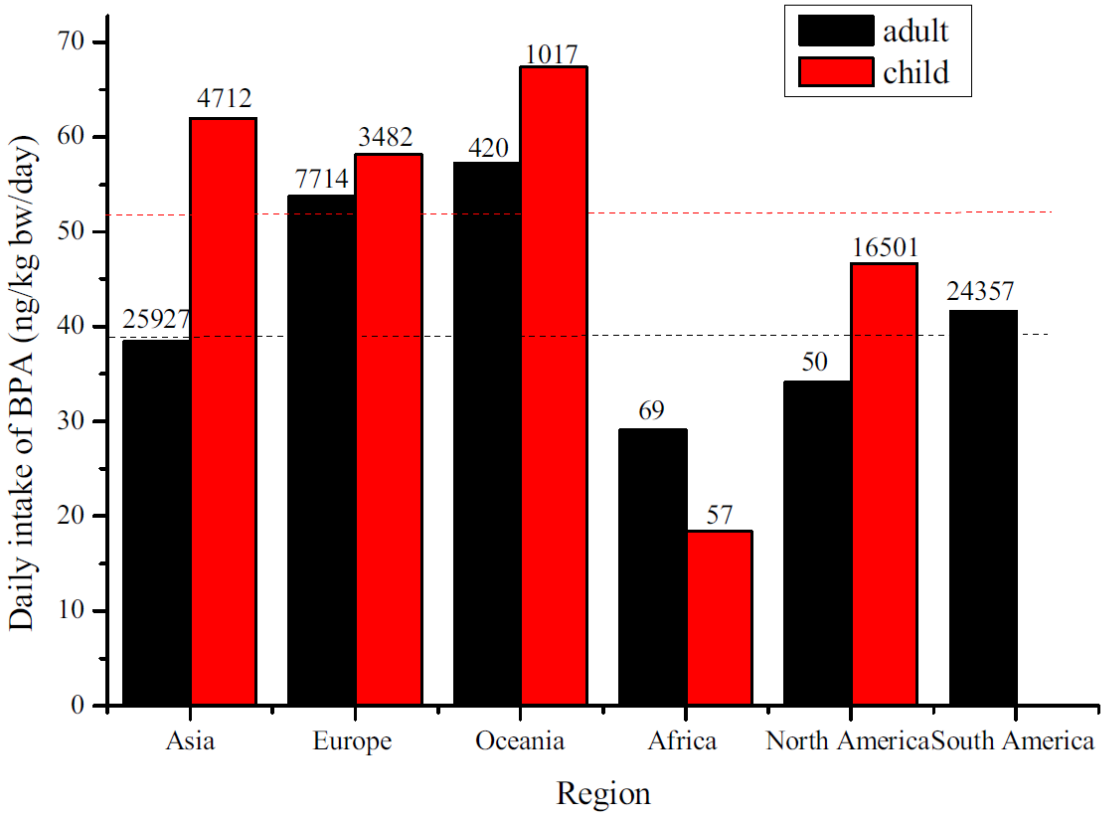


Fig. 1. Continental distributions of BPA intakes between children and adult populations. Urine sample sizes in six different continents are marked above the histogram. The world's average daily intake of BPA is marked with dash lines with the adult population of 38.78 ng/kg bw/day and children population of 51.74 ng/kg bw/day. The data for children population in South America is not available.

Composti perfluorurati (PFC)

I composti perfluorurati (PFC) sono una famiglia di sostanze chimiche costituite da legami di carbonio-fluoro. La loro particolare struttura rende i perfluorocarburi idrofobici e lipofobici, ovvero in grado di repellere l'acqua e le sostanze oleose/grasse.

Per questo motivo, i PFC vengono usati per realizzare molti prodotti di uso comune per renderli più resistenti o repellenti alle macchie, al grasso e all'acqua.

I PFC trovano dunque impiego nei prodotti più disparati:

divani, poltrone e altri mobili imbottiti/rivestiti, abbigliamento, contenitori per alimenti, sedili per auto, scarpe, moquette….

In genere, ogni volta che un tessuto viene etichettato come "impermeabile", "resistente all'acqua", o "resistente alle macchie", con ogni probabilità contiene PFC.

Environmental Chemicals in Pregnant Women in the United States: NHANES 2003–2004

Tracey J. Woodruff, Ami R. Zota, and Jackie M. Schwartz

VOLUME 119 | NUMBER 6 | June 2011 • Environmental Health Perspectives

Perfluorinated compounds (PFCs)

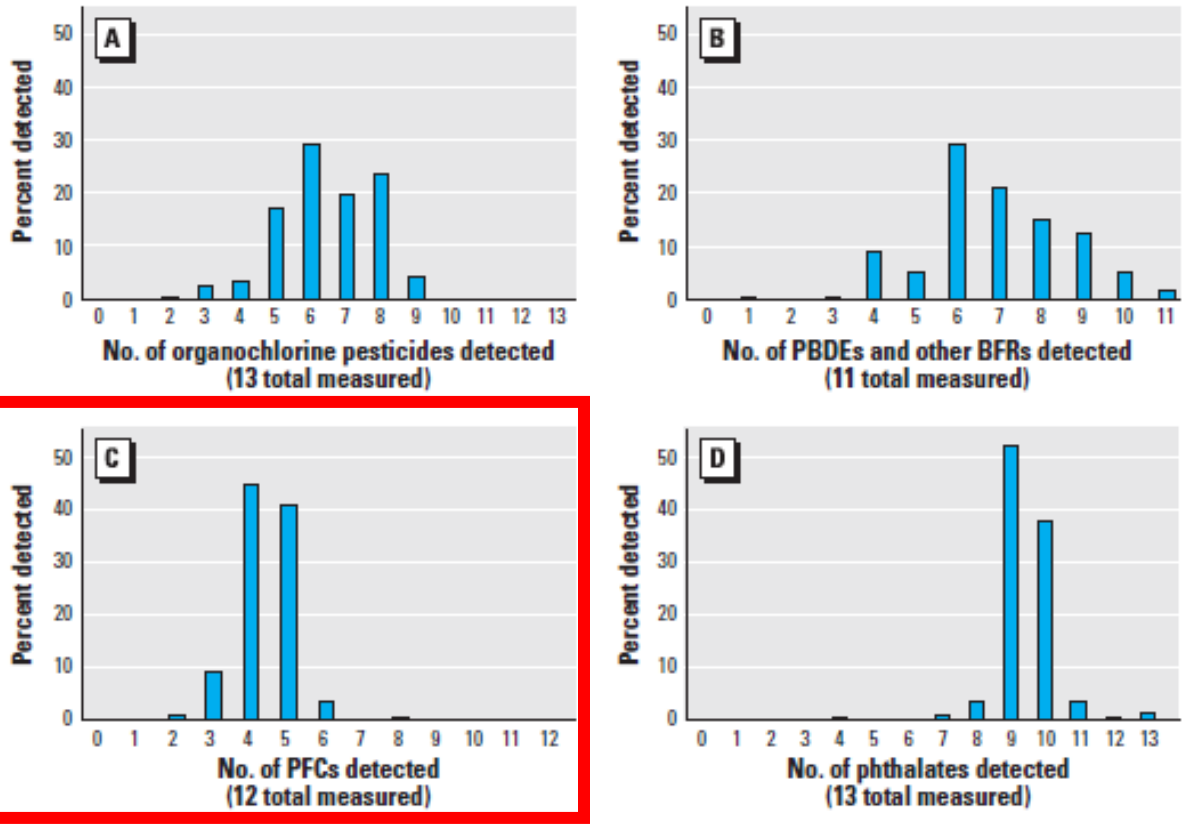


Figure 1. Distribution of the number of chemicals detected in U.S. pregnant women for four chemical classes: organochlorine pesticides (*A*; $n = 71$), PBDEs (*B*; $n = 75$), PFCs (*C*; $n = 76$), and phthalates (*D*; $n = 91$).

Eteri di difenile polibromurato (PBDE)

I ritardanti di fiamma bromurati (BFR) sono miscele di sostanze chimiche artificiali che vengono aggiunte a un'ampia gamma di prodotti, anche per usi industriali, per diminuirne l'infiammabilità. Vengono spesso impiegati nelle plastiche, negli articoli tessili e nelle apparecchiature elettriche/elettroniche.

Esistono cinque classi principali di BFR, elencate di seguito con l'indicazione dei loro usi più comuni:

- **eteri bifenili polibromurati (PBDE): plastiche, articoli tessili, circuiti stampati, circuiteria**.
- esabromociclododecani (HBCDD): isolamento termico in edilizia
- tetrabromobisfenolo A (TBBPA) e altri fenoli:circuiti stampati, termoplastiche (soprattutto nei televisori)
- bifenili polibromurati (PBB): dispositivi di largo consumo, articoli tessili, schiume plastiche
- altri ritardanti di fiamma bromurati.

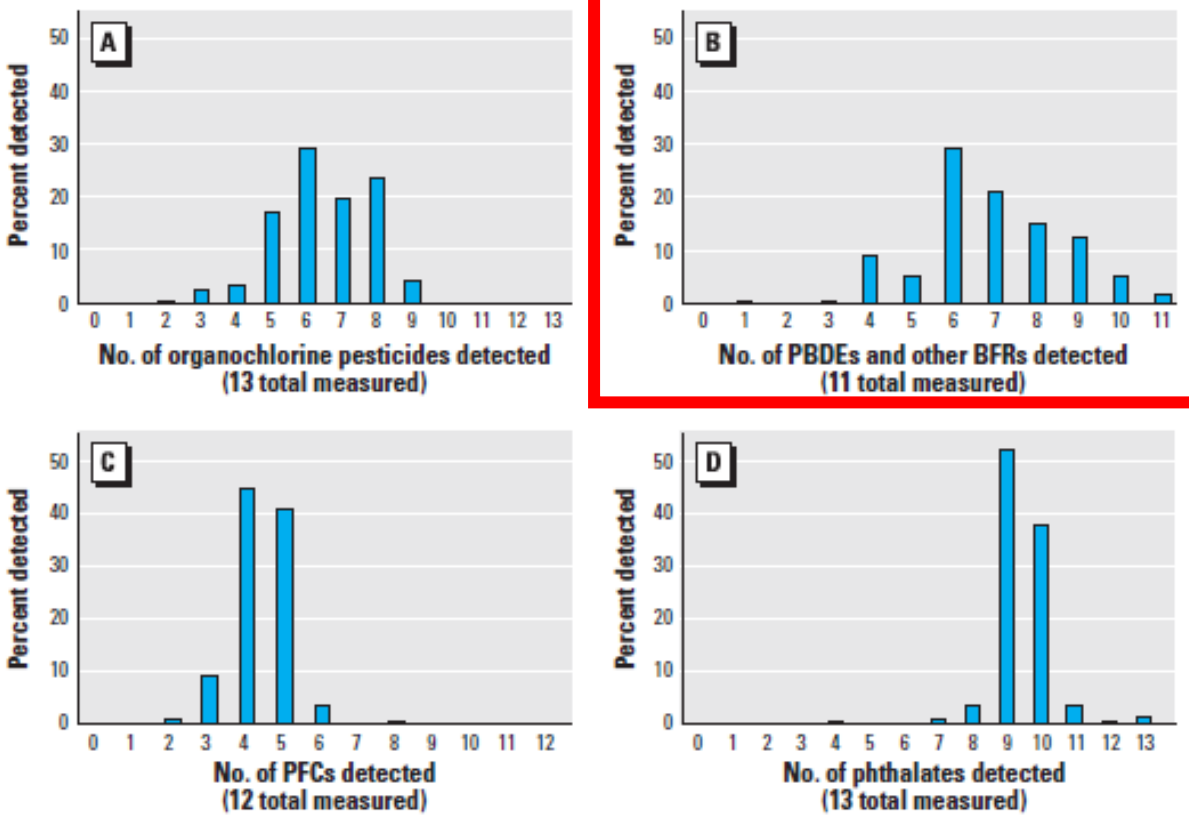
Nell'Unione europea (UE) l'uso di alcuni BFR è vietato o limitato; tuttavia, a causa della loro persistenza nell'ambiente, tali sostanze chimiche continuano a destare timori per i rischi che comportano per la salute pubblica. I prodotti trattati con BFR, sia in uso che di scarto, lasciano "filtrare" i BFR nell'ambiente e contaminano l'aria, il suolo e l'acqua. Questi contaminanti possono successivamente penetrare nella catena alimentare, dove si rinvengono soprattutto in alimenti di origine animale come pesce, carne, latte e prodotti derivati

efsa
European Food Safety Authority

Environmental Chemicals in Pregnant Women in the United States: NHANES 2003–2004

Tracey J. Woodruff, Ami R. Zota, and Jackie M. Schwartz

VOLUME 119 | NUMBER 6 | June 2011 • Environmental Health Perspectives

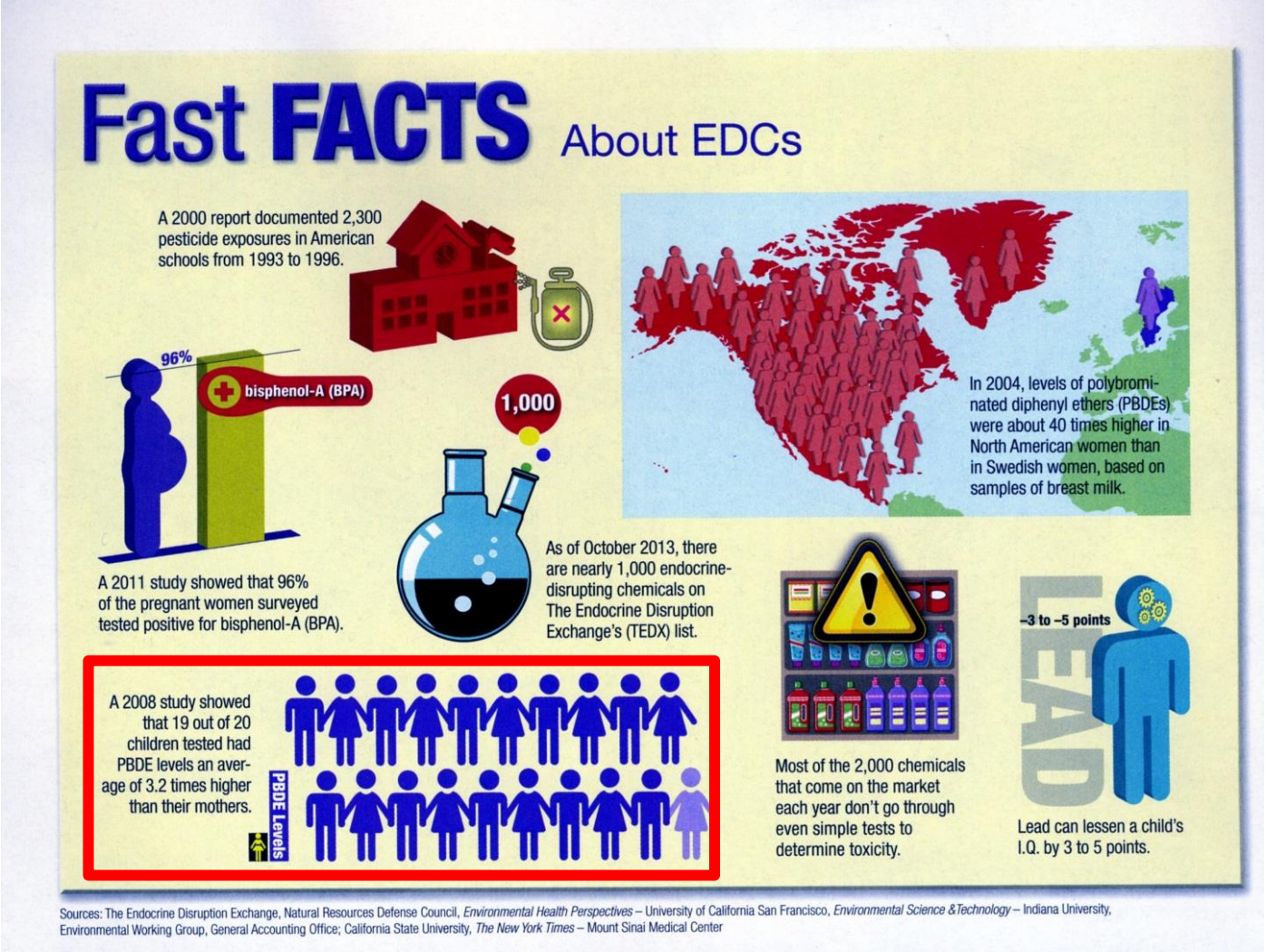


Polybrominated diphenyl ethers (PBDEs)

Figure 1. Distribution of the number of chemicals detected in U.S. pregnant women for four chemical classes: organochlorine pesticides (*A*; $n = 71$), PBDEs (*B*; $n = 75$), PFCs (*C*; $n = 76$), and phthalates (*D*; $n = 91$).

Endocrine News April 2014

Polybrominated diphenyl ethers (PBDEs)

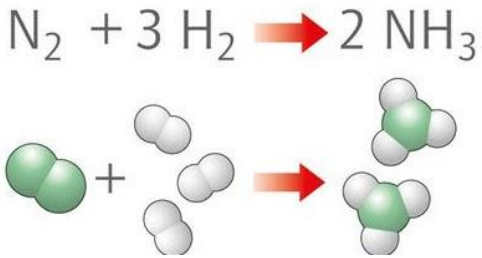


La chimica (e la scienza in generale) è complessa e pone delle problematiche

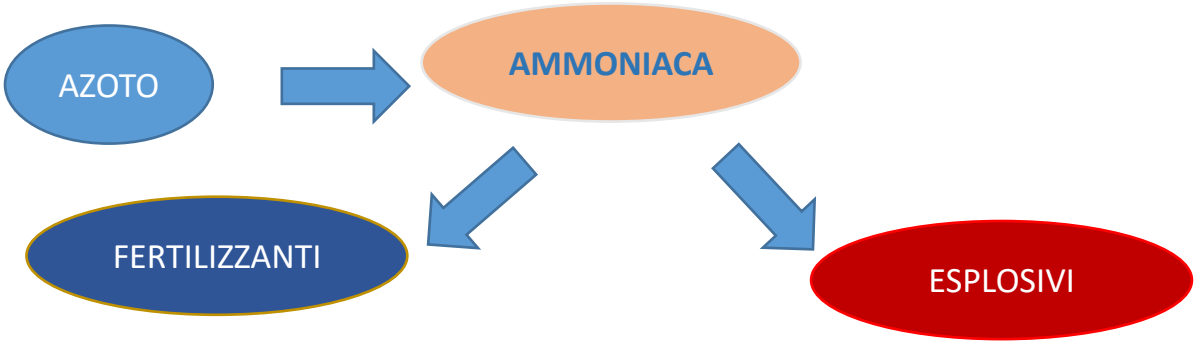
Valentina Domenici

Un caso emblematico:

La rilevanza scientifica della scoperta del nuovo processo di sintesi dell'ammoniaca.



Le implicazioni della scoperta dell'ammoniaca.

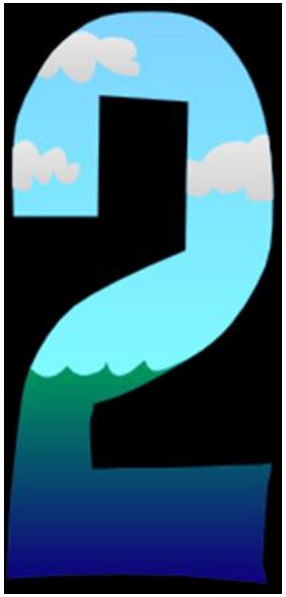


L'effetto della scoperta di Haber sul ciclo dell'azoto.

Citation: Braun JM, Gray K (2017) Challenges to studying the health effects of early life environmental chemical exposures on children's health. PLoS Biol 15(12): e2002800. https://doi.org/10.1371/journal.pbio.2002800

- **1) In the United States, over 85,000 chemicals are used in commerce, and thousands of these are produced in quantities of over one million pounds per year**
- **2) The potential toxicity of the vast majority of these chemicals is not routinely evaluated before they are introduced into commerce or industry. While recent US legislation mandates assessments of the health effects of the most concerning of these chemicals , the scale of this problem is daunting given the large number of chemicals used and wide range of potential effects they could have on human health and development**
- **3) For instance, >200 chemicals used in commerce or industry are known to be neurotoxic to humans, and approximately two new human neurotoxicants have been identified each year between 2006 and 2013**

1. SOSTANZE CHIMICHE NELL'AMBIENTE
2. **INTERFERENTI ENDOCRINI**



The Impact of Endocrine Disruption: A Consensus Statement on the State of the Science

VOLUME 121 | NUMBER 4 | April 2013 · Environmental Health Perspectives

- **Close to 800 (1000-1400) chemicals are known or suspected to be capable of interfering with hormone receptors, hormone synthesis or hormone conversion. However, only a small fraction of these chemicals have been investigated in tests capable of identifying overt endocrine effects in intact organisms.**
- **The vast majority of chemicals in current commercial use have not been tested at all.**
- **This lack of data introduces significant uncertainties about the true extent of risks from chemicals that potentially could disrupt the endocrine system.**

Åke Bergman,[1] Jerrold J. Heindel,[2,a]
Tim Kasten,[3,b] Karen A. Kidd,[4]
Susan Jobling,[5] Maria Neira,[6,c]
R. Thomas Zoeller,[7] Georg Becher,[8]
Poul Bjerregaard,[9] Riana Bornman,[10]
Ingvar Brandt,[11] Andreas Kortenkamp,[5]
Derek Muir,[12] Marie-Noël Brune Drisse,[6,c]
Roseline Ochieng,[13] Niels E. Skakkebaek,[14]
Agneta Sundén Byléhn,[3,b] Taisen Iguchi,[15]
Jorma Toppari,[16] and Tracey J. Woodruff[17]

MICROBIOME Research Hub

Table 1. Endocrine-disrupting chemicals (EDCs) most relevant to human health.

EDC	Metabolites	Exposure Sources
Bisphenol [10] Bisphenol A (BPA) Bisphenol S (BPS) Bisphenol F (BPF) Bisphenol B (BPB)	[26] BPA glucuronide (BPA-G) BPA sulfate (BPA-S)	Synthetic [10] Food packaging; Thermal receipts; Plastic dinnerware; Polycarbonate plastic; Epoxy resins; Dental sealants;
High-Molecular-Weight Phathalate [10] Di(2-ethylhexyl) phthalate (DEHP)	[10] Mono(2-ethyl-5-hydroxyhexyl) phthalate; mEHHP Mono(2-ethylhexyl) phthalate; mEHP Mono(2-ethyl-5-oxohexyl) phthalate; mEOHP Mono(2-ethyl-5-carboxypentyl) phthalate; mECPP	Synthetic [10] Food packaging and processing; Pharmaceutical coatings; PVC plastics; Building materials; Medical devices;
Low-Molecular-Weight Phathalate [10] Diethyl phthalate (DEP)	[10] Monoethyl phthalate; mEP	Synthetic [10] Fragrant PCPs:| perfumes/colognes; deodorants; soaps, shampoos lotions;

Nutrients **2020**, *12*, 1744; doi:10.3390/nu12061744

Review

Fetal–Maternal Exposure to Endocrine Disruptors: Correlation with Diet Intake and Pregnancy Outcomes

Alessandro Rolfo [1,*], Anna Maria Nuzzo [1], Ramona De Amicis [2], Laura Moretti [1], Simona Bertoli [2,3] and Alessandro Leone [2]

Table 1. Endocrine-disrupting chemicals (EDCs) most relevant to human health.

EDC	Metabolites	Exposure Sources
Persistent Organic Pollutants (POPs) Dichlorodiphenyltrichloroethane (DDT) [27] Dioxins (PCDD, PCDF) [5]	chlorodiphenyldichloroethylene (DDE)	Synthetic Pesticides; [27] Insecticide; Combustion; [5] Incineration; Waste burning; Paper bleaching;
Polycyclic Aromatic Hydrocarbons (PAHs) [27] polybrominated diphenyl ethers (PBDEs) polychlorinated biphenyls (PCBs) brominated flame retardants (BFRs)		Synthetic [27] Combustion processes; Building materials; Electronics furniture; Hydraulic fluids;
Perfluorinated Alkylated Substances (PFAS) [7] Perfluoroalkyl Polyfluoroalkyl		Synthetic [7] Personal care products: Polishes and Paints; Non-stick cookware; Fire-fighting foams;
Phytoestrogens [8] Isoflavonoids (Genistein, Daidzein)		Natural [8] Soy beans and other legumes

Nutrients **2020**, *12*, 1744; doi:10.3390/nu12061744

Review

Fetal–Maternal Exposure to Endocrine Disruptors: Correlation with Diet Intake and Pregnancy Outcomes

Alessandro Rolfo [1,*], Anna Maria Nuzzo [1], Ramona De Amicis [2], Laura Moretti [1], Simona Bertoli [2,3] and Alessandro Leone [2]

C. R. Biologies 340 (2017) 421–431

Rémy Slama [a,*], Céline Vernet [a], Feiby L. Nassan [b], Russ Hauser [b], Claire Philippat [a]

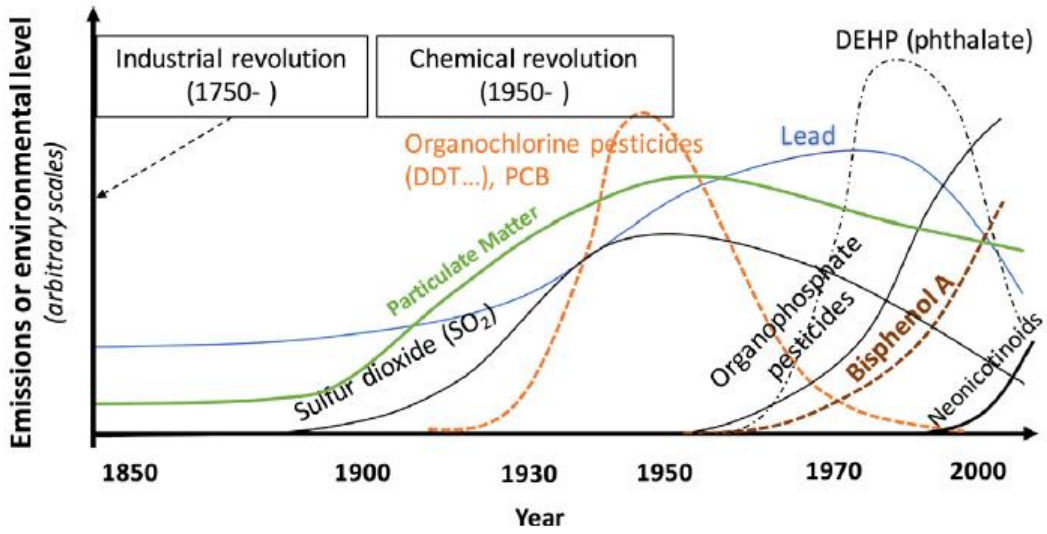


Fig. 4. Qualitative depiction of the production levels of typical chemicals in Western countries during the Anthropocene era [49]. The vertical axis corresponds to an arbitrary scale.

Neonicotinoids, which are among the world's most widely used insecticides, can affect the sperm count of male honey bees and reduce the number of queen bees; they may also play a role in recent declines in bumblebee colonies. Adverse effects on pollinators, in turn, have direct effects on agricultural yields and food supplies (Moffat *et al.* 2015; Straub *et al.* 2016).

Potential human exposures to neonicotinoid insecticides: A review

Q. Zhang [a, b], Z. Li [a, b], C.H. Chang [b], J.L. Lou [c], M.R. Zhao [a], C. Lu [b, d, *]

Environmental Pollution 236 (2018) 71–81

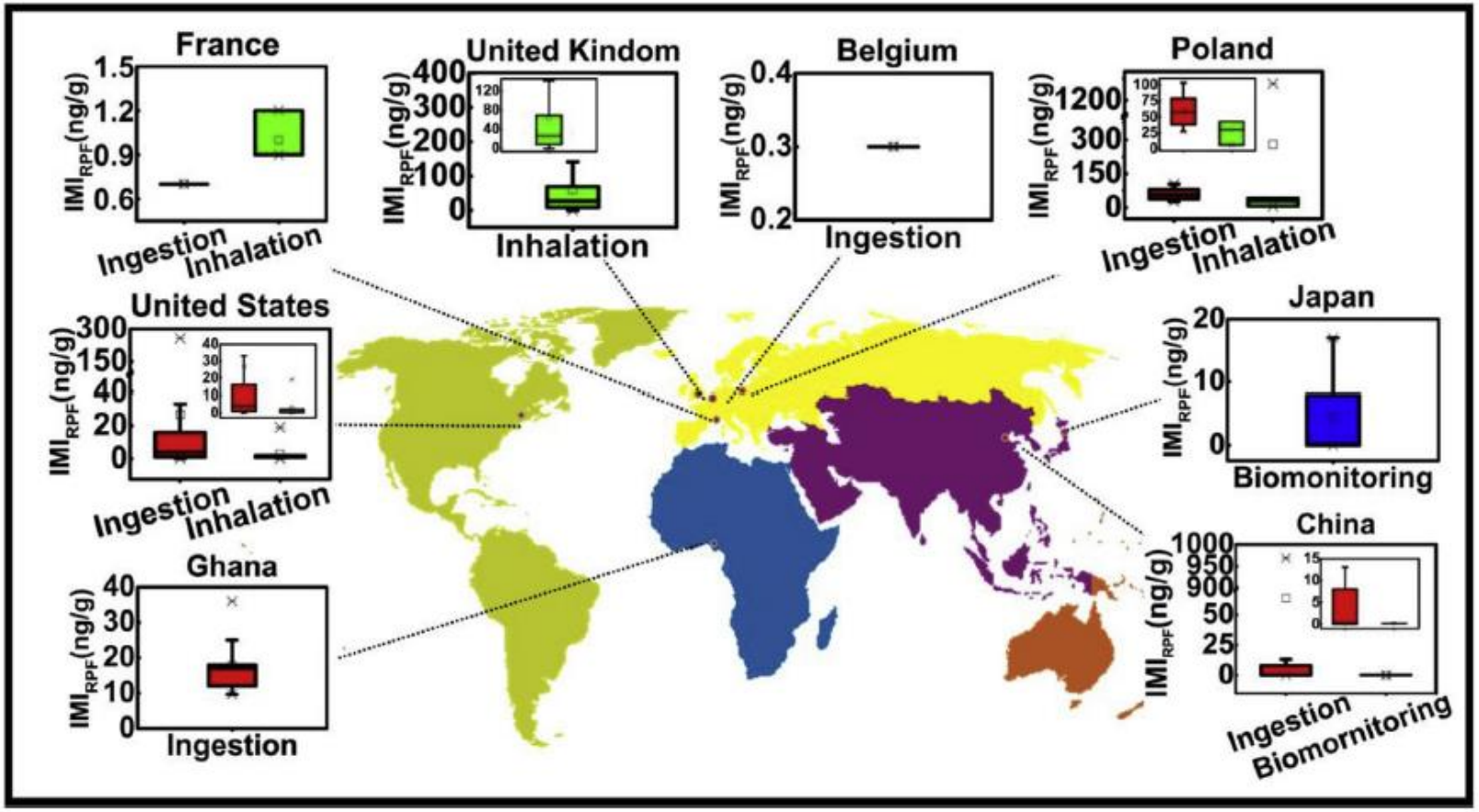


Fig. 2. Distributions of total neonicotinoid insecticides, as expressed of IMI_{RFP} (ng/g), in potential human exposure pathways reported by studies conducted worldwide. Smaller figures nested within the main figures represent distributions without the high values. References were included in Tables 1–3.

Human exposure, hazard and risk of alternative plasticizers to phthalate esters

Science of the Total Environment 541 (2016) 451–467

Thuy T. Bui [a,b,*,1], Georgios Giovanoulis [a,b,1], Anna Palm Cousins [a], Jörgen Magnér [a], Ian T. Cousins [b], Cynthia A. de Wit [b]

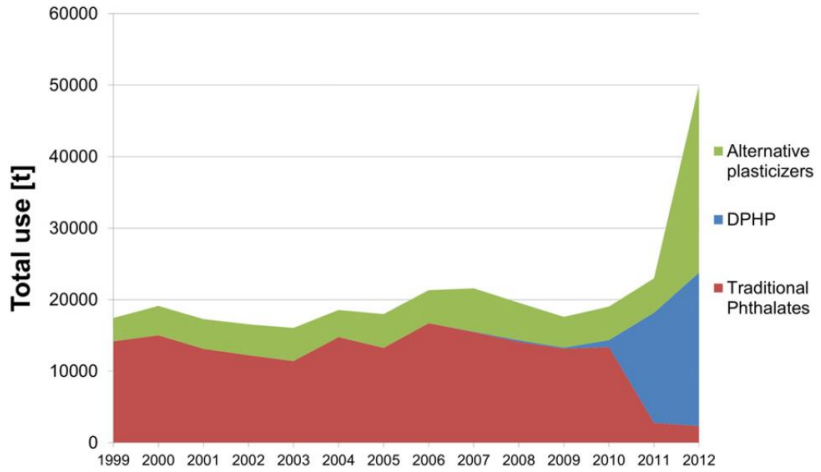
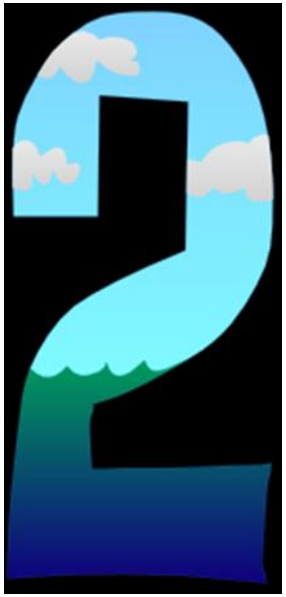


Fig. 3. Total use of "traditional phthalates" (sum of DEP, DnBP, DiBP, BBzP, DEHP, DINP and DIDP) and the more recently occurring DPHP compared to the use of alternative plasticizers (sum of substances listed in Table 2 excluding COMGHA) in chemical products in Sweden from 1999 to 2012.

A reason for concern is that all of the selected substances are chemicals with high production volumes and widespread use in consumer products, including children's articles. The availability of human exposure data is currently limited, which hinders strong conclusions to be drawn as well as adequate human risk assessments for some alternatives. In the case of DINCH, production, use and human exposure

1. SOSTANZE CHIMICHE NELL'AMBIENTE
2. **INTERFERENTI ENDOCRINI**

- meccanismo d'azione

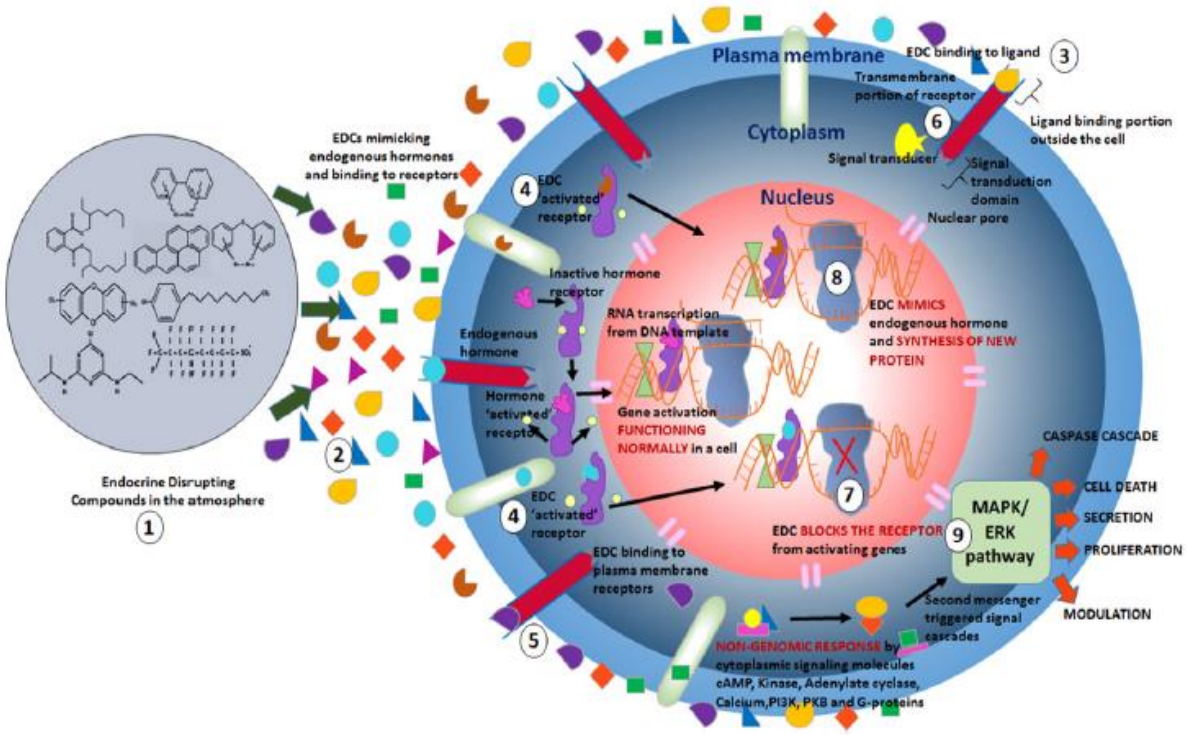


MECCANISMO D'AZIONE

Endocrine disrupting chemicals in the atmosphere: Their effects on humans and wildlife

Jayshree Annamalai *, Vasudevan Namasivayam

Environment International 76 (2015) 78–97



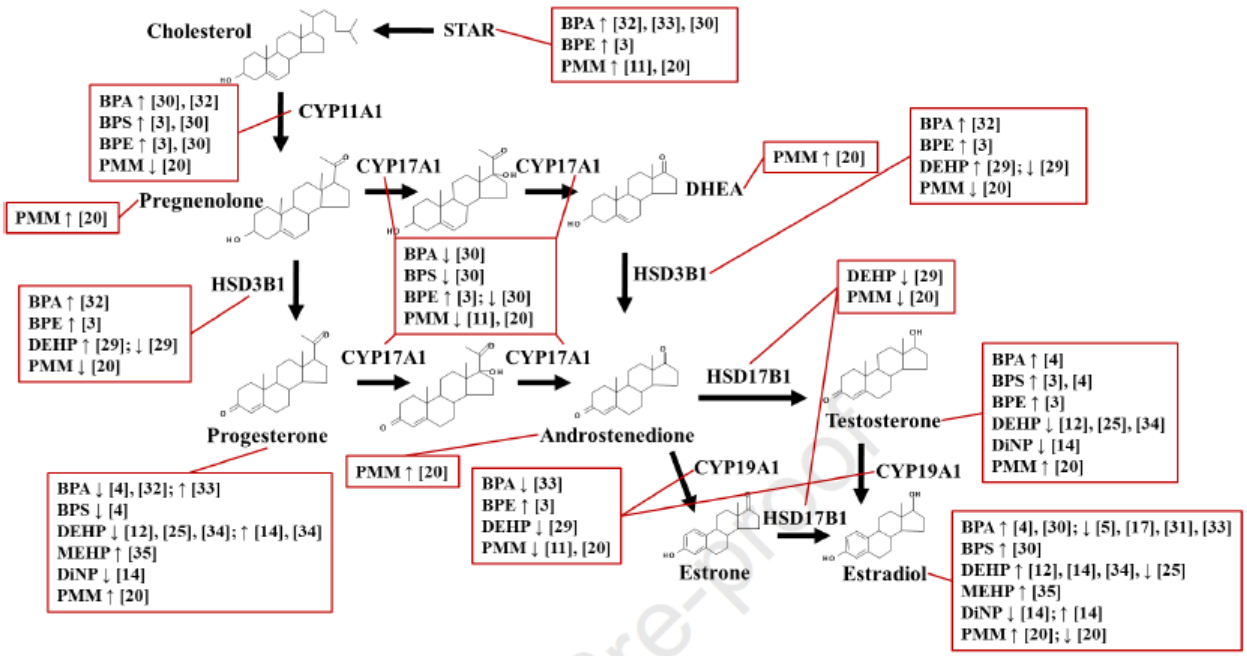


Figure 2 Effects of bisphenols and phthalates on steroidogenesis

Current studies demonstrate bisphenols and phthalates can alter steroidogenesis by dysregulating expression of steroidogenic enzymes and altering steroid hormone production. Major findings from these studies are summarized here. ↓ indicate decreased and ↑ indicate increased gene/protein expression or hormone production relative to vehicle controls. PMM refers to studies performed with phthalate metabolite mixtures.

Regulation of Thyroid-disrupting Chemicals to Protect the Developing Brain

Mary E. Gilbert,[1*] Katherine L. O'Shaughnessy,[1*] and Marta Axelstad[2]

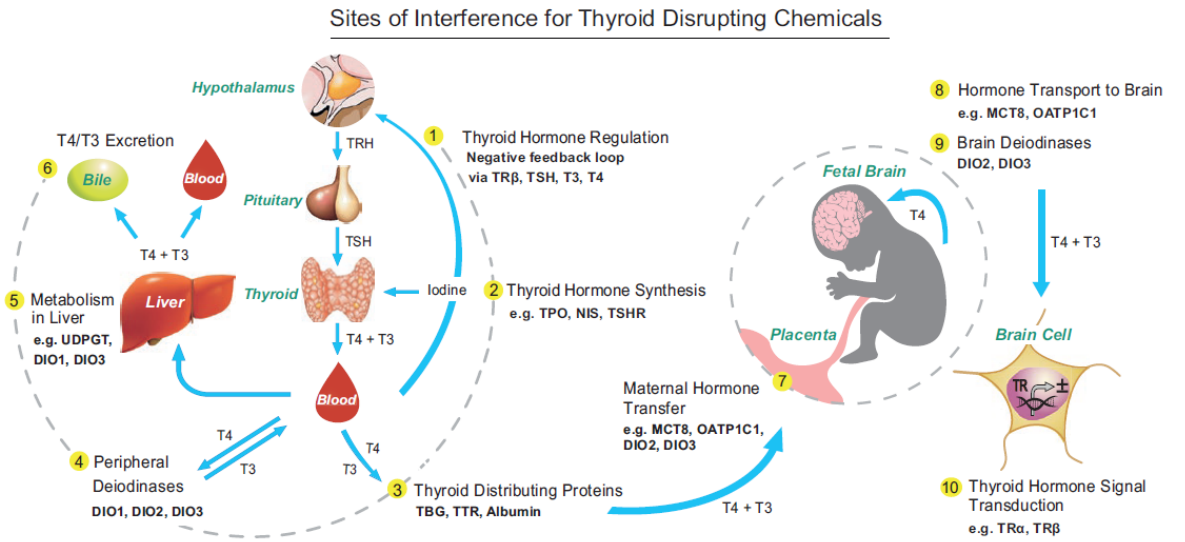


Figure 1. Sites of potential chemical interference of the thyroid system of the mother and fetus are denoted 1 through 10 (yellow circles), and range from interaction with central regulation of the HPT axis (1), thyroid gland function (2), hormone distribution (3), metabolism (4-6), tissue concentrations (4 and 7-9), and cellular action (10). The concentrations of THs in peripheral tissues are mediated by TH transporters (not shown) and deiodinating enzymes in all tissues. TH transporters also regulate the transfer of THs from the mother to the fetus via the placenta (7), and transporters in blood–brain and blood–cerebrospinal fluid brain barriers control the uptake of T4 and/or T3 into the developing brain tissue (8). The concentrations of brain THs are further controlled by deiodinase enzymes (9). The primary action of THs in cells is to control gene transcription through activation of nuclear receptors (10); however, it is now known that other mechanisms of cell signaling exist (229). Environmental contaminants have the potential to disrupt several of these sites in the mother, fetus, and the child.

Adapted from Gilbert et al., Developmental thyroid hormone disruption: prevalence, environmental contaminants and neurodevelopmental consequences. *Neurotoxicology*. 2012;33(4):842-852, with permission from Elsevier (230).

Early-life exposure to widespread environmental toxicants and maternal-fetal health risk: A focus on metabolomic biomarkers

Science of the Total Environment 739 (2020) 139626

Yifeng Dai [a,b], Xia Huo [c], Zhiheng Cheng [a,d], Marijke M. Faas [b,e], Xijin Xu [a,f,*]

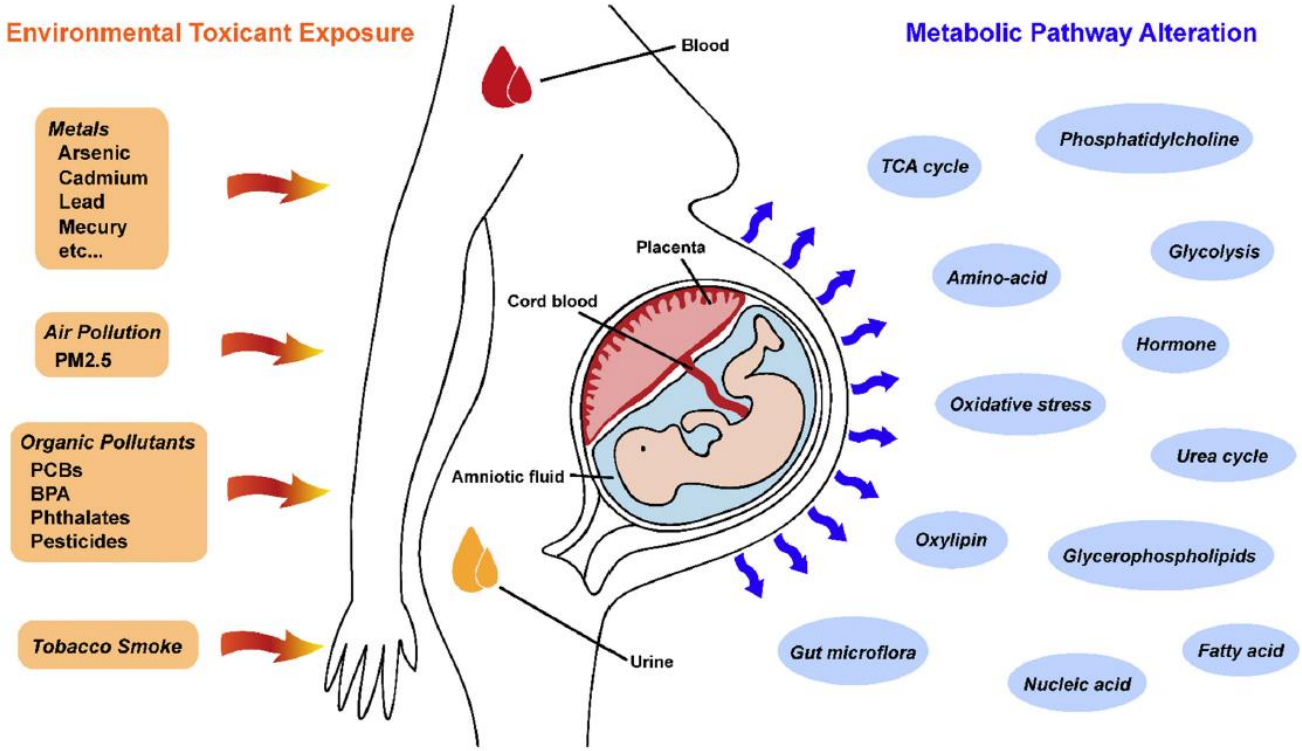


Fig. 2. Effects of environmental toxicant exposure on the alteration of metabolic pathways in maternal blood and urine, cord blood, placenta and amniotic fluid.

MICROBIOME Research Hub

The negative impact of the environment on methylation/ epigenetic marking in gametes and embryos: A plea for action to protect the fertility of future generations

Yves Menezo[1,2] | Brian Dale[3] | Kay Elder[4]

Mol Reprod Dev. 2019;1–10.

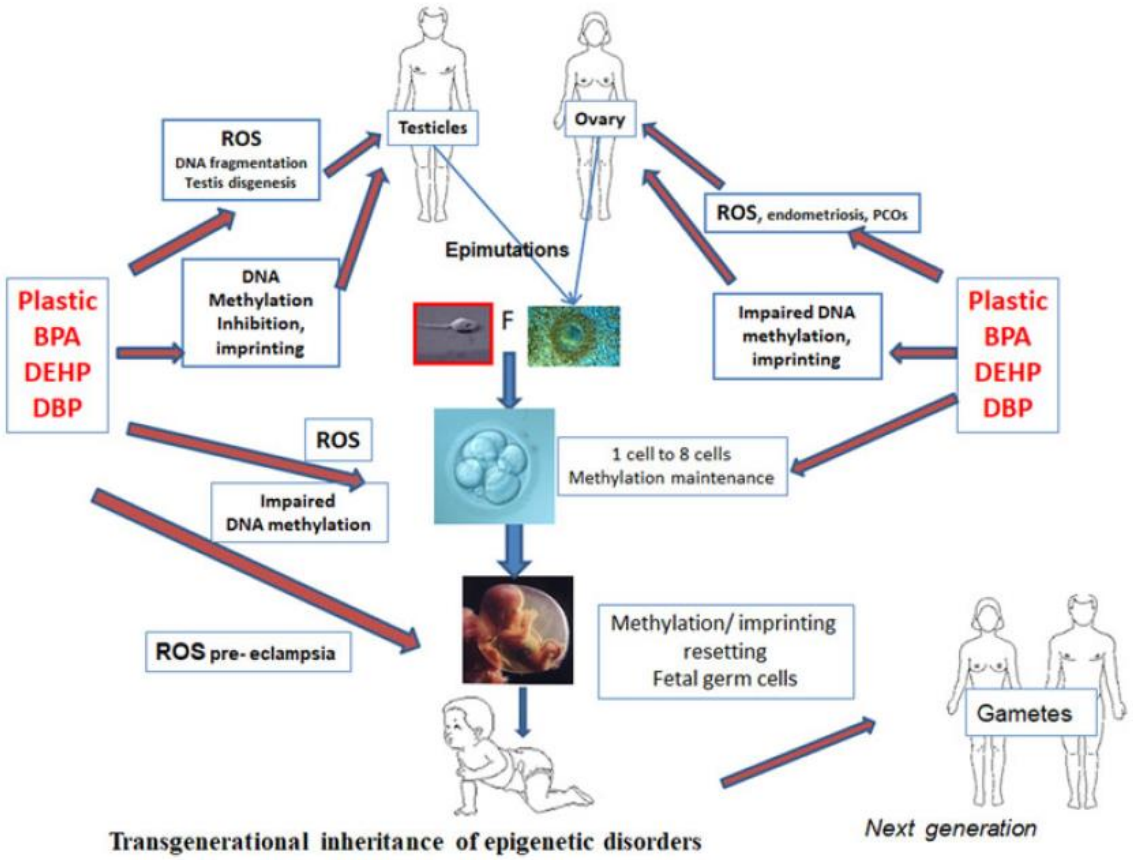


FIGURE 5 EDCs effects on gametes and embryos. EDCs affect negatively methylation, imprinting, and epigenetic marking. The critical steps are gametes during fetal life or early life: this may lead to defective embryo quality. Moreover, embryo preimplantation stages are very sensitive to EDCs as methylation maintenance is very active up to 4–8 cell stages. Imprinting or Epigenetic anomalies may be transgenerationally transmitted, leading to endocrine, and reproductive pathologies [Color figure can be viewed at wileyonlinelibrary.com]

Endocrine disruptors and testicular function

Metabolism Clinical and Experimental 86 (2018) 79–90

Stefania Lymperi [a,*], Aleksander Giwercman [b]

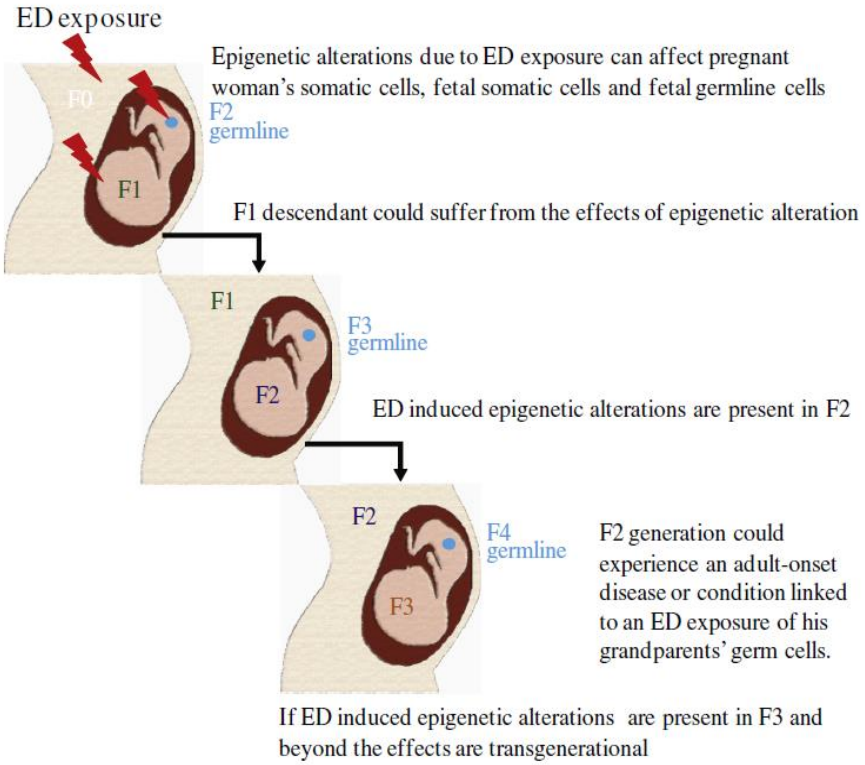
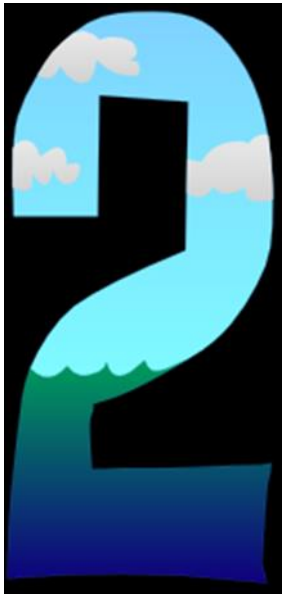


Fig. 4. Schematic representation of the ED induced epigenetic transgenerational inheritance.

1. SOSTANZE CHIMICHE NELL'AMBIENTE
2. **INTERFERENTI ENDOCRINI**
   - meccanismo d'azione
   - **origine**



Carlos Barrios-Estrada [a], Magdalena de Jesús Rostro-Alanis [a], Blanca Delia Muñoz-Gutiérrez [a], Hafiz M.N. Iqbal [a,*], Soundarapandian Kannan [b], Roberto Parra-Saldívar [a,*]

Science of the Total Environment 612 (2018) 1516–1531

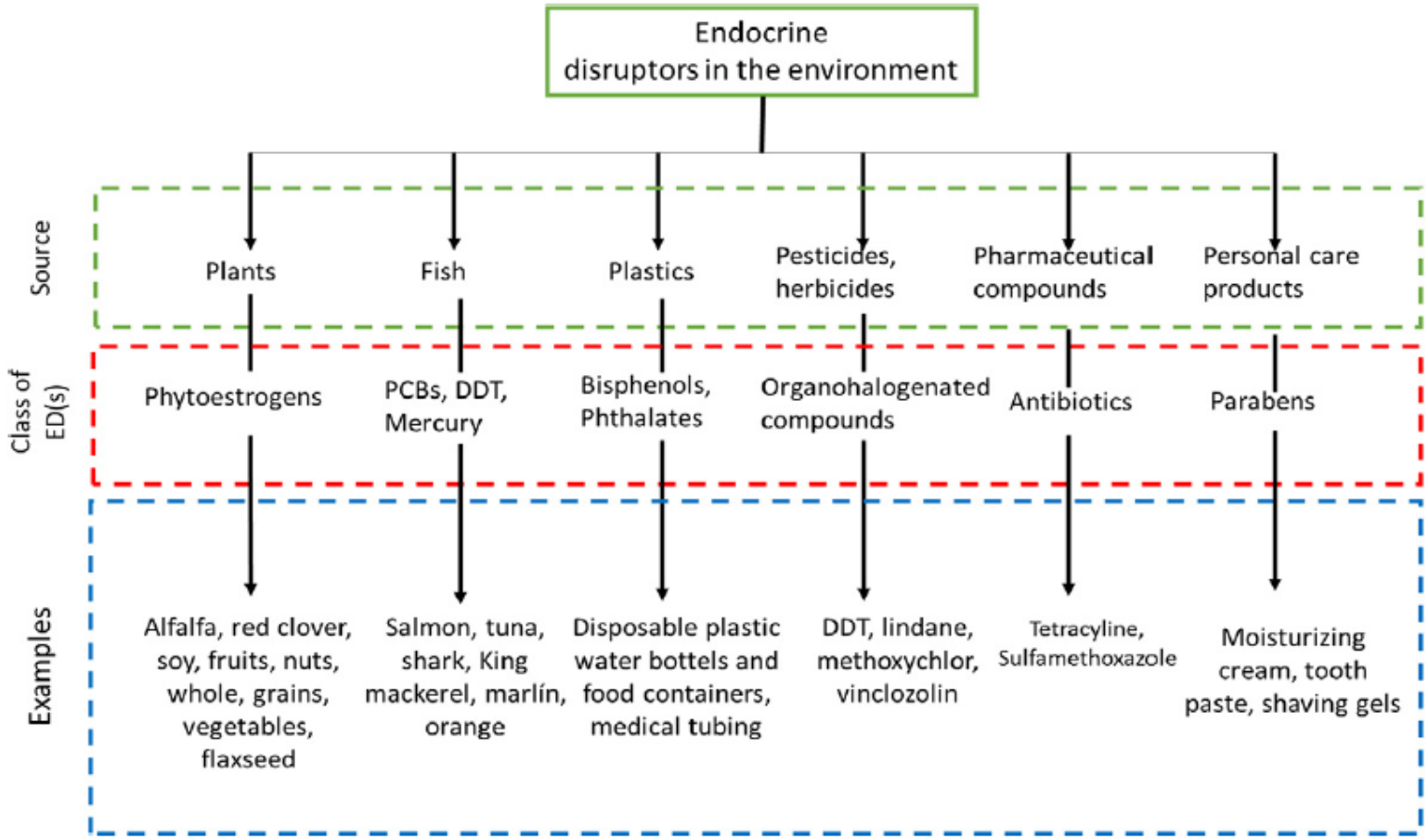
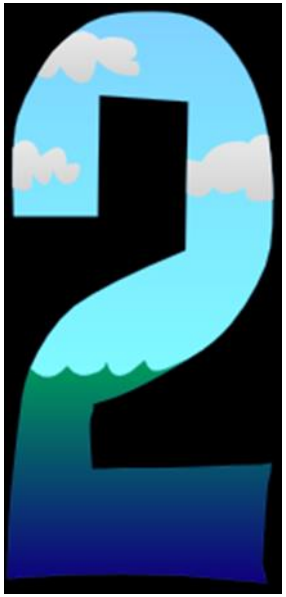


Fig. 2. Common sources of EDs in the environment.

1. SOSTANZE CHIMICHE NELL'AMBIENTE
2. INTERFERENTI ENDOCRINI
   - meccanismo d'azione
   - origine
   - vie d'ingresso nell'organismo



What Are the Sources of Exposure to Eight Frequently Used Phthalic Acid Esters in Europeans?

Risk Analysis, Vol. 26, No. 3, 2006

Matthias Wormuth,[1] Martin Scheringer,[1]* Meret Vollenweider,[1] and Konrad Hungerbühler[1]

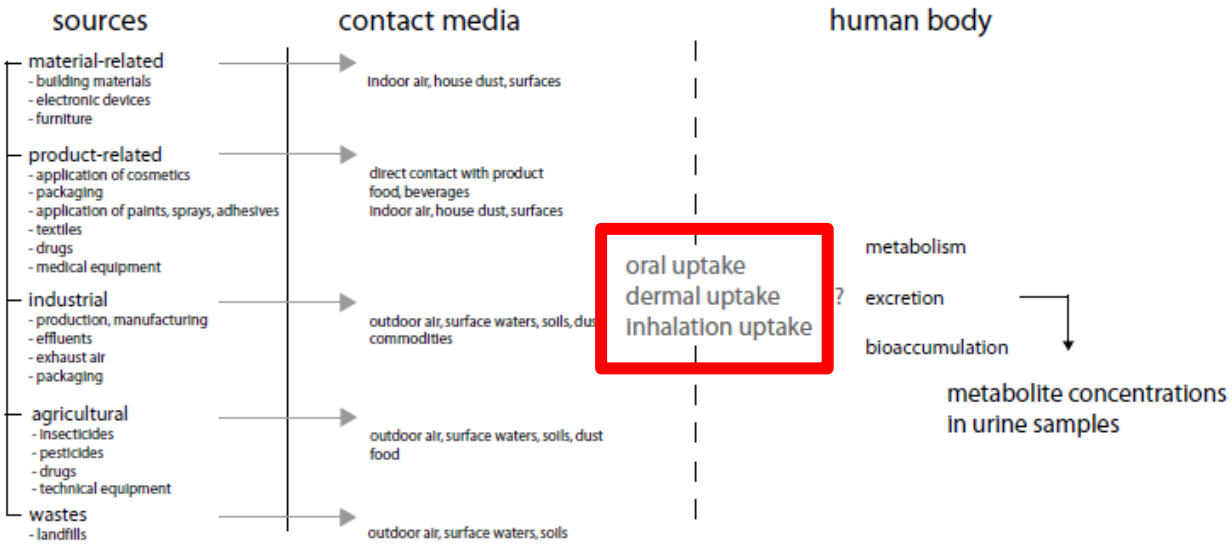
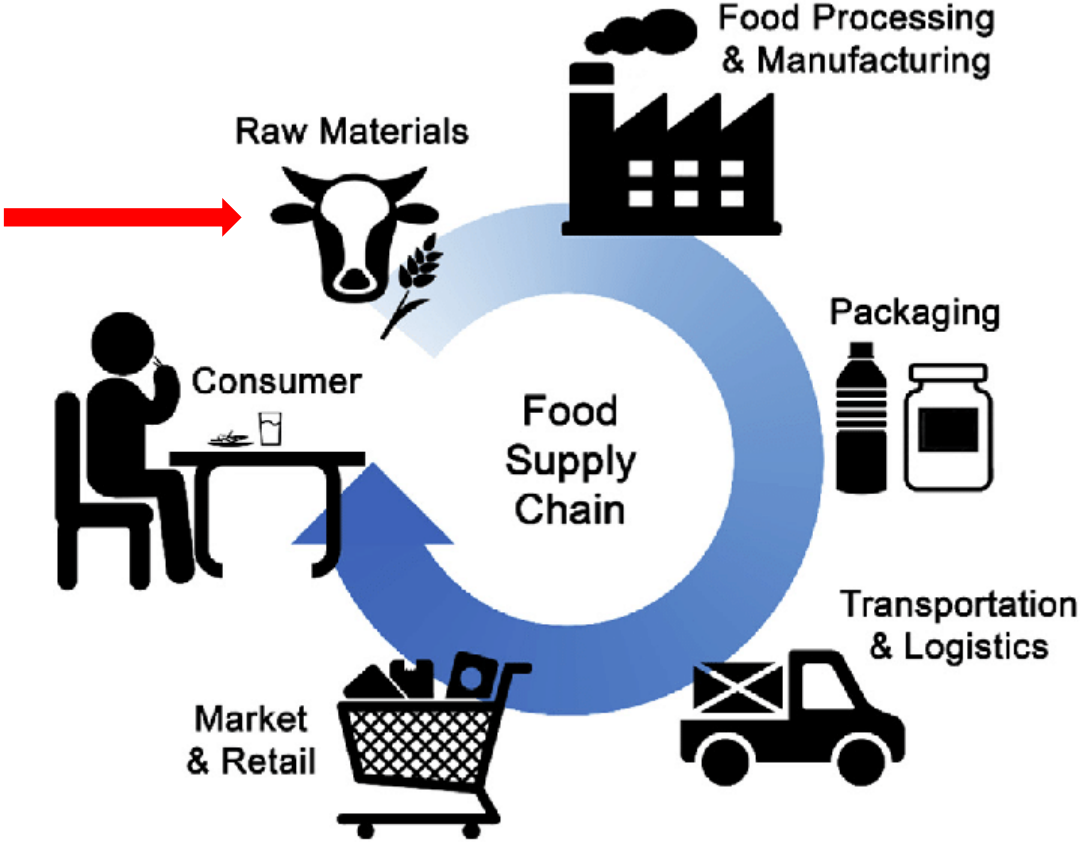


Fig. 1. Consumers are exposed to phthalates via different sources. Measurements of concentrations of phthalate metabolites in urine samples have demonstrated the ubiquitous consumer exposure to these plasticizers.

PESTICIDI

ALLEVAMENTO



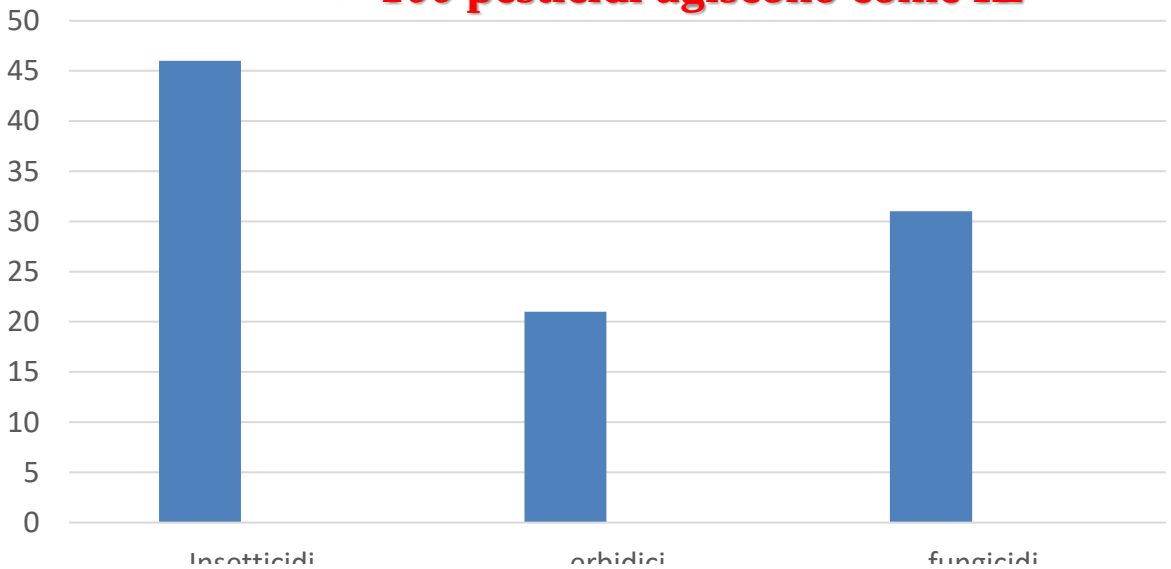
Effect of Endocrine Disruptor Pesticides: A Review

Wissem Mnif [1,2], Aziza Ibn Hadj Hassine [1], Aicha Bouaziz [1], Aghleb Bartegi [3], Olivier Thomas [4] and Benoit Roig [4,*]

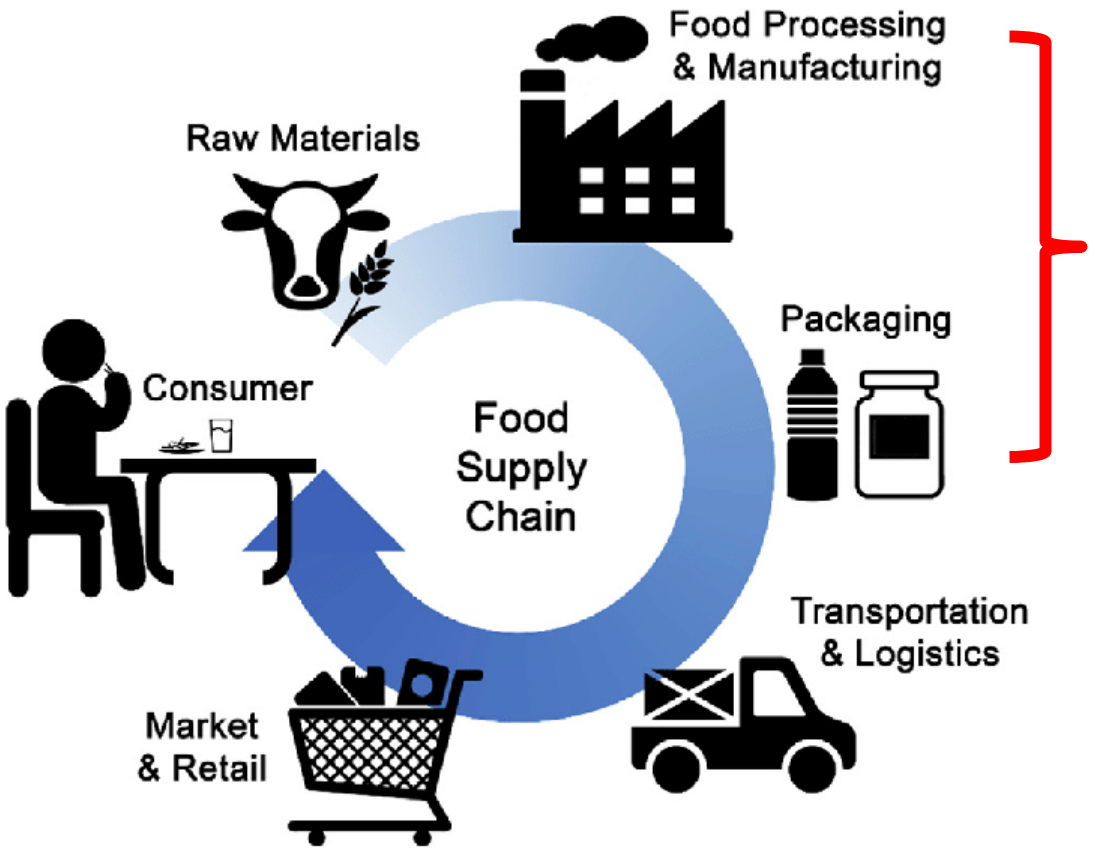
Int. J. Environ. Res. Public Health **2011**, *8*, 2265-2303;

About 105 substances can be listed… some of them were withdrawn from general use many years ago but are still found in the environment (ex. DDT and atrazine in several countries).

> 100 pesticidi agiscono come IE



MICROBIOME Research Hub


Food Processing
& Manufacturing
Raw Materials
Packaging
Consumer
Food
Supply
Chain
Transportation
& Logistics
Market
& Retail

Impacts of food contact chemicals on human health: a consensus statement

Analysis of FCC lists issued by legislatures, industry, and NGOs worldwide indicates that almost 12.000 distinct chemicals may be used in the manufacture of food contact materials and articles [67].

Many of the chemicals that are intentionally used in the manufacture of food contact articles have not been tested for hazard properties at all, or the available toxicity data are limited [67]. Moreover, endocrine disruption, as a specific hazard of concern, is not routinely assessed for chemicals migrating from food contact articles, although some chemical migrants are known endocrine disruptors [73–77].

Children's Exposure to Di(2-ethylhexyl)phthalate and Dibutylphthalate Plasticizers from School Meals

Teresa Cirillo,*,† Evelina Fasano,† Enrica Castaldi,† Paolo Montuori,‡ and Renata Amodio Cocchieri†

J. Agric. Food Chem. 2011, 59, 10532–10538

Table 3. DEHP Concentrations in Ready Courses before (n = 60) and after Packaging at Consuming Time (n = 60)

	DEHP (ng/g ww)			
	before packaging		after packaging	
course	mean ± SD (min–max)	median	mean ± SD (min–max)	median
first[a]	146.6 ± 99.7 (37.9–379.4)	112.6	311.4 ± 255.1 (36.6–1050.8)	224.6
second	182.4 ± 100.3 (24.6–329.5)	154.8	250.4 ± 163.4 (43.6–497.2)	253.3
vegetables	117.0 ± 70.0 (22.6–365.0)	111.4	183.0 ± 140.4 (21.3–365.0)	127.0

[a] First course values showed statistically significant differences between before and after packaging (p = 0.02).

1. SOSTANZE CHIMICHE NELL'AMBIENTE
2. INTERFERENTI ENDOCRINI
3. **IMPATTO SULLA SALUTE**

1. SOSTANZE CHIMICHE NELL'AMBIENTE
2. INTERFERENTI ENDOCRINI
3. **IMPATTO SULLA SALUTE**

- studi epidemiologici e sperimentali

Minireview: Endocrine Disruptors: Past Lessons and Future Directions

Mol Endocrinol, August 2016, 30(8):833–847

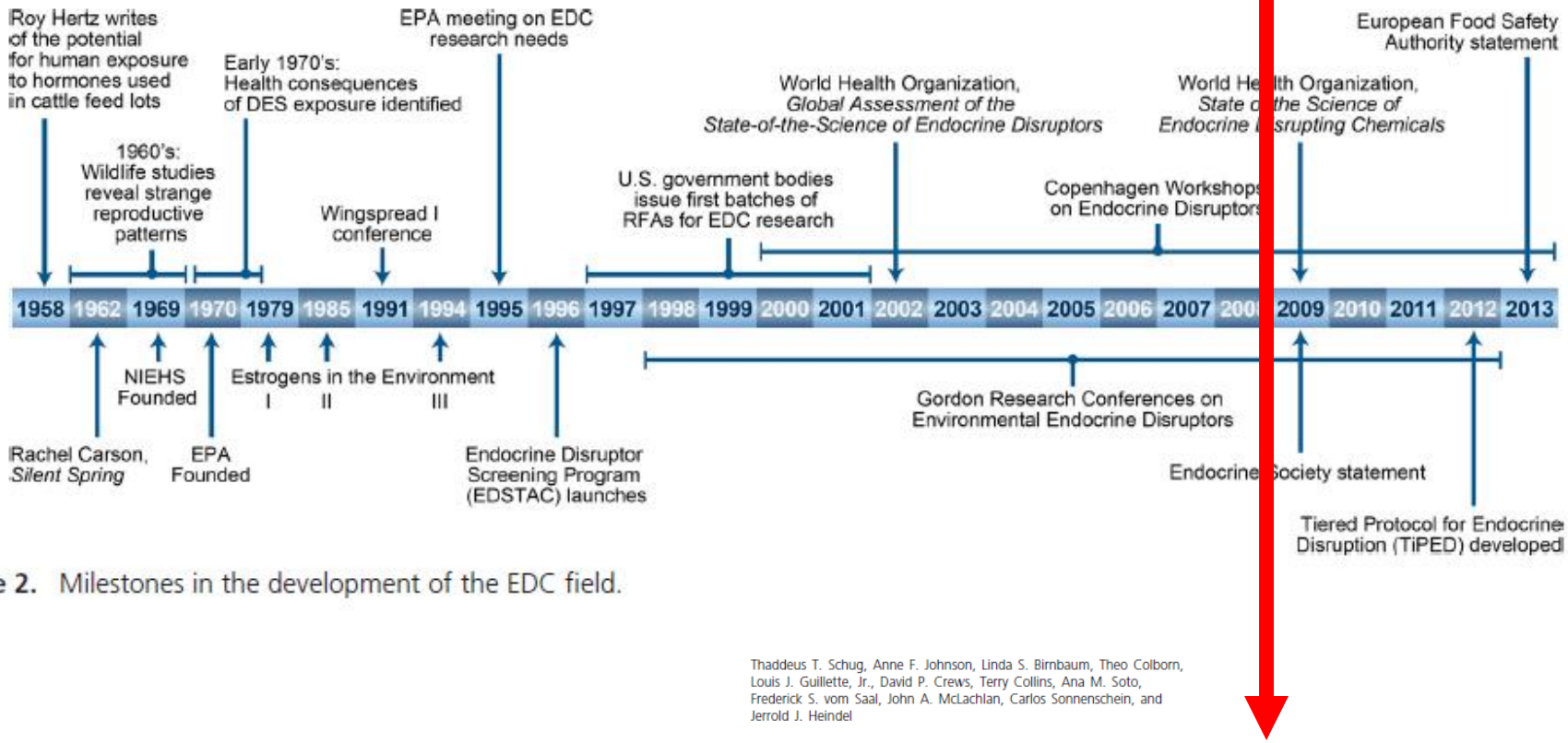
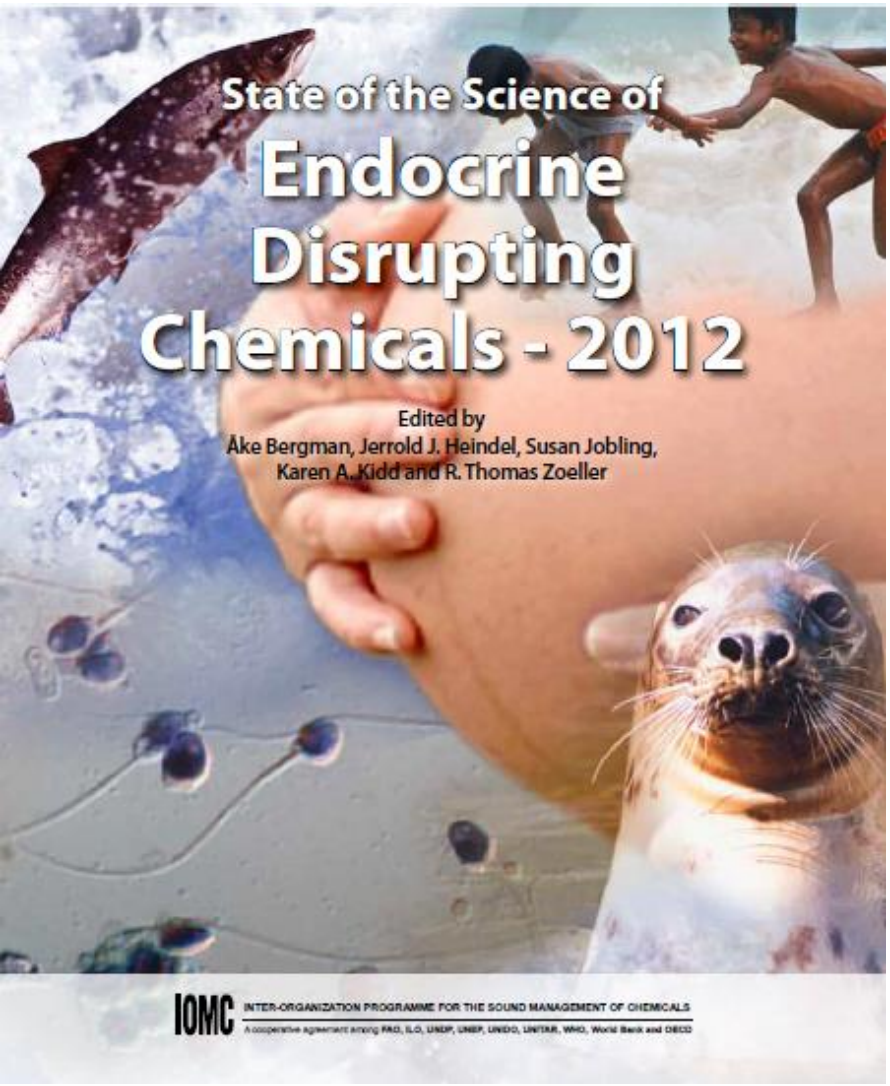


Figure 2. Milestones in the development of the EDC field.

Thaddeus T. Schug, Anne F. Johnson, Linda S. Birnbaum, Theo Colborn, Louis J. Guillette, Jr., David P. Crews, Terry Collins, Ana M. Soto, Frederick S. vom Saal, John A. McLachlan, Carlos Sonnenschein, and Jerrold J. Heindel



World Health Organization

UNEP
United Nations Environment Programme

Figure 1.

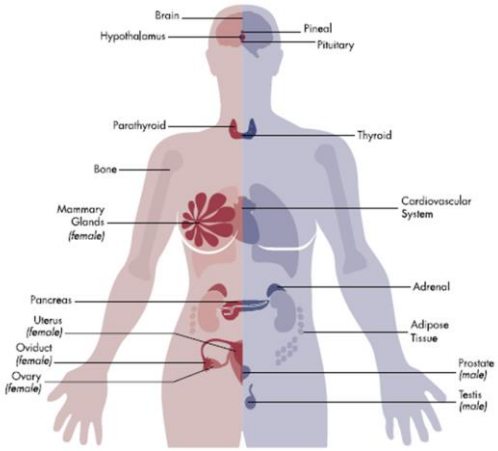


Figure 1. Diagram of many of the body's endocrine glands in females (left) and males (right).

Reproductive Toxicology 42 (2013) 132–155

Bisphenol A and human health: A review of the literature

Johanna R. Rochester*

1. SOSTANZE CHIMICHE NELL'AMBIENTE
2. INTERFERENTI ENDOCRINI
3. **IMPATTO SULLA SALUTE**

   - studi epidemiologici e sperimentali
   - **controversie**

Scientifically unfounded precaution drives European Commission's recommendations on EDC regulation, while defying common sense, well-established science and risk assessment principles

Chemico-Biological Interactions 205 (2013) A1–A5

Daniel R. Dietrich, Editor-in-Chief, Chemico Biological Interactions
Sonja von Aulock, Editor-in-Chief, ALTEX
Hans Marquardt, Editor-in-Chief, Toxicology
Bas Blaauboer, Editor-Europe, Toxicology in Vitro
Wolfgang Dekant, Editor-in-Chief, Toxicology Letters
James Kehrer, Editor-in-Chief, Toxicology Letters
Jan Hengstler, Editor-in-Chief, Archives of Toxicology
Abby Collier, Section Editor, Chemico Biological Interactions
Gio Batta Gori, Editor-in-Chief, Regulatory Pharmacology and Toxicology
Olavi Pelkonen, Editor-in-Chief, Frontiers in Predictive Toxicology
Florian Lang, Editor-in-Chief, Toxins
Frank A. Barile, Editor-in-Chief, Toxicology in Vitro
Frans P. Nijkamp, Editor-in-Chief, European Journal of Pharmacology
Kerstin Stemmer, Assoc. Editor, Toxicology in Vitro
Albert Li, Section Editor, Chemico Biological Interactions
Kai Savolainen, Editor for Europe and rest of the World, Human and Experimental Toxicology
A. Wallace Hayes, Editor for the Americas, Human and Experimental Toxicology and Editor-in-Chief, Food and Chemical Toxicology
Nigel Gooderham, Editor-in-Chief, Toxicology Research
Alan Harvey, Editor-in-Chief, Toxicon

Bergman et al. Environmental Health 2013, 12:69
http://www.ehjournal.net/content/12/1/69

ENVIRONMENTAL HEALTH

COMMENTARY Open Access

Science and policy on endocrine disrupters must not be mixed: a reply to a "common sense" intervention by toxicology journal editors

Åke Bergman[1*], Anna-Maria Andersson[2], Georg Becher[3], Martin van den Berg[4], Bruce Blumberg[5], Poul Bjerregaard[6], Carl-Gustaf Bornehag[7], Riana Bornman[8], Ingvar Brandt[9], Jayne V Brian[10], Stephanie C Casey[5], Paul A Fowler[11], Heloise Frouin[12], Linda C Giudice[13], Taisen Iguchi[14], Ulla Hass[15], Susan Jobling[10], Anders Juul[2], Karen A Kidd[16], Andreas Kortenkamp[10], Monica Lind[9], Olwenn V Martin[10], Derek Muir[17], Roseline Ochieng[18], Nicolas Olea[19], Leif Norrgren[20], Erik Ropstad[21], Peter S Ross[12], Christina Rudén[22], Martin Scheringer[23], Niels Erik Skakkebaek[2], Olle Söder[24], Carlos Sonnenschein[25], Ana Soto[25], Shanna Swan[26], Jorma Toppari[27], Charles R Tyler[28], Laura N Vandenberg[29], Anne Marie Vinggaard[15], Karin Wiberg[20] and R Thomas Zoeller[30]

"Common sense is the collection of prejudices acquired by age eighteen"

- Albert Einstein

MICROBIOME Research Hub

Editorial

Human exposure to synthetic endocrine disrupting chemicals (S-EDCs) is generally negligible as compared to natural compounds with higher or comparable endocrine activity. How to evaluate the risk of the S-EDCs?

Chemico-Biological Interactions 326 (2020) 109099

Sir Colin Berry
Queen Mary University of London, UK

As outlined above, the potencies of S-EDCs are much lower than for N-EDCs, drugs or endogenous hormones. Therefore, at the low human exposures that have been demonstrated in all sensibly conducted studies, S-EDCs have virtually no chance to physiologically compete with natural hormones in binding to free receptors. This implies that the health risks of the known S-EDCs are nil or at least negligible. On these grounds and with the conservative assumption of similar endocrine mechanisms for S-EDCs, N-EDC and endogenous hormones, it is proposed to compare S-EDCs potencies with standard N-EDCs using appropriate *in vitro* test systems. Selection of the reference N-EDCs should be based on their potencies compared to the corresponding physiological hormones. When the potency of an S-EDC is similar or lower than for the N-EDC standard, further studies and regulatory consequences will not be warranted.

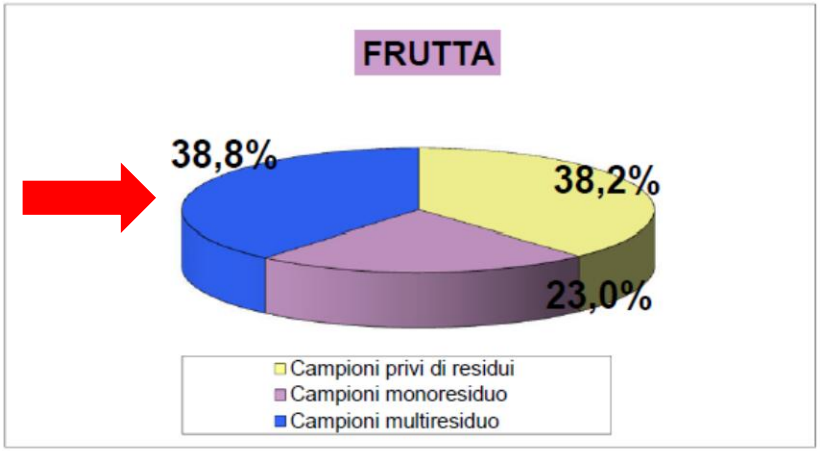
Clinical expression of endocrine disruptors in children

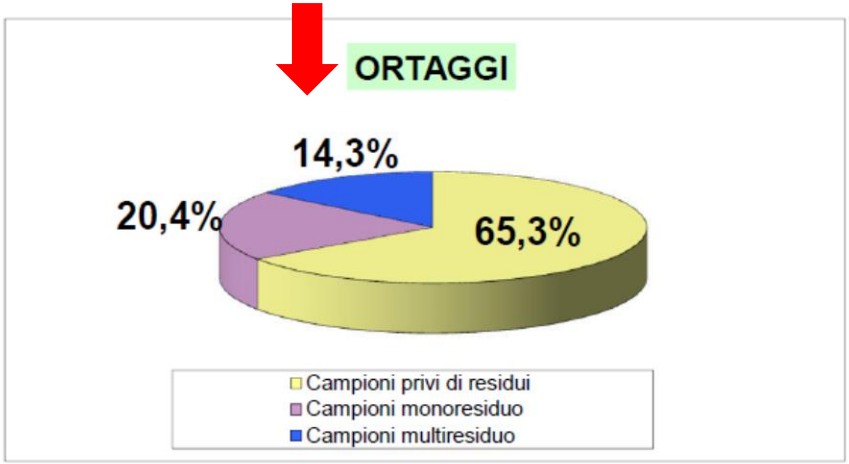
Lorenzo Iughetti[a], *Laura Lucaccioni*[a], *Maria E. Street*[b], *and Sergio Bernasconi*[c]

Curr Opin Pediatr 2020, 32:554–559

(1) Each human being is exposed to many different EDCs over time, to a mixture rather than to single compounds.
(2) Effects may be not dose dependent, and exposure to low doses of chemicals could induce disrupting effects.
(3) Different animal species react differently to the same compound, thus it is impossible to reliably infer directly what occurs in wildlife to human beings.
(4) Age groups and sexes react differently and fetal life is the most susceptible period, as discussed in the following chapters.
(5) EDCs may have transgenerational effects with an impact on health visible only in the next generations. These effects are thought to be mediated via epigenetic mechanisms that transfer the effects to the next generations in the absence of direct exposure.
(6) It is not possible to relate exposure directly to a disease, especially when the lag time is of years.
(7) EDCs are not pure agonists or antagonists of a single hormone receptor or pathway.
(8) Bioavailability differs among EDCs as they may or may not bind to binding proteins and/or be rapidly metabolized and excreted or be deposited in specific tissues (especially fat) and slowly released over time.

Graf. 11


FRUTTA
38,8%
38,2%
23,0%
Campioni privi di residui
Campioni monoresiduo
Campioni multiresiduo


ORTAGGI
14,3%
20,4%
65,3%
Campioni privi di residui
Campioni monoresiduo
Campioni multiresiduo

Clinical expression of endocrine disruptors in children

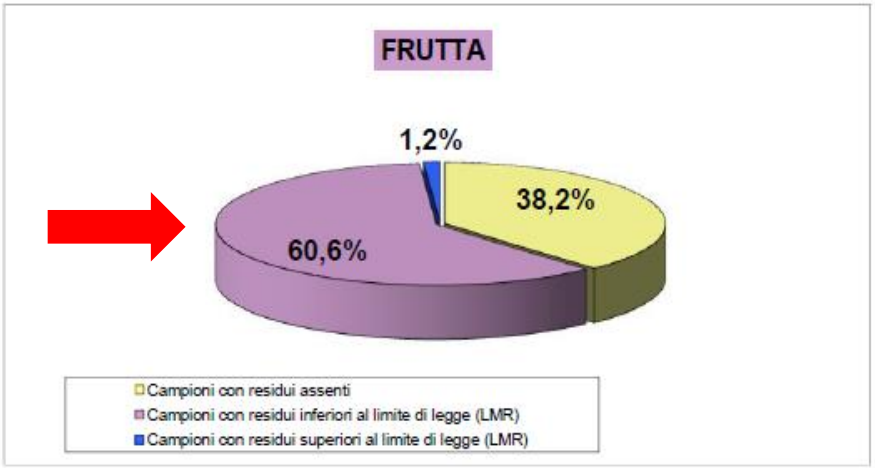
Lorenzo Iughetti[a], *Laura Lucaccioni*[a], *Maria E. Street*[b], *and Sergio Bernasconi*[c]

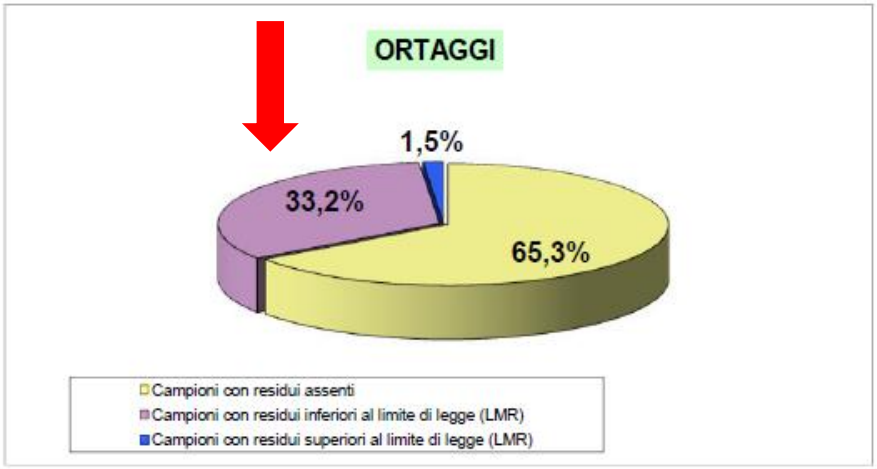
Curr Opin Pediatr 2020, 32:554–559

(1) Each human being is exposed to many different EDCs over time, to a mixture rather than to single compounds.
(2) Effects may be not dose dependent, and exposure to low doses of chemicals could induce disrupting effects.
(3) Different animal species react differently to the same compound, thus it is impossible to reliably infer directly what occurs in wildlife to human beings.
(4) Age groups and sexes react differently and fetal life is the most susceptible period, as discussed in the following chapters.
(5) EDCs may have transgenerational effects with an impact on health visible only in the next generations. These effects are thought to be mediated via epigenetic mechanisms that transfer the effects to the next generations in the absence of direct exposure.
(6) It is not possible to relate exposure directly to a disease, especially when the lag time is of years.
(7) EDCs are not pure agonists or antagonists of a single hormone receptor or pathway.
(8) Bioavailability differs among EDCs as they may or may not bind to binding proteins and/or be rapidly metabolized and excreted or be deposited in specific tissues (especially fat) and slowly released over time.

Distribuzione dei residui di prodotti fitosanitari su ortofrutta

Graf. 7





Non-monotonic dose-response relationships and endocrine disruptors: a qualitative method of assessment

Fabien Lagarde[1], Claire Beausoleil[1*], Scott M Belcher[2], Luc P Belzunces[3], Claude Emond[4], Michel Guerbet[5] and Christophe Rousselle[1]

Lagarde *et al. Environmental Health* 2015, **14**:13
http://www.ehjournal.net/content/14/1/13

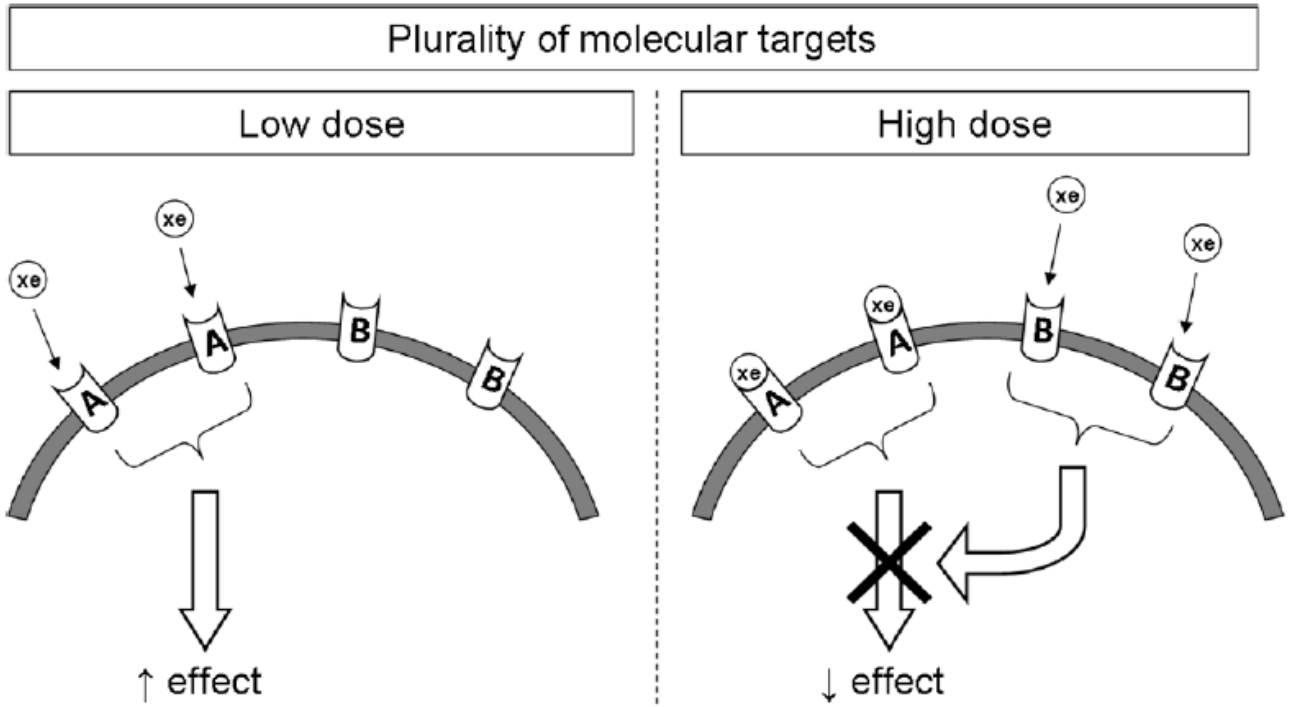


Figure 2 Mechanism of the NMDR relationship phenomenon induced by the "plurality of molecular targets". At low concentrations, EDC binds to the A receptors and induces the observed effect. At high concentrations, the A receptors are still activated and EDC binds to the B receptors, which induces the opposite effect, resulting in an NMDR. Notes: A = Receptor A; B = Receptor B; xe = xenobiotic (e.g., EDC); affinity for A > B.

Non-monotonic dose-response relationships and endocrine disruptors: a qualitative method of assessment

Fabien Lagarde[1], Claire Beausoleil[1*], Scott M Belcher[2], Luc P Belzunces[3], Claude Emond[4], Michel Guerbet[5] and Christophe Rousselle[1]

Lagarde *et al. Environmental Health* 2015, **14**:13
http://www.ehjournal.net/content/14/1/13

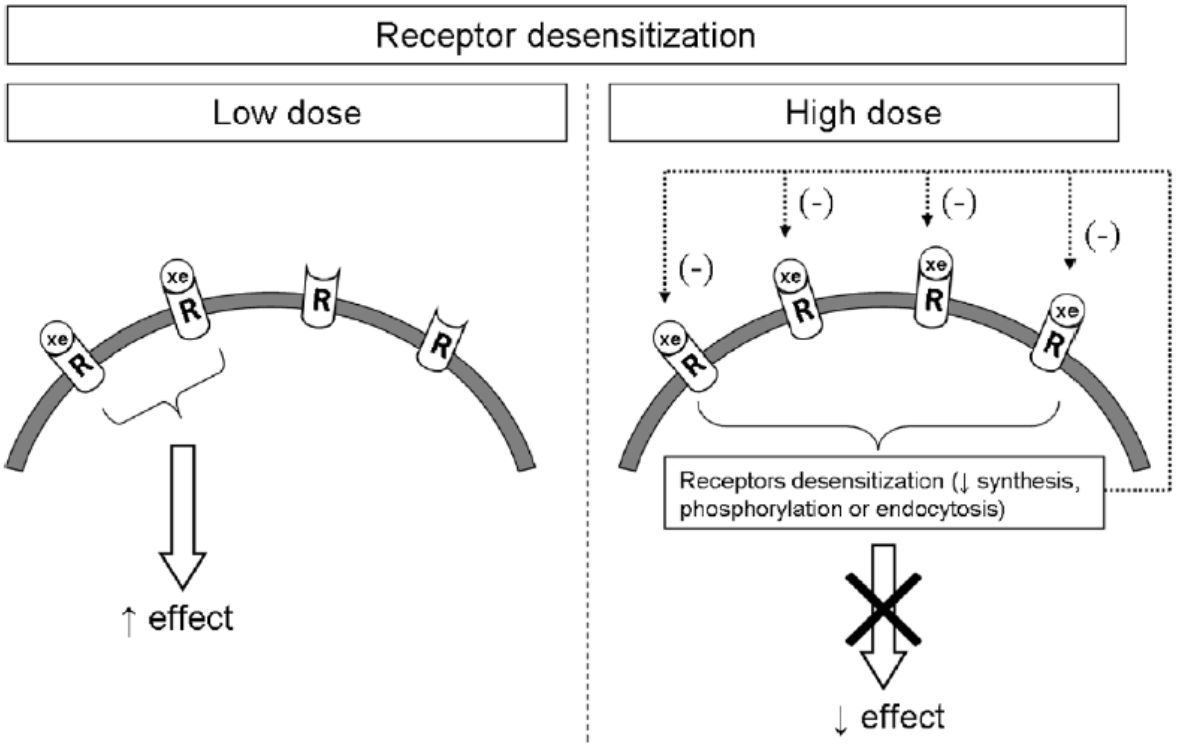


Figure 3 Mechanism of the NMDR phenomenon induced by "receptor desensitization". At low concentrations, EDC binds to some receptors and induces the observed effect. At high concentrations, numerous receptors are bound, resulting in a down-regulation phenomenon characterized by receptor desensitization. Consequently, the intensity of the effect is decreased, resulting in an NMDR. Note: (-) = negative effect; R = receptor; xe = xenobiotic (e.g., EDC).

Non-monotonic dose-response relationships and endocrine disruptors: a qualitative method of assessment

Fabien Lagarde[1], Claire Beausoleil[1*], Scott M Belcher[2], Luc P Belzunces[3], Claude Emond[4], Michel Guerbet[5] and Christophe Rousselle[1]

Lagarde *et al. Environmental Health* 2015, **14**:13
http://www.ehjournal.net/content/14/1/13

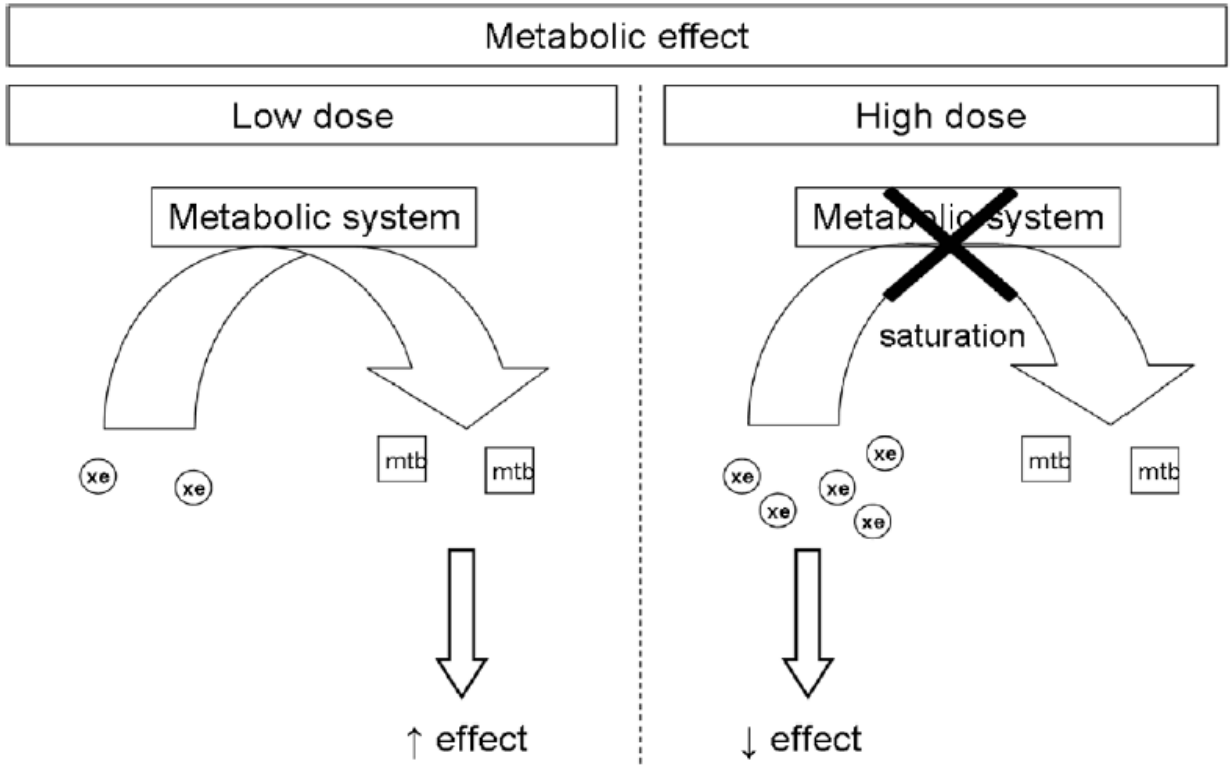


Figure 4 Mechanism of the NMDR relationship phenomenon induced by one of the "metabolic effect" hypotheses. At low concentrations, EDC is catabolized into active metabolites that induce the observed effect. At high concentrations, the metabolic system is saturated, and the parent substance induces an opposite effect, resulting in an NMDR relationship. Note: Mtb = metabolite; xe = xenobiotic (e.g., EDC).

Clinical expression of endocrine disruptors in children

Lorenzo Iughetti[a], *Laura Lucaccioni*[a], *Maria E. Street*[b], *and Sergio Bernasconi*[c]

Curr Opin Pediatr 2020, 32:554–559

(1) Each human being is exposed to many different EDCs over time, to a mixture rather than to single compounds.
(2) Effects may be not dose dependent, and exposure to low doses of chemicals could induce disrupting effects.
(3) Different animal species react differently to the same compound, thus it is impossible to reliably infer directly what occurs in wildlife to human beings.
(4) Age groups and sexes react differently and fetal life is the most susceptible period, as discussed in the following chapters.
(5) EDCs may have transgenerational effects with an impact on health visible only in the next generations. These effects are thought to be mediated via epigenetic mechanisms that transfer the effects to the next generations in the absence of direct exposure.
(6) It is not possible to relate exposure directly to a disease, especially when the lag time is of years.
(7) EDCs are not pure agonists or antagonists of a single hormone receptor or pathway.
(8) Bioavailability differs among EDCs as they may or may not bind to binding proteins and/or be rapidly metabolized and excreted or be deposited in specific tissues (especially fat) and slowly released over time.

1. SOSTANZE CHIMICHE NELL'AMBIENTE
2. INTERFERENTI ENDOCRINI
3. IMPATTO SULLA SALUTE

- studi epidemiologici e sperimentali
- controversie
- nuove impostazioni della ricerca

1. SOSTANZE CHIMICHE NELL'AMBIENTE
2. INTERFERENTI ENDOCRINI
3. IMPATTO SULLA SALUTE

- studi epidemiologici e sperimentali
- controversie
- nuove impostazioni della ricerca
- alcuni esempi

Brett T. Doherty[1] · Jeremy P. Koelmel[2] · Elizabeth Z. Lin[2] · Megan E. Romano[1] · Krystal J. Godri Pollitt[2]

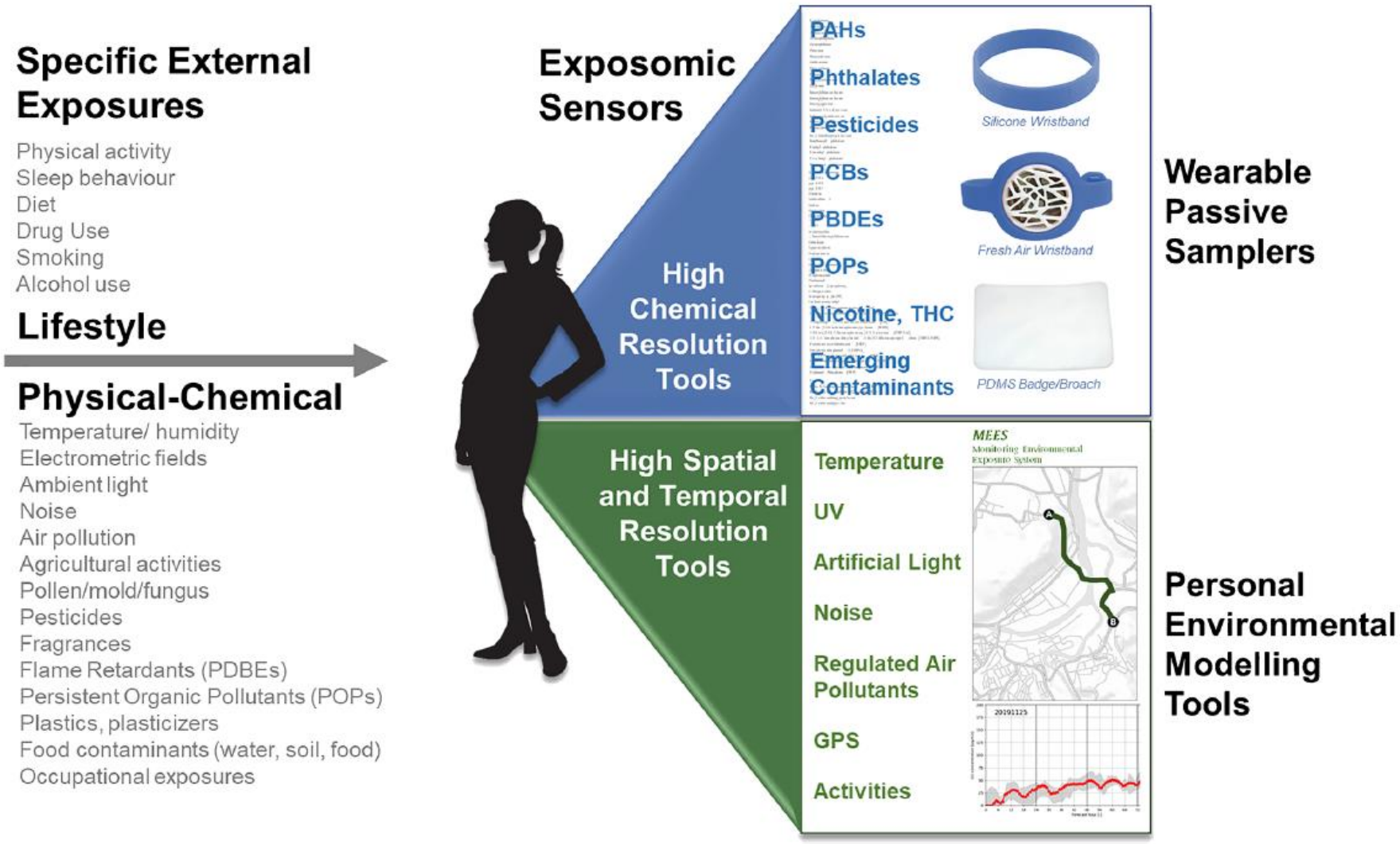


Fig. 1 Exposomic sensors for capturing high chemical and spatiotemporal resolution measurements of external exposures related to physical-chemical and lifestyle stressors. Examples of these external factors have been adapted from Vermeulen et al. [1••].

Integrating -Omics Approaches into Human Population-Based Studies of Prenatal and Early-Life Exposures

Todd M. Everson [1] · Carmen J. Marsit [1,2]

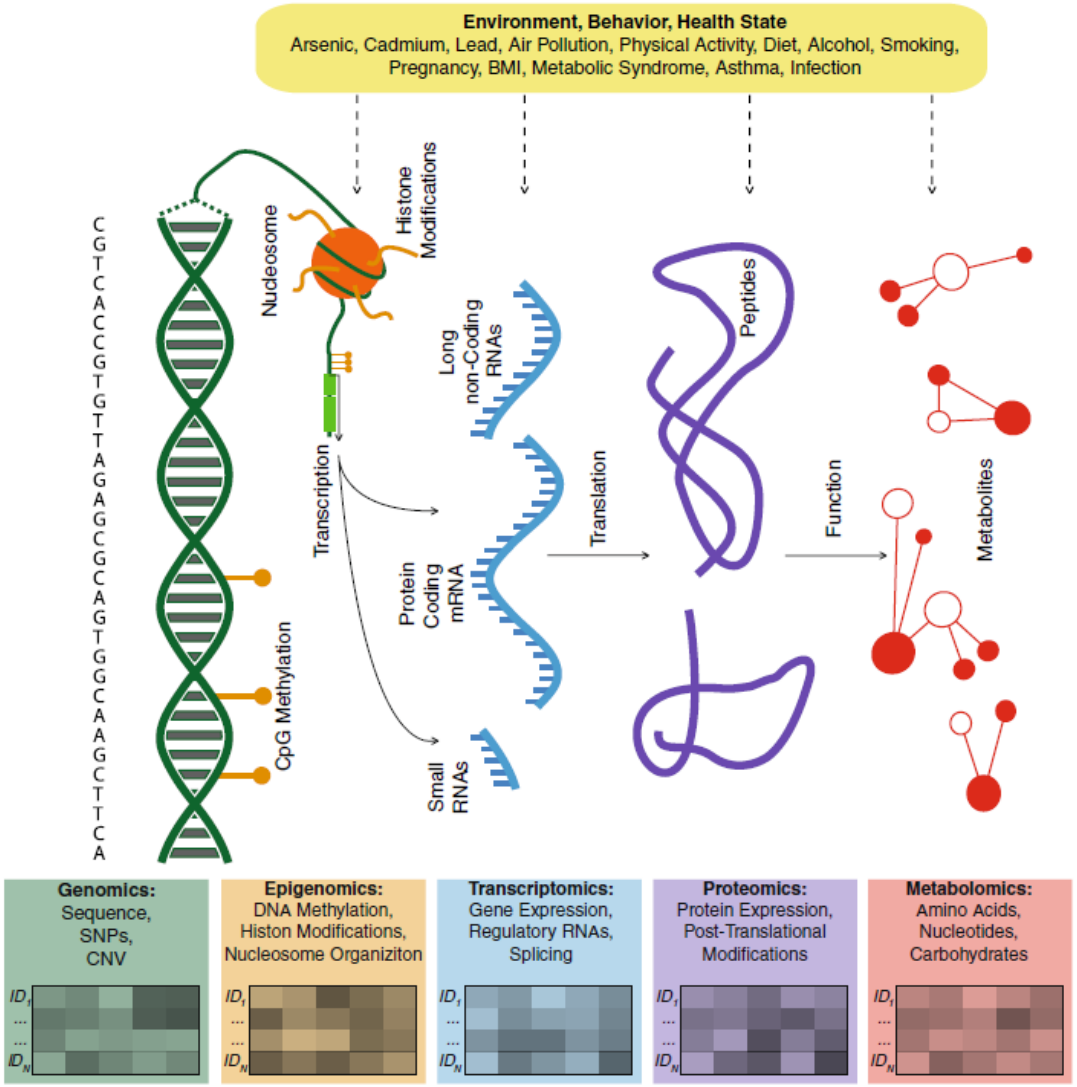


Fig. 1 Environmental exposures, as well as behaviors and disease processes, can influence the activities of multiple molecular domains individually or at the system levels. Epigenomics includes molecules that interact with DNA to regulate gene expression potential, transcriptomics includes expression of RNAs, proteomics includes the expression levels of peptides, and metabolomics includes the activities and interactions of metabolites. While the genomic sequence is biologically inherited, genotype may influence the biological response to certain exposures across multiple domains. SNP, single nucleotide polymorphisms; CNV, copy number variations; CpG, cytosine-phosphate-guanine

Early-life exposure to widespread environmental toxicants and maternal-fetal health risk: A focus on metabolomic biomarkers

Science of the Total Environment 739 (2020) 139626

Yifeng Dai [a,b], Xia Huo [c], Zhiheng Cheng [a,d], Marijke M. Faas [b,e], Xijin Xu [a,f,*]

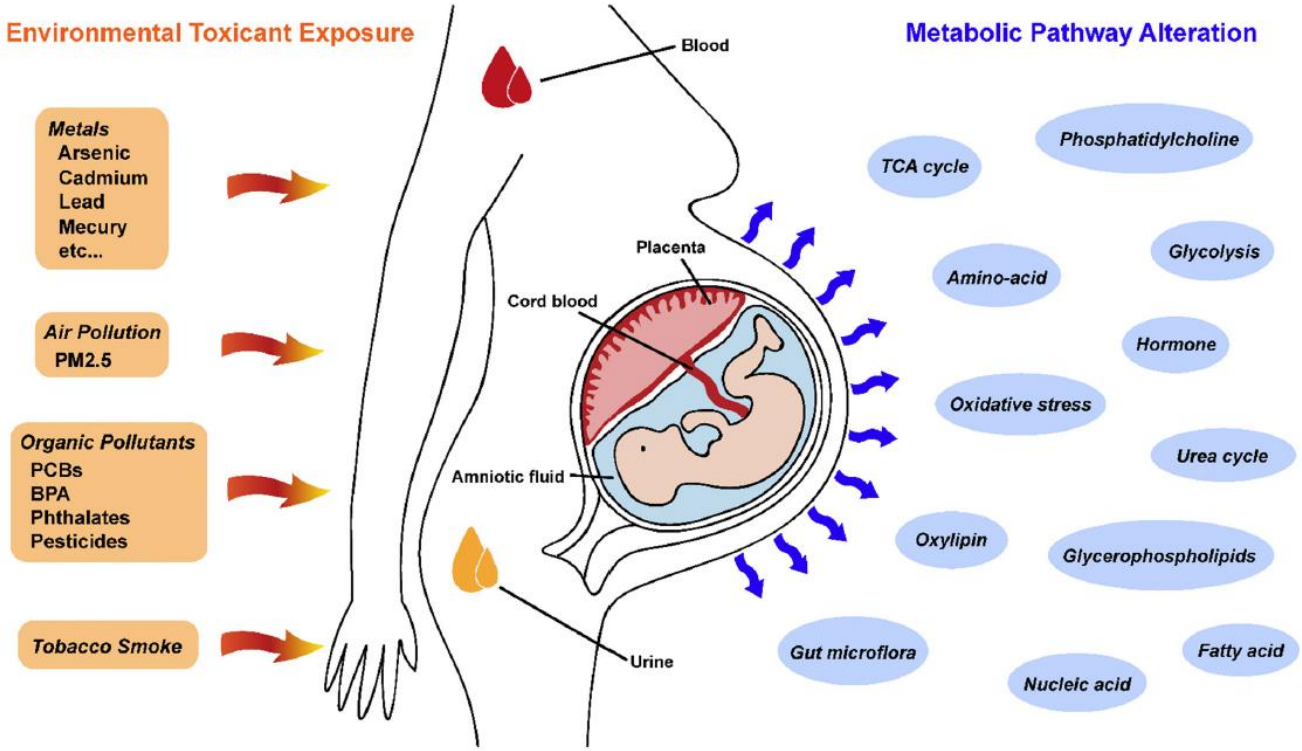


Fig. 2. Effects of environmental toxicant exposure on the alteration of metabolic pathways in maternal blood and urine, cord blood, placenta and amniotic fluid.

MICROBIOME Research Hub

Review

The Need for Multi-Omics Biomarker Signatures in Precision Medicine

Michael Olivier [1,*], Reto Asmis [1], Gregory A. Hawkins [2], Timothy D. Howard [3] and Laura A. Cox [1]

Int. J. Mol. Sci. **2019**, *20*, 4781; doi:10.3390/ijms20194781

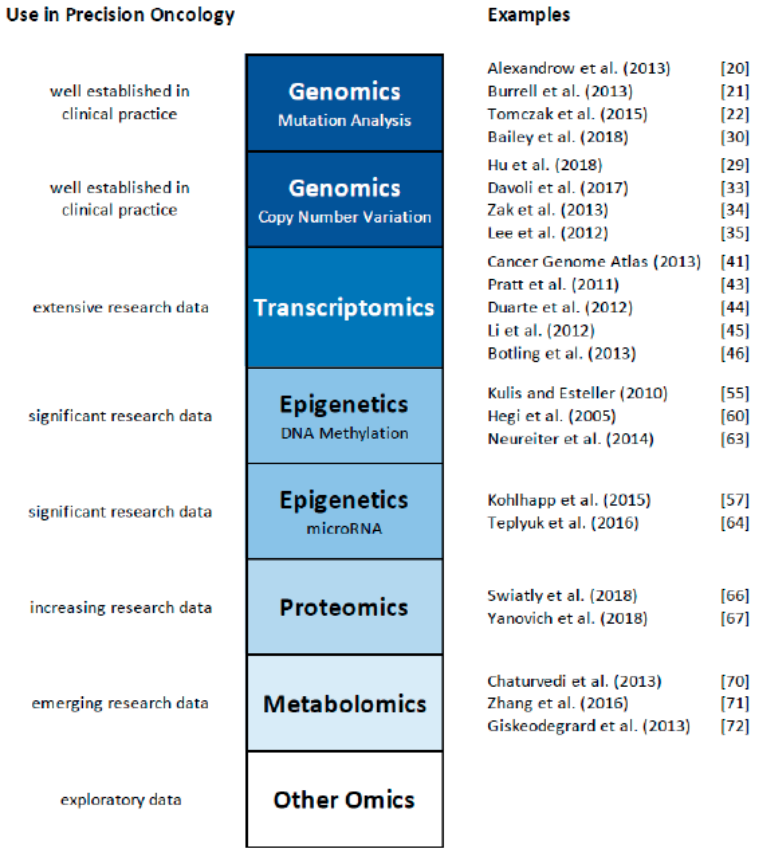


Figure 1. Summary of the applications of individual omics technologies to study cancer and other human disorders.

Messerlian C, Martinez RM, Hauser R, Baccarelli AA. 'Omics' and endocrine-disrupting chemicals - new paths forward. Nat Rev Endocrinol. 2017 Dec;13(12):740-748.

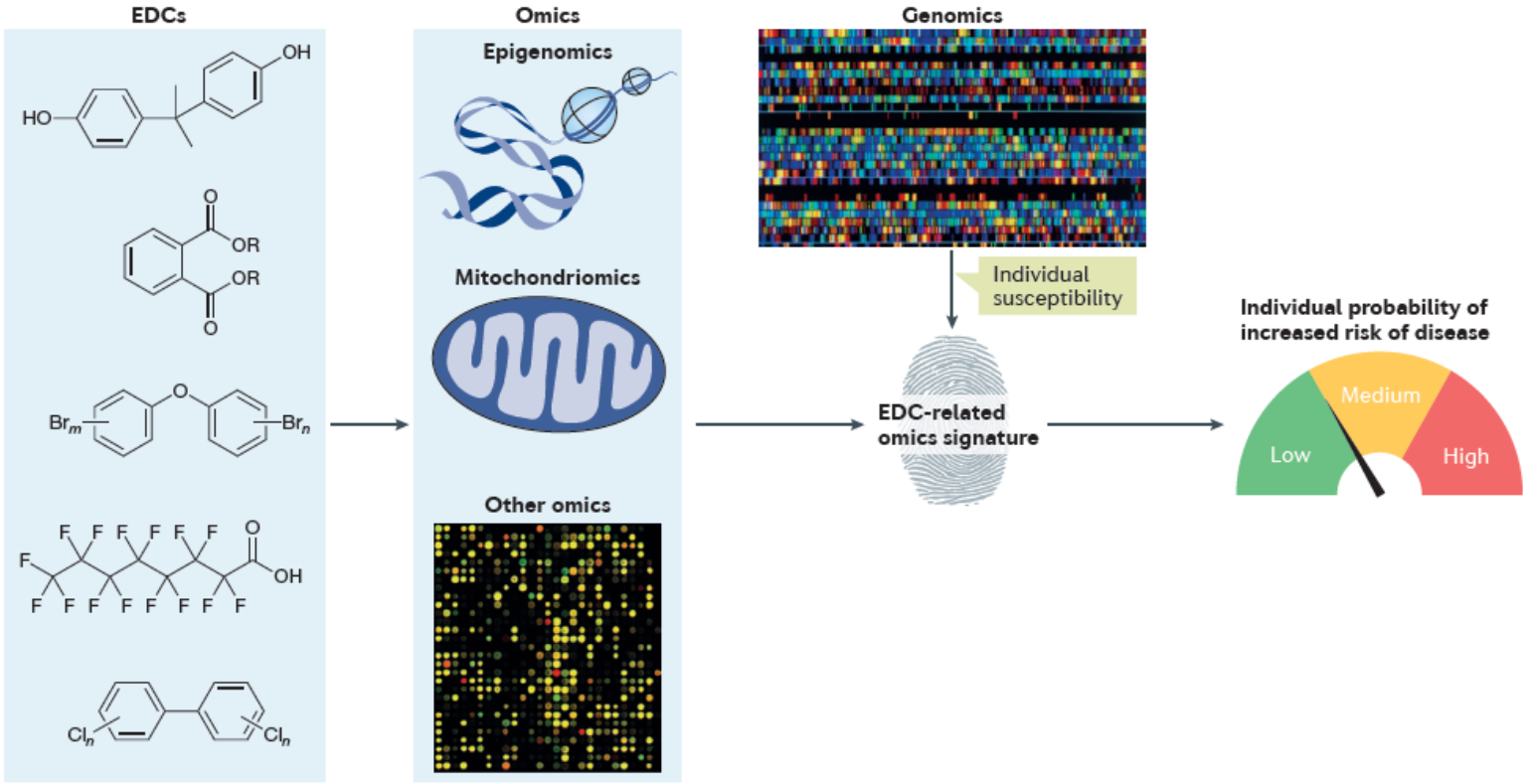
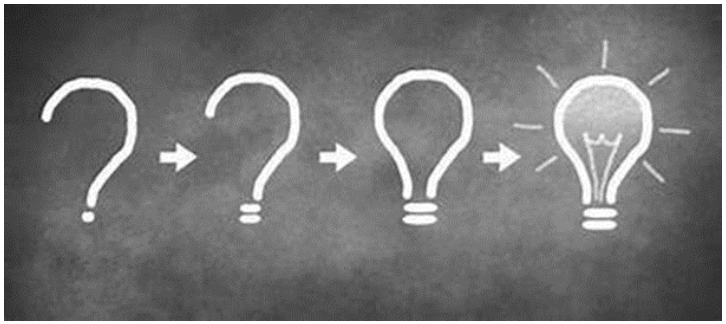


Figure 2 | **Role of omics in identifying molecular fingerprints in EDC research.** Schematic representation of the overall paradigm of using genomics, epigenomics, mitochondriomics and other omics technologies in endocrine-disrupting chemical (EDC) research to create unique molecular 'fingerprints' that represent personal exposure, dose, biological response and susceptibility to EDCs.

MICROBIOME Research Hub

IN ATTESA CHE IL PROGRESSO SCIENTIFICO DIA RISPOSTE ?



1. SOSTANZE CHIMICHE NELL'AMBIENTE
2. INTERFERENTI ENDOCRINI
3. IMPATTO SULLA SALUTE
4. **APPROCCIO PRECAUZIONALE**

THE ENDOCRINE SOCIETY®

POSITION STATEMENT

ENDOCRINE-DISRUPTING CHEMICALS
JUNE 2009

- Policy should be developed and revised under the direction of a collaborative group comprising endocrinologists, toxicologists, epidemiologists, and policymakers. The same group should identify knowledge gaps and recommend research directions to fill those gaps.

- **Until such time as conclusive scientific evidence exists to either prove or disprove harmful effects of substances, a precautionary approach should be taken in the formulation of EDC policy.**

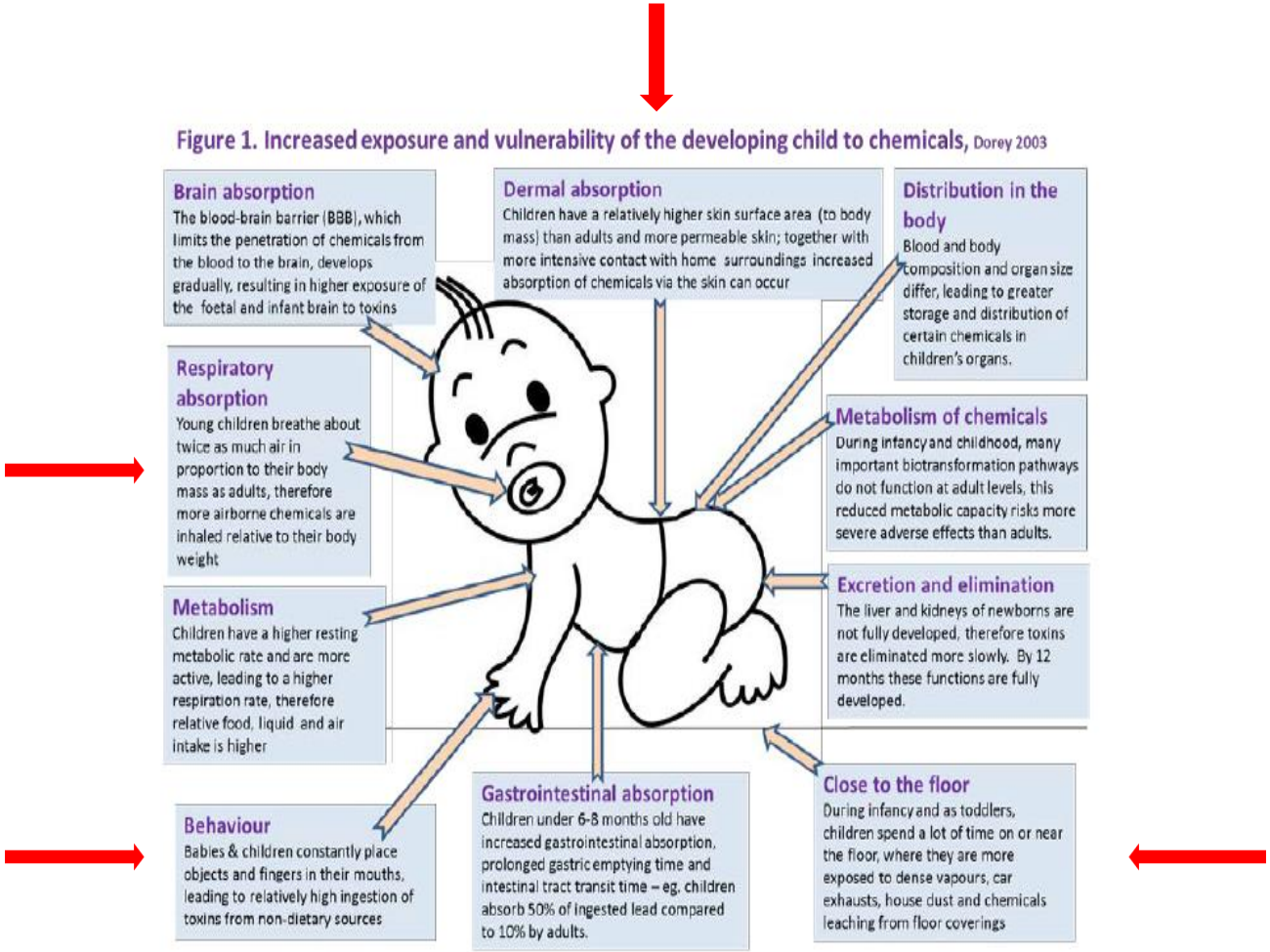
- The federal government should develop a public awareness campaign to inform the public of the risks and potential risks related to the presence of EDCs in the environment and in the food supply.

MICROBIOME Research Hub

PERIODO FETALE

PRIMI DUE ANNI POSTNATALI

Figure 1. Increased exposure and vulnerability of the developing child to chemicals, Dorey 2003



Review

Endocrine-Disrupting Chemicals in Human Fetal Growth

Int. J. Mol. Sci. **2020**, *21*, 1430; doi:10.3390/ijms21041430

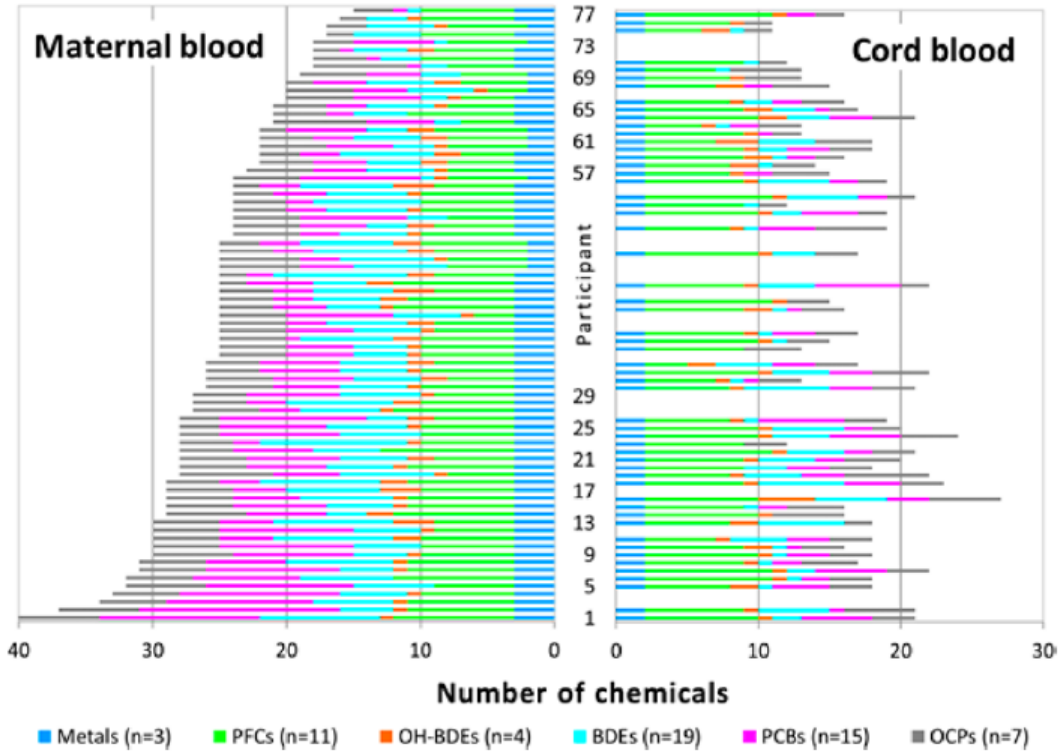
Maria Elisabeth Street [1] and Sergio Bernasconi [2,*]

Periodo fetale

Environmental Chemicals in an Urban Population of Pregnant Women and Their Newborns from San Francisco

DOI: 10.1021/acs.est.6b03492
Environ. Sci. Technol. 2016, 50, 12464−12472

Rachel Morello-Frosch,[*,†,‡] Lara J. Cushing,[○] Bill M. Jesdale,[†] Jackie M. Schwartz,[§] Weihong Guo,[∥] Tan Guo,[∥] Miaomiao Wang,[∥] Suhash Harwani,[∥] Syrago-Styliani E. Petropoulou,[∥] Wendy Duong,[∥] June-Soo Park,[∥] Myrto Petreas,[∥] Ryszard Gajek,[⊥] Josephine Alvaran,[⊥] Jianwen She,[⊥] Dina Dobraca,[#] Rupali Das,[#] and Tracey J. Woodruff[*,§]



MICROBIOME Research Hub

Review of the environmental prenatal exposome and its relationship to maternal and fetal health

Julia E. Rager[a,b,c,*], Jacqueline Bangma[a], Celeste Carberry[a], Alex Chao[e], Jarod Grossman[f], Kun Lu[a,c], Tracy A. Manuck[b,g], Jon R. Sobus[d], John Szilagyi[a], Rebecca C. Fry[a,b,c]

Reproductive Toxicology 98 (2020) 1–12

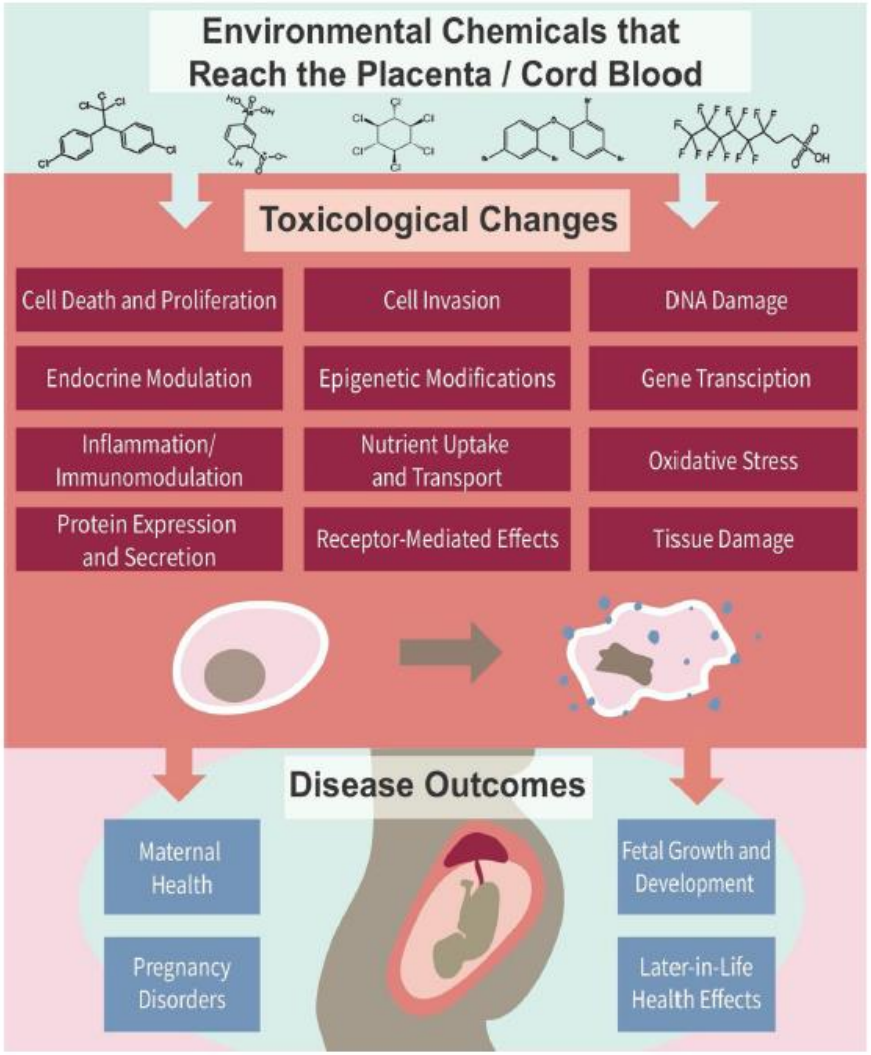


Fig. 3. Example toxicological endpoints and disease outcomes that can be related to measures of the prenatal exposome to better understand relationships and mechanisms underlying environmental exposure-induced disease.

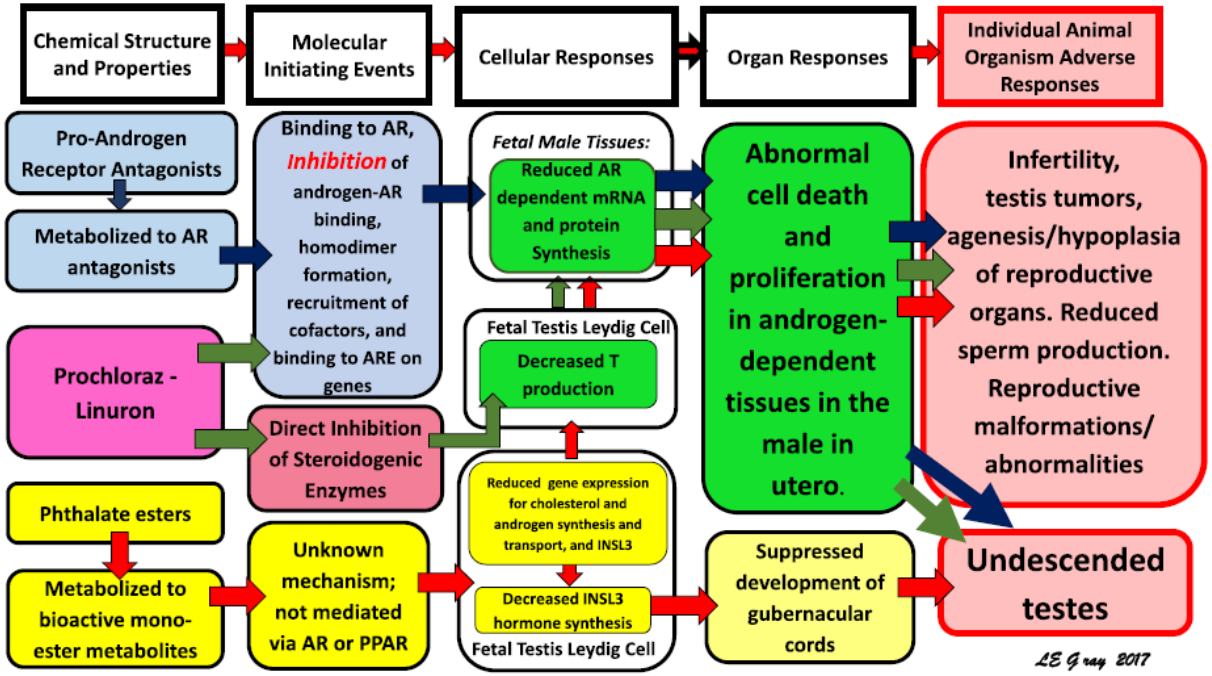
ALTERAZIONE RIVELABILE CLINICAMENTE ALLA NASCITA

Twenty-five years after "Wingspread" – Environmental endocrine disruptors (EDCs) and human health

Leon Earl Gray Jr.

Current Opinion in Toxicology 2017, 3:40–47

Fig. 1



Antiandrogen AOP network (and Graphical Abstract). Adverse outcome pathway network for disrupted androgen- and insulin-like hormone 3 (INSL3)-dependent reproductive development in male rats. The first column of the AOP network identifies three classes of chemicals known to disrupt the androgen-signaling pathways via three different mechanisms of action. Different colored arrows indicate the pathway through which each set of chemicals exerts its affects: ...blue arrows, androgen receptor (AR antagonists); green arrows, dual mechanism of action chemicals (AR antagonists and steroid enzyme inhibitors); and red arrows, phthalates (molecular initiating event unknown, but known to inhibit fetal testosterone (T) production) [7]. Abbreviations: AR-androgen receptor; ARE- androgen receptor response element on target gene; mRNA-messenger ribonucleic acid.

ALTERAZIONE RIVELABILE CLINICAMENTE ALLA NASCITA

DANNI RILEVABILI NEI PRIMI ANNI POSTNATALI

Agrochemicals and neurogenesis

Molecular and Cellular Endocrinology 510 (2020) 110820

M. Florencia Rossetti[a,b], Cora Stoker[a,b], Jorge G. Ramos[a,b,*]

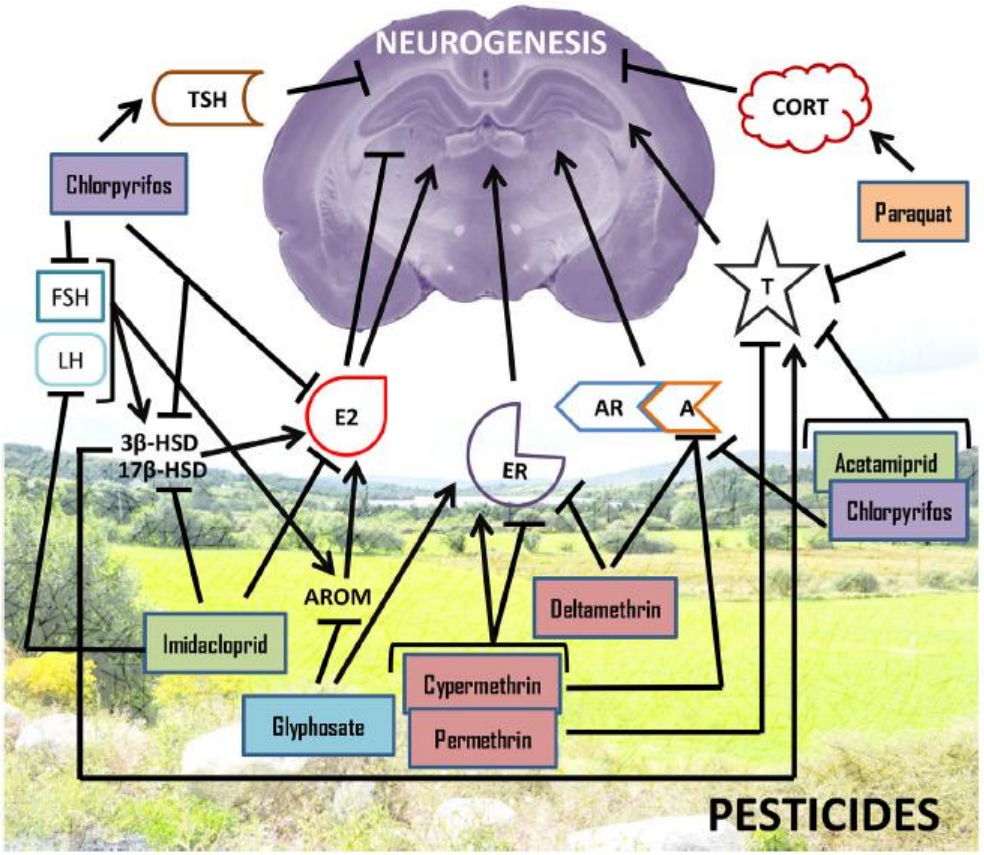


Fig. 1. Possible mechanisms by which pesticides could alter neurogenesis via endocrine disruption. Pesticides alter the expression of steroidogenic enzymes, hormone levels and hormone receptor activity. Since hormones and their receptors have been reported to regulate hippocampal neurogenesis, this hormonal disruption could be the mediator, at least in part, of the adverse effects of pesticides on neurogenesis. Nevertheless, more experiments are needed to clarify whether these effects are due to the endocrine disrupting properties *per se* or to other mechanisms. T: Testosterone; CORT: Corticosterone; TSH: Thyroid-Stimulating Hormone; A: Androgen; E2: Estradiol; LH: luteinizing hormone; FSH: follicle-stimulating hormone; 3β-HSD:3β-hydroxysteroid dehydrogenase/Δ5-Δ4-isomerase; 17β-HSD: 17β-hydroxysteroid dehydrogenase; AROM: Aromatase; ER: Estrogen Receptor; AR: Androgen Receptor; Activation: ↑; Inhibition: ⊤.

International Federation of Gynecology and Obstetrics opinion on reproductive health impacts of exposure to toxic environmental chemicals☆

Gian Carlo Di Renzo [a], Jeanne A. Conry [b], Jennifer Blake [c], Mark S. DeFrancesco [b], Nathaniel DeNicola [b], James N. Martin Jr. [b], Kelly A. McCue [b], David Richmond [d], Abid Shah [d], Patrice Sutton [e], Tracey J. Woodruff [e,*], Sheryl Ziemin van der Poel [f], Linda C. Giudice [g]

International Journal of Gynecology and Obstetrics 131 (2015) 219–225

Box 1

Adverse health outcomes linked with preconception and prenatal exposure to environmental chemicals.[a]

Neurodevelopment

- Impaired cognitive and neurodevelopment, increase in attention problems and attention deficit hyperactivity disorder behaviors at age 5 years, and reduction in working memory capabilities at age 7 years with pesticides [74–77]
- Impaired neurodevelopment in girls and reduction in executive function at age 4–9 years with phthalates [78,79]
- Intellectual impairment with lead [80]
- Reduced cognitive performance, impaired neurodevelopment, and reduced psychomotor outcomes with methyl mercury [81–85]
- Decreased placental expression of genes implicated in normal neurodevelopmental trajectories with increasing in utero exposure to fine particle air pollution [86]
- Reduced intelligence quotient score and a wide range of attention and executive function deficits with PCBs [87–91]
- Impaired neurodevelopment and reduction in sustained attention with polybrominated diphenol ethers [92,93]
- Attention problems at age 6–7 years with polycyclic aromatic hydrocarbons [94,95]
- Aggression and hyperactivity in girls, and reduction in executive functioning skills in girls aged 3 years with bisphenol A [96,97]

Elucidating the Links Between Endocrine Disruptors and Neurodevelopment

(*Endocrinology* 156: 1941–1951, 2015)

Thaddeus T. Schug, Ashley M. Blawas, Kimberly Gray, Jerrold J. Heindel, and Cindy P. Lawler

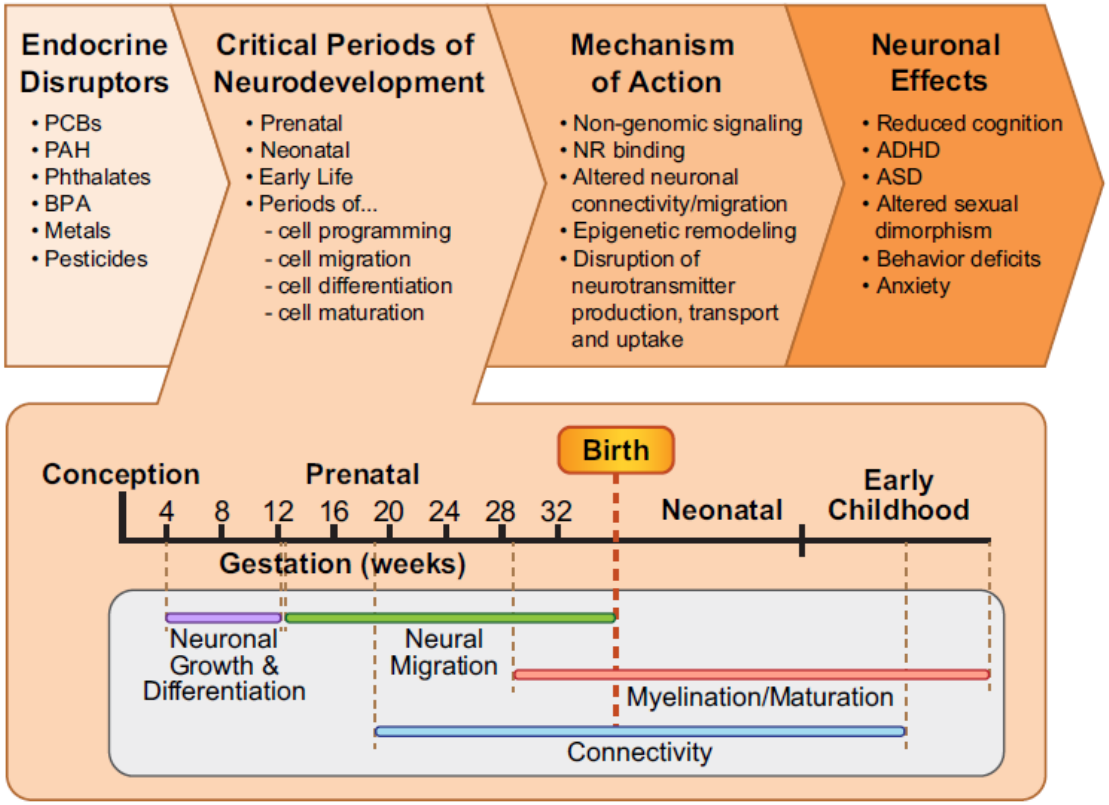


Figure 2. Schematic diagram illustrating how exposure to EDCs during critical periods of development can lead to neurodevelopmental disease.

ALTERAZIONE RIVELABILE CLINICAMENTE ALLA NASCITA

DANNI RILEVABILI NEI PRIMI ANNI POSTNATALI

DANNI EVIDENZIABILI NELL'ADULTO

MICROBIOME Research Hub

Perspective

Elucidating Adverse Nutritional Implications of Exposure to Endocrine-Disrupting Chemicals and Mycotoxins through Stable Isotope Techniques

Nutrients **2018**, *10*, 401; doi:10.3390/nu10040401

Victor O. Owino *, Carolin Cornelius and Cornelia U. Loechl

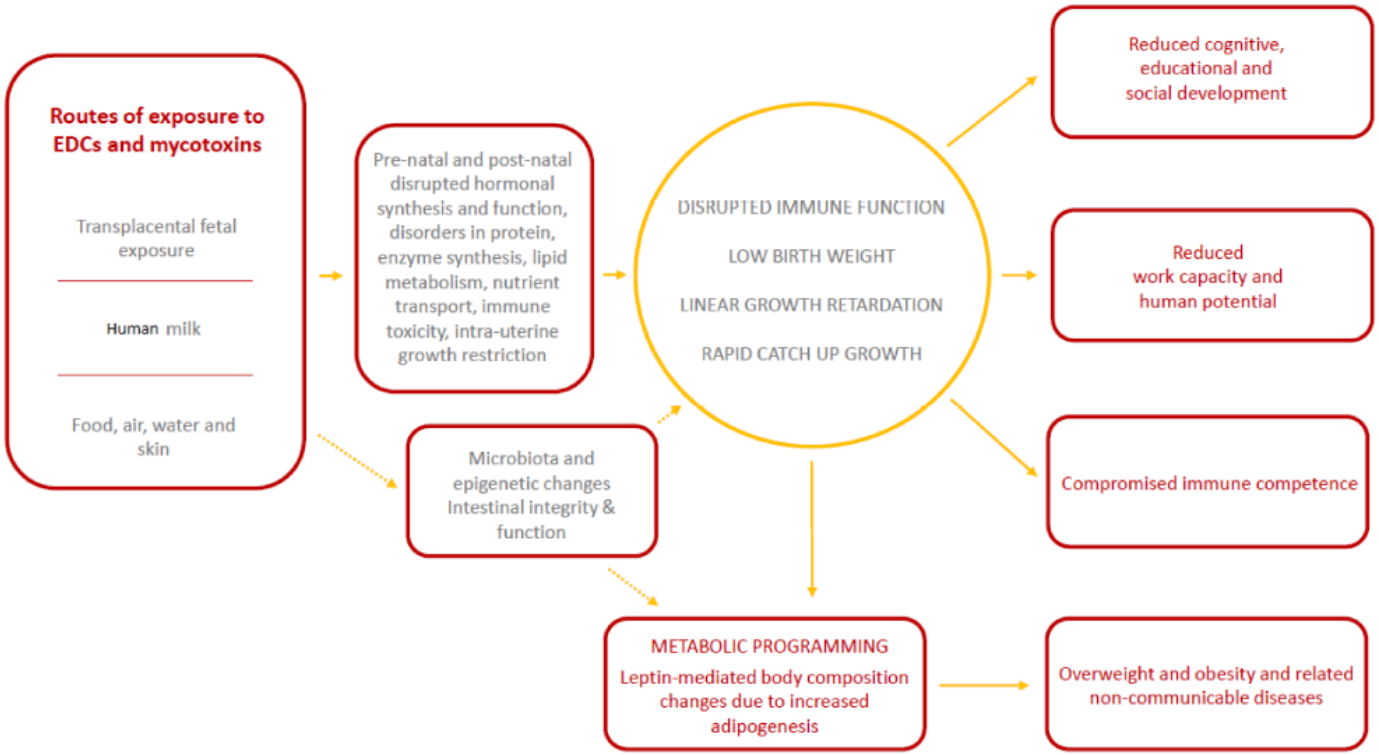


Figure 1. Conceptual framework for the effects of exposure to endocrine disrupting chemicals (EDCs) and mycotoxins on pre-natal and post-natal growth and long-term health and development outcomes.

Environmental Endocrine-Disrupting Chemical Exposure: Role in Non-Communicable Diseases

frontiers in Public Health

published: 24 September 2020
doi: 10.3389/fpubh.2020.553850

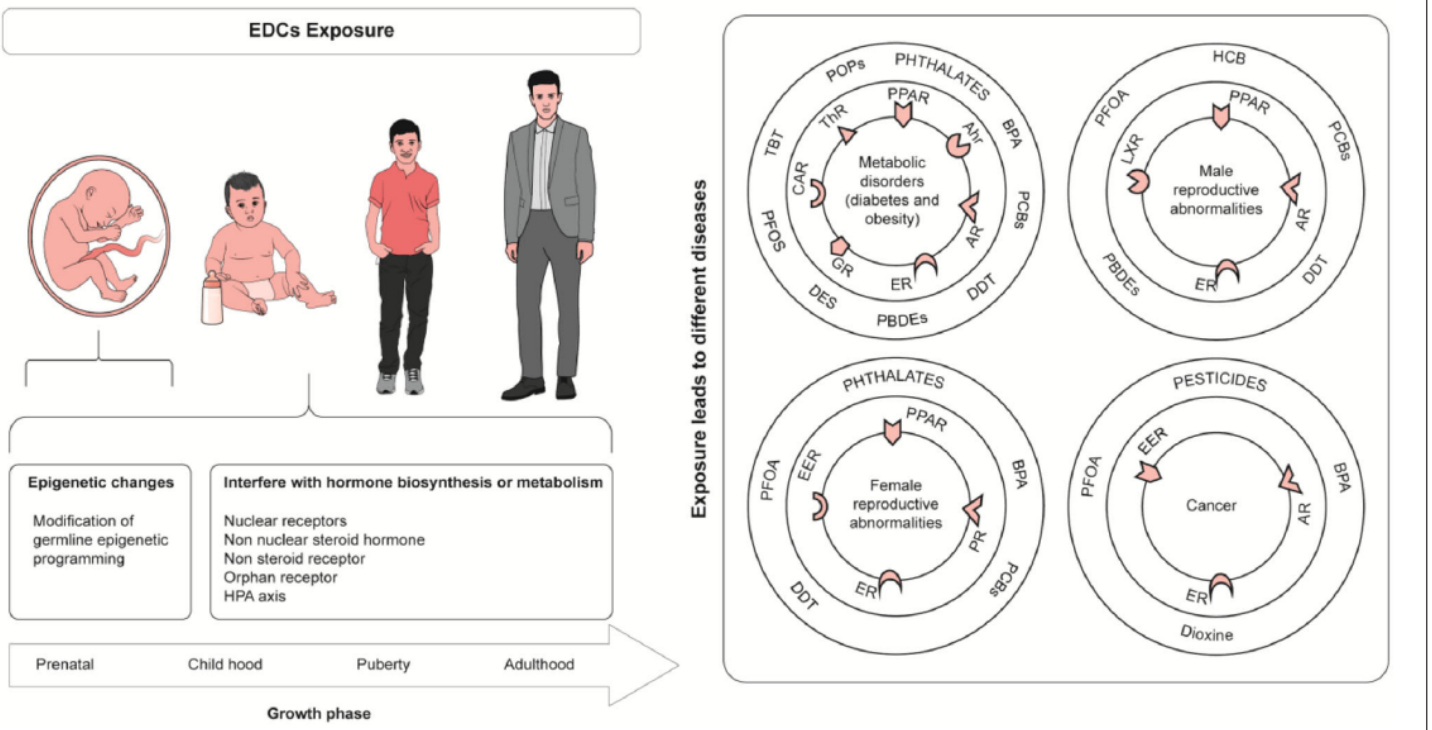


FIGURE 2 | Health Effect of Endocrine disrupting chemicals. Tributyltin (TBT), PerfluorooctaneSulfonate (PFOS), Perfluorinated compounds (PFCs), Perfluorooctanoic acid (PFOA), Bisphenol A (BPA), Diethylstilbestrol (DES), hexachlorobenzene (HCB), dichlorodiphenyltri-chloroethane (DDT), Polybrominated diphenyls ethers (PBDEs), constitutive androstane receptor (CAR), Thyroid Hormone Receptor (ThR), glucocorticoid receptor (GR), Aryl hydrocarbon receptor (Ahr), Androgen receptor (AR), Peroxisome proliferator-activated receptor (PPAR), Estrogen receptor (ER), Liver X Receptor (LXR).

Review

Fetotoxicity of Nanoparticles: Causes and Mechanisms

Chuanfeng Teng [1], Cuijuan Jiang [2], Sulian Gao [3], Xiaojing Liu [4] and Shumei Zhai [1,*]

Nanomaterials **2021**, *11*, 791.

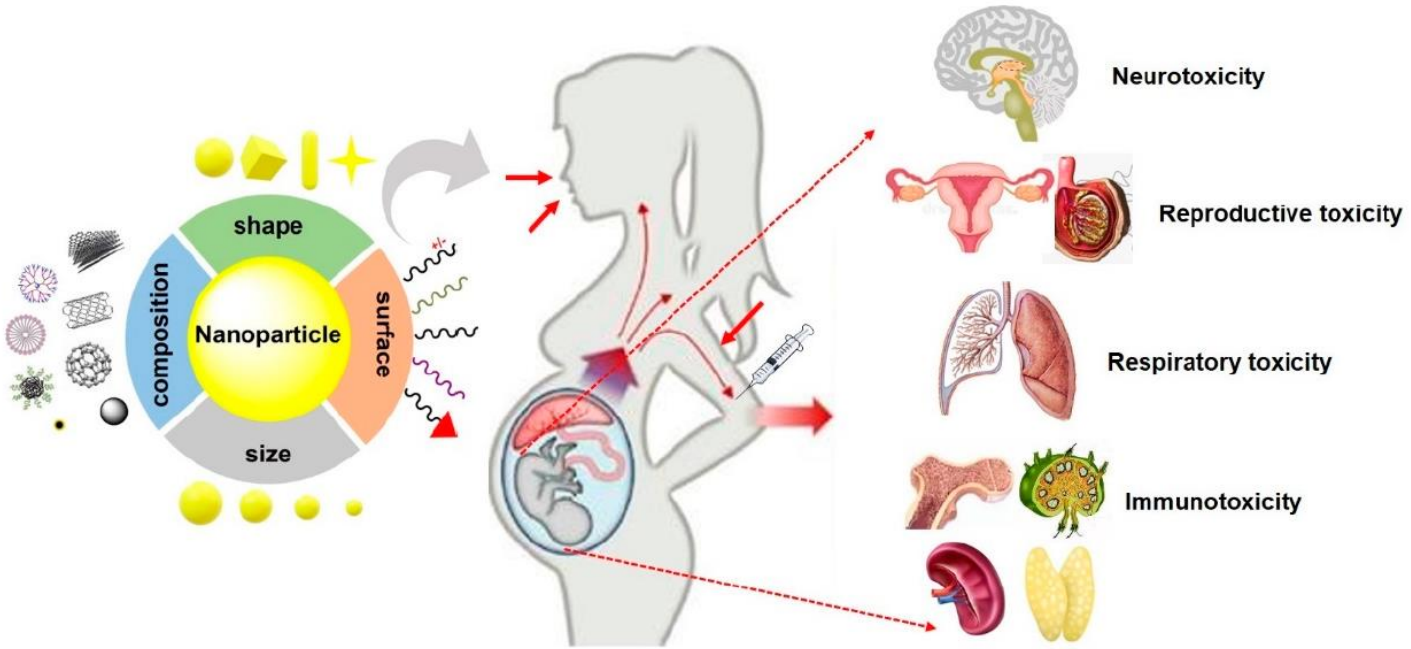


Figure 2. Typical fetotoxicity potentially induced by various NPs. The properties of NPs such as size, shape, composition and surface chemistry are key parameters that affect fetotoxicity following maternal exposure NPs during pregnancy. In addition, maternal conditions and exposure routes, also play crucial roles in NP-induced fetotoxicity.

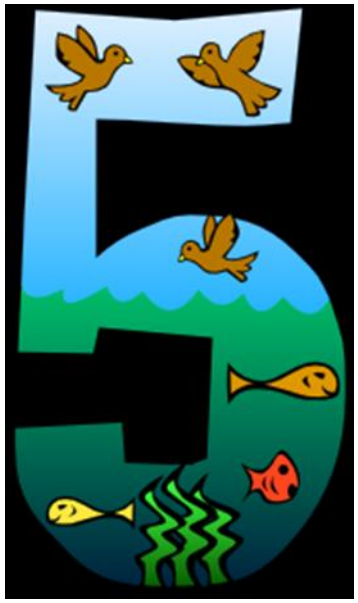
COMMENTARY Open Access

Microplastics, environment and child health

Maria Elisabeth Street[1*] and Sergio Bernasconi[2]

Italian Journal of Pediatrics (2021) 47:75

1. SOSTANZE CHIMICHE NELL'AMBIENTE
2. INTERFERENTI ENDOCRINI
3. IMPATTO SULLA SALUTE
4. APPROCCIO PRECAUZIONALE
5. **RUOLO DEL MEDICO**



The Paradox of Progress: Environmental Disruption of Metabolism and the Diabetes Epidemic

Brian A. Neel[1] and Robert M. Sargis[2]

DIABETES, VOL. 60, JULY 2011

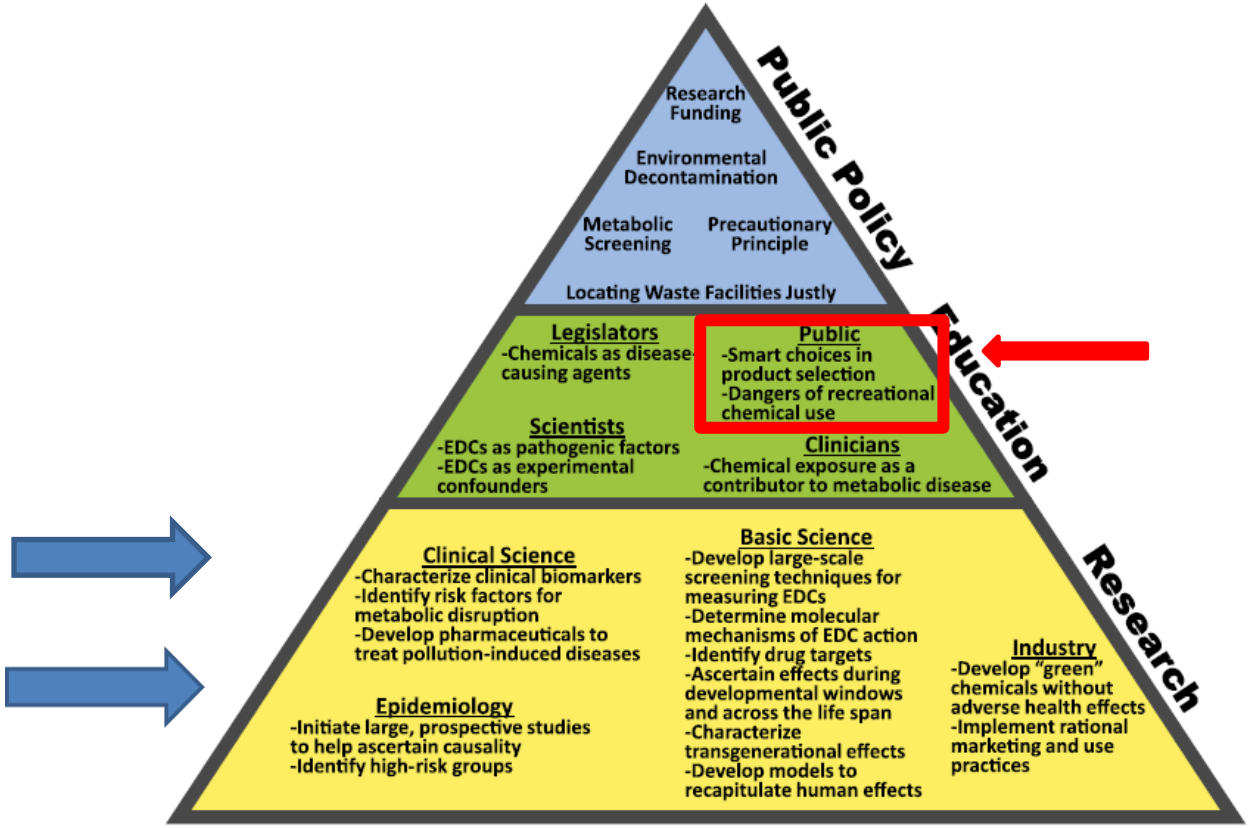
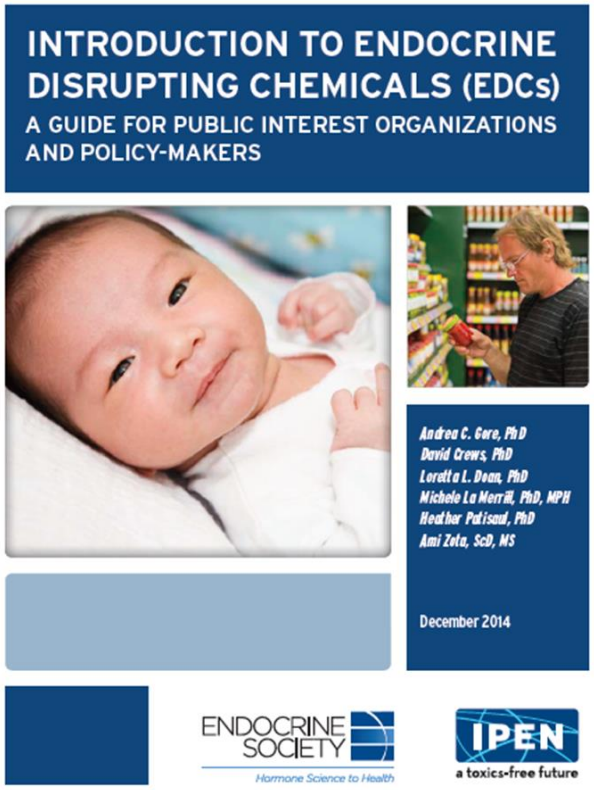


FIG. 3. Strategies for addressing environmental disruption of metabolism.

Fig. 1. FIGO's recommendations for healthcare providers.



MINISTERO DELL'AMBIENTE
E DELLA TUTELA DEL TERRITORIO E DEL MARE

CONOSCI, RIDUCI, PREVIENI GLI INTERFERENTI ENDOCRINI

UN DECALOGO PER IL CITTADINO

ISTITUTO SUPERIORE DI SANITÀ

Ruolo del MMG e del PLS e più in generale del medico e del personale sanitario nell'educazione ambientale

MICROBIOME Research Hub

Some recommendations to minimize exposure to EDCs

In what follows, we present a brief summary of recommendations issued by the Endocrine Society, WHO and the United Nations Environment Programme, and from experts in the field.[7,157–159]

Encarnação T, Pais AA, Campos MG, Burrows HD. Endocrine disrupting chemicals: Impact on human health, wildlife and the environment. Sci Prog. 2019

- It is preferable to opt for fresh food instead of processed and canned foods

Food contact materials (FCMs) are a significant source of contamination. In general, the FCMs are made of plastics that can contain additives, plasticizers and monomers that can leach and migrate to food. Several reports have been published on this subject.[69,160–163] Metal cans are normally coated inside with a thin layer of epoxy resin, which is made from BPA.

- It is preferable to opt for added chemicals-free food

Exposure to pesticides is linked to many diseases. Organic food may also be contaminated with pollutants because of the effects of the entire food chain and whole environment; however, this exposure is far less than conventional food. The option for organic food could be more expensive, but as the consumption increases (the organic food market is growing at a compound annual growth rate (CAGR) of around 14.56%, between 2017 and 2024), the prices of organic food products have tended to decrease.

Some recommendations to minimize exposure to EDCs

In what follows, we present a brief summary of recommendations issued by the Endocrine Society, WHO and the United Nations Environment Programme, and from experts in the field.[7,157–159]

Encarnação T, Pais AA, Campos MG, Burrows HD. Endocrine disrupting chemicals: Impact on human health, wildlife and the environment. Sci Prog. 2019

- Food in plastic containers should not be heated in a microwave oven. Plastic containers can be replaced by glass or ceramic ones.

The migration of the FCMs to foodstuffs can be accelerated by increasing the temperature. Some plastics, such as polycarbonate, may leach BPA. BPA analogues, such as bisphenols F and S, which were synthesized, have replaced BPA in numerous consumer products.[91] These analogues also exhibit endocrine disrupting activity, cytotoxicity, genotoxicity, reproductive toxicity and neurotoxicity.[91,92]

- The consumption of fat dairy or meat products should be reduced.

POPs bioaccumulate through the food chain, and their lipophilicity means they accumulate in fatty tissues. Bioaccumulation leads to biomagnification. POPs are absorbed by lower trophic organisms, such as phytoplankton, that are consumed by zooplankton and then by fish. They accumulate in fatty tissues of the organisms that are eaten by other organisms, thus magnifying their effect up the food chain. This concentration effect reaches maximum levels in top predator species, such as humans and other mammals.

Some recommendations to minimize exposure to EDCs

In what follows, we present a brief summary of recommendations issued by the Endocrine Society, WHO and the United Nations Environment Programme, and from experts in the field.[7,157–159]

Encarnação T, Pais AA, Campos MG, Burrows HD. Endocrine disrupting chemicals: Impact on human health, wildlife and the environment. Sci Prog. 2019

- Products such as makeup, perfume and skin care should be free of phthalates, parabens, triclosan and other chemicals.

Products with fragrances generally contain phthalates as carriers. Products that are labelled 'antibacterial' generally contain triclosan. Information about ingredients of cosmetics can be found in databases such as the EWG's Skin Deep Cosmetics Database.

- It is preferable to opt for ecological household cleaning products

Human exposure to BPA, phthalates and triclosan occurs, besides food, water and consumer products, through households cleaning products. The use of household cleaning products during pregnancy, at least once per week, was associated with 10%–44% greater levels of phthalate metabolites in urine.[164]

Some recommendations to minimize exposure to EDCs

In what follows, we present a brief summary of recommendations issued by the Endocrine Society, WHO and the United Nations Environment Programme, and from experts in the field.[7,157–159]

Encarnação T, Pais AA, Campos MG, Burrows HD. Endocrine disrupting chemicals: Impact on human health, wildlife and the environment. Sci Prog. 2019

- Flame retardant treated furniture should be avoided

PBDEs are widely used as brominated flame retardants in furniture. These have been gradually phased-out worldwide since 2004; however, biomonitoring studies indicate that they are still ubiquitous in human blood and breast milk worlwide.[77] A number of older products contain significant amounts of these pollutants that are still being released into the surroundings environment. PBDEs have been found in human breast milk and in infants and toddlers, probably as a result of contamination by house dust.

- Indoors environments should be ventilated regularly

It is estimated that the major source of contamination comes from indoor environments, since we spend about 90% of our life in enclosed spaces, particularly home and work-place, and also the car. Therefore, the IAQ has a considerable impact on our exposure to contaminants and poses a risk to human health.[138,139,142,143]

Some recommendations to minimize exposure to EDCs

In what follows, we present a brief summary of recommendations issued by the Endocrine Society, WHO and the United Nations Environment Programme, and from experts in the field.[7,157–159]

Encarnação T, Pais AA, Campos MG, Burrows HD. Endocrine disrupting chemicals: Impact on human health, wildlife and the environment. Sci Prog. 2019

- Alternatives to plastic toys are preferred

Children toys and teething items are generally made of plastics that contain additives which are intended to modify the properties of the polymer. The most common additives or plasticizers, added to increase flexibility, durability and so on, have been phthalate esters. Children's normal behaviour, such as hand-to mouth and object-to-mouth contacts, increases the exposure through inhalation and ingestion routes. Phthalates have been implicated in various male malformations. Reports on the effects of prenatal exposure to phthalates in humans showed that birth outcomes were associated with high levels of phthalate esters in the urine of the mothers during pregnancy.[102,103] Although EU has imposed a limit of 0.1% (W/W) of phthalates in toys, these have been found in much higher concentrations (from 0.1% to 63.34%).[165]

Grazie per l'attenzione

sbernasconi3@gmail.com