Recent Research related to Autism, and Connections with Widespread Environmental Toxins

During the last half century or so, toxins that have become widespread in the environment have also become substantial contaminants in human milk.[1] Breast milk in contemporary developed countries now includes four neuro-developmental toxins at levels greatly exceeding governmentally-established thresholds for safety**:**

(a) dioxins, exceeding the EPA's Reference Dose (estimated reasonably safe dose, or RfD) by scores to hundreds of times**;**[2]

(b) PBDEs, normally well above and up to 20 times the EPA's RfD**;**[2a] and

(c) mercury, typically four times the maximum allowed by U.S. law in bottled water, but in many cases much higher than that.[2b]

(d) PCBs, in human milk in concentrations about 20 times the maximum allowed by law in U.S. public water supplies.[2c]

All four of the above are present in infant formula in concentrations less than 4% as high, and usually less than 1% as high, as their concentrations in human milk.[3a]

According to an expert on the subject (in line with statements by several other authorities), "Significantly more (10 to 20 times) of a mother's body burden of persistent organohalogens is transferred to the infant via the milk than by the transplacental route."[3b] Note that persistent organohalogens include dioxins, PCBs and PBDEs, three of the neurodevelopmental toxins itemized just above.

Substantially increasing the effects of the above concentrations, breastfeeding became far more prevalent in the U.S. after 1971, and that upward trend is continuing today.[3]

Why autism rates were stable in the U.K. while they were growing rapidly in the U.S.:
Recent trends in autism prevalence in the U.K. compared with prevalence in the U.S. provide evidence of a causal link with the recently-increased toxins in human milk. In Autism Speaks' Oct. 16 Science News article, "Study Finds Autism Prevalence Has Leveled Off in United Kingdom," it was stated that reported prevalence of autism in the U.K. was stable from 2004 to 2010, in contrast with continuing rapid growth of ASD prevalence in the U.S.[4] We should look at breastfeeding data that would apply to the years of the infancies of the (8-year-old) children whose autism prevalence was recorded, therefore ideally finding data for the years 1996 to 2002. For the U.K., the closest years for which there are data are 1995 to 2000. According to the UK's National Health Service, "the prevalence of breastfeeding at later ages (referring in this case to all breastfeeding past initial breastfeeding in the hospital) did not increase between 1995

and 2000."[5] After those years of stable breastfeeding, the first data point at which an increase is shown is 2005. So, during the general period of the infancies of the U.K. children whose autism rates were not increasing, breastfeeding was basically level.

That same October 16 article points out that there was a large *increase* in estimated prevalence of autism *in the U.S.* between 2002 and 2008. Since the prevalence discussed applied to 8-year-olds, the most relevant years of U.S. infant exposures to toxins would have been 1994 to 2000. During that brief time interval, breastfeeding at 6 months in the U.S. increased 34%.[6]

To sum up: In the U.K., no increase in autism rates among children born during the period when breastfeeding rates were not increasing in that country. In the U.S. by contrast, large increase in autism prevalence among children born when there were ongoing rapid increases in breastfeeding rates.

Another unexpected relationship involving autism: A typical fourth child's risk of autism is half as high as that of a firstborn. The odds of being diagnosed with autism decrease progressively from first to 2nd-, 3rd-, and 4th-born children.[8] Infants later in birth order (a) are less likely to be breastfed,[9a] (b) are breastfed for shorter periods on average,[9b] and (c) the milk they receive has toxin levels that have been reduced as a result of excretion to earlier-born infants during previous breastfeeding.[9c]

Could later-born children conceivably benefit from the greatly reduced exposure to toxins in breast milk?

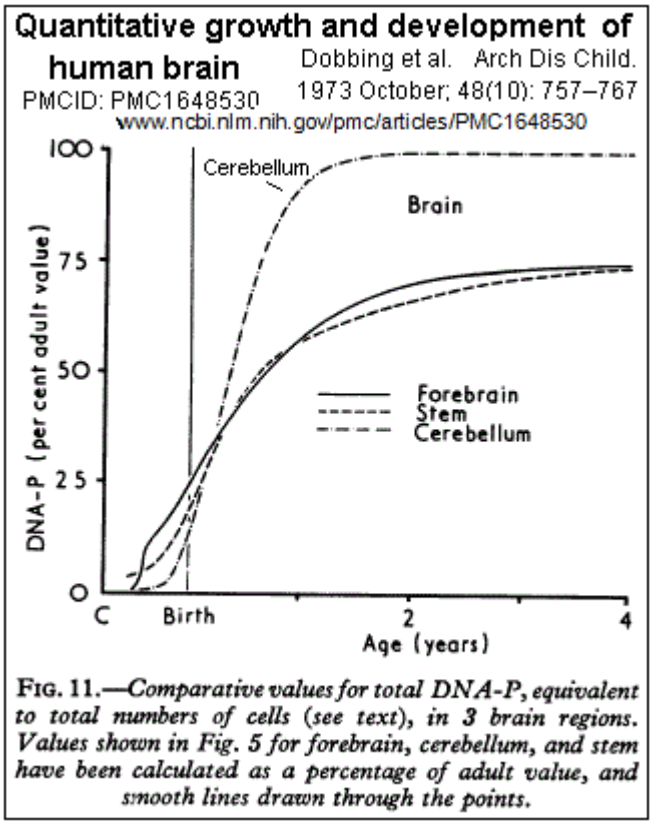

FIG. 11.—*Comparative values for total DNA-P, equivalent to total numbers of cells (see text), in 3 brain regions. Values shown in Fig. 5 for forebrain, cerebellum, and stem have been calculated as a percentage of adult value, and smooth lines drawn through the points.*

Breast milk (with its undisputed content of at least four neuro-developmental toxins, in doses scores of times higher than in formula) is consumed during the time period when harmful effects leading to autism are very likely to be taking place; *most* of the brain's growth and a large part of

its development takes place during the first year after birth.(see chart and footnote 10)
According to EPA researchers, an organ is generally at its greatest vulnerability to environmental toxicants if exposure to the toxins occurs *during development* of that organ.[11]

There is a widespread assumption that vulnerability of infant development to effects of environmental toxins takes place prenatally rather than postnatally. That assumption is probably valid in relation to certain toxins, but it is not at all valid in relation to others, according to the highest authorities and according to many scientific studies. For considerable information on this topic, go to www.autism-research.net/postnatal-effects.htm.

Remember that in recent decades, while autism has been increasing, there have been dramatic increases in *both* breastfeeding rates *and* in pollutants in breast milk.

The cerebellum and autism

A 2013 study in the NIH's National Library of Medicine reported on "converging findings from human postmortem research, human neuroimaging studies, and animal models…. Evidence appears to support *cerebellar dysfunction… as a contributor to the autism phenotype.*"[12]
Remembering the special vulnerability of an organ to toxins during development of the organ, consider that *about 80% of the cerebellum's growth apparently takes place during the first year after birth* (see chart),[13] which is to say that *this autism-linked brain region*'s *greatest vulnerability to toxins occurs during the period when breastfed infants are receiving extraordinarily high doses of developmental toxins.*

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One of the forms of mercury that is widely present in human milk (due to its increasing presence in fish and seafood), methylmercury, is one of the "environmental agents with the property of killing neurons as they are born," according to a study referred to by the NIH.[11] In an experiment, rats exposed to methylmercury on postnatal day 7 were found to have brain cell death induced by *a single* exposure to that chemical at a level estimated to be *chronic* for many humans[14] –A 2006 study determined that, *of the three sources of infant mercury* exposure, ingestion (breast milk), inhalation, and dermal exposure, *the largest contribution was from breast milk, providing 96 to 99.6% of the total exposure.*[15] Authoritative studies have found that mercury concentrations in infants that had been breastfed for six months or one year were two or three times as high as in bottle-fed infants.[18]

Eye contact normal shortly after birth, then declining as environmental toxins in the infant's body increase greatly and continue accumulating

In a 2013 study dealing with "this basic mechanism of social adaptive action" among infants who were later diagnosed with ASD, the researchers found that the infants *started out with normal eye contact* as of their first two months after birth**;** then a decline in eye contact *began* and *continued steadily downward*. This decline following initial normalcy was seen by the researchers to represent a "derailment" of a social developmental process that had initially been satisfactory.[16] Seeing this distinctly *postnatal* transition from good to bad, taking place while the infant's brain is going through its period of greatest vulnerability to toxins (see above), we should think about any toxic exposures that are known to take place shortly before that derailment. Of special interest are toxic exposures that (a) have effects widely in the population, and (b) continue as the decline continues**:**

1) Remember from the introduction that dioxins in breast milk typically exceed the EPA's RfD by scores to hundreds of times**;** a German study found that, by 11 months of age, dioxin toxicity-equivalent concentrations in the breastfed infants had become 10 times higher than in formula-fed infants.[17]

2) Remember that PBDEs in breast milk are normally well above but have been found to be up to tens of times the EPA's RfD, and also that concentrations of PBDEs in infant formula have been found to be less than 2% as high as in human milk.

3) Remember that PCBs in human milk are typically about 20 times the level allowed in U.S. public water supplies.

4) Note again that mercury in breast milk averages about four times the maximum allowed by U.S. law in bottled water, and that studies have found mercury in infants breastfed for a year to be three times as high as in bottle-fed infants.[18] In addition to this extraordinarily high *general* presence in breastfed infants, note also that mercury has been found to *accumulate in the brain*, reaching levels *seven times the levels in blood*.[18a] All that should be born in mind along with knowledge of mercury's "property of killing neurons as they are born."[11]

Just *one* exposure to a neurodevelopmental toxin that greatly exceeds established safe levels would be highly significant when considering toxic effects on infants that occur shortly after birth, and which could therefore help explain the derailment that has been found to start at two months after birth. But *consider that a typical breastfed infant is subject to <u>all four</u> exposures,*
a) <u>each</u> of which far exceeds established safe levels, and
b) <u>each</u> of which begins not long before adverse outcomes regularly start to become apparent.

Also bear in mind the following trends related to autism's increase:

(a) Breastfeeding was uncommon in the U.S. as of the 1960's,[19] when autism was extremely rare, and increased many times over after 1971[(3)];

(b) only during the last half century or so have environmental toxins become substantial contaminants in human milk;[1]

(c) dioxins, although declining in human milk in some countries, were increasing in the U.S. as of the latest reports,[20] and in every case still exceed governmentally-established safe levels by large multiples;

(d) mercury, emitted by fossil fuel combustion, has increased several-fold in the environment of modern generations**;**[21] and

(e) a study of sediment from multiple locations in the Great Lakes found that PBDE levels increased by a factor of *several hundred times since the 1970s.*[22] PBDE concentrations in human milk in Canada were found to increase 7-fold between 1992 and 2002.[23]

Autism-related effects of relatively *commonly-present concentrations* of these toxins:

(a) A 2011 study found that 4-year-olds with higher levels of PBDEs had over 2½ times the *risk of poor social competence,* compared with children with lower levels of PBDEs**;**[24] this should be seen in combination with the nearly 3-to-1 difference in levels of PBDEs in breastfed as compared with formula-fed children at age 4, as reported in what is apparently the only study that has made such a comparison.[24b]

(b) At least five published studies have found high levels of mercury in the autistic.[24a] (The studies that have failed to find this association have (a) focused on thimerosal, which contains only *ethyl*mercury, one of many species of that chemical or (b) measured mercury levels in children far past the vulnerable early-postnatal period.) *The studies finding associations of autism with mercury levels less than twice the normal range should be seen together with the findings in multiple studies of doubling or tripling of infant mercury levels resulting from breastfeeding, taking place during the infant's period of rapid brain growth.*[18]

(c) A major 2013 study, analyzing data from all over the U.S., found close associations between autism prevalence and exposures of the mothers to variations of air pollution of kinds very widely present across the U.S., especially diesel emissions.[27] Note that diesel emissions include dioxin, PCBs and PBDEs, and that these toxins are passed on to a breastfed infant in greatly concentrated form -- see below.

Such studies have sometimes been interpreted to mean that harm results from fetal exposure to toxins during gestation, but close reading of the studies reveals nothing indicating that the harm

was necessarily *prenatal*. The effects were at least as likely to have originated from *post*natal exposures, as indicated by the following**:** two leading experts on toxins involved in child development (P. Grandjean and P.J. Landrigan) have stated that "Persistent lipophilic substances (which include dioxins, PCBs and PBDEs), *accumulate in maternal adipose tissue and are passed on to the infant via breast milk*, resulting in *infant exposure that exceeds the mother's own exposure by 100-fold* on the basis of bodyweight."[28] So high levels of toxins, accumulated from the mother's long-term exposures, are continuously ingested by a breastfed infant *during the period when the brain is especially vulnerable to toxins due to its rapid growth* (see earlier chart and accompanying text).

Related to the above**:** On the basis of data from all 50 states and 51 U.S. counties, a highly-published scientist and Fellow of the American College of Nutrition found that *"exclusive breast-feeding shows a direct epidemiological relationship to autism"* and also that ***"*the longer the duration of exclusive breast-feeding, the greater the correlation with autism."**[25] Another U.S. study and a U.K. study arrived at compatible findings.[26]

For considerable other information on correlations between lactational exposures to toxins (especially mercury) and subsequent incidence of autism, see www.autism-correlations.info

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COMMENTS or questions: At the next link are comments and questions from readers, including six doctors. Some of the doctors have been critical but others have been in agreement with us (including one with children and one who says she has delivered thousands of babies)**;** they put into briefer, everyday language and personal terms some important points that tend to be immersed in detail when presented in our own publications. Also, we have responded to many readers' questions and comments, including about having breast milk tested for toxins and about means of trying to achieve milk that is relatively free of toxins, including the "pump and dump" option. To read the above, go to www.pollutionaction.org/comments.htm .

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So we have the unexpected close geographic correlations of autism prevalence with breastfeeding rates, *plus* the surprising stability of autism rates for a significant number of years in the U.K. while breastfeeding rates were stable there (unlike in the U.S.), *plus* the progressively lower rates of autism among 2nd-, 3rd-, and 4th-born children (who have progressively lower exposures to toxins in breast milk). And we have seen a key mechanism of social development (eye contact) proceed to *derail after initial satisfactory postnatal*

development. The above all lead to important questions**:**

Q #1: Given the presence of four different neuro-developmental toxins in typical breast milk, *each* of which typically far exceeds recognized safe levels *and* levels in infant formula, is there any reason why those exposures could not be a reasonable explanation for all of the unexpected outcomes mentioned?

Q #2: Are there *any* toxins known to widely reach infants in doses well in excess of a recognized safe level (e.g., EPA's RfD), **aside from the *four* such toxins that are ingested by means of breast milk? If so, please identify them.**

The above Q #2 was mailed to seven members of the science team at the major autism-advocacy organization, Autism Speaks, and, as of several months later, of the three responses received, not one has offered an answer to that question.

The essential contents of the above Q #1 were mailed to the above scientists and also to the three U.S physicians' associations that promote breastfeeding (the associations of pediatricians, obstetrician/gynecologists and family physicians) and the World Health Organization. Of the three total responses received, not one has attempted to answer that question.

Those who promote breastfeeding or who even consider doing it ought to think carefully about the fact that nobody seems to be able to answer the above questions.

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Another especially important reason to reconsider the type of infant feeding that is the focus of this article**:** *Something can be done to rapidly, greatly reduce infants' exposures to this source of infant ingestion of toxins*. Specific toxins that apparently lead to autism have been identified in at least two major recent scientific studies**:** atmospheric pollution including diesel emissions[27] (diesel emissions include dioxins, PCBs and PBDEs). But few parents are able to move away from the locations that are high in this pollution**;** and a mother's body burden of these "persistent" toxins is a result of many years of accumulation, so a move of residence would have only minor effect anyway, unless it is done years ahead of pregnancy. And reduction of those pollutants in the environment and in the bodies of mothers is something that can only be *worked towards*, seeking reductions that could only come over a period of many years**;** but millions

more children would be impaired for life in the meantime, while reductions of contaminants in breast milk come only gradually. On the other hand, most *parents could promptly discontinue the type of feeding that is channeling concentrations of developmental toxins to their infants at the most vulnerable stage of the infants' lives.* All that is required is *informing* parents of what is presented here, to enable them to make informed decisions about breastfeeding. At this point all that most parents know on the question of breast-vs.-bottle feeding is summarized in the catch-phrase as "breast is best."

But isn't breastfeeding recognized as beneficial for infants? Of all the disorders that are said by the U.S. Surgeon General to be reduced by breastfeeding, all but one has actually substantially *increased* in the U.S. since breastfeeding greatly increased, after 1971. In the case of that one disorder that did not increase, neither was it reduced following the major increases in breastfeeding.[31] Although various studies have found desirable effects to be *associated* with breastfeeding (always with known confounders present[31a]), over 50 scientific studies have found breastfeeding to be associated with *worse* health outcomes,[32] Among those was the study that was apparently the only study on effects of breastfeeding on childhood obesity that was randomized, which is the recognized best way to avoid effects of the confounders that often cause false conclusions in typical studies.

For the U.S. generation born in the mid-20th century, breastfeeding was unusual. That generation did not have the unexplained childhood epidemics and major increases that have become prevalent since then**:** diabetes, asthma, allergies, obesity, ADHD and autism. In the decades since 1971, there have been not only major increases but *also lows and mid-levels* of multiple childhood disorders that have correlated closely with preceding increases, lows and mid-levels of breastfeeding rates.(see www.breastfeedingprosandcons.info and www.autism-correlations.info, with many authoritative sources cited at both websites.) There are many other well-substantiated, authoritative reasons to doubt the popularly-accepted view about benefits of breastfeeding.[32]

Various U.S. doctors' associations (American Academy of Pediatrics, American Academy of Family Physicians, American Congress of Obstetricians and Gynecologists) and WHO promote breastfeeding, but they appear to be unable to answer appropriate questions about the basis for their recommendations. Multiple letters to each of those organizations from the director of Pollution Action, asking how they have determined that the known toxins in breast milk are not having harmful effects, have never been responded to. Medical authorities are promoting

feeding infants a substance that is *known* to currently contain multiple developmental toxins, each of which is ingested in doses very far in excess of established safe levels, while several unexplained childhood epidemics and increases have arisen and are continuing; if those authorities who are doing the promoting are unwilling (or, more likely, unable) to answer questions about their recommendations, what does that say about the merits of their recommendations?

It is well established that risk of autism is much higher in children of older mothers than in children of younger mothers. The reasons for that are currently being researched, but the fact that older mothers are known to have far higher body burdens of "persistent bioaccumulative toxins" than younger mothers seems to be a logical explanation; this is especially true since some of those toxins are transmitted to breastfed infants in concentrations recognized to be far above established relatively safe levels. For details, see www.autism-research.net/older-mother-autism-risk.htm.

Research published in 2014 has found "patches of disorganization" in brains of children with autism (examined postmortem), and there is an opinion that this disorganization has its origins in prenatal development. But there are excellent reasons to see that the observed disorganization actually originates postnatally, due to postnatal exposures to developmental toxins. For details, see www.autism-research.net/brain-impairment.htm.

For additional relevant information, see www.breastfeeding-toxins.info. And for another web page with considerable information about postnatal environmental exposures that are probably leading to autism, see www.autism-research.net/postnatal-origins.htm.

Comments related to this are welcome, to be sent to:

*Donald P. Meulenberg, Director, Pollution Action, 33 McWhirt Loop, Ste. 115, Fredericksburg, VA 22406
or to dm@pollutionaction.org For information about Pollution Action, see www.pollutionaction.org

(A copy of this statement in PDF format is at www.breastfeeding-research.info/A.pdf

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1) Grandjean and Jensen, Breastfeeding and the Weanling's Dilemma Am J Public Health. 2004 July; 94(7): 1075. PMCID: PMC1448391 at www.ncbi.nlm.nih.gov/pmc/articles/PMC1448391

2) Re: EPA's RfD for dioxin: At www.epa.gov/iris/supdocs/dioxinv1sup.pdf in section 4.3.5, at end of that section, "...the resulting RfD in standard units is 7×10^{-10} mg/kg-day." (that is, O.7 pg TEQ/kg-d)

Re: breastfed infants' exposures to dioxins, in U.S. and internationally:
- Infant Exposure to Dioxin-like Compounds in Breast Milk Lorber (Senior Scientist at EPA) et al., VOL. 110 No. 6 June 2002, Environmental Health Perspectives http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=54708#Download
- Wittsiepe J, PCDD/F and dioxin-like PCB in human blood and milk from German mothers. Chemosphere. 2007 Apr;67(9):S286-94. Epub 2007 Jan 10. http://www.ncbi.nlm.nih.gov/pubmed/17217986
-Yang J, et al., PCDDs, PCDFs, and PCBs concentrations in breast milk from two areas in Korea: body burden of mothers and implications for feeding infants. Chemosphere. 2002 Jan;46(3):419-28. At www.ncbi.nlm.nih.gov/pubmed/11829398
- Bencko V et al., Exposure of breast-fed children in the Czech Republic to PCDDs, PCDFs, and dioxin-like PCBs. Environ Toxicol Pharmacol. 2004 Nov;18(2):83-90. Abstract at http://www.ncbi.nlm.nih.gov/pubmed/21782737/
- Nakatani T, et al., Polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and coplanar polychlorinated biphenyls in human milk in Osaka City, Japan Arch Environ Contam Toxicol. 2005 Jul;49(1):131-40. Epub 2005 Jun 22. Found at http://link.springer.com/article/10.1007%2Fs00244-004-0051-y#page-1
- Deng B, et al., Levels and profiles of PCDD/Fs, PCBs in mothers' milk in Shenzhen of China: estimation of breast-fed infants' intakes.Environ Int. 2012 Jul;42:47-52.. At http://www.ncbi.nlm.nih.gov/pubmed/21531025
- Chovancová J, et al., PCDD, PCDF, PCB and PBDE concentrations in breast milk of mothers residing in selected areas of Slovakia Chemosphere. 2011 May;83(10):1383-90. doi: 10.1016/j. At www.ncbi.nlm.nih.gov/pubmed/21474162
- J Grigg, Environmental toxins; their impact on children's health, Arch Dis Child 2004;89:244-250 doi:10.1136/adc.2002.022202 at http://adc.bmj.com/content/89/3/244.full

2a) Re: PBDEs ingested by breastfed infants:
-Table 5-4 of EPA (2010) An exposure assessment of polybrominated diphenyl ethers. National Center for Environmental Assessment, Washington, DC; EPA/600/R-08/086F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=210404, Schechter (2006) study in first page of table.(daily dose of 306 ng/kg-d for breastfed infants) Also Section 5.6.2, near end of section, of above.
- Costa et al., Developmental Neurotoxicity Of Polybrominated Diphenyl Ether (PBDE) Flame Retardants, Neurotoxicology. 2007 November; 28(6): 1047–1067. PMCID: PMC2118052 NIHMSID:

- EPA Technical Fact Sheet on Polybrominitated Diphenyl Eithers (PBDEs) and PBBs, p.4 at http://www2.epa.gov/fedfac/technical-fact-sheet-polybrominated-diphenyl-ethers-pbdes-and-polybrominated-biphenyls-pbbs -- RfDs: 1 x 10-4 mg/kg/day (=100ng/kg/day) for the BDE 47 and 99 congeners. (Note that BDE 47 typically constitutes over half of the PBDEs present in humans. -- Daniels et al., Individual Characteristics Associated with PBDE Levels in U.S. Human Milk Samples, Environmental Health Perspectives, at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2831961/figure/f1-ehp-118-155/) Regarding prevalence of tetraBDEs (47), see also Costa LG, et al., Polybrominated diphenyl ether (PBDE) flame retardants: environmental contamination, human body burden and potential adverse health effects. Acta Biomed. 2008 Dec;79(3):172-83 at www.ncbi.nlm.nih.gov/pubmed/19260376.

2b) Re: Mercury levels in breast milk:
- U.S. ATSDR document on mercury at www.atsdr.cdc.gov/toxprofiles/tp46-c5.pdf, p. 443
- Code of Federal Regulations, Title 21, Chapter 1, Subchapter B, Part 165, Subpart B, Sec. 165-110 at http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfCFR/CFRSearch.cfm?fr=165.110

2c) Re: PCBs in human milk**:** U.S. Agency for Toxic Substances and Disease Registry, Toxicological Profile for Polychlorinated Biphenyls (PCBs), 2000, at http://www.atsdr.cdc.gov/toxprofiles/tp17.pdf This ATSDR report quotes a range of concentrations of PCBs in human milk as from 238 to 271 ng/g lipid weight. 1 g lipid weight = about 25g whole weight (assuming 4% fat in human milk). So the concentrations found in the studies were about 250 ng/25g whole weight, which = 10ng/g whole weight. 1 g (gram) = 1 ml of water., so the 10 ng/g whole weight is the same as 10ng/ml. That is the same as 10,000 ng per liter, which is the same as .01 mg/liter. So the levels of PCBs in human milk seem to be about **.01** mg/liter, compared with .**0005** mg/liter, the maximum allowed by law in U.S. public water systems. That is, about 20 times the concentration that would be allowed in public water systems. (U.S.EPA, Drinking Water Contaminants, National Primary Drinking Water Regulations, at http://water.epa.gov/drink/contaminants/index.cfm#Organic)

3) "Surgeon General's Call to Action to Support Breastfeeding, 2011," p. 6 and Fig. 1, at www.surgeongeneral.gov/library/calls/breastfeeding/calltoactiontosupportbreastfeeding.pdf

3a) Re: dioxins in formula less than 1% of dioxins in breast milk:
- U.K. Food Standards Agency Food Survey Information Sheet 49/04 MARCH 2004, Dioxins and Dioxin-Like PCBs in Infant Formulae, found at http://www.food.gov.uk/multimedia/pdfs/fsis4904dioxinsinfantformula.pdf
- Compatible figures were found in Weijs PJ, et al., Dioxin and dioxin-like PCB exposure of non-breastfed Dutch infants. Chemosphere. 2006 Aug;64(9):1521-5. Epub 2006 Jan 25 at www.ncbi.nlm.nih.gov/pubmed/16442144

Re: PBDEs in formula less than 2% of concentration in breast milk:
-Section 4.7 , 2nd paragraph (citing Schechter et al.) of U.S. EPA (2010) An exposure assessment of polybrominated diphenyl ethers. http:/cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=210404
-Section 5.6.2 of above, 2nd paragraph. The EPA states the figure as "44.1 ng/g lwt" (44.1 ng = 44,100 pg). For comparison purposes, the lipid (fat) weight indicated here needs to be converted to whole weight, which can be done as follows: The EPA here assumes a fat content of 4%. Using that figure, 44,100 pg/g lwt becomes 1760 pg/g wwt.

Re: Mercury in formula less than 1% as high as in human milk:
- Food Additives & Contaminants: Part B: Surveillance Volume 5, Issue 1, 2012 Robert W. Dabeka et al., Survey of total mercury in infant formulae and oral electrolytes sold in Canada DOI: 10.1080/19393210.2012.658087 at www.tandfonline.com/doi/full/10.1080/19393210.2012.658087#tabModule

-Re: PCBs in infant formula typically less than 1% but up to about 4% as high as in human milk:
- In breast milk**:** About **250** ng/g lipid weight. In soy-based formula: about **10** ng/g lipid weight. U.S. Agency for Toxic Substances and Disease Registry, Toxicological Profile for Polychlorinated Biphenyls (PCBs), 2000, pp. 560, 573, at http://www.atsdr.cdc.gov/toxprofiles/tp17.pdf Data does not appear to be available for PCBs in cow's-milk-based infant formula, but data for whole milk could give an approximation, as follows: adding together the figures for the two kinds of PCBs in this study provides a range of 52 to 2455 ng/kg fat, which equals **.05 to 2.45** ng/g fat (lipid) (Krokos et al., Levels of selected ortho and non-ortho polychlorinated biphenyls in UK retail milk, Chemosphere. 1996 Feb;32(4):667-73. at www.ncbi.nlm.nih.gov/pubmed/8867147)

3b) Jensen, A.A. et al, Chemical Contaminants in Human Milk, CRC Press, Inc., Boca Raton, Ann Arbor, Boston, 1991, p 15. This is fully compatible with the statement by two other experts as follows:
"Persistent lipophilic substances, including specific pesticides and halogenated industrial compounds, such as PCBs, accumulate in maternal adipose tissue and are passed on to the infant via breast milk, resulting in infant exposure that exceeds the mother's own exposure by 100-fold on the basis of

bodyweight." (Grandjean P, Landrigan PJ. Developmental neurotoxicity of industrial chemicals. Lancet. 2006;368:2167–2178
at www.reach-compliance.eu/english/documents/studies/neurotoxity/PGrandjean-PjLandrigan.pdf p. 2
Other earlier research that is still cited decades later is compatible with this: Gallenberg et al., Transfer of persistent chemicals in milk. Drug Metab. Rev. 1989;21:277-317
This is also compatible with the very large differences between concentrations of toxins in breast milk and those in alternative infant feeding -- see Section 2, cont.
Also see Needham et al., Partition of Environmental Chemicals between Maternal and Fetal Blood and Tissues, Environ Sci Technol. Feb 1, 2011; 45(3): 1121–1126, at
http://pubs.acs.org/doi/pdf/10.1021/es1019614, Table 2, finding weight-based concentrations of organohalagens to be over 30 times higher in human milk than in umbilical cord tissue.

4) Taylor et al., Prevalence and incidence rates of autism in the UK: time trend from 2004–2010 in children aged 8 years. BMJ Open 2013;3:e003219. doi:10.1136/bmjopen-2013-003219 at http://bmjopen.bmj.com/content/3/10/e003219.full.pdf+html?sid=01d45cb4-5ed1-45fd-91fe-c1544700b513

5) catalogue.ic.nhs.uk/publications/public-health/surveys/infant-feed-surv-2010/ifs-uk-2010-sum.pdf , Ch. 2, p.13

6) CDC's 2011 Pediatric Nutrition Surveillance, National Summary of Trends in Breastfeeding, Table 13D, at www.cdc.gov/pednss/pednss_tables/pdf/national_table13.pdf

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8) -- Durkin et al., Advanced Parental Age and the Risk of Autism Spectrum Disorder, Am J Epidemiol. 2008 December 1; 168(11) Table 3's "Birth order" section, at
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31a) see www.breastfeeding-benefits.net for considerable detail on this topic.

32) see www.breastfeeding-studies.info

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