INSTITUTE FOR AGRICULTURE AND TRADE POLICY

Dietary Sources of Chemical Exposure and Opportunities for Exposure Reduction

Report to the Kaiser Permanente National Program Office

April 15, 2011

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I. Purpose and background for the paper

Kaiser Permanente's Environmental Stewardship Public Education Campaign seeks to "improve public health by executing an education strategy to prevent health impacts of environmental toxins, and to illuminate the disproportionate impact of those toxins on underserved communities." The Institute for Agriculture and Trade Policy has undertaken a scope of work to fulfill Kaiser Permanente's campaign goal by developing an approach to promote actions in communities to reduce their exposure to environmental toxins in the food chain. This paper summarizes the work of this project including: background research on toxins in food and their health effects, food source exposures, affected populations, general consumer advice on reducing exposures and recommendations for an effective consumer campaign.

II. Background on Chemicals of Concern and Exposure Sources

Introduction to the problem:

Widespread exposure

One unfortunate result of the widespread production and use of industrial chemicals in both agriculture and consumer products is their ubiquity in our environment and in the food chain. Some chemicals used in industrial applications find their way into the environment and into the food chain: PCBs, PBDEs, PFCs, mercury and DDT. PCBs and DDT were banned decades ago, but still contaminate fish and other foods. Other chemicals used in plastic food containers and packaging can leach into the food: phthalates, bisphenol A and styrene. Other chemicals like food dyes and nitrates are intentionally added during food processing to improve appearance and preserve freshness. Additional chemicals and harmful substances end up in our foods due to modern methods of growing crops and raising livestock: hormones, arsenic, mercury, pesticides. In addition, the widespread use of GMO crops increases exposure to pesticides and may carry other risks to human health.

Body Burden

From birth our bodies are polluted with a complex mixture of dozens of industrial chemicals, including substances known to cause cancer, harm the brain, disrupt the functions of hormones, and impair reproduction. According to recent CDC data, virtually all pregnant women in the U.S. have body burdens of lead, mercury, perchlorate, bisphenol A, as well as some phthalates, pesticides, perfluorochemicals and PCBs.[1] Many chemicals move up the food chain, ending up in the human body. Some persist in the body for many years e.g. PCBs, PBDEs, and some pesticides. Others like BPA remain in the body for a short time, but are so prevalent in our environment that 93% of people have BPA in their bodies.

Exposures before birth can also have critical impacts on health. Emerging science points to the fetal origins of adult disease. A large body of animal studies and limited epidemiological research point to prenatal and early life exposure to hormone disrupting chemicals affecting reproductive system development and increasing susceptibility to carcinogens.[2] In this context, scientists are beginning to explore the extension of the "Barker hypothesis," which links adult cardiovascular disease with in utero nutritional deficiencies, to environmental toxicants as well.[3]

Health risks

Human health risks from exposure to chemical food contaminants range from well documented (PCBs, mercury, pesticides, BPA, phthalates) to less well known (growth promoter hormones). Recent science tells us that exposure to multiple chemicals including mixtures of different pesticides, as well as mixtures of pesticides and heavy metals or other common toxic chemicals, may cause more harm than one would expect from merely considering their individual hazards.[4]

Our biological systems work via enzymes, hormones and other critical cellular pathways. These are the same processes disrupted by environmental pollutants. Many compounds including pesticides, plastics, chemicals, and synthetic substances in food are recognized as hormone disruptors that mimic the naturally occurring hormones in our body and upset our body's natural balance. We naturally believe that low dose exposures to pesticides are not harmful. However, in a powerful paradigm shift, we are seeing that the dose does not make the poison and that the effects of toxic chemicals are more complex. Just as the body's own hormones are effective at miniscule levels, low doses of hormone disrupting chemicals can set into motion a cascade of effects in the body, including birth defects, disruption of sexual differentiation, disturbed thyroid function, decreased fertility, as well as obesity.

Emerging Role of Obesogens

As noted, many of the chemicals that contaminate the food system are hormone disrupters that impact the delicate hormone balance in the human body. Examples include PCBs, PBDEs, PFCs, bisphenol A and phthalates. New evidence is emerging that many of these chemicals are "obesogens" or "chemical agents that inappropriately regulate and promote lipid accumulation and adipogenesis."[5] [6] Fetal or early life exposure to organotins from seafood, agricultural products, drinking water and plastics leaching is associated with acute and long tem adipogenic effects.[7] There is evidence that other chemicals affect the same hormone receptor mechanism that organotins act on to disrupt lipid regulation. These chemicals include bisphenol A, DEHP (a phthalate), PFOA and[8] PBDEs.[9] There is evidence of a dose response relationship between exposure to persistent organic pollutants (POPs) and metabolic syndrome (risk factors for coronary artery disease, stroke, and type 2 diabetes),[10] insulin resistance[11] and diabetes.[12] Exposure to certain POPs (DDT, oxychlordane) was associated with increased body mass index and waist circumference.[13]

Benefits of Good Nutrition

While food can be a vehicle for exposure to contaminants that are linked with adverse health effects, there is also evidence for the mediating effects of good nutrition. Kordas et al provide a model for examining interactions between nutrition and environmental exposures. As a toxicant is absorbed by the human body it interacts with other nutrients to determine absorption and retention of the toxicant and may also affect absorption of nutrients. Furthermore, interactions between toxicants and nutrients may affect the occurrence or severity of health outcomes.[14] For example, lead interacts with micro nutrients in the body and iron deficiency contributes to lead absorption.[15] Women with higher calcium levels absorb less lead and placental absorption of lead was reduced in women with high levels of iron in their bodies.[16] Low iron is also associated with higher body burden of cadmium.[17] Resource poor individuals and communities would be at higher risk for both poor nutrition and greater toxicant exposures, further exacerbated by the interaction of the two factors.

Health risks from a diet rich in processed foods are well documented. Cardiovascular diseases, diabetes and obesity are now major public health problems in developed countries, but less so in populations that rely on traditional hunting, gathering and individual farming.[18] Inflammation and oxidative stress are associated with these metabolic diseases and also with toxicant exposure. Good nutrition can modulate the effects of toxicant exposure and can prevent or mitigate these chronic diseases.[19] Examples of nutrients that have shown positive health effects include flavonoids (e.g. polyphenols in green tea, blueberries, onions, honey, and spinach) and Omega -6 fatty acids. A diet high in flavonoids may reduce the risk of ovarian cancer,[20] [21]cardiovascular disease[22] and tooth decay.[23] Omega-3 fatty acids have protective effects in cases of aggressive prostate cancer.[24] Supplementation with omega-3 and omega-6 fatty acids has positive effects on neurodevelopment in children[25] and may ameliorate cognitive decline and cardiovascular disease in older people. [26] Nutritional interventions are sometimes successful in treating high chemical body burdens. For example, calcium supplementation was associated with a decrease in blood lead levels.[27] Selenium may play a role in excretion of arsenic from the body.[28]

III. Chemicals of Concern:

IATP has a long history of working to reduce environmental toxins in the food system and to inform consumers on how to reduce their personal exposures to food toxins. In 1996, IATP helped found Health Care Without Harm, the international campaign to "green" health care. Early work focused on mercury and dioxin, common persistent and bioaccumulative food toxins. While IATP staff has worked with health care systems and public policymakers to reduce levels of these toxins in our environment, we have also made it a priority to provide consumers with the best available information on how to reduce personal exposures to toxicants in food. Since 2001, we have produced a series of Smart Guides, including: Smart Plastics Guide, Smart Meat and Dairy Guide, Smart Fish Guide, Smart Produce Guide, Smart Guide to Minnesota Dairy

Without rBGH, Smart Guide to Food Dyes and Smart Guide to Hormones in the Food System. We have also conducted numerous food testing projects including arsenic in chicken and mercury in high fructose corn syrup. Our extensive knowledge base and experience with consumer advice on food contaminants has led us to conclude that the following chemicals are of greatest concern to public health, based on the current state of the science. The list of chemicals includes:

- chemical byproducts of industrial processes and energy production (dioxins, PCBs, PDBEs, PFCs, perchlorate) and agricultural production (pesticides, animal growth hormones)
- chemicals used in food packaging (phthalates, bisphenol A, styrene)
- food additives (nitrites, food colorings)
- chemicals formed through cooking processes (nitrosamines, HCAs, acrylamide, PAHs.)

1) Dioxins and PCBs.

Dioxins are unintentional byproducts of industrial processes like metal smelting and refining, chemical manufacturing, biological and photochemical processes and combustion. For example, burning chlorine-containing products, like polyvinyl chloride (PVC) plastic, generates dioxin. Currently the largest source (57%) of new dioxin emissions is backyard burn barrels.[29]

Dioxins released into the air from combustion settle on grasslands, where grazing cows ingest them, and in water bodies where they build up in fish. Dioxins can also accumulate in animal feed. Fetuses are at greatest risk from exposure to dioxins, which cross the placenta during pregnancy. Fetal exposure to dioxins and dioxin-like compounds is correlated with the mother's body burden of these chemicals. [30]

PCBs are dioxin-like chemicals used in electrical equipment, hydraulic fluids, adhesives and other products until 1979, when they were banned in the U.S. due to evidence of toxicity even at low levels. Their widespread use and persistence in the environment ensures that PCBs will continue to remain a significant source of environmental contamination for many years. According to the Institute of Medicine, "Dietary intake is widely believed to contribute up to 90% of human exposure to dioxin-like chemicals."[31]

Health impacts from long-term exposure to low levels of dioxins and PCBs include:

- **Non-cancer health effects.** Effects on thyroid hormone, impaired brain development, and effects on birth weight and immunity.[32] Also, prenatal exposure to dioxins and PCBs can result in permanent IQ deficits.[33] [34]
- **Changes in Behavior.** Dutch researchers found effects on gender-specific behavior. Specifically, higher PCB dietary exposures were associated with girls displaying more "masculine" behaviors and boys displaying more "feminine" behaviors. Likewise, higher dioxin diet exposures were associated with more feminized behavior in both boys and girls.[35]

- **Cancer.** The World Health Organization classifies dioxin as a human carcinogen and PCBs as probable human carcinogens.[36] Although the EPA also considers dioxins and PCBs to be carcinogens, a causal link from long-term low-level human exposures is less clear.[37]

2) Flame Retardants.

Certain brominated flame retardant chemicals (BFRs) are widely used in foam products, textiles, electrical equipment, building materials and transportation. They are chemically similar to PCBs. While levels of dioxins and PCBs in food and breast milk have slowly declined over time, BFR levels are increasing at an exponential pace.[38] Levels in U.S. women's breast milk are reported to be 10 -100 times higher than levels in European women.[39]

Although data on ***human health effects*** are lacking, animal studies confirm that BFRs are toxic to developing organisms, with adverse effects on the brain, reproductive system and liver. They also disrupt thyroid function.[40] [41] Dietary intake of animal-based foods contributes to high body burdens of BFRs in the U.S.[42] Children have higher levels of these chemicals in their bodies due to both dietary exposure and exposure through household dust.

3) Perfluorinated chemicals

(Perfluorooctanoic acid or PFOA, Perfluorooctanesulfonic acid or PFOS). Perfluorinated chemicals (PFCs) are persistent toxic chemicals that are found world-wide in the environment, wildlife, and humans. They bioaccumulate in wildlife and humans, and are extremely persistent in the environment. Studies of laboratory animals and wildlife provide evidence of reproductive, developmental, and systemic health effects. Health effects on human are less well documented, but "given the long half-life of these chemicals in humans (years), it can reasonably be anticipated that continued exposure could increase body burdens to levels that would result in adverse outcomes."[43] One study found an association between higher levels of PFOS and PFOA in blood and increased risk of infertility. [44] Another found reduced semen quality in men with higher levels of PFCs in their bodies.[45]

PFCs have many industrial applications that provide numerous opportunities for human exposure. For example, environmental contamination of drinking water and fish exposes communities in the vicinity of manufacturing sites. Global transport of PFCs and subsequent accumulation in the food chain expose fish and meat eating populations as far north as the Arctic. In addition, a common food source exposure to PFCs is through Teflon coated cookware and grease resistant food packaging coatings e.g. pizza boxes, fast food wrappers and popcorn bags. Recent NHANES biomonitoring results found four PFCs were 98% of participants sampled.[46]

4) Mercury

Methyl mercury is 95% absorbed by the gut after ingestion, as in fish consumption. Humans can eliminate mercury from the body over a period of months. However, when the amount of mercury ingested exceeds the ability of the body to eliminate it, mercury builds up in the body over time. The CDC reports that 8% of women of childbearing age carry a body burden of mercury that could put their offspring at risk for adverse developmental effects, potentially affecting 325,000 newborns a year.[47]

Health effects Mercury is a potent neurotoxin and chronic exposure to methyl mercury is associated with toxicity to the central nervous system. It affects the brain, spinal cord, kidneys and liver. Methyl mercury passes through the placenta and is excreted into breast milk, so it can interfere with normal fetal and infant development, preventing the brain and nervous systems from developing normally. Infants exposed to mercury at high levels can experience mental and physical retardation. Some effects may be reduced intelligence, impaired hearing, poor coordination or delayed motor and verbal skills.[48] Thus, even small amounts of mercury in the diet over a long period of time can potentially cause health effects. Several long-term studies suggest that offspring of mothers who eat greater amounts of fish experience adverse effects on learning and attention.

5) Perchlorate

Perchlorate is a chemical used in rocket fuels, explosives and other industries that is now a widespread contaminant in soil and surface and groundwater, and is widely found in drinking water supplies and common foods. It is known to disrupt thyroid function and blocks the body's ability to move iodine to where it is most needed to make the thyroid hormone.[49] Our thyroid glands need iodine to make hormones essential for our bodies' function, as well as for early brain and nervous system development in fetuses and children.[50] [51] Nursing infants must get essential iodine from mothers' milk; babies lacking sufficient iodine may become mentally impaired. In women, levels of thyroid hormone change inversely to the level of their exposure to perchlorate. Perchlorate-exposed moms actively concentrate perchlorate in their breast milk,[52]passing it directly to their nursing infants—plus, iodine levels in their milk are diminished. That's a double whammy for nursing infants who receive less iodine in milk, as well as more perchlorate, which blocks their ability to use the iodine. Three-quarters of 285 commonly consumed foods and beverages are contaminated with perchlorate, including lettuce, milk and produce, according to FDA data. Some fruits can contain enough perchlorate to exceed the National Academy of Sciences' safe daily dose by more than 25 percent;[53] 250,000 one-year-olds have perchlorate exposure above the government's safe dose, from these 285 food sources alone.[54] Perchlorate also contaminates drinking water in 28 states, including Minnesota, at concentrations from 4 to 420 ppb.[55]

6) Pesticides

Many pesticides are known to be toxic to the brain, causing lasting effects on brain function and behavior.[56] Other pesticides have been found to increase the risk of cancer.[57] Up to fifty-seven pesticides are known to disrupt the function of hormones, which are critical in sending proper signals to cells during development. [58] [59] [60] [61] Health effects depend not only on the amount of pesticide and the length of exposure, but also on the vulnerability of the exposed person. Exposure begins in the womb, even to neurotoxic pesticides.[62]

Children are especially vulnerable to the effects of pesticides and they consume more of some types of produce than adults. Take apples, for example. They are a favorite fruit of children and are also among the fruits with the highest pesticide residues. Thus a young child who consumes many apples in short period of time may exceed a safe dose of pesticides. Since young children develop quickly, this exposure could coincide with a critical period in their development.

- Pound for pound, a child ages 1-2 eats nearly four times as much food as the average person – so they can proportionally consume more pesticide residues.[63]
- Children eat more of certain foods that tend to carry more pesticides, such as apples. The average one to two-year-old's weight-adjusted apple consumption is 4 times that of the average person. Kids that age also consume four times more fruit juice and drinking water.[64] [65]
- A young child's immune system and organ systems for detoxifying poisons are too immature to protect against some pesticides. The "blood-brain barrier," which protects the brain from toxins in the bloodstream, is not fully developed until a child is one year old. [66]

American adults on average carry residues of 31 different pesticides or their break down products in the body, according to the Centers for Disease Control (CDC). [67] The CDC's latest study detected numerous pesticides in the bodies of people aged 12 and over, including: dieldrin (detected in 87.3%); DDT (73.8%); DDT metabolite DDE (99.7%); hexachlorobenzene (99.9%); oxychlordane (82.9%); trans-nonachlor (92.6%); heptachlor epoxide (60%); and Mirex (40.7%). Even though all but one of these pesticides are banned or severely restricted in the U.S., they were still detected in these 2002-2003 blood samples.

This human pollution begins before birth, as pesticides in the mother's body pass through the placenta to her growing fetus. One study examining exposures of urban women to pesticides during pregnancy measured eight pesticides in personal air samples and seven in blood samples. Pesticides detected in the mothers' blood correlated with those found in cord blood, illustrating a routine fetal exposure to chlorpyrifos, diazinon, bendicarb, and other pesticides.[68] Umbilical cord blood is polluted with pesticides banned more than 30 years ago.[69] This is alarming because exposure during pregnancy has the most profound influence on childhood development.[70] [71] For example, studies of identical twins have indicated that chromosomal changes occur in utero that increase susceptibility to subsequent environmental exposures that can increase risk for acute lymphocytic leukemia (ALL).[72] Increased risk of ALL is associated with prenatal pesticide exposure. [73] [74]

After birth, mothers' breast milk can deliver fat soluble pesticides directly to baby.[75] [76] Breast milk remains the best nutrition for babies, despite pollutants detracting from its extraordinary benefits. We are all exposed to pesticides through water and food residues. Conventionally grown fruits and vegetables can contain residues of multiple pesticides. Dietary exposure to organophosphate pesticides residues is a major source of exposure for young children.[77] GMO crops, used to grow corn, soybeans and rapeseed oil or canola prevalent in the U.S. agricultural system, have been bred to tolerate or produce pesticides, including Roundup. A little recognized side effect of GMO food consumption is exposure to pesticide residues, "some of which have been demonstrated as human cellular endocrine disrupters at levels around 1000 times below their presence in some GM feed." [78]

7) Hormones: steroid and arsenic growth promoters, rBGH

Health problems. Hormones, functioning in balance, are essential for people to grow and develop. Hormones coordinate early brain growth, sexual development and other important sequencing that takes places in our bodies. The body makes its own hormones. But exogenous hormones, those originating outside the body—birth control, estrogen replacement therapy, pharmaceuticals, pollutants, and so on—clearly can disrupt our own hormone function, sometimes causing grievous harm, as with diethylstilbestrol (DES).[79] Some exogenous hormones are intentionally added to the food system. Others accumulate in food as unintentional (though foreseeable) contaminants. Common practices of our industrialized food system—such as the "recycling" of rendered animal fats back into feed for other animals—can exacerbate contamination.

Today, many hormone-related chronic diseases are common and/or on the rise.[80] We know these unhealthy trends likely have multiple social and environmental causes and are too recent to be attributable to a change in genetics. Nevertheless, ever-strengthening science links exposure to many individual hormone disruptors—pesticides, Teflon chemicals, plasticizers and food contaminants—with these common or rising chronic conditions,[81] including:

- Breast and prostate cancer [82]
- Thyroid disease [83]
- Obesity and diabetes [84]
- Endometriosis,[85] uterine fibroids[86] and infertility[87]
- Immune-related disease, such as asthma or allergies[88]
- Increasingly, exposure in the womb to these same chemicals is implicated in serious problems found in newborns such as birth defects and low birth weight, as well as reduced odds of having a boy child.[89]
- A recent study links a mother's high beef consumption while pregnant (steroid growth promoter use is widespread in beef production) with lower sperm counts in her son.[90]

Steroid growth promoters

Hormones routinely given to U.S. beef cattle to spur faster growth end up in the meat, and ultimately, our bodies. The Food and Drug Administration (FDA) banned one synthetic estrogen, DES, as an animal growth promoter in 1979. But at least three natural steroids and three synthetic surrogates remain in widespread use as growth hormones by U.S. and Canadian beef cattle producers.[91] One of them, trenbolone acetate, is thought to have 8–10 times greater anabolic activity than testosterone.[92] A 2004 congressional investigation also revealed that the U.S. veal industry had been giving trenbolone implants to more than 90 percent of veal calves; an illegal practice the industry admitted had been commonplace for decades.[93] Though illegal in Europe since 1988, the U.S. government's position is that hormone residues in beef from adult cattle pose no threat to human health.[94] This safety presumption, however, rests mostly on outdated research concerning the ability of estrogen (estradiol) to mutate genes. The latest research suggests instead that harm from early life exposure to hormones and hormone-disrupting chemicals could stem not from their ability to change the genes, but rather their ability to change the crucial protein environment surrounding the genes, called the epigenome. It is this protein environment that determines, in part, at which points in one's life particular genes will be turned on and off. By changing this environment, hormone exposure early in life may basically re-program the body's resilience, reproduction and metabolism later in life.

Arsenic growth promoters

Inorganic arsenic causes cancer causes cancer and contributes to diabetes, heart disease and declines in intellectual function. Adult cancers may form decades after in-womb exposure to arsenic because it re-programs some genes responsible for proper hormone function. Recent research shows arsenic affects at least 187 different genes, about a quarter of which impact how estrogen or other steroid hormones work in the body.[95] Arsenic now appears to also interfere with thyroid function, essential for normal brain development as well as adult function.[96] Researchers see arsenic-related hormone effects even at exposures below 1 parts per billion (ppb), or more than 10 times lower than the legal limit for arsenic in drinking water.[97] Americans drinking water containing greater than 10 ppb of arsenic number 13 million

Since 1946, an arsenic compound has been fed to American poultry to spur growth, feed efficiency and to pigment meat. Adding arsenic to animal feed was never approved as safe in the European Union. The FDA fails to test chicken meat for arsenic, although retail chicken meat appears to commonly contain arsenic residues. A 2005 IATP study consistently detected arsenic in retail chicken, much more often in "conventional" brands than in certified organic or other premium brands.[98] Roxarsone, the most common U.S. arsenic feed additive, promotes the growth of blood vessels in chickens to produce pinker meat. However, a 2008 study also found that roxarsone promotes human blood vessel growth. This process, called angiogenesis, is one that occurs in cancers and other diseases.[99]

rBGH (recombinant bovine growth hormone, also known as rBST)

rBGH is a genetically engineered growth hormone injected into dairy cows to increase milk production. About 15% of dairy farmers inject their cows with recombinant synthetic bovine growth hormone (rBGH or rBST) to increase milk production,[100] though its use is unnecessary to produce milk. Though declared "safe" by the FDA, food safety officials in many other countries—including Canada, Japan, Australia, New Zealand and all 25 nations of the European Union—have refused to approve its use. Concerns with use of rBGH revolve around its known adverse impacts on dairy cows (including increased mastitis infections needing antibiotic use) and the potential harm to humans.[101] Increased antibiotic use in food animals contributes to antibiotic resistance transmitted to humans. Information on potential adverse human health effects from consuming dairy products from rBGH-treated cows is lacking, because the Food and Drug Administration (FDA) required only limited testing on rats before approving the use of rBGH. However, there is evidence that rBGH milk increases IGF-1 (insulin-like growth factor), a natural hormone in cows and cow milk.[102] Increased IGF-1 levels in humans have been implicated in higher rates of colon, breast and prostate cancer.[103 104] Because of human and animal health concerns, rBGH milk is not sold on the European market. As yet, the science is insufficient to assure the safety of drinking milk from cows given rBGH because it is unknown whether doing so will also increase IGF-1 levels in the human bloodstream.

8) Styrene:

Styrene can leach from polystyrene plastic. It is toxic to the brain and nervous system, among workers with longer-term exposures,[105 106] but also adversely affects red blood cells, liver, kidneys and stomach in animal studies.[107] Aside from exposure from food containers, children can be exposed to styrene from secondhand cigarette smoke, off-gassing of building materials, auto exhaust fumes, and drinking water.

9) Bisphenol A (BPA)

BPA is a chemical that mimics the action of the human hormone estrogen can leach from polycarbonate plastic. [108] Fetuses and infants are at highest risk from exposure to BPA. One study found that premature babies in neonatal intensive care units had ten times higher levels of BPA in their bodies than the general population, most likely due to their exposure from plastic medical devices and infant formula.[109] In general BPA in babies could be eleven times higher than in adults, due to differences in metabolism and body size.[110] Almost everyone carries a BPA body burden. A Centers for Disease Control study detected BPA in the urine of 93 percent of adults sampled.[111] Scientists have measured BPA in the blood of pregnant women, in umbilical cord blood and in the placenta, all at levels shown to cause harm in laboratory animals.[112 113]

Considering that 93% of us carry a BPA body burden, the results of new study by the Silent Spring Institute are not surprising. Five families (20 people) were fed a fresh food, packaging free diet for a three day period. At the end of the intervention measured urine levels of BPA decreased 66% and DEHP levels decreased 53-56%.The levels of these chemicals increased when participants returned to their normal diets. [114] This study dramatically illustrates the contribution of food packaging to daily exposure to BPA.

BPA disrupts hormones in the human body and low-dose early life exposures are linked with reproductive and developmental problems, cancer and diabetes. Early life exposure to BPA can also cause genetic damage, including chromosomal errors at low levels of exposure in mice, which can lead to spontaneous miscarriages and birth defects.[115] Ninety-three percent of 202 government-funded studies found significant developmental, reproductive or immune effects from low-level exposure to BPA. Of the 14 industry-funded studies, none found significant effects.[116] Animal studies document low dose effects at exposure levels hundreds of times lower than the current level considered "safe" by the EPA. [117]

Bisphenol A mimics the action of the human hormone estrogen and hormones can stimulate certain cancers. BPA stimulates prostate cancer cells[118] and causes breast tissue changes that resemble early stages of breast cancer in both mice and humans.[119 120] As an environmental estrogen, BPA may also contribute to testicular germ cell cancer.[121] While BPA can stimulate cancers, it also reduces the efficacy of chemotherapeutic agents at environmentally relevant doses.[122] As a hormone disrupter, BPA is also implicated as an "obesogens" or chemical agent that promotes fat accumulation.[123] [124]

While there are hundreds of studies showing adverse effects of BPA on animals, the body of science on BPA's effects in human studies is growing. Higher BPA levels in urine were associated with ovarian dysfunction in humans.[125] Another study found that women with a history of recurrent miscarriages had over 3-fold higher levels of BPA in their blood compared to women without a miscarriage history.[126] Higher urinary BPA concentrations were associated with cardiovascular diagnoses, diabetes, and with abnormal concentrations of liver enzymes.[127]

10) Phthalates: DEHA [Di (2-ethylhexyl) adipate]

DEHA is one of several *plasticizers* (softeners) to which people have daily exposure through food, water, air and consumer products. PVC cling wrap contains DEHA, a hormone disrupting chemical that can leach into oily foods on contact and when heated. DEHA exposure is linked to adverse effects on the liver, kidney, spleen, bone formation and body weight. It is also a possible human carcinogen, affecting the liver.[128]

11) Food Dyes.

Industrialization of the food system, including a rise in food processing, has increased the use of food additives such as food dyes, preservatives and sweeteners. The FDA maintains of list of over 3,000 food additives, which includes those that are FDA-approved as well as those bypassing the approval process because the FDA has designated them as GRAS (generally recognized as safe).[129] Scientists have long been concerned that synthetic food dyes and other additives may contribute to hyperactivity and other disturbed behavior in children.[130] Nine synthetic food dyes, mostly petroleum-derived, are U.S.-approved for use in foods under the Food, Drug, and Cosmetics Act of 1938 (FD&C).[131] Pigments from natural sources are exempt from FDA certification. Water soluble "dyes" are added to beverages, baked and dairy goods, and other products; non-soluble dye versions of the colors, called "lakes," are used in hard candies, chewing gums and to coat tablets. Since 1990, all synthetic food dyes must be listed in food products by their common name.

Synthetic food dyes, purely cosmetic, are unnecessary—the only food additives for which this is true. Highly processed foods can lose natural color (as well as flavor and vitamins) with exposure to high temperatures, light, air and moisture. Post-processing, synthetic dyes are often added to offset the color loss, enhance natural color, color otherwise colorless food and make food attractive. Food dyes are common in foods specifically marketed to children, including many foods, dressings, treats, and dipping sauces at fast food outlets.[132] While six common synthetic food dyes are no longer sold in Great Britain, some global companies now sell two versions of their products: a version without food dyes for the UK, and a version with food dyes for the U.S.[133]

Health Concerns

Over the last three decades, repeated studies have concluded that modest doses of synthetic colors added to foods can provoke hyperactivity, cognitive disturbances[134] and compulsive aggression;[135] asthma and hives;[136 137] low-serum iron and zinc;[138] and irritability and poor sleep.[139] A 2007 UK study in The Lancet found increased hyperactivity among nearly 300 children who were fed a mixture of the six suspect food dyes, plus the food preservative sodium benzoate.[140] Hyperactivity worsened within about an hour of children ingesting the mixture. Hyperactivity is a pattern of behavior—being overactive, impulsive and inattentive — that varies substantially across the population. But in this study, effects were seen not only among children diagnosed with Attention-deficit/hyperactivity disorder (ADHD), but also among children in the general population. Because science links child hyperactivity to problems with learning (especially reading), the study's authors concluded that the increased hyperactivity triggered by these food additives could impair a child's potential to learn in school. The study replicated findings in earlier studies as well.[141]

12) Nitrite (sodium nitrite)

Nitrite is added to meat to preserve flavor and freshness. Sodium nitrite is toxic at high doses in animal studies. Carcinogenic nitrosamines can be formed when nitrate containing foods are cooked at high temperatures. However, the additional of ascorbic acid, now required in meat manufactured in the U.S, inhibits nitrosamine formation. Sodium nitrite consumption is linked to triggering migraines and frequent consumption is linked to COPD lung disease. However, up to 85% of dietary nitrate is consumed in vegetables.[142]

While nitrites have not been established as the main culprit, there appears to be an association between consumption of processed meat and pancreatic cancer. High consumption was associated with a 68% increase in risk in one study and consumption of red meat and pork was associated with a 50% increase in risk. Because these was no increased risk associated with high intake of poultry, dairy products, eggs, fish or total fat intake, the authors conclude carcinogenic substances related to meat preparation, rather than fat, were likely responsible for the positive association.[143] In another study consumption of some high-fat processed meat products (sausage, salami, and bacon) was associated with increased risk of pancreatic cancer.[144] Nitrate free processed meat products are now available in food cooperatives and organic markets, like Whole Foods. We will need to investigate their availability in mainstream grocery stores and corner markets.

13) Chemicals in foods cooked at high temperatures.

- Heterocyclic amines (HCAs) and polycyclic aromatic hydrocarbons (PAHs) are chemicals formed when muscle meat, including beef, pork, fish, and poultry, is cooked using high-temperature methods, such as pan frying or grilling directly over an open flame.[145] Carcinogenic nitrosamines can also be formed when meat is fried.
- Acrylamide is formed when carbohydrate foods are cooked at a high temperature, e.g. French fries. Acrylamide exposure is common in the US, with estimated intakes by children being twice that of adults and exceeding the EPA reference dose. Acrylamide

exposure is associated with increased risk of cancer, nerve damage and adverse effects on reproduction.[146]

IV. Dietary Sources of Exposure

Meat and Dairy:

Meat and dairy products can be part of a healthy well-balanced diet. They are good sources of protein, iron, calcium, vitamin D, and other vitamins and nutrients essential for growing children and pregnant and nursing women. Meat and dairy products also can contain varying levels of toxic pollutants, including **dioxins, PCBs, PFCs, pesticides** and **flame retardants.** Chemicals that accumulate in fat are present at higher levels in foods like meat and dairy products that contain animal fat. These chemicals share common properties. Aside from their tendency to accumulate in fat, they are all toxic and persist in the environment and in living tissues. For example, the half life of dioxins and PCBs in the human body is between 7 to 11 years, so it is especially important for girls and young women to reduce exposure whenever possible.[147] These chemicals are also neurotoxins, meaning they are toxic to the developing brain, putting fetuses and young children at greatest risk.

Arsenic is intentionally added to 70% of chicken feed. Some of this arsenic stays in the meat, creating a little known source of exposure to this toxic metal. IATP found arsenic in 55% of meat samples tested.[148] Lasky et al calculated the average intake of inorganic arsenic from chicken at 3.6-5.2 ug/day.[149] Additional exposure from chicken consumption on top of arsenic in average drinking water exposure adds an additional risk of developing cancer increases to 1-in 300.[150] Common exposures to arsenic include drinking water, playground equipment and contaminated soil. However, arsenic is also found in foods, including rice, chicken and fish. The source of arsenic in American grown rice seems to be residues of arsenical pesticides on former cotton fields now used to grow rice.

Fish and Seafood:

Fish are an excellent source of protein, vitamin D and beneficial omega-3 fatty acids, which help prevent heart disease and promote mental health and healthy brain development in infants and children. Pregnant women are advised to eat fish to contribute to healthy brain development in their unborn child, but to follow fish consumption advice for the safest choices. The same chemicals that build up in meat and dairy products also accumulate in fish: e.g. mercury, PCBs (polychlorinated biphenyls), dioxins, PFCs, flame retardants and pesticides. Large predatory fish have higher pollutant levels and some fatty fish species tend to be higher in PCBs and dioxins. Smarter fish consumption can reduce health risks.

Anyone eating fish with mercury and PCBs faces potential health problems. However, fetuses and young children are at greatest risk. Exposure to these brain toxins early in life when the brain is still developing can lead to adverse effects on learning and behavior.[151] [152]Because mercury and especially PCBs remain in the body, reflecting months or even years of past exposure, any woman capable of bearing children needs to pay attention to the fish she eats, even before becoming pregnant. In addition to mercury and PCBs, PBDEs, PFCs and pesticides are common fish contaminants that present increased risk for adverse effects on development. During pregnancy these toxins travel easily through the placenta to the developing fetus. Mothers also pass these pollutants in breast milk to nursing babies. Since brain development continues into the teen years, children under 15 should also follow fish consumption guidelines.

Produce:

Fruits and vegetables provide essential minerals, vitamins and fiber that are critical for growing children and pregnant and nursing women. To maximize health benefits, everyone should try to eat 3-5 servings of vegetables and 2-4 servings of fruit each day. On the other hand, produce often contains residues of pesticides, chemicals designed to kill weeds and insects. Pesticide residue levels vary depending on the type of produce and how it's grown. Consuming fruits and vegetables that have lower residues can minimize pesticide exposure, while enjoying the benefits of fresh produce.

Food packaging:

Plastic containers:

Plastics are widely used to store and package foods and beverages. Plastic is convenient, lightweight, unbreakable and relatively inexpensive. However, use of plastics in cooking and food storage can carry health risks, especially when hormone-disrupting chemicals from some plastics leach into foods and beverages.

A variety of petroleum-based chemicals go into the manufacture of plastics. Some can leach into food and drinks and possibly impact human health. Leaching increases when plastic comes in contact with oily or fatty foods, during heating and from old or scratched plastic. Use of some detergents can degrade plastic, also allowing the chemicals to leach out. Types of plastics shown to leach toxic chemicals are polycarbonate, PVC and styrene.

Can linings:

Most food cans are lined with an epoxy resin that contains bisphenol A, which is known to leach into the food.

Teflon-coated cookware and grease resistant coatings:

A common food source exposure to PFCs is through Teflon coated cookware and grease resistant food packaging coatings e.g. pizza boxes, fast food wrappers and popcorn bags.

Food Processing: High fructose corn syrup (HFCS):

Caustic soda made with mercury cell technology used to process high fructose corn syrup, that ubiquitous sweetener used in many processed foods, creates a little known exposure to toxic mercury. Testing by IATP found mercury in nearly one third of HFCS-containing products tested, including in snack bars, barbecue sauce, yogurt, chocolate syrup, jelly, catsup, chocolate milk and other processed foods. [153] Using the USDA's estimate of 50 grams HFCS consumption per day, the average person would ingest about 28.5 ug total mercury per day from these sources. While this figure is not directly comparable to the EPA reference dose for methylmercury (about 5.5 ug/kg/day for the average person), HFCS could represent a significant new exposure to toxic mercury.[154] Exposure from consuming these everyday foods adds to exposure from fish consumption and other sources.

Cooking at High Temperatures:

Toxic acrylamide, nitrosamines, HCAs and PAHs can be formed when foods are cooked at high temperatures or for a long time.

Breast milk:

As with meat, fish and dairy products, persistent, toxic chemicals build up in human milk. These include dioxin, PCBs, PFCs, PBDEs and pesticides. Because breast milk affords extraordinary health benefits to the nursing infant, breastfeeding is clearly the best choice for mothers. Therefore, efforts to reduce these contaminants in the environment should be prioritized.

V. Potential Audiences

While everyone can benefit from advice on reducing exposure to food contaminants, the following groups may reap the greatest benefits:

New parents, parents of young children, especially mothers

Parents are an important audience for avoiding toxins in food, because they are especially open to information on actions they can take to create a healthy environment for their children. New parents are learning and absorbing information on caring for their new baby every day. IATP has published a series of Smart Guides for parents with tips on reducing exposures to food contaminants and we receive numerous inquiries from concerned parents almost every week and many parent and health groups request to use the guides in their parent/patient education work. Results of a parent education project with Early Childhood Parent Education classes, conducted by Kathleen Schuler indicate that 85% of parents reported that they were motivated to make at least one change in behavior to protect their child, including 10% of parents who said they would try to buy more organic foods.[155]

In addition to greater receptivity to information by parents of young children, actions taken by parents at this stage can have the greatest impact. Children are more vulnerable to environmental exposures, due to their small body size, patterns of food consumption and mouthing and other behaviors that create greater exposure to toxins. Young children are rapidly growing and developing, making them more vulnerable to harm from exposures to toxins that could impact health later in life. Emerging science on low dose early life exposures to hormone disrupting chemicals is especially concerning.

Women of childbearing age and pregnant women

Like new parents, pregnant women and expecting fathers are very receptive to tips on promoting their baby's health. This is also the period of development, when humans are most vulnerable to environmental exposures, so information on reducing exposures can have the greatest impact on a child's health. In this report we describe the unique risks to fetuses from exposures to environmental toxins from food and other sources.

Dietary advice to women before they get pregnant is even more valuable, as an informed woman has an opportunity to prepare her body through healthy eating and avoiding toxic exposures. While some women might be less receptive to dietary advice before they get pregnant, one study found that women realized the importance of optimizing health before conception, but demonstrated deficiencies in knowledge of basic risk factors. Most (95.3%) preferred to receive information on preconception health from their primary care physician.[156]

Underserved communities – environmental impacts and food insecurity

Low income and communities of color are more likely than white or middle income people to live in neighborhoods with high pollution levels and to experience food insecurity, which is defined as lack of access to healthy, affordable and sufficient quantities of food needed for normal nourishment. Nearly eighteen percent of US households with children experienced food insecurity, while prevalence in black and Hispanic households was 23.7% and 21.7% respectively and prevalence in households below the federal poverty level was 36.8%.[157] These factors make these communities more vulnerable to the impacts of food toxins, with fewer resources to adopt healthy food practices.

Environmental pollution

Communities of color, low income communities and Indigenous peoples are more likely to experience multiple pollution sources, including air pollution, proximity to superfund sites, industrial pollutants diesel emissions, lead in older housing, as well as occupational exposures through blue collar jobs. Exposures to food contaminants are in addition to these everyday baseline exposures, putting them at higher risk for adverse health outcomes from cumulative exposures to harmful chemicals.

Food insufficiency, poverty and health disparities

Disease burden is higher in low income and minority populations.[158] The highest prevalence of overweight status occurs in black girls aged 6-19 years and Mexican-American boys in the same age group, with an even higher prevalence for American Indian populations.[159] Higher rates of disease are related to many factors including poverty, family stressors and food insecurity.

- Three percent of all households and 7.5% of low-income households with children experienced insufficient food i.e. "sometimes don't have enough to eat." When compared with higher-income food-sufficient households, children in low income food-insufficient households consumed fewer calories, had higher cholesterol, were more likely to be overweight, consumed fewer fruits and spent more time watching TV.[160]

- Maternal stressors (including poverty), combined with food insecurity is linked with increased risk of being overweight in 3-10 year olds, but not in adolescents. Maternal stressors also impacted overweight status in food-secure households for the same age group.[161]
- Food insecurity is associated with being overweight in children aged 12-17, girls and in households at or below 100% of the poverty level.[162]

Food access

Communities of color and low income communities often have diminished access to healthy, affordable food sources, including fresh fruits and vegetables.

- Availability of fresh produce is associated with neighborhood racial composition. In Brooklyn NY there were no supermarkets in predominately black areas, while there was one in every third census tract in predominately white areas. Supermarkets carried the largest variety of fresh produce and organic foods, compared with corner stores. [163]
- Obesity was significantly associated with the availability of supermarkets and food stores, fitness facilities and income in New York City[164] and lower numbers of supermarkets and higher numbers of convenience stores within census tracts.[165]
- In Baltimore, 43% of black neighborhoods and 46% of low income neighborhood were in the lowest tertile of healthy food availability, compared with white neighborhoods (4%) and higher-income areas (13%).[166]
- Low-income neighborhoods have fewer chain supermarkets than middle-income neighborhoods and the availability of these supermarkets in African-American neighborhoods is only 52% of that in white neighborhoods. Supermarket availability is 32% in Hispanic neighborhoods of that in non-Hispanic areas.[167]
- The availability of fast food restaurants and energy-dense foods is greater in lower-income and minority neighborhoods.[168]

Greater availability of fresh produce and garden and farmers' market initiatives contribute to increased consumption of fresh fruits and vegetables.

- Greater availability of produce was associated with an increase in consumption of fresh fruits and vegetables[169] and fruit and vegetable intake was higher in census tracts with more supermarkets.[170] In New Orleans, greater availability of fresh vegetables in the neighborhood, regardless of type of store, was associated with increased intake.[171]
- Garden-based nutrition education programs may have potential to increase consumption of fruits and vegetables among youth and increased willingness to taste fruits and vegetables among younger children.[172] Nutrition education, combined with gardening was more effective than nutrition education alone in increasing consumption of fruits and vegetables in a lunchroom setting[173] and for sixth-grade adolescents.[174]

- African-American women participating in the WIC Program who received and redeemed Farmers' Market vouchers were more likely to purchase fruits and vegetables at farmers' markets.[175]

Other groups

Other target audiences we could consider are seniors and new immigrants. Since seniors are more likely to have chronic health conditions and complex health needs, they are not the ideal audience. The great diversity of immigrant groups across the U.S., with varying cultures, dietary habits and levels of acculturation, makes this target audience less conducive to general dietary advice.

VI. Consumer Exposure Reduction Opportunities- Examples of Consumer Advice

Meat and dairy consumption

Following these guidelines will also help control weight.

- **Select lean cuts of meat and poultry.**[176]
- **Use low-fat cooking methods** for meats, including broiling, grilling, roasting or pressure-cooking. Cut off any visible fat, before cooking. If you pan fry, discard the fat after cooking. These preparation and cooking methods can reduce dioxin levels by up to half. [177] [178] [179]
- **Avoid gravies made from meat fat or juices.** Do not use lard, bacon grease or butter for frying. Dioxins concentrate in these fats.[180]
- **Serve skim milk** to adults and children age 2 and older. Children under age 2 need milk with a higher fat content.[181]
- **Choose other low-fat dairy products,** including cheese, yogurt and cottage cheese.
- **Look for grass-fed beef.** Beef from grass-fed cattle is leaner, lower in fat and calories, [182] while higher in Vitamin E[183] and antioxidants than beef from cattle raised on a corn diet. It is also lower in saturated fats and higher in Omega-3 fats.[184] One study showed eating grass-fed beef helped reduce "bad" cholesterol and increased "good" cholesterol.[185]
- **Use the Eat Well Guide,** an on-line guide to sources of organic, sustainably-raised meats and dairy products near you.
- **Use proper handling and cooking practices** to reduce risk of food poisoning. See FDA recommendations. www.cfsan.fda.gov/~dms/fdunwelc.html
- **Try to buy organic.** *"Certified organic"* meats are raised without use of antibiotics, genetic engineering, irradiation, sewage sludge and artificial ingredients. Organic meat or dairy comes from animals never given hormones (or growth promoting antibiotics or arsenic), and only fed organic grains. Organic grains or produce are those raised without synthetic pesticides, which may disrupt hormones. Organic production also cannot involve sewage sludge, which may contain oral contraceptives, cadmium and heavy

metals, and other industrial chemicals that disrupt hormones and are absorbed into plants and grasses eaten by pastured animals.

- **Look for hormone free milk.** Some products will be labeled as coming from cows not given rBGH. Others are not. Here are some dairy brands that are rBGH free. (IATP has a list for Minnesota. A national list could be compiled.)

Fish Consumption

- If you eat canned tuna, choose "chunk light" rather than "albacore", which has higher levels of mercury.
- Eat smaller fish rather than larger predator fish.
- Eat smaller portions of fish that may be contaminated. A 3 oz. serving is about the size of a deck of cards.
- To reduce the level of PCBs and dioxins, broil, bake or grill fish, so the fat drips away. Deep-frying and pan-frying are not recommended.
- Trim fat to reduce exposure to PCBs and dioxin. Because these toxins concentrate in fat, removing the fat will reduce contaminant levels. Trimming the fat will not get rid of mercury, because it gets into the flesh of the fish.
- Follow fish consumption advice for local fish species provided by your state health department. EPA provides general information at http://water.epa.gov/scitech/swguidance/fishshellfish/fishadvisories/advisories_index.cfm

Plastics

- **Avoid #7, labeled PC.** PC or polycarbonate plastic can leach bisphenol A (BPA), a hormone disrupting chemical. Other #7 plastics like co-polyester, polyamide, acrylic and polylactic acid (PLA), are safer choices because they don't contain BPA.
- **Avoid using plastic containers in the microwave.** Chemicals are released from plastic when heated. Instead use glass or ceramic containers, free of metallic paint. <u>Note that "microwave safe" does not mean that there is no leaching of chemicals.</u> Avoid using for fatty foods, as there is greater leaching of chemicals into fatty foods.
- **Beware of cling wraps,** especially for microwave use. Instead use waxed paper, paper towel or a plate for covering foods. For plastic wrapped deli foods, slice off a thin layer where the food came in contact with the plastic and re-wrap in non-PVC plastic wrap or place in a container.
- **Use alternatives to plastic packaging whenever possible.** Use refillable containers at your local food cooperative. Bring your own take home containers to restaurants. Bring reusable bags or cardboard boxes to the grocery store.
- **Avoid plastic bottled water.** (Unless you're traveling or live in an area where the quality of water is questionable.) Bottled water, because it is less regulated, has less certain purity and safety than tap water, and is much more expensive. If you're worried about tap water quality, consider installing a home water filter or use an inexpensive filter pitcher.

- **If you do use plastic water bottles, take precautions.** Using a refillable water bottle is a good idea, as it reduces plastic waste, saves energy and non-renewable petrochemical resources and also saves money. If you use a refillable water bottle, avoid polycarbonate (labeled #7 PC) and choose instead bottles made of stainless steel, glass or safer plastics like co-polyester or polyethylene. If you choose to use a polycarbonate water bottle, avoid use for hot liquids and avoid placing in the dishwasher, to reduce leaching of BPA. Discard worn or scratched bottles. Water bottles from #1 or 2 plastics are recommended for single use only. For all types of plastic, you can reduce bacterial contamination by thoroughly washing daily. However, avoid using harsh detergents that can break down the plastic and increase chemical leaching.
- **Choose non-polycarbonate baby bottles and "sippy cups."** While many plastic baby bottles and sippy cups used to be made of polycarbonate plastic, putting baby's health at risk from exposure to BPA leaching, most manufacturers are now using BPA-free plastic. Alternatives include baby bottles made of glass, polyethylene, polypropylene or polyamide, as well as sippy cups made of stainless steel or safer plastics. While seven states and the City of Chicago have banned BPA in baby bottles and sippy cups, it's still a good idea to check before purchasing these products to assure they are BPA-free.

Teflon cookware and grease resistant coatings

- Minimize packaged and greasy foods in your diet e.g. take-out pizza, fast food and microwave popcorn.
- Avoid cooking with Teflon-coated cookware. Instead use stainless steel, cast iron or anodized aluminum.

Pesticides on produce

- **Wash and peel.** Wash produce in a very diluted solution of liquid dish soap, rinse thoroughly, and then do what you would normally do: peel carrots, stem strawberries, and so on. Washing reduced the amount of produce containing pesticide residue by half in one study, and where residues remained, levels declined significantly after washing.[186]
- **Buy organic produce as much as possible.** Since organic certification restricts the use of chemical pesticides, look for certified organic produce at your local supermarket, food co-op or farmer's market. If you can't buy all organic, selectively purchase organic among the types of produce that typically have the highest pesticide residues, especially for produce your child eats the most e.g. strawberries, peaches, grapes, red raspberries, carrots, bell peppers, green beans, potatoes, spinach, celery, pears.
- **Choose local produce whenever possible.** Not all local farms are organic, but small-scale, local farmers tend to be more receptive to consumer demands. Ask local farmers if they use pesticides and chemical fertilizers.
- **Shop at your local farmers market.** For information see USDA National Farmers Market Directory State By State at http://www.ams.usda.gov/farmersmarkets/map.htm.
- **Grow your own pesticide-free produce in your backyard or join a community garden.** To get more information, see www.communitygarden.org/.

- **Join a community supported agriculture (CSA) farm,** where you buy a share of the year's crop to guarantee the farmer's income and get fresh organic produce during the growing season. For more information see http://localharvest.org.

Food Dyes

- **Eat whole foods** (i.e., fresh vegetables, fruits, whole grains, healthy fats and protein/dairy). Whole foods are better for you, and allow you to avoid the inspection of food labels necessary to avoid toxic food dyes.
- At home or at restaurants, **avoid foods with synthetic food dyes**, especially if your child suffers from hyperactivity, ADHD, or other learning or developmental disabilities.
- **Garden with your kids**, visit a farm or join a CSA to help teach your children how ripe whole foods should actually look, smell and taste.
- If you occasionally purchase treats for your kids, **avoid candy or other snacks with food coloring**, like Skittles, M&Ms, etc.

Cooking

- **Avoid grilling, barbecuing, broiling, and pan-frying**, which are more likely to produce HCAs, nitrosamines and PAHs than baking or roasting, because they generate more heat or
- **boil, steam, poach or stew** meats.
- **Precook or marinate** meats to reduce levels of these chemicals.
- If you grill, **keep food away from an open flame** and cut off charred sections. Also reduce total grilling time by using a meat thermometer to make sure the meat is done without overcooking.
- **Reduce consumption of fried foods** to reduce exposure to acrylamide.

VII. Criteria for Selecting Top Candidates for Consumer Advice in Exposure Reduction- See Tables 1 and 2

The goal of this project is to develop unique consumer messages that will provide the best opportunity to enhance health outcomes through reducing exposures to chemical food contaminants. These messages should be effective in spurring consumer actions, so must be:

- memorable - effective in getting the attention of the target audiences
- actionable - describe clear and attainable actions that people can take.

We developed a two tiered approach to rating both chemicals and dietary advice clusters. For individual chemicals (Tier 1) we rated toxicity, exposure and risk reduction opportunities and also took into consideration whether the chemical impacted obesity. We develop dietary advice clusters and rated them in Tier 2 based on additional positive benefits to health, potential for unintended consequences and positive environmental impacts.

NOTE: Fish consumption was eliminated from consideration, and therefore mercury. This project seeks to craft a unique and effective dietary campaign. Since many groups, state and federal agencies among them, are already focused on providing local, regional and national advice on healthy fish consumption, it will not be considered for this project.

TIER 1: Criteria for Rating Chemical Candidates For Dietary Advice.

1. **Toxicity of the chemical.** The toxicities of persistent, bioaccumulative chemicals like PCBs, mercury, dioxin, pesticides and PBDEs are well known. Other chemicals like bisphenol A are harmful because they cause adverse effects at low does during critical periods of development. For some substances like rBGH definitive science showing harm is lacking.

   Table 2 gives a toxicity rating of 1-3 with 3 being the highest.
   (1) Limited evidence of toxicity to human health.
   (2) Evidence of harm from animal and some human health studies and/or evidence of low dose effects, endocrine disruption or cancer.
   (3) Persistent, bioaccumulative toxic chemicals based on significant scientific evidence.

   Explanation of ratings in Table 1: PCBs/dioxins (3), PBDEs (3), PFCs (2) and many pesticides (3) are persistent and bioaccumulative and for all but PFCs, there is extensive body of science supporting toxicity. The evidence of harm to health is much less extensive for PFCs. Likewise, perchlorate (2) is highly persistent and ubiquitous in water, but evidence of human toxicity is weak at present. Growth hormones (1) used in meat production create problems for livestock health and for the environment, but there is scarce evidence at present of human health impacts. Evidence of styrene (1) toxicity is mostly from occupational studies, so preventing human exposures from food contact uses is mostly precautionary. Both BPA (2) and phthalates (2) are hormone disrupters and there is extensive evidence from animal and some human studies that low dose early life exposures cause harm to health. For food dyes (2), nitrites/nitrates (2) and cooking at high temperatures (2) there is moderate to strong evidence linking exposure to adverse human health effects.

2. **Potential for exposure.** Foods consumed in higher quantities or more frequently should be prioritized. Foods most commonly consumed by children include infant formula, fruits, juices, dairy products and sweets. Whether there is exposure from multiple sources is also an important consideration. For example, exposure to bisphenol A includes food contact uses like food can linings and polycarbonate plastic, as well as thermal receipts and flame retardants. Exposure to phthalates includes plastic wrap as

well as fragranced personal care products and vinyl toys, shower curtains and other products.

Table 2 gives an exposure potential rating of 1-3 with 3 being the highest.

(1) Low consumption, one source
(2) High to moderate consumption **or** many sources.
(3) High consumption and many sources.

Explanation of ratings in Table 1: Because PCBs/dioxins (3), PBDEs (3), and pesticides (3) accumulate in the food chain, especially in fat they are widely found in meat and dairy products. They are also among the foods most consumed by children, especially dairy products. In addition, for PBDEs and pesticides cumulative impacts are possible, as home and community exposures from non-food sources are common. Because PFCs (2) are present in fish mostly in areas of high PFC contamination like many communities in Minnesota, as well in contaminated drinking water in those areas, they are rated low consumption overall. However, the general public is exposed to PFCs through multiple sources: cookware, food packaging and other household uses. Perchlorate (1) exposure is limited to produce and drinking water in contaminated areas. Growth hormones (3) are widely used in milk and meat production and are among the foods most consumed by the average person. Styrene (1) exposure is from one source, food containers. Exposure BPA (3) is from multiple sources, food cans, food containers and many non-food sources (dental sealants, thermal credit card receipts) and exposure to children would be high due to use in can linings, especially formula cans and in the lids of baby food jars. Phthalate (2) exposure from food contact is limited to DEHP in plastic cling wrap, but exposure to phthalates is extensive through non-food products like personal care products and those made of vinyl. Food dyes (2), nitrites/nitrates (2) are in foods most consumed by children, like hot dogs, deli meats, candies, snacks and convenience foods. Cooking at high temperatures (1) is mostly limited to one source (meat) and one route of exposure.

3. **Risk reduction opportunity- actionable.** Exposure to some chemicals contaminants like PCBs and dioxins can be reduced through careful dietary choices. Avoiding other chemicals is more challenging. For example, it's hard to avoid pesticides unless one's diet consists of 100% organic.

Table 2 gives a risk reduction opportunity rating of 1-3 with 3 being the highest.

(1) Challenging.
(2) Possible with good information.
(3) Clean advice and simple actions can reduce single or multiple exposures.

Explanation of ratings in Table 1: Because PCBs/dioxins (3) and PBDEs (3) build up in fat, advice to eat low fat can significantly reduce exposure to these toxins. Advice to avoid pesticides (1) is more complex, since avoiding pesticide residues involves buying organic, properly washing and peeling produce and/or knowing which fruits and vegetables are highest in pesticide residues, so one can buy organic selectively. Advice to avoid PFCs (2) in cookware is simple, but reducing exposure through food packing is more challenging, as the chemicals are not labeled and are used ubiquitously in pizza boxes, microwave popcorn and fast food containers. Because perchlorate (1) contamination tends to be local and regional, it is not conducive to general consumer advice. Growth hormones (1) used in meat production are not labeled at the consumer level. Often, but not always, hormone free milk and dairy products are labeled. In general, consumer advice on avoiding hormones is challenging. Styrene (3) exposure is from one source, food containers, so avoiding exposure is quite simple. Exposure to BPA (2) from food sources water bottles and other plastic containers is possible with good information. However, because epoxy resin can linings containing BPA are still used in most food cans, it's challenging to avoid, unless one excludes canned food from one's diet. Phthalate (3) exposure is easy to avoid by eliminating use of cling wrap and/or avoiding direct contact with food. Food dyes (2) can be easily avoided in candies and other brightly colored food products, but their hidden presence in processed and fast foods makes complete avoidance challenging. Nitrites/nitrates (2) are easy to avoid if one has access to nitrate-free products labeled as such, which is not the case for people who shop at corner stores or most mainstream grocery stores. Cooking at high temperatures (2) is mostly limited to one source (meat) and one route of exposure.

4. **Obesogen.** Because the problem of obesity is so rampant in the U.S. today, consideration should be given as to whether a chemical is known to be an obesogen, in order to maximize positive effects on health. Since most known obesogens are also hormone disrupters, other health effects could be avoided. Table 2 denotes chemical obesogens and gives an extra point (1) to these chemicals.

   Explanation of ratings in Table 1: There is scientific evidence that PCBs/dioxins, PBDEs, PFCs, hormones, BPA and phthalates are obesogens.[187]

TIER 2: Criteria for Rating Dietary Advice Clusters

1. **Multiple positive impacts on health.** Table 2 gives a multiple health impact rating of 1-3 with 3 being the highest.
   (1) No additional health outcome benefit.
   (2) Advice impacts 1-2 health outcomes.
   (3) Advice impacts 3 or more health outcomes

   Explanation of ratings in Table 2: Eating low fat (3) can reduce exposure to PCBs/dioxins, PBDEs, pesticides and PFCs and can also help control weight. It can also contribute to prevention of obesity, heart disease and cancer. Eating organic (1) can reduce exposures to pesticides, hormones, nitrates and food dyes, but there is no evidence for additional health benefits. Eating less processed food (3) reduces exposure to PFCs, hormones, food dyes and nitrites/nitrates, while potentially increasing consumption of healthy grains, fruits and vegetables. It can also reduce total consumption of fat and calories resulting in better weight control and reduction in obesity, heart disease and cancer. Safer packaging (2) reduces exposure to styrene, BPA, PFCs and phthalates and could result in reduced consumption of processed food, if canned and prepackaged foods are avoided.

2. **Unintended consequences.** Table 2 gives an unintended consequences rating of minus one (-1) for unintended consequences.

   Explanation of ratings in Table 2: Advice to eat low fat (-1) might result in inadequate protein intake, for populations that might not have adequate access to low fat foods. Emphasizing the importance of eating organic produce (-1) could reduce total consumption of nutritious fruits and vegetables.

3. **Positive environmental impacts.** Table 2 notes positive environmental impacts and gives an extra point (1) for positive impacts.

   Explanation of ratings in Table 2: For example, increasing the market for organic (1) produce will have positive impacts on soil and water quality and increasing the market for hormone free meat and dairy products will improve the health of livestock and help prevent antibiotic resistance. Eating less processed foods (1) and increased demand for safer packaging (1) can reduce chemical pollution in the environment (BPA, phthalates, styrene, PFCs) and potentially reduce the total quantity of packaging in the waste stream.

VIII. Message Development and Testing

IATP contracted with the Rabin Group to develop messages around the three highest-rated dietary advice clusters: eat low fat; eat less processed; safer packaging. We asked them to take the following into consideration when crafting consumer messages:

- **Is the advice easy to communicate?** For example, "choose low fat meat and dairy products" is fairly easy to communicate, while explaining the plastics numbering system and why #7 plastic contains both bad and good plastics is more challenging.
- **Are the recommended actions easy to do?** For example, buying hormone free milk might be challenging as it's not always labeled. Many people can't afford to buy organic produce, but cutting out processed foods with food dyes might be feasible for some.
- **Does the advice appeal to diverse populations?** Higher income people can afford to buy organic milk and produce, but resource poor families and communities may not have access to these foods because they can't afford them or they are not available in their neighborhoods. Advice should be applicable across the income spectrum and applicable across the U.S. That's why fish consumption advice, which is regional, was eliminated as a candidate.

The Rabin Group developed a script for consumer focus groups. IATP conducted two focus groups and reported the results to the Rabin Group. The Rabin Group incorporated the focus group results into their April 15, 2011 memo, entitled *Strategic Communications Recommendations for "Dietary Sources of Chemical Exposure and Opportunities for Exposure Reduction."*

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TABLE 1: High Risk Chemicals in the Food Chain
Tier 1 Scoring

	toxicity 1-3 low-high	exposure potential 1-3 low-high	high consumption	many sources	Risk reduction opportunity 1-3 worst-best	obesogen	TOTAL
1. PCBs/dioxins	3	3	yes	yes	3	1	10
2. PBDEs	3	3	yes	yes	3	1	10
3. PFCs	2	2		yes	2	1	7
5. Perchlorate	2	1			1		4
6. Pesticides	3	2	yes		1		6
7. Hormones	1	3	yes	yes	1	1	6
8. Styrene	1	1			3		5
9. BPA	2	3	yes	yes	2	1	8
10. Phthalates	2	2		yes	3	1	8
11. food dyes	2	2	yes		2		6
12. Nitrites	2	2	yes		2		6
13. Cooking at high temps	2	1			2		5

Scoring Key:
Toxicity: 1) limited evidence of toxicity to human health 2) evidence of harm from animal studies and some human studies and/or low dose or endocrine effects 3)persistent, bio-accumulative and toxic based on significant scientific evidence
Exposure: 1)Low consumption, one source 2) high to moderate consumption or many sources 3) high consumption and many sources
Risk reduction opportunity: 1) Challenging 2) possible with good information 3) clean advice with simple actions can reduce one or more exposures
Obesogen: If obesogen +1

NOTE: Mercury was eliminated, as main source is fish consumption, which was eliminated as a focus of this project.

Table 2: Dietary Advice Clusters
Tier 2 Scoring

Eat Low Fat	Scores	Eat Organic	Scores	Eat less processed	Scores	Safer Packaging	Scores
Chemicals	Tier 1 Score	Chemicals	Tier 1 Score	Chemicals	Tier 1 Score	Chemicals	Tier 1 Score
1. PCBs/dioxins	10	6. pesticides	6	3. PFCs	7	8. styrene	5
2. PBDEs	10	7. hormones	6	7. hormones	6	9. BPA	8
3. PFCs	6	11. food dyes	5	11. food dyes	6	10. phthalates	8
6. pesticides	6	12. nitrites	6	12. nitrites	6		
Average Tier 1:	8		6		6		7
Positive impacts on health:	3		1		3		2
Unintended Consequences:	-1		-1		0		0
Environmental impacts:	0		1		1		1
TOTAL	10		7		10		10

Scoring Key:
Multiple positive impacts on health: 1) no additional health benefits 2) advice impacts 1-2 health outcomes 3) advice impacts 3 or more health outcomes
Unintended consequences: If unintended consequences from advice -1
Positive environmental impacts: If positive impacts on the environment +1

Perchlorate (#5) and cooking at high temperatures (#13) did not fit into the above clusters and were therefore eliminated.