

# *The Organic Factor*

*Tilting the Odds Toward Healthy Development*



*Six Ways Organic Food  
Can Help Prevent  
Disease Throughout Life*

*By Dr. Charles Benbrook*





According to a study in *Epidemiology* published in January of this year, the number of newly diagnosed cases of autism in California children rose over six-fold, from 205 new cases in 1990 to 3,000 in 2006.<sup>1</sup> Food allergies among children are becoming much more common and serious, as is asthma.

Newly diagnosed eczema cases in the U.S. increased 6.7-fold from 1977 to 2006<sup>2</sup> and rose 42 percent from 2001 to 2005 in the U.K.<sup>3</sup>

One in four children is now overweight or obese, and the number of children and teenagers with diabetes is rising sharply.

*What is driving these trends?*

Many scientists are beginning to suspect some causes are linked to what we eat and are exposed to very early in life through food, water and air—with pesticides posing more and more of a proven risk. In fact, the list of health problems for which pesticide exposure has emerged as a risk factor overlaps almost perfectly with the list of health problems that have risen most sharply in the last decade.

Given our medical advances and record-high health care expenditures, coupled with decades of progress in cleaning up the air and water, *why does it seem to be getting harder to raise a healthy kid in America?*

There are three plausible answers. First, maybe it really isn't. Perhaps epidemiologists have gotten better at collecting health statistics, and in fact, kids today are no more or less healthy than those 20 years ago. A number of studies in the last few years have explored this possibility in trying to explain steeply rising rates of autism, asthma, eczema, and childhood allergies. Virtually all conclude that the increases are, for the most part, real.

A second theory is that maybe parents today are raising children in environments that are not as healthy as they used to be. No doubt there are many children growing up in unhealthy places, and hundreds of thousands that are homeless for a few weeks to years during their formative years. Still, there are many children growing up with developmental problems in two-parent families where there are no obvious sources of unusual stress or unhealthy living conditions, as well as many children growing up healthy despite far less than ideal home environments.

New science is solidifying support for a third explanation involving changes in what pregnant women, infants and children are eating and drinking. Food and beverages are the fuel for human growth from conception through adolescence, but they are also common carriers for chemicals and other contaminants, many of which can disrupt normal developmental patterns. New insights and research on this have given rise to one of the hottest areas of science today: the developmental or fetal origins of adult disease.

A decade ago a modest number of studies linked exposures to pesticides, other chemicals or nutritional deficiencies during fetal development to increased risk of problems later in life with immune system function, reproduction, management of blood sugar, or neurological development and behavior. Today, thousands of scientists from around the world are pursuing diverse lines of research designed to establish how, when, and why the intricate patterns of development in the womb and during the first years of life are sometimes knocked off course.

In March, the Organic Center released a report exploring how food and dietary choices can impact trends in overweight, obesity and diabetes, with special focus on the fetal origins of adult disease. "That First Step: Organic Food and a Healthier Future," written by Drs. Christine McCullum-Gómez, Charles Benbrook and Richard Theuer, highlights six ways in which sound dietary choices and organic food can lay a firmer foundation for healthy development and lifelong health.

## In the Beginning

Three of the six ways are grounded in the human reproductive cycle and play out in the months before a child is conceived, during fetal growth, and through adolescence. The Center's report cites over 150 studies in concluding that a well-balanced diet composed of ample organic fruits and vegetables, dairy and grain products will:

1. *Lay the groundwork for normal endocrine system regulation of blood sugars, lipids, energy intake and immune system functions.*
2. *Establish and help sustain taste-based preferences in the child for familiar nutrient-dense and flavorful foods.*
3. *Largely eliminate dietary exposures to pesticides.*

A 2009 study in *Environmental Health Perspectives* reported that a mother's diet plays a major role in determining how many synthetic chemicals are present in amniotic fluids and whether the levels approach those capable of disrupting normal development by, for example, predisposing the child to diabetes or reproductive problems.<sup>4</sup> The diet during pregnancy can also impact the "wiring" of the child's satiety mechanism, which is the biochemical/neurological pathway in the body that transmits the crucial "I am getting full" signal to the brain. When this signal is weak or delayed, the stage is set for weight problems, diabetes and other chronic disease.



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**The Epigenetic Link.** Significant disruption of fetal development, especially in the first trimester, typically results in a miscarriage, many of which go unnoticed. Society is grappling today with the consequences of generally much more subtle changes that happen during pregnancy. These "epigenetic" changes can trigger abnormal patterns of cell differentiation that alter the developmental and health trajectories of individuals, without altering an individual's underlying DNA. Hence the label, "epi" (beyond)-"genetics."

In addition, science has now convincingly proven that in the case of epigenetics, the timing of exposure is just as important, and in some cases, more important than the dose levels delivered to the developing embryo and fetus. While these epigenetic changes may not be noticeable at birth, they can evolve into health issues and chronic disease later in life.

And risks for epigenetic changes continue as a child develops through adolescence. The average child in America is exposed to 10 to 13 pesticides daily through food and beverages,

based on an analysis of food consumption and pesticide residue data collected by the U.S. Department of Agriculture (USDA).<sup>5</sup> Fresh fruits and vegetables, and juices account for nearly half of these exposures. Milk contributes two to three additional residues, and drinking water another three. Exposures are clearly happening, which leads to the question—how risky are these residues?

**Weighing the Pesticide Risk.** Opinions vary widely among scientists regarding whether contemporary pesticide levels in the diet pose risks worth worrying about. In general, most scientists working for or supported by pesticide manufacturers conclude that the levels are far too low to pose any significant risks. Many research scientists working for government agencies and universities, however, are deeply concerned about these risks, especially those stemming



from exposures to pregnant women, infants and children. Nearly every monthly issue of the country's leading journal on toxic chemicals, *Environmental Health Perspectives*, contains a new research report on the mechanisms through which low levels of pesticide exposure can disrupt normal development. Some issues have three or more new studies.

One topic that has become the focus of intense research is exposure to metals and pesticides during pregnancy and its link to autism. A recent study found that mothers who used pet shampoos containing pesticides were twice as likely to give birth to children afflicted by autism.<sup>6</sup> Consider then how much more of a risk there may be when mothers actually ingest these same pesticides. Despite growing consensus that environmental factors, and in particular chemicals, are pushing autism rates higher, the government is spending 10 to 20 times more money on assessments of possible genetic factors leading to autism.<sup>7</sup>

In addition, it's well known that exposure to pesticides during pregnancy increases the risk of premature delivery and low birth-weight babies. Low birth-weight is a major risk factor for diabetes<sup>8</sup> and problems with neurological and reproductive development.<sup>9</sup>

Adding yet another risk factor for diabetes, a 2008 study found that children whose mothers were exposed to hexachlorobenzene (a fungicide) during pregnancy had a higher risk of being overweight at 6 years of age.<sup>10</sup> Researchers at the National Institute of Environmental Health Sciences also reported that brief exposure early in life to environmental endocrine-(hormone) disrupting chemicals (especially diethylstilbestrol - DES) resulted in increases in body weight as mice aged.<sup>11</sup>

In a 2008 study on parathion, an organophosphate (OP) pesticide, scientists observed that, "It is increasingly evident that exposures experienced during fetal or neonatal life, including chemical exposures such as those studied here [parathion] can lead to misprogramming of metabolism, appetite and endocrine

status, contributing ultimately to morbidities such as obesity and diabetes."<sup>12</sup> In a separate study, fetal and neonatal rats exposed to chlorpyrifos (another OP pesticide) had excessive weight gain and leptin dysfunction (leptin is a hormone that helps regulate appetite).<sup>13</sup>

In yet another 2008 study on parathion, the pesticide was found to alter brain development in rats in several ways and regions at doses below those that cause observable systemic toxicity. The team reported that low-level exposures to parathion at critical stages of development impair the role of the brain in sexual differentiation, and as a result, adult males become more female-like in their behaviors, and vice versa. Curiously, they found that female rats had greater ability to repair the damage caused

by early-life exposures to parathion in terms of sexual differentiation and behavior, compared to male rats exposed to the same levels of parathion.<sup>14</sup>

Other pesticides have also been shown to affect sexual development as well. The fungicide vinclozolin caused transgenerational effects in a rat study. Pregnant rats exposed at the critical window for sexual differentiation gave birth to males that suffered from impaired sexual development, effects that were transferred through genes of the male rats to nearly all males born in the next four generations.<sup>15</sup>

**Roundup: What We Don't Know May Hurt Us.** While the use of the OP pesticide parathion has declined sharply compared to a decade ago, the use of glyphosate (Roundup) herbicide has risen several-fold since 1996 in the wake of much wider planting of cropland to genetically modified (GM) "Roundup Ready" soybeans,



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corn and cotton varieties. Indeed, glyphosate is now the most heavily used pesticide active ingredient in the world. Manufacturers of herbicides containing glyphosate typically mix the active ingredient with one to four so-called "inert" ingredients. It turns out that some of these inert ingredients might not actually be so inert after all.

Scientists in Ecuador found increased DNA damage in people exposed to glyphosate herbicides that had been sprayed on cocoa plants by helicopters and planes.<sup>16</sup> Work by a team of French scientists offers an explanation why. They explored the toxicity of four glyphosate-containing herbicides, each with different combinations of inert ingredients, as well as glyphosate alone, in three different human cell types. According to the team, concentrations tested were comparable to levels expected in food or feed treated with Roundup herbicides.

All four Roundup herbicide formulations caused total cell death in 24 hours in the human cell experiments. The team concluded that the toxicity of various Roundup formulations was not a function of the level of glyphosate, the active ingredient, but instead was related to the adjuvants and other "inert" ingredients in the formulations. According to the team, the adjuvants in Roundup formulations are not inert and, in fact, can cause cell damage and even death at expected exposure levels, based on contemporary herbicide use patterns.<sup>17</sup>

This research raised eyebrows in the United States, where belief in the safety of glyphosate-based herbicides is a sort of First Commandment for the true believers in biotechnology and modern pesticide chemistry. This French research, thankfully, has led some U.S. scientists and regulators to ask more probing questions about what is

actually known about glyphosate-based herbicides and human health effects, and the answer turns out to be very little.

This is because U.S. pesticide law allows pesticide manufacturers to not disclose the identity of so-called “inert” ingredients. To this day and despite the fact that over 100 million acres of cropland are treated every year with glyphosate-based herbicides, independent scientists cannot obtain information on exactly what is in these herbicides. Lacking such information, scientists have one hand tied behind their backs.

## The Rest of Life

As we grow and age, new challenges must be confronted, such as keeping caloric intake in balance with energy needs, sustaining vascular system health, and avoiding diabetes, cancer and other degenerative diseases. It is no secret that as a nation we are flunking these challenges and paying an enormous price as a result.

The Centers for Disease Control and Prevention (CDC) reports that the number of obese people (about 34 percent) now outnumber those who are overweight (about 33 percent), and that the rate of new diabetes cases nearly doubled over the last decade, reaching 9.1 new cases per 1,000 persons between 2005 and 2007.

Overweight and obesity are rising fastest among children, setting the stage for far more cases of Type 2 diabetes, which used to be called “adult-onset diabetes.” Today though, two-thirds of American teenagers have a least one of the five conditions associated with the metabolic syndrome. Overweight among children is leading to many more cases of Type 2 diabetes that strike earlier in life, leaving more time for the insidious complications of diabetes to erode well-being and drive up health care costs.

Total health care costs attributed to obesity/overweight and their complications are projected to double each decade to nearly \$1 trillion in 2030, which would then account for 16 to 18 percent of total U.S. health care costs. The Organic Center’s report found that organic food may help reverse these trends by:

4. *Triggering or reinforcing a sense of satiety, or fullness, thereby reducing excessive caloric intake at the end of satisfying meals.*
5. *Lessening or limiting the cellular and genetic damage done by reactive oxygen species (so-called free radicals) and reducing the risk of diabetes and other diseases rooted in inflammation (e.g., arthritis, cardiovascular disease) and rapid cell growth (cancer).*
6. *Slowing, and perhaps even reversing certain aspects of neurological aging, leading to improved memory and retention of cognitive skills.*

In managing blood sugar levels and promoting cardiovascular health, organic food and farming delivers benefits in two important ways. First, organic farming dramatically lowers exposures to endocrine-disrupting chemicals that can trigger epigenetic changes and set the stage for developmental and/or disease problems later in life.

For example, OP pesticides have been shown to impair insulin sensitivity and increase risk of Type 2 diabetes.<sup>18</sup> These pesticides are among a new group of environ-



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mental contaminants that have been called “obesogens,” a class of chemicals known to predispose an organism toward excessive weight gain and obesity.<sup>19</sup>

Second, organic food delivers higher daily intakes of health-promoting phytochemicals that reinforce the body’s defense and repair mechanisms and help maintain blood sugars within healthy ranges.<sup>20</sup>

The phytochemical resveratrol has, in particular, captured the attention of scientists and the food industry because, among many other benefits, a 2008 study revealed that resveratrol mimics the action of a key regulatory protein that helps trigger satiety.<sup>21</sup> Moreover, a team of USDA scientists has shown that the most potent analogue of resveratrol can reverse neurological aging in animal studies,<sup>22</sup> leading to whimsical speculation that resveratrol might be the source of the “Fountain of Youth.”

Several studies have shown that organic farming enhances resveratrol levels in red grapes by, on average, about 30 percent.<sup>23</sup> Conventional farming can, paradoxically, drive down resveratrol levels. For example, five Muscadine grape cultivars were managed using a typical, nine-spray fungicide disease control program, in contrast to an organic system.<sup>24</sup> In one variety, the grapes sprayed with fungicides contained one-fifth the concentration of resveratrol in the grapes from vines under organic management. The resveratrol levels in the organic grapes grown from two other cultivars were about three-fold higher.

Remarkably, this study shows that grapes under organic management can fight off plant pathogens through biosynthesis of resveratrol nearly as effectively as grapes treated nine times with fungicides. Resveratrol, moreover, works wonders in both the plant and animal kingdoms. Higher levels of dietary intake of resveratrol have been shown to help preserve sensitivity to insulin,<sup>25</sup> a critical step in preventing pre-diabetes from progressing to full-fledged diabetes.

The upward trend in overweight, obesity and diabetes must be stopped and

then reversed in order to offer any hope that the health and longevity of the baby boomer generation will equal that of the previous generation. A measure of the challenge ahead is that French fries are the most common vegetable consumed by children past the age of 18 months.<sup>26</sup>

There will be no single pill or medical breakthrough, no change in policy or education programs, nor a revolutionary diet that will turn the tide on overweight, obesity, and diabetes. Changes are needed in all these arenas.

The good news is that relatively modest changes in exercise and food consumption patterns can dramatically alter the trajectory of current trends, especially among young people and those moving toward, but not yet into the overweight zone. A net reduction in excess caloric intake of 100 to 200 calories per day would, according to some experts, stop the progression to overweight among as many as 90 percent of Americans.<sup>27</sup>

Significant progress can also be made by reducing or eliminating food additives known to cause problems with development and weight management, like most artificial food colorings, some preservatives, and high-fructose corn syrup (HFCS). Indeed, a rapidly growing body of science is pointing at HFCS as a major contributor to today's obesity and diabetes epidemics.

In a paper published this year, a team of scientists at Johns Hopkins University in Baltimore, Maryland concluded that fructose actually increases cravings for more food intake, whereas glucose (regular sugar) triggers a signal in the brain that food energy needs are covered, at least for the time being.<sup>28</sup> This is especially bad news, given that HFCS-sweetened drinks are among the most common snacks consumed by children between meals and the odds of kids being overweight double among those children drinking sweetened drinks between meals compared to those who do not.<sup>29</sup> The combination of changes in diet and exposure to chemicals known to disrupt healthy development results in many of today's kids having an elevated risk of developing diabetes as an adult, or

even earlier.

One caution is worth emphasizing. For people now consuming too many calories and/or making poor dietary choices, switching to organic versions of the same foods will do little good in combating overweight and diabetes. People engaging in unhealthy lifestyles may experience some improvements in health from switching to organic food, but major improvements will depend on progress in addressing other negative lifestyle factors like drug use, smoking, or too little sleep.



*Organic red grapes are shown to have an average of 30 percent more resveratrol, a phytochemical shown to prevent aging and help preserve sensitivity to insulin, a key step in preventing diabetes.*

## Nutrient Content

The impacts of organic farming on the nutrient content of food came into sharper focus in the past year. About 15 new studies were published comparing nutrient levels in side-by-side organic and conventional crops. The results are similar to those reviewed in the Organic Center's March 2008 "State of Science Review" entitled "New Evidence Confirms the Nutritional Superiority of Plant-Based Organic Food."<sup>30</sup> That report concluded that across 11 nutrients and 236 matched pairs of organically and conventionally grown food, nutrient content was about 25 percent higher in the organic food. (See *OP's* March-April 2008 issue for a full story on this).

More evidence has emerged that the nutrient content of conventionally grown fruits and vegetables has declined over the last five decades. In fact, three kinds of evidence now support the conclusion that the nutrient content of fresh produce has been declining since the 1950s. According to a paper published this year in *Horticultural Science*: "In fruits, vegetables, and grains, usually 80 to 90 percent of the dry weight yield is carbohydrate. Thus, when breeders select for high yield, they are, in effect, selecting for high carbohydrate with no assurance that dozens of other nutrients and thousands of phytochemicals will all increase in proportion to yield. Thus, genetic dilution effects seem unsurprising."<sup>31</sup>

In order to explore more deeply how, and the degree to which organic farming can reverse the downward trend in food nutrient density, The Organic Center and Dr. Preston Andrews of Washington State University organized a symposium at the 2009 annual meeting of the American Association for the Advancement of Science entitled "Living Soil, Food Quality, and the Future of Food."

Six encouraging conclusions on the impacts of organic farming on soil quality and the nutritional content of food were reached by the panel of scientists:<sup>32</sup>

1. Enhancement of soil quality in organic apple production systems can lead to measurable improvements in fruit nutritional quality, taste and storability.
2. Organically farmed tomatoes have significantly higher levels of soluble solids and natural plant secondary metabolites, including flavonoids, lycopene, and vitamin C that act as antioxidants.
3. As crop yields increase, the nutrient density of the harvested portion of the crop tends to decline as a result of what is called "the dilution effect."<sup>33</sup> Organic farming can delay the onset of this effect.
4. Studies of 27 cultivars of organically grown spinach demonstrate significantly



- higher levels of flavonoids and vitamin C, and lower levels of nitrates (a good thing—nitrates in food can form carcinogenic nitrosamines in the GI tract).
- The levels of vitamins and antioxidants in food appear to be driven by the forms of nitrogen added to a farming system as fertilizer, as well as the ways in which nitrogen is processed by the biological communities of organisms in the soil. The nitrogen cycle on organic farms is rooted in substantially more complex biological processes and soil-plant interactions, and for this reason, organic farming offers great promise in consistently producing nutrient-enriched foods.
  - Organic soil fertility methods, which use less readily available forms of nutrients, especially nitrogen, improve plant gene expression patterns in ways that lead to more efficient assimilation of nitrogen and carbon in tomatoes. This leaves plants with more energy to produce beneficial vitamins and antioxidants, compounds that promote plant health as well as human health by preventing the damage caused by reactive oxygen species, or so-called free radicals.
- Literally hundreds of studies point to a variety of reasons why the generally higher concentrations of antioxidant phytochemicals in organic food can promote healthy development and graceful aging. A 2009 study in the prestigious *Journal of Agricultural and Food Chemistry* found that the flavonoids rutin and coumaric acid reduced the buildup of insulin in rats on a high-fat diet by 48 to 68 percent,<sup>34</sup> reductions that would virtually guarantee blockbuster status for a new human drug.

## A Parting Thought

Unlike our current economic woes, there is no stimulus package available to make things right when food production technology and poor dietary choices undermine healthy patterns of development.

Scientists have years of complicated research ahead of them to definitively answer the question we started with: Why is it becoming so hard to raise a healthy child in America? In the interim, prudence dictates that concrete actions should be taken and sustained to reduce daily exposures to any and all known risk factors.

Government has important roles to play in financing necessary changes and conducting the careful research needed to identify priority challenges and calibrate the direction of change. But the bulk of responsibility will fall upon individuals, especially parents, who need to think deeply and strategically about what they feed themselves and their families in order to tip the odds in favor of healthy development and life-long health. □

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## References:

- Hertz-Picciotto, I. et al. 2009. The rise in autism and the role of diagnosis. *Epidemiology* 20, no. 1.
- Hanifin, J. M. et al. 2007. A population-based survey of eczema prevalence in the United States. *Dermatitis* 18, no. 2.
- Simpson, C. R. et al. 2009. Trends in the epidemiology and prescribing of medication for eczema in England. *J. Royal Soc. of Medicine* 102, no. 3: 108-117.
- Verhulst et al. 2009. Intra-uterine exposure to environmental pollutants and body mass index during the first three years of life. *Environ. Health Perspect.* 117:122-126.
- Benbrook, C. et al. 2008. New evidence confirms the nutritional superiority of plant-based organic food. *State of Science Review, The Organic Center* (March). Accessible at: [http://www.organiccenter.org/science.nutri.php?action=view&report\\_id=126](http://www.organiccenter.org/science.nutri.php?action=view&report_id=126)
- Roberts, E. M. et al. 2007. Maternal residence near agricultural pesticide applications and autism spectrum disorders among children in the California Central Valley. *Environmental Health Perspectives* 115, no. 10:1482-1489.
- Cone, M. 2009. *Environmental Health News* (January 9).
- Hales, C. N., et al. 1991. Fetal growth and impaired glucose tolerance at age 64. *British Medical Jour.* 303:1019-1022.
- Hanke, W., and J. Jurewicz. 2004. The risk of adverse reproductive and developmental disorders due to occupational pesticide exposure: an overview of current epidemiological evidence. *Int. J. Occup. Med. Envir. Health.*
- Smink, A., N. Ribas-Fito, R. Garcia, et al. 2008. Exposure to hexachlorobenzene during pregnancy increases risk of overweight in children aged 6 years. *Acta Paediatr.* 97:1465-9.
- Newbold, R. R., E. Padilla-Banks, R. J. Snyder, et al. 2007. Developmental exposure to endocrine disruptors and the obesity epidemic. *Reprod. Toxicol.* 23:290-296.
- Lassiter, T.L., et al. 2008. Exposure of neonatal rats to parathion elicits sex-selective reprogramming of metabolism and alters response to high-fat diet in adulthood. *Environmental Health Perspectives*, 116:1456-1462.
- Lassiter, T. L., and S. Brimjoin. 2008. Rats gain excess weight after developmental exposure to the organophosphorothionate pesticide, chlorpyrifos. *Neurotoxicol. Teratol.*30:125-130.
- Slotkin, T. A., et al. 2008. Exposure of neonatal rats to parathion elicits sex-selective impairment of acetylcholine systems in brain regions during adolescence and adulthood. *Environmental Health Perspectives* 116, no. 10: 1308-1314.
- Anway, M.D. et al. 2005. Epigenetic transgenerational actions of endocrine disruptors and male fertility. *Science* 308, no. 5727:1466-1469.
- Paz-y-Mino, C., et al. 2007. Evaluation of DNA damage in an Ecuadorian population exposed to glyphosate. *Genetics and Mol. Bio.* 30, no. 2:456-460.
- Benachour, N. and Gilles-Eric Seralini. 2008. Glyphosate formulations induce apoptosis and necrosis in human umbilical, embryonic, and placental cells. *Chem. Res. Toxicol.* (published online December 23).
- Lassiter et al. 2008.
- Newbold, R. R. et al. 2007. Developmental exposure to endocrine disruptors and the obesity epidemic. *Reprod. Toxicol.* 23, no. 3:290-296.
- Benbrook, C. et al. 2008.
- Jiang, W. J. 2008. Sirtuins: novel targets for metabolic disease in drug development. *Biochem. Biophys. Res. Comm.* 373, no. 3: 341-344.
- Joseph, J. A., et al. 2008. Cellular and behavioral effects of stilbene resveratrol analogues: implications for reducing the deleterious effects of aging. *J. Agricultural and Food Chemistry* 56, no. 22:10,544-10,551 (December).
- Benbrook, C. 2005. Elevating antioxidant levels in food through organic farming and food processing. *State of Science Review. The Organic Center* (January). Accessible at: [http://www.organic-center.org/science.antiox.php?action=view&report\\_id=3](http://www.organic-center.org/science.antiox.php?action=view&report_id=3)
- Maggee, J. B., and B. J. Smith. 2002. Resveratrol content of muscadine berries is affected by disease control spray program. *HortScience* 37, no. 2:358-361.
- Ahn, J., et al. 2008. Dietary resveratrol alters lipid metabolism-related gene expression of mice on an atherogenic diet. *J. of Hepatology*, 49: 1019-1028.
- Fox, M.K., et al. 2006. Relationship between portion size and energy intake among infants and toddlers: evidence of self-regulation. *J. Am. Diet. Assoc.* 106, Supplement 1:S77-83.
- Hill et al. 2003. Obesity and the environment: Where do we go from here?. *Science* 299 (Feb. 7). Butte and Ellis. 2003. Comment on "Obesity and the environment: Where do we go from here?" *Science*. 301 (Aug. 1).
- Lane, M. D. and S. H. Cha. 2009. Effect of glucose and fructose on food intake via malonyl-CoA signaling in the brain. *Biochem. Biophys. Res. Comm.* (accessed March 3, 2009).
- Dubois, L. and M. Girard. 2006. Early determinants of overweight at 4.5 years in a population-based longitudinal study. *Int. J. Obesity*, 30:610-617.
- Benbrook, C. et al. 2008.
- Davis, D. 2009. Declining fruit and vegetable nutrient composition: What is the evidence. *HortScience* 44, no. 1 (February).
- Andrews, P., et al. 2009. Scientists agree that organic farming delivers healthier, richer soil and nutritionally enhanced food. *The Organic Center*, (March). Accessible at: [http://www.organic-center.org/science.events.php?action=view&report\\_id=148](http://www.organic-center.org/science.events.php?action=view&report_id=148)
- Halweil, B. 2007. Still no free lunch: Nutrient levels in the U.S. food supply eroded by pursuit of high yields. *Critical Issue Report, The Organic Center* (September 2007). Accessible at: [http://www.organic-center.org/science.nutri.php?action=view&report\\_id=115](http://www.organic-center.org/science.nutri.php?action=view&report_id=115)
- Hsu, C.L. et al. 2009. Phenolic compounds rutin and o-coumaric acid ameliorate obesity induced by high-fat diet in rats. *J. Ag Food Chemistry*, Vol. 57: 425-431.