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# ARSENIC IN OUR FOOD SUPPLY

UPDATES ON HUMAN HEALTH EFFECTS, FOOD POLICY AND REGULATORY STANDARDS

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Research Center  
Geisel School of Medicine at Dartmouth**

# DISCLOSURES

- No conflicts of interest or other disclosures
- No discussion of “off-label” use of commercial products

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Center*

NIEHS P01 ES022832  
U.S. EPA RD-83544201





# LEARNING OBJECTIVES

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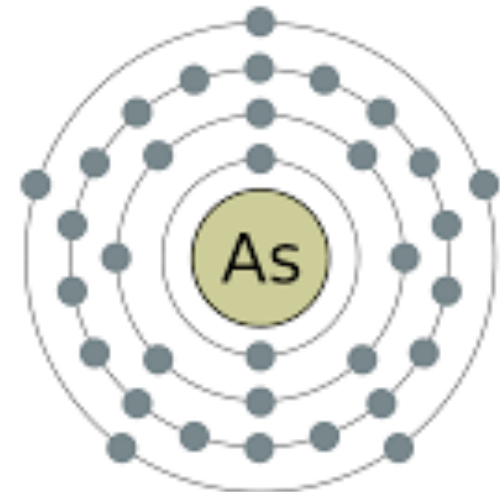
**Describe the most common sources of iAs in our diets**

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**Describe human health effects, including recent findings from the NHBCS**

33: Arsenic

2,8,18,5



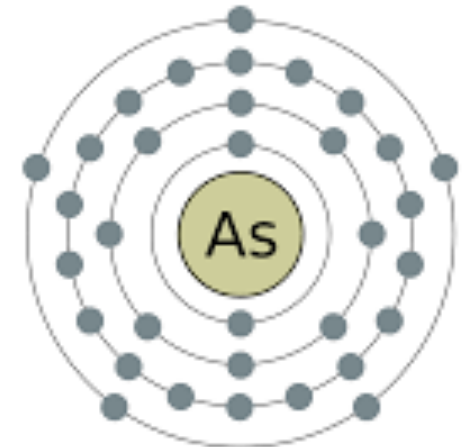
# LEARNING OBJECTIVES

**Describe recent regulatory agency actions to address iAs in food**

**Consider how best to guide consumers, in particular vulnerable populations**

33: Arsenic

2,8,18,5



# WHAT IS ARSENIC?



**Natural environmental contaminant**

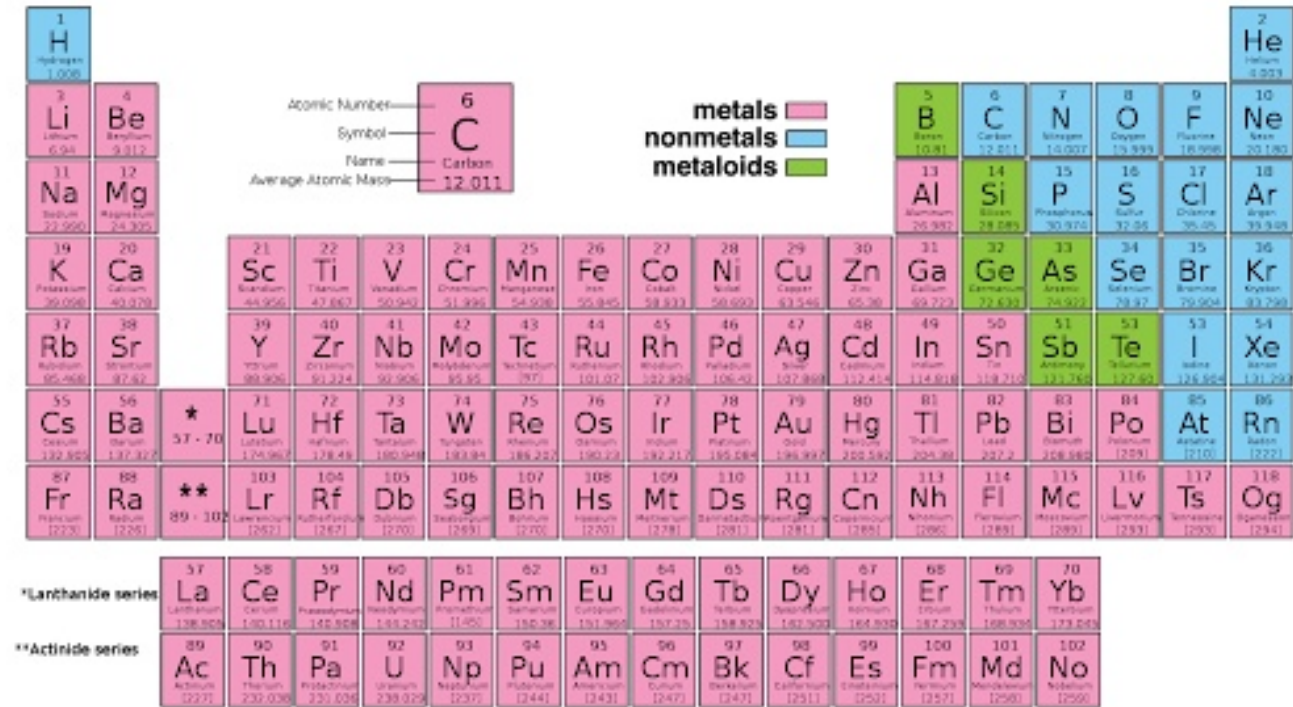


**Humans routinely exposed in food, water, air and soil**



**Metalloid- several structural forms and oxidation states**

## Metalloid



<http://www.differencebetween.net/science/difference-between-metals-metalloids-and-nonmetals/>

# ACUTE TOXICITY



“King of Poisons” and  
“Poison of Kings”



*Arsenic Poisoning at Church Mystifies a Maine Town*



By Kate Zernike

May 1, 2003



# ANTHROPOGENIC SOURCES OF ARSENIC

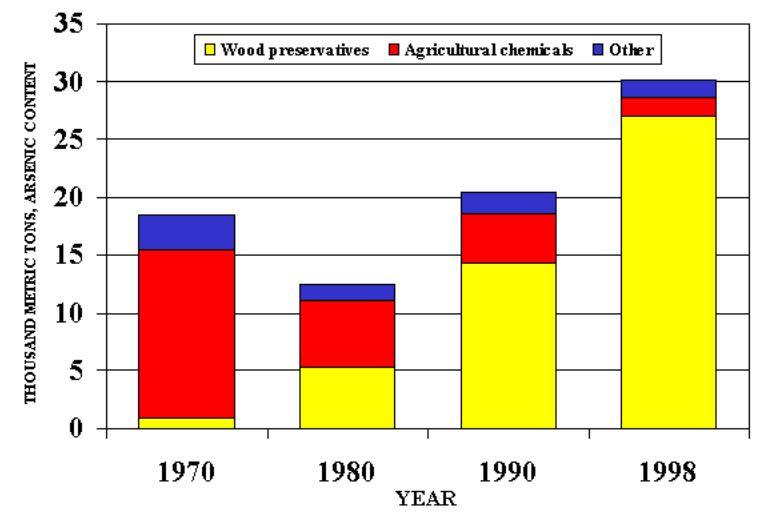
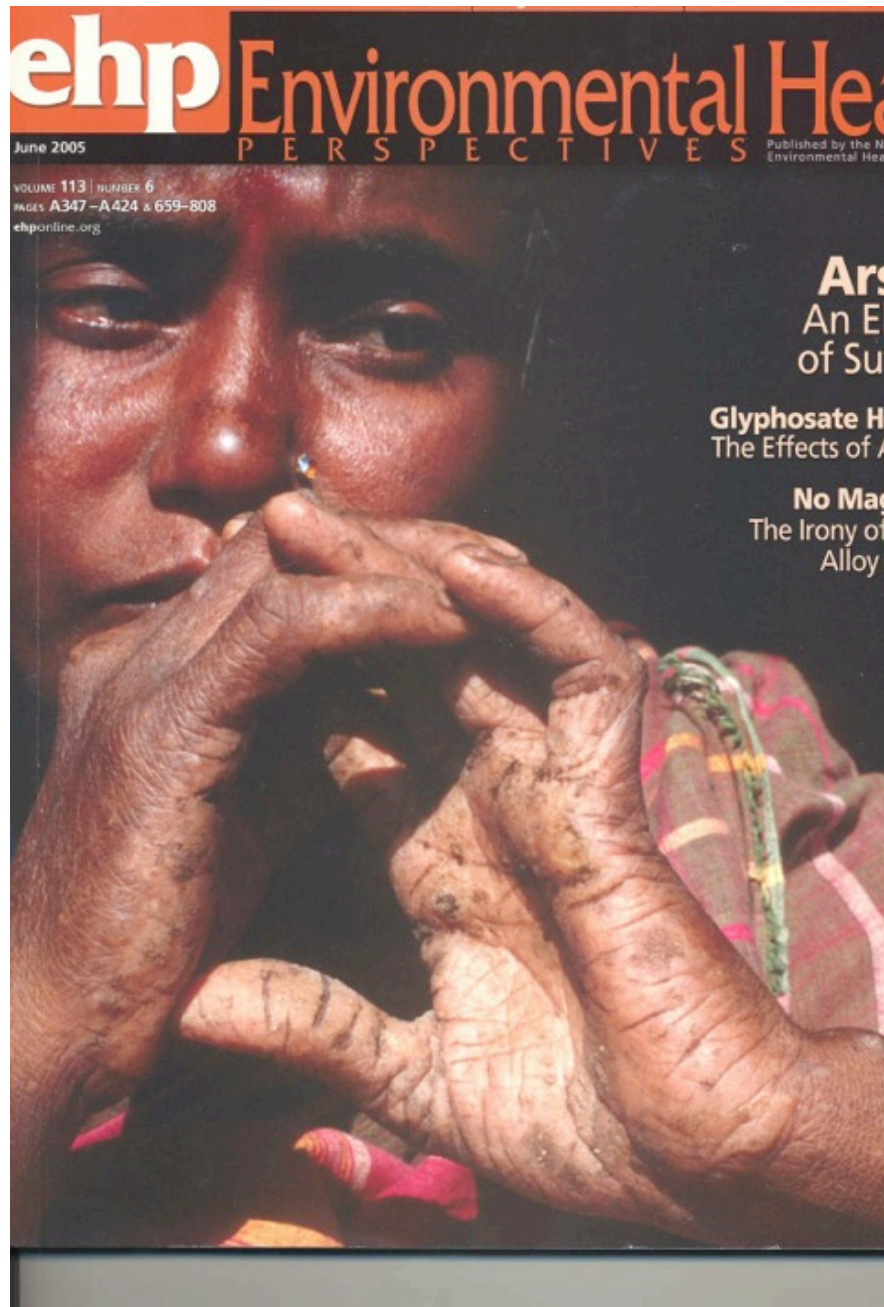


Figure 1. Domestic use of arsenic in selected years. Source of data: Loebenstein, 1994, and Reese, 1999b.



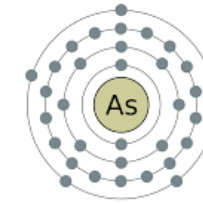


Origins of research on health effects of chronic arsenic exposure

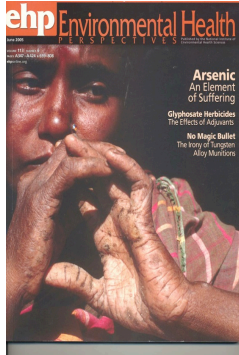
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# ARSENIC: CLASS 1 CARCINOGEN (SKIN, BLADDER AND LUNG)



**Growing evidence on CVD, PVD, lung disease, diabetes, growth, neurodevelopment, infection, mortality**



Critical Aspects of EPA's IRIS  
Assessment of Inorganic Arsenic  
Interim Report

Committee on Inorganic Arsenic  
Board on Environmental Studies and Toxicology  
Division on Earth and Life Studies

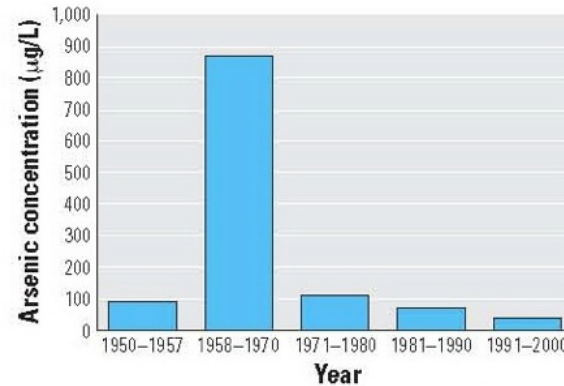
NATIONAL RESEARCH COUNCIL  
OF THE NATIONAL ACADEMIES

THE NATIONAL ACADEMIES PRESS  
Washington, D.C.  
www.nap.edu



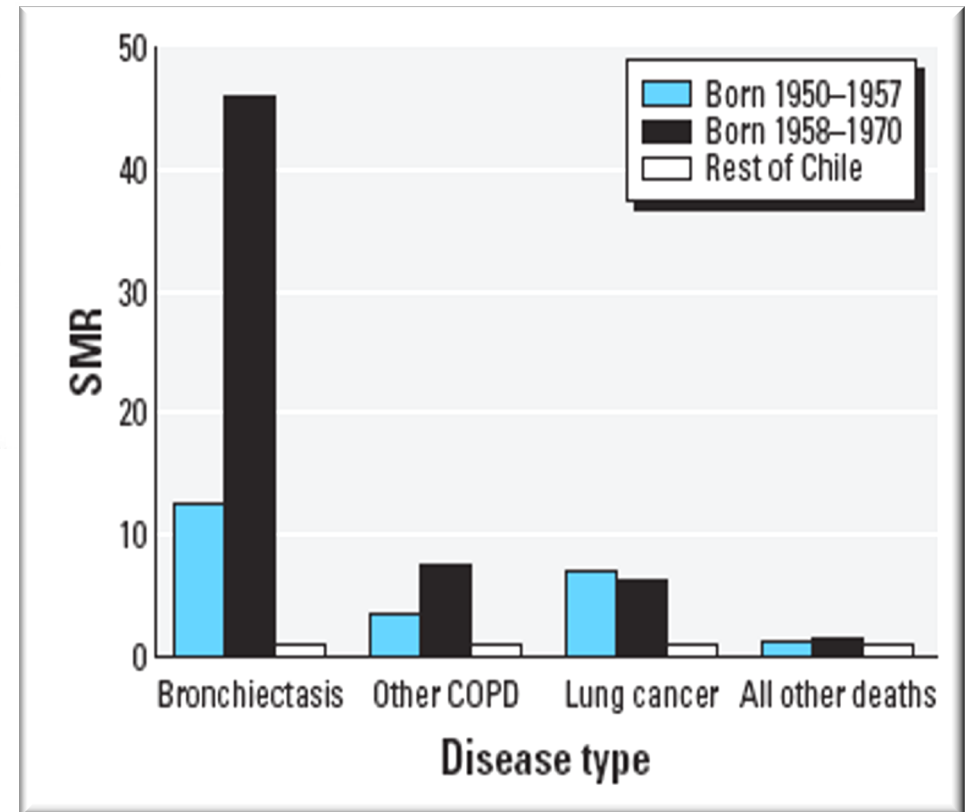
**Estimated 100 million worldwide exposed & relatively little data on health impacts on *in utero* and early life exposure, and at common levels of exposure.**

# ECOLOGIC STUDIES FROM CHILE SUGGEST EARLY LIFE EXPOSURE IS IMPORTANT



**Figure 1.** Arsenic concentrations in Antofagasta/Mejillones water by year. An arsenic removal plant was installed in 1971.

*Recent evidence on decreased pulmonary function*

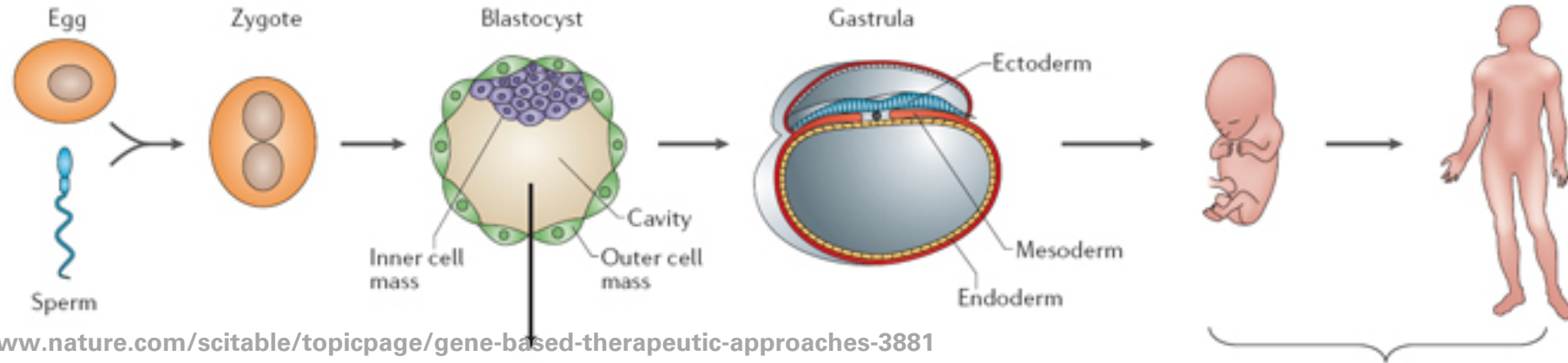


***Smith et al., 2006; 2012; Liaw et al., 2008; Steinmaus et al., 2014; 2017***

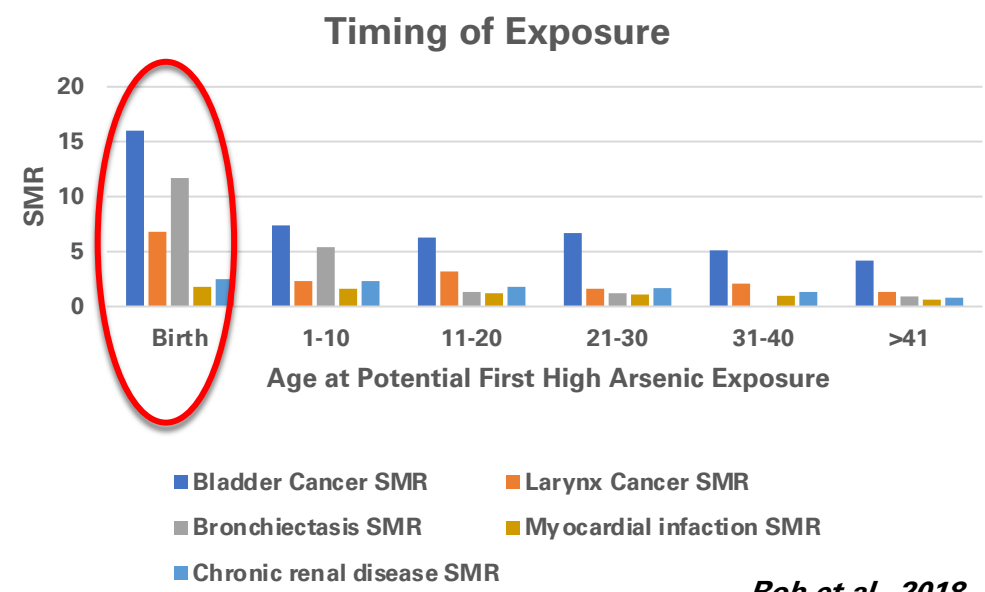


# PERTURBING EARLY LIFE DEVELOPMENT

## LIFELONG CONSEQUENCES



[www.nature.com/scitable/topicpage/gene-based-therapeutic-approaches-3881](http://www.nature.com/scitable/topicpage/gene-based-therapeutic-approaches-3881)



Roh et al., 2018

# Water Arsenic in the USA

## World Health Organization

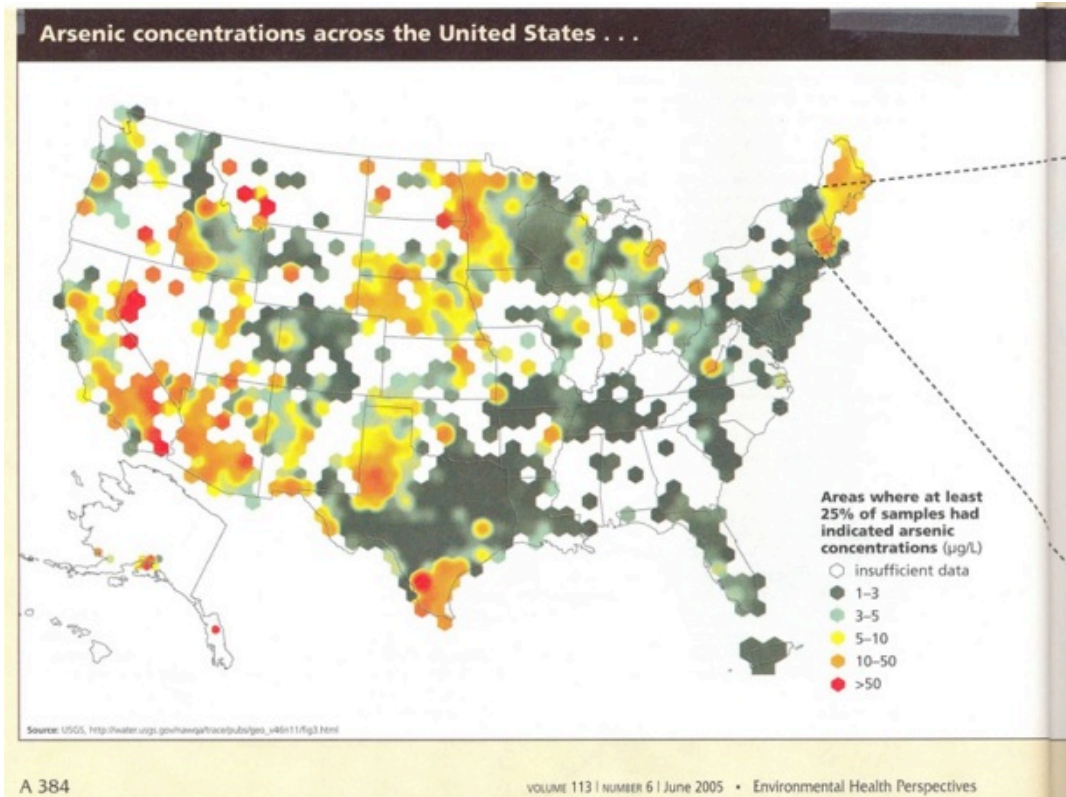
- 1958 – 200 µg/L
- 1963 – 50 µg/L
- 1993 – 10 µg/L

## US EPA MCL for public water systems

- 1970 – 50 µg/L
- 2001 – 10 µg/L

## Some states (e.g., NJ)

- 5 µg/L NH (2019)



**Private Wells are not Regulated by the EPA**

# DRINKING WATER STANDARDS FOR ARSENIC

- NAS State of the Evidence Review complete in 2014 to assist revision of EPA's IRIS updated toxicological assessment
- Three-tiered hierarchy of health endpoints

## FIRST TIER (causality)

- Lung, skin and bladder cancer
- IHD, Skin lesions

**“for a number of these endpoints, the doses required to elicit adverse effects may be close to or even overlap with levels of current human exposure”**

## SECOND TIER/ Priority

- Prostate and renal cancers
- Diabetes, non-malignant resp dz
- Infant morbidity, neurodevelopmental toxicity, immune effects

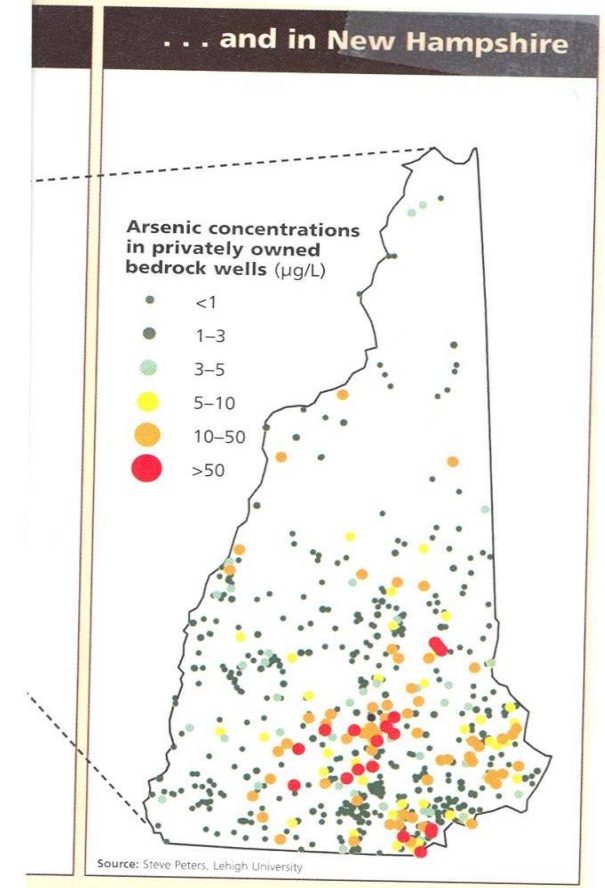
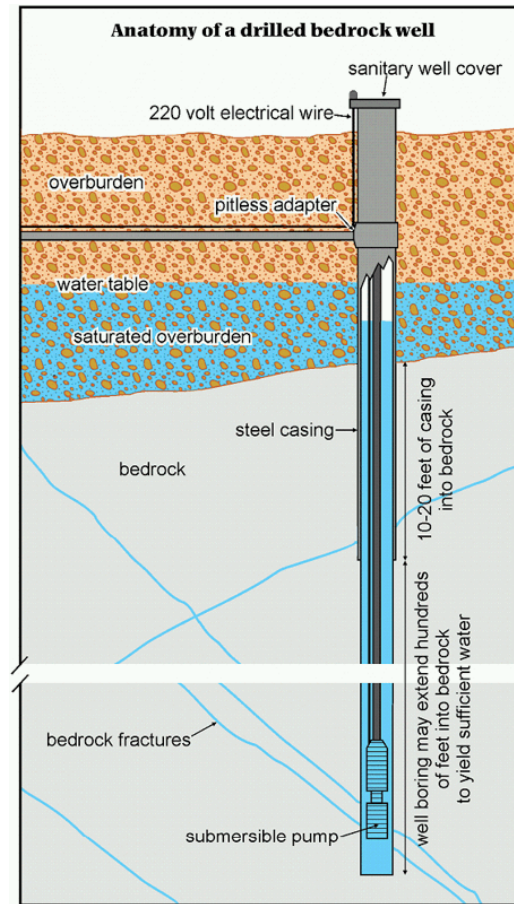
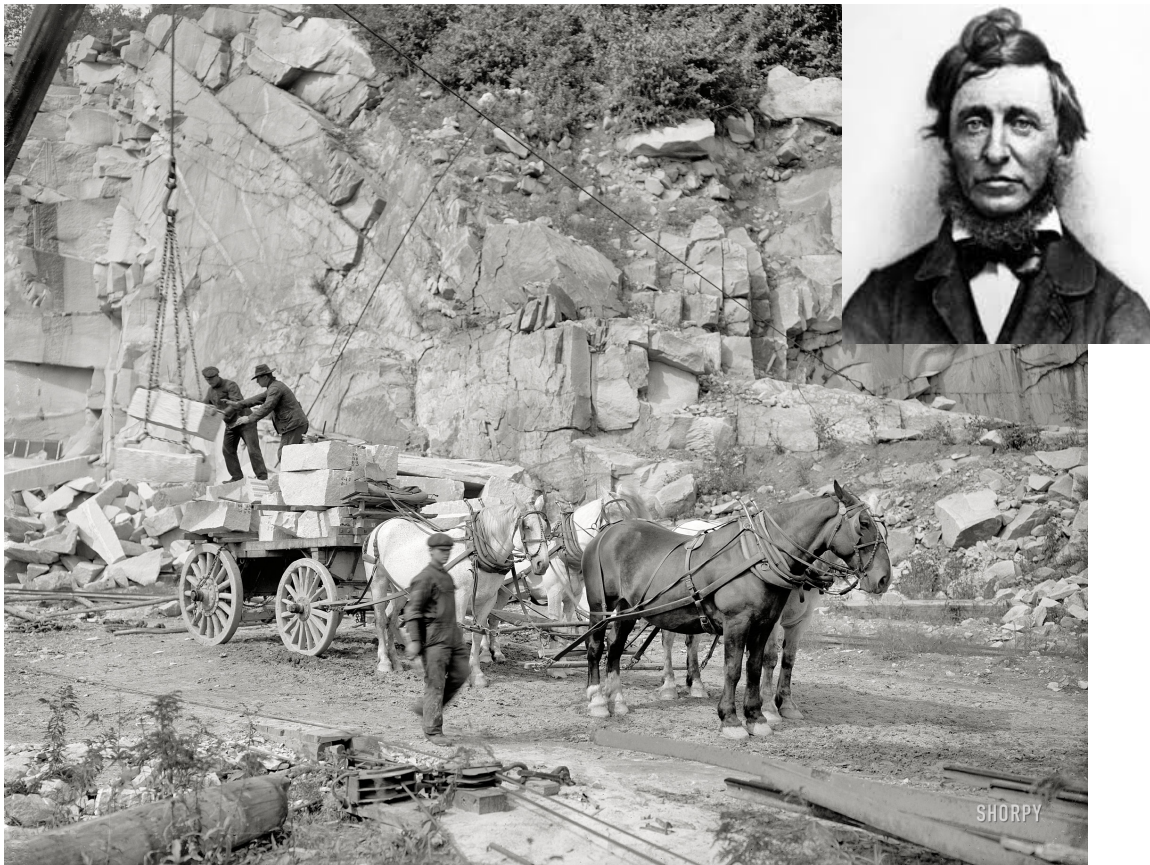
## CRITICAL ASPECTS OF EPA'S IRIS ASSESSMENT OF INORGANIC ARSENIC

- (Disease not yet developed)
- Liver and pancreatic cancer
- Renal disease
- HTN, stroke
- Other pregnancy outcomes

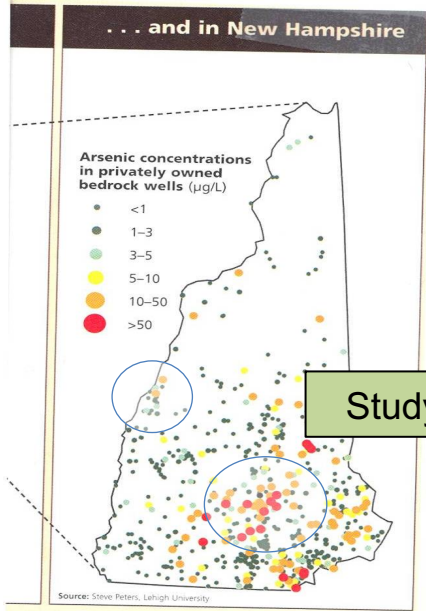
<https://www.nap.edu/catalog/18594/critical-aspects-of-epas-iris-assessment-of-inorganic-arsenic-interim#toc> NRC, 2014



# New Hampshire: The Granite State



**~40% use private water systems**  
**>10% private well As >MCL**  
**Largely attributed to bedrock geology**



**Pregnancy**



**Delivery**



**Childhood**



15% of pregnant women – tap water exceeds the MCL of  $10 \mu\text{g/L}$  As

Enrolled pregnant women  
From prenatal clinics in NH

nh birth cohort study

Margaret Karagas, PhD Principal Investigator

Following >2500 pregnant women and their offspring



# Study Design

Pregnancy



Delivery



Months



Years



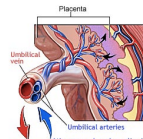
Arsenic Exposure: water, urine (total & metabolites), toenails, FFQ



Measure of Fetal Growth  
Ultrasound, birth outcomes



Cord blood immune profile  
& epigenetics, placental  
gene expression



Immune response measures:  
Infection/Allergy/Atopy



# Health Impacts?

## Arsenic exposure during pregnancy & maternal-fetal outcomes

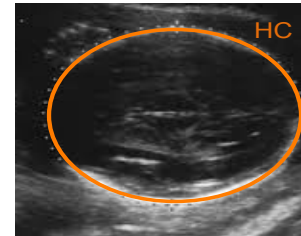
### Pregnancy



### Delivery



**Greater increases in maternal blood pressure** Farzan et al, 2015



**Reduced head circumference on ultrasound** Davis et al., 2015 & **at birth** Gilbert-Diamond et al., 2016



**Elevated risk of gestational diabetes** Farzan et al. , 2016

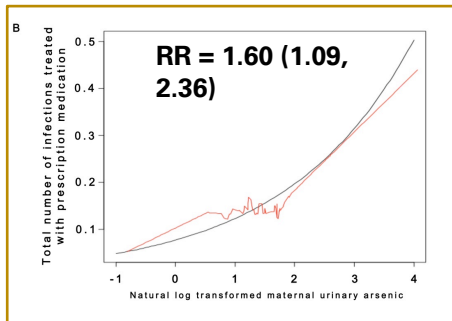


**Reduced birthweight in girls** Gilbert-Diamond et al., 2016

# Health Impacts?

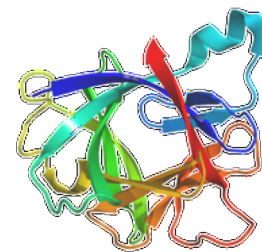
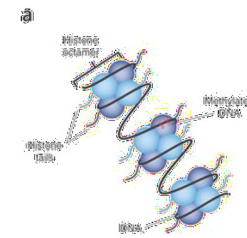
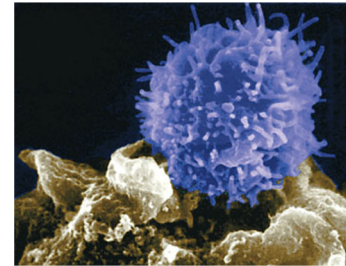
In *utero* arsenic, even relatively low exposures, associated with infant infections & altered immune biomarkers

## Infants



**Heightened risk of respiratory symptoms, including wheeze & infection** Farzan, 2013; Farzan, *EH*, 2016; Farzan, 2017

## Mechanisms



**Cord blood lymphocyte, placental epigenetic & gene expression alterations** Green, 2016; Everson, 2017; Winterbottom, 2017; Appleton, 2017; Everson, 2016; Winterbottom, 2015



# EARLY FINDINGS

**Effects on Maternal Health**



**Effects on Infant Health**



**Sources of Environmental Exposures**



# Rice consumption contributes to arsenic exposure in US women

Diane Gilbert-Diamond<sup>a,b,1,2</sup>, Kathryn L. Cottingham<sup>a,c,1</sup>, Joann F. Gruber<sup>a,b</sup>, Tracy Punshon<sup>a,c</sup>, Vicki Sayarath<sup>a,b</sup>, A. Jay Gandolfi<sup>d</sup>, Emily R. Baker<sup>a,e</sup>, Brian P. Jackson<sup>f</sup>, Carol L. Folt<sup>a,c</sup>, and Margaret R. Karagas<sup>a,b</sup>

<sup>a</sup>Children's Environmental Health and Disease Prevention Center at Dartmouth, Hanover, NH 03755; <sup>b</sup>Section of Biostatistics and Epidemiology, Department of Community and Family Medicine, Dartmouth Medical School, Hanover, NH 03756; <sup>c</sup>Department of Biological Sciences, Dartmouth College, Hanover, NH 03755; <sup>d</sup>Department of Pharmacology and Toxicology, University of Arizona, Tucson, AZ 85721; <sup>e</sup>Dartmouth Hitchcock Medical Center, Lebanon, NH 03756; and <sup>f</sup>Trace Element Analysis Laboratory, Department of Earth Sciences, Dartmouth College, Hanover, NH 03755



0.56 cups of cooked rice/day = total urinary arsenic concentration from 1 liter/day of water at 10 mcg/l arsenic (EPA MCL)

## **Arsenic concentration and speciation in infant formulas and first foods**

**Brian P. Jackson<sup>1</sup>, Vivien F. Taylor<sup>1</sup>, Tracy Punshon<sup>2</sup>, and Kathryn L. Cottingham<sup>2</sup>**

<sup>1</sup>Trace Element Analysis Laboratory, Earth Sciences, Dartmouth College, Hanover, NH, USA

<sup>2</sup>Department of Biological Sciences, Dartmouth College, Hanover, NH, USA

### **Arsenic, Organic Foods, and Brown Rice Syrup**

***Brian P. Jackson,<sup>1</sup> Vivien F. Taylor,<sup>1</sup> Margaret R. Karagas,<sup>2</sup> Tracy Punshon,<sup>3</sup> and Kathryn L. Cottingham<sup>3</sup>***

<sup>1</sup>Trace Element Analysis Core Laboratory, Department of Earth Sciences, Dartmouth College, Hanover, New Hampshire, USA;

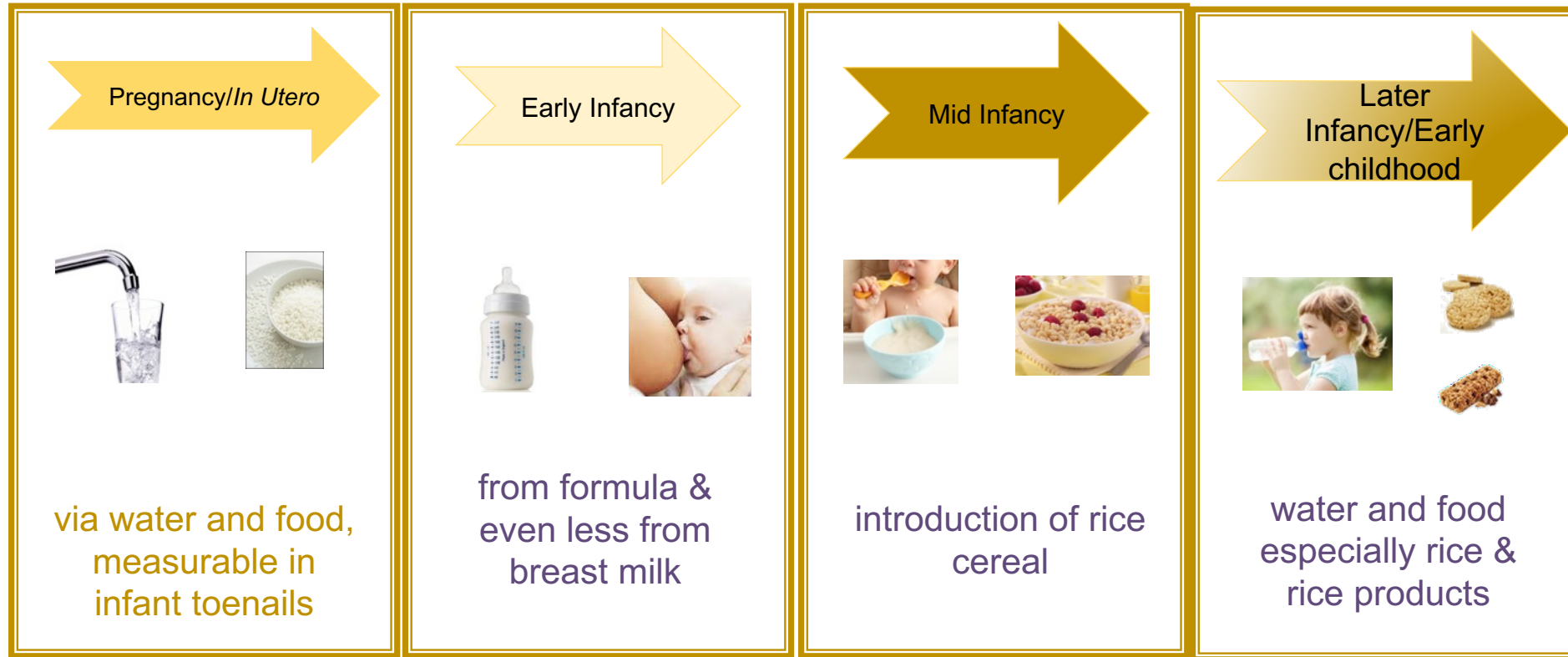
<sup>2</sup>Department of Community and Family Medicine, Section of Biostatistics and Epidemiology, Dartmouth Medical School, Lebanon, New Hampshire, USA; <sup>3</sup>Department of Biological Sciences, Dartmouth College, Hanover, New Hampshire, USA

VOLUME 120 | NUMBER 5 | May 2012 • Environmental Health Perspectives



**Organic Brown Rice Syrup significant source of iAs content in “healthy foods”, including those marketed for children (“toddler formula”)**

# Filling the Gap: Quantifying arsenic exposure from water and food sources through vulnerable developmental stages...



Gilbert-Diamond et al. 2011 PNAS; Davis et al., JESEE 2014; Carignan et al. 2015 EHP; Carignan et al. 2016 JESEE; Karagas et al. 2016 JAMA Peds; Signes-Pastor et al., 2018 Sci Rep; Davis et al. 2014

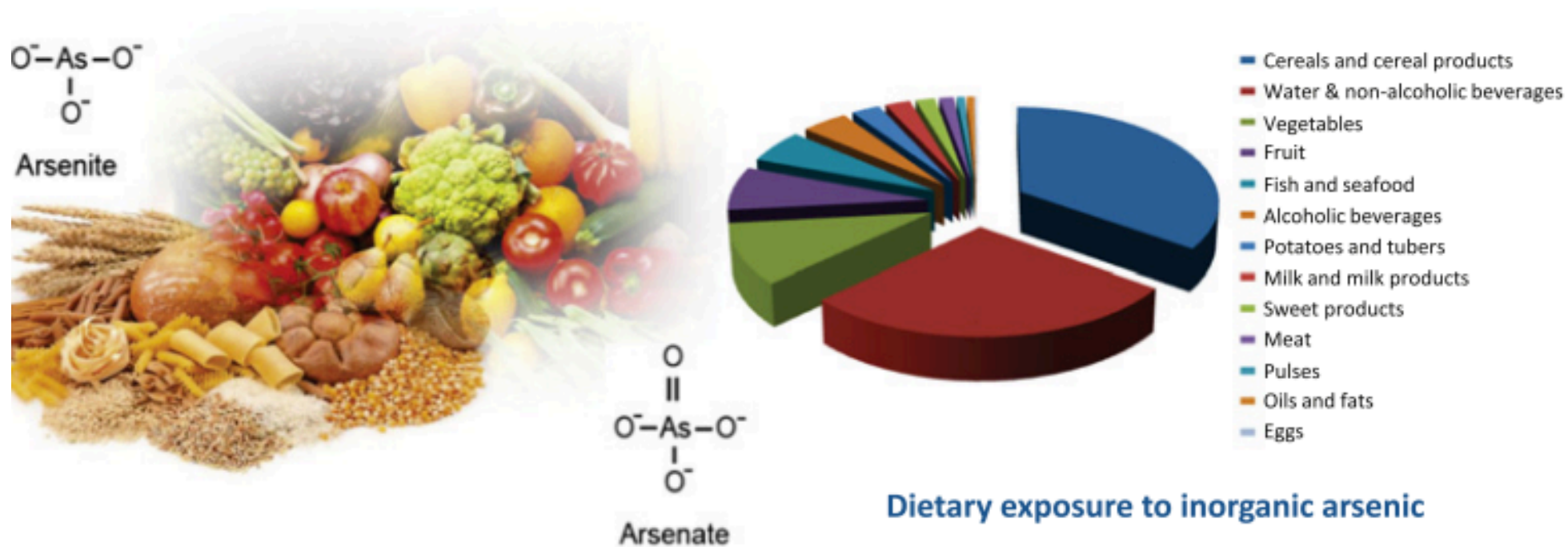


# **WHAT FOODS CONTRIBUTE TO DIETARY EXPOSURE TO ARSENIC AND WHY?**

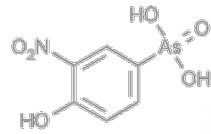
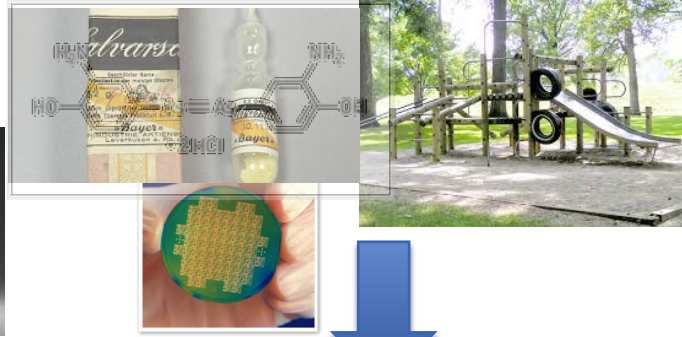
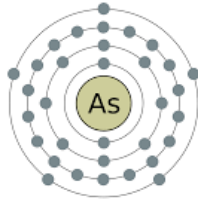




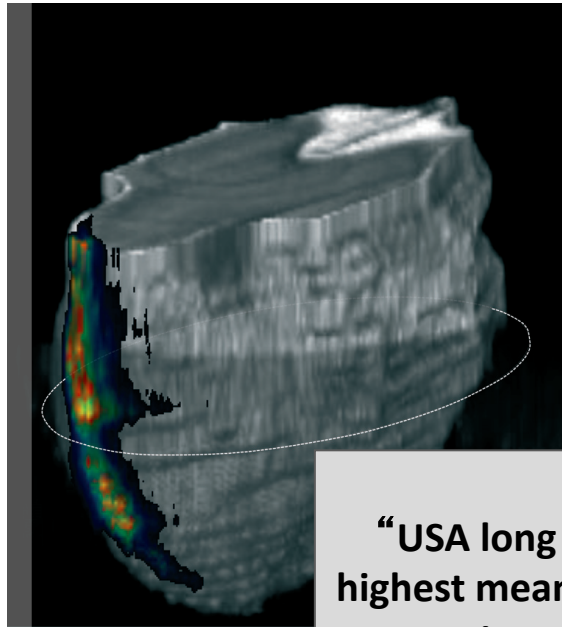
# DIETARY EXPOSURE TO INORGANIC ARSENIC



Cubadda, F., Jackson, B., Kuzurius-Spencer, M., Cottingham, K., Ornelas Van Horne, Y.,  
2017. Human exposure to dietary inorganic arsenic and other arsenic species: state of knowledge, gaps and uncertainties. *Sci. Total Environ.* 579, 1228–1239.



# ARSENIC IN RICE

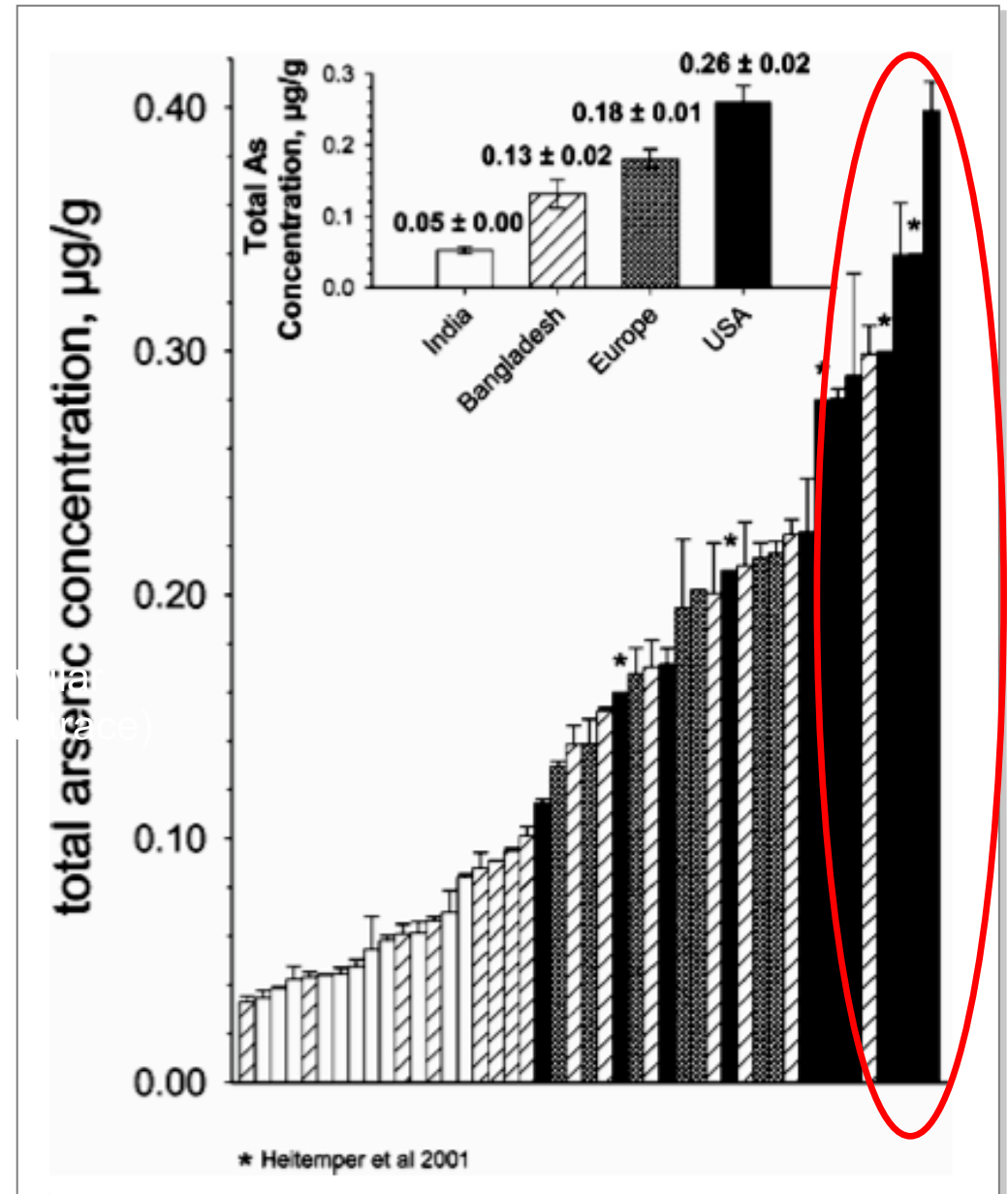


ovular vascular trace

“USA long grain rice had the highest mean arsenic level in the grain at  $0.26 \mu\text{g As g}^{-1}$ ”

No statutory limits for iAs in rice in the US.

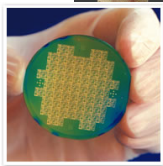
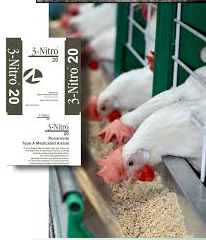
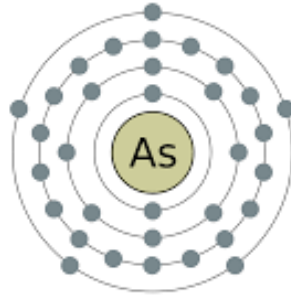
Williams et al., 2005; Meharg et al., 2008.; Carey et al., 2011



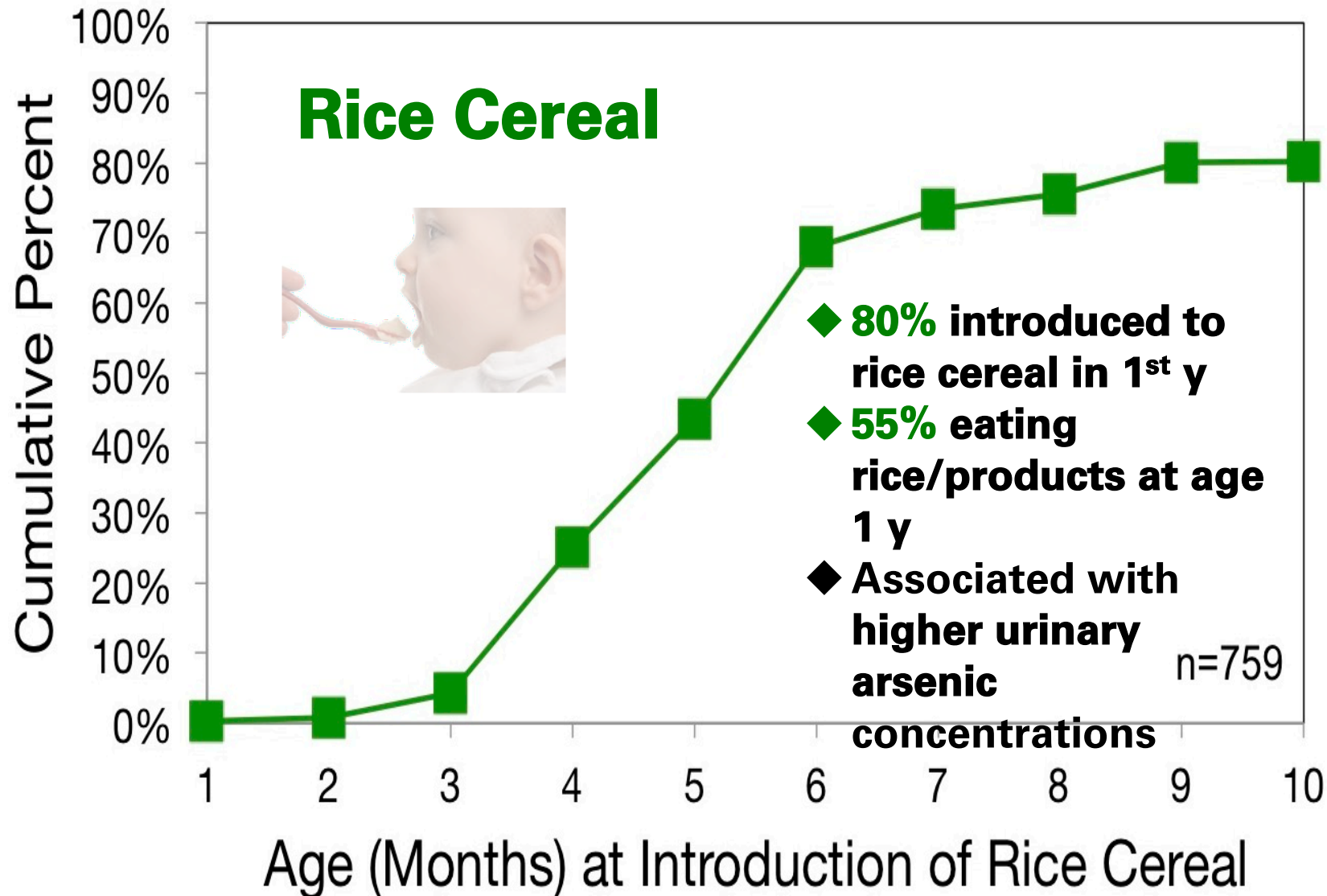




33: Arsenic 2,8,18,5



# WHAT DO WE FEED OUR BABIES?

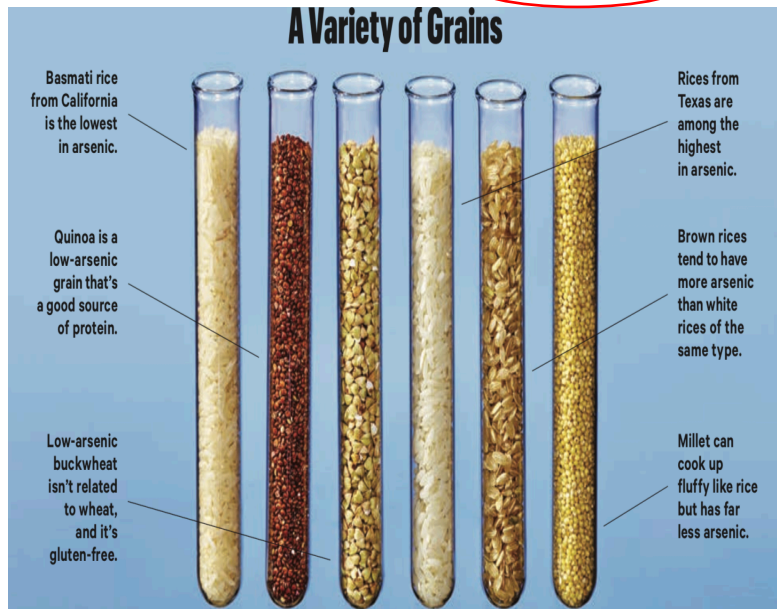


# Collaborations with Consumer Reports: extending our science and providing evidence-based advice to reduce exposure

## Arsenic in Your Rice: The Latest

November 2014

Two years after Consumer Reports released groundbreaking findings, we have new data and guidelines. They're important for everyone but especially for gluten avoiders.



**ConsumerReports.org**

Arsenic in your food

Our findings show a real need for federal standards for this toxin

Consumer Reports magazine: November 2012

November 2012



Our analysis found varying levels of arsenic in more than 60 rices and rice products.

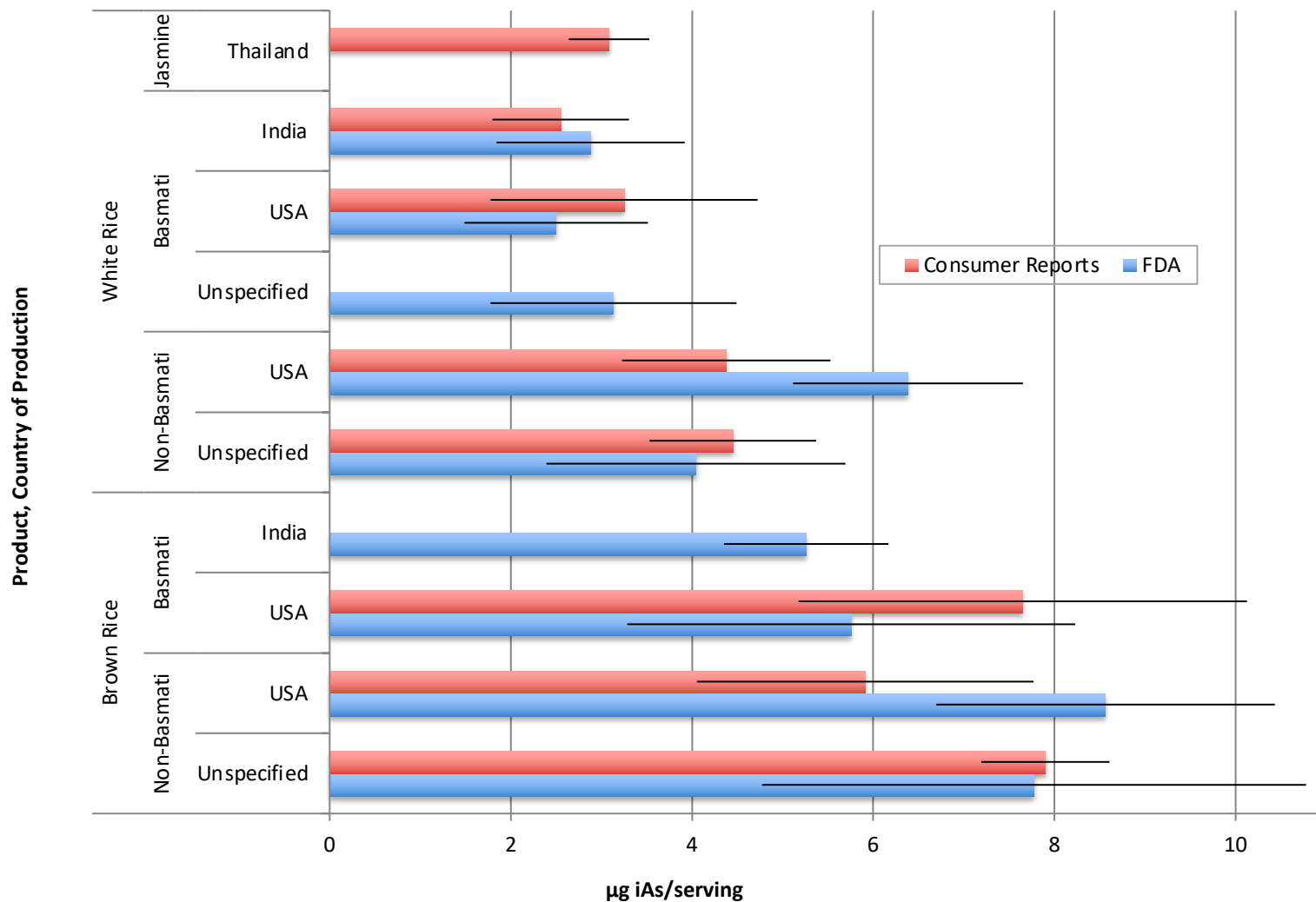


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# CONSUMER REPORTS

- **White rice grown in Arkansas, Louisiana, Missouri, and Texas, which account for 76 percent of domestic rice, generally had higher levels of total arsenic and inorganic arsenic than rice samples from elsewhere.**
- **Within any single brand of rice, the average total and inorganic arsenic levels were always higher for brown rice than for white.**
- **People who ate rice had arsenic levels that were 44 percent greater than those who had not**

# AS AND RICE BY COLOR, TYPE, COUNTRY





# **FROM SCIENCE TO POLICY**



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# MITIGATION CHALLENGES

- **Variability in iAs content within and between food types**
- **Variability in intra-population rates of consumption of iAs-containing foods**
- **Regulatory attention has been focused on water (and soil), yet dietary sources predominate for most**
- **Fragmented regulatory roles (EPA, FDA, USDA)**
- **Currently available consumer information is insufficient for making informed choices**

# FDA ACTIONS

## Apple Juice Showdown: Dr. Oz Arsenic Claim Questioned by Dr. Besser

The FDA balks at claims that apple juice has **Arsenic in Your Juice**

How much is too much? Federal limits don't exist.

By Consumer Reports  
Last updated: October 03, 2013

## Draft Guidance for Industry: Action Level for Arsenic in Apple Juice

JULY 2013

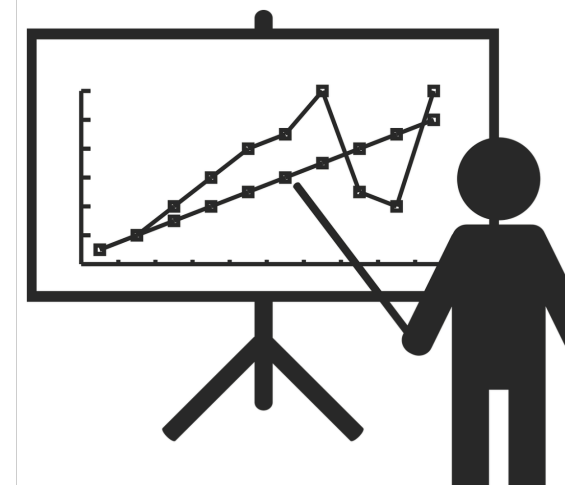




# The Maze of Food Safety

## The FDA Food Advisory Committee

US Food and Drug Administration  
Center for Food Safety and Applied Nutrition  
December 17, 2014 Silver Springs, Maryland



## Meetings with FDA Center for Food Safety and Applied Nutrition

Suzanne Fitzpatrick, Ph.D., DABT  
Senior Advisor for Toxicology CFSAN, FDA

## Congresswoman Rosa L. DeLauro (CT-03) Office

RE: legislation on FDA & arsenic in rice

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# FDA ACTIONS

FDA NEWS RELEASE

## FDA proposes limit for inorganic arsenic in infant rice cereal

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**For Immediate Release:** April 01, 2016

# Legislation

## DeLauro Introduces Legislation To Limit Inorganic Arsenic In Rice

WASHINGTON, DC—Congresswoman Rosa DeLauro (D-CT) today introduced legislation to limit the amount of inorganic arsenic, the most toxic form of arsenic found in foods, that is permitted in rice and rice-based products. The [R.I.C.E \(Reducing food-based Inorganic Compounds Exposure\) Act](#) would require the Food and Drug Administration (FDA) to set a maximum permissible level of inorganic arsenic in rice and food containing rice.

### FOOD SAFETY:

#### Federal Efforts to Manage the Risk of Arsenic in Rice

GAO-18-199: Published: Mar 16, 2018. Publicly Released: Apr 16, 2018.

FAST FACTS

HIGHLIGHTS

RECOMMENDATIONS

VIEW REPORT (PDF, 55 PAGES)

Share

#### What GAO Found

The National Research Council (NRC) of the National Academy of Sciences, in 2013, and more recent key scientific reviews reported evidence of associations between long-term ingestion of arsenic and adverse human health effects, such as cardiovascular disease. Many of the studies NRC reviewed as part of its survey of the scientific literature examined the ingestion of arsenic in drinking water, but others looked at arsenic from all sources, including dietary sources such as rice. NRC stated that evidence suggests that food, particularly rice, may be a significant source of inorganic arsenic, the more toxic of the two forms of arsenic; however, consumption of rice and levels of arsenic in rice vary widely, making it difficult to estimate arsenic intake from rice. NRC identified stronger evidence for some health effects at higher levels of arsenic—defined by NRC as 100 parts per billion or higher in drinking water—than at lower levels, which are more common in the United States, and noted that research on the health effects of ingesting lower levels of arsenic is ongoing.


The Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA) have taken actions to manage the risk of arsenic in rice to human health, including assessing the type and prevalence of health effects that may result from long-term ingestion of arsenic in rice. FDA also has taken action to publicly communicate and report on the risk. In 2016, FDA issued a risk assessment about the human health effects from long-term ingestion of arsenic in rice and draft guidance recommending industry not exceed a level of 100 parts per billion of inorganic arsenic in infant rice cereal. FDA noted it issued this guidance because infants face a higher risk owing to their less-varied diets. However, FDA has not updated the risk assessment, which was informed by a review of scientific studies published before February 2015, or finalized the draft guidance. In prior work, GAO has found that sharing risk information and incorporating stakeholder feedback can help organizations identify and better manage risks, as well as increase transparency and accountability to Congress and taxpayers. FDA officials stated that they may update the risk assessment based on newly-available information and consider public comments before finalizing the draft guidance. However, FDA officials could not provide a

#### Additional Materials:

 [Highlights Page:](#)  
(PDF, 1 page)

 [Full Report:](#)  
(PDF, 55 pages)

 [Accessible Version:](#)  
(PDF, 69 pages)

 [Related WatchBlog:](#)  
[Arsenic in Rice](#)

#### Contact:

Steve D. Morris  
(202) 512-3841  
[Morriss@gao.gov](mailto:Morriss@gao.gov)

## Recommendations for Executive Action

1. **Recommendation:** The Commissioner of FDA should develop a timeline for updating the risk assessment on arsenic in rice. (Recommendation 1)

**Agency Affected:** Department of Health and Human Services: Food and Drug Administration

2. **Recommendation:** The Commissioner of FDA should develop a timeline for finalizing the draft guidance on arsenic in infant rice cereal. (Recommendation 2)

**Agency Affected:** Department of Health and Human Services: Food and Drug Administration

3. **Recommendation:** The Commissioner of FDA should develop a mechanism for working with relevant agencies to identify their roles and responsibilities for coordinating risk assessments of contaminants in food, including arsenic in rice. (Recommendation 3)

**Agency Affected:** Department of Health and Human Services: Food and Drug Administration

# Most foods without regulatory standard or industry guidance

- EPA – drinking water, human biosolids, air and wastewater from power plants, pesticides

Guidance and “Action Levels” (FDA)

Apple juice (10 ppb)

Infant Rice Cereal (100 ppb)

Fruit Juice importation

Limited Action on Legislative Front

Rose DeLauro R.I.C.E. Act

Many gaps!!!

Irrigation water

- FDA – bottled water, animal drugs, selected foods, food additives

- USDA National Organic Program – PT  
lumber and pesticide use





**Collaborative on Food with Arsenic and associated Risk and Regulation**

*Dartmouth College | Toxic Metals Superfund Research Program | Children's Environmental Health Center*

**2 year collaboration of broad range of scientists**

**Goals:**

- **Synthesize current state of science related to dietary arsenic exposure “From soil to plate”**
- **Identify emerging topics**
- **Connect to policy stakeholders in US FDA, EPA, and USDA**



## **Collaborative on Food with Arsenic and associated Risk and Regulation**

*Dartmouth College | Toxic Metals Superfund Research Program | Children's Environmental Health Center*

- **Punshon, T., et al., Understanding arsenic dynamics in agronomic systems to predict and prevent uptake by crop plants, Sci Total Environ (2016).**
- Cubadda, F., et al., Human exposure to dietary inorganic arsenic and other arsenic species: State of knowledge, gaps and uncertainties, Sci Total Environ (2016).
- Taylor, V., et al., Human exposure to organic arsenic species from seafood, Sci Total Environ (2016).
- Davis, M., et al., Assessment of Human Dietary Exposure to Arsenic through Rice, Sci Total Environ (2017).
- **Nachman, K.E., et al., Mitigating dietary arsenic exposure: Current status in the United States and recommendations for an improved path forward, Sci Total Environ (2016).**



THE CHILDREN'S ENVIRONMENTAL  
HEALTH & DISEASE PREVENTION  
RESEARCH CENTER AT DARTMOUTH



Collaborative on Food with Arsenic and associated Risk and Regulation

Dartmouth College | Toxic Metals Superfund Research Program | Children's Environmental Health Center

## Our workgroup:

Keeve Nachman, PhD, MHS JHU Bloomberg School of PH

Gary Ginsberg, PhD, Connecticut Dept of Public Health

Mark Miller, MD, Pediatrician, California EPA/ PEHSU

Carolyn Murray, MD, MPH, Dartmouth Children's Center

Anne Nigra, MS, JHU Bloomberg School of PH

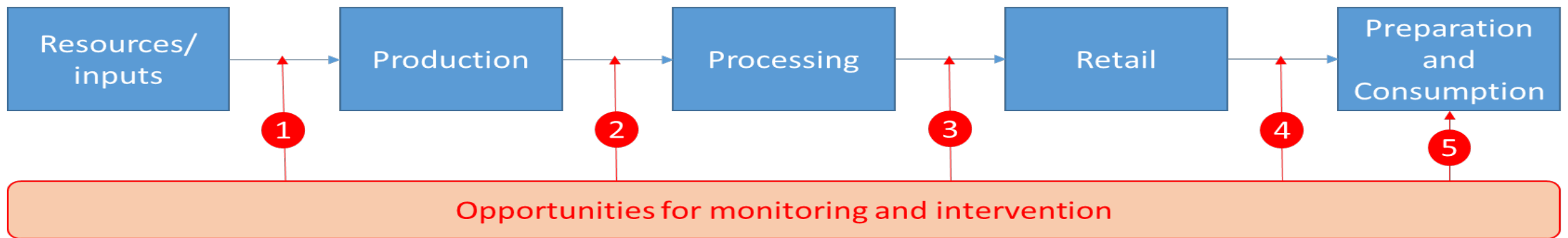
Claire Prendergast, Dartmouth College



National Institute of  
Environmental Health Sciences

*Superfund Research Program*

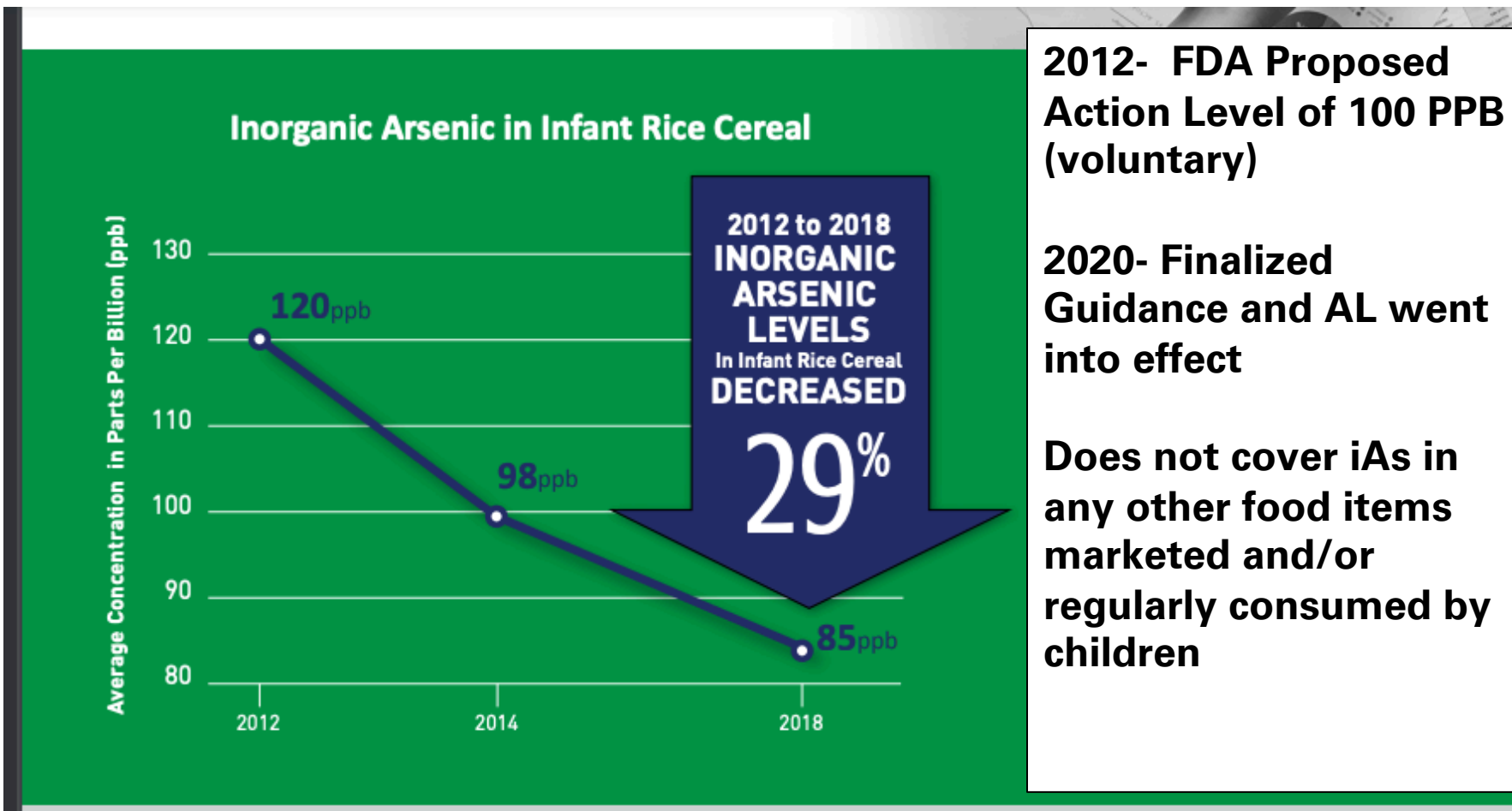
# Mitigating Dietary Arsenic Exposure: Opportunities for Monitoring and Intervention



1. Agricultural practice, plant biology/science to prevent/reduce arsenic in rice
2. Production practices that could reduce arsenic content, such as organic brown rice syrup
3. Intervention post processing/ pre-market to divert high-arsenic foods



# INFANT RICE CEREAL



# Arsenic Drinking Water Standards

## US EPA

1975-2001

- MCL 50  $\mu\text{g/L}$

2001

- Goal: ZERO
- **MCL 10  $\mu\text{g/L}^*$**

- Currently under review

2019

**NH Dept of Env Services  
proposed state  
reduction in arsenic  
MCL to 5  $\mu\text{g/L}$**



# New Arsenic-limiting law based on Dartmouth research

New Hampshire law limits arsenic in public water to 5 parts per billion

10 Shares

Updated: 7:43 PM EDT Jul 16, 2019



## N.H. is 2nd state to drop allowable arsenic levels in drinking water

by David Brooks | Jul 15, 2019 | Blog, Newsletter | 0 comments



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### Environment

### Arsenic alert sounds as NH drops allowable levels

### Dartmouth News

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#### Dartmouth Research Informs N.H. Action on Arsenic in Drinking Water

July 30, 2019 by David Hirsch

Granite State lawmakers voted to reduce the level allowed in public water.

Hor

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#### With new arsenic law, N.H. becomes leader in environmental regulation

By DAVID BROOKS  
Monitor staff

Published: 7/15/2019 5:34:38 PM

### Environmental Factor

Your Online Source for NIEHS News

AUGUST 2019



National Institute of Environmental Health

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#### New Hampshire arsenic rule builds on NIEHS-funded research

The new law lowers public drinking water levels to half the federal standard based on links to health effects at low exposures.

BY ADELINE LOPEZ

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News > Local-Regional

## N.H. law lowers threshold for acceptable arsenic levels in public drinking water



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## N.H. Becomes Second State To Sharply Lower Arsenic Limit In Drinking Water

### The Dartmouth

AMERICA'S OLDEST COLLEGE NEWSPAPER. FOUNDED 1799.

Latest Issue | October 27, 2019 | 45° F

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#### Study measures arsenic contamination in wells

RELATED

"Dream big, fight hard": campaign event



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# The Baby Food Safety Act of 2021

*Introduced by Rep. Raja Krishnamoorthi (D-IL), Senator Amy Klobuchar (D-MN),  
Senator Tammy Duckworth (D-IL), and Rep. Tony Cárdenas (D-CA)*

- FDA should accelerate its proposed timelines for publishing final limits for these toxic heavy metals and require companies to conduct finished-product testing.
- Baby food manufacturers should voluntarily adopt the practice of testing their finished products for toxic heavy metals.
- Baby food manufacturers should phase out products that have high amounts of ingredients that frequently test high in toxic heavy metals, such as rice.



**Baby Foods Are Tainted with Dangerous Levels of  
Arsenic, Lead, Cadmium, and Mercury**



Staff Report

Subcommittee on Economic and Consumer Policy  
Committee on Oversight and Reform  
U.S. House of Representatives

February 4, 2021

[oversight.house.gov](https://oversight.house.gov)



# FDA CLOSER TO ZERO INITIATIVE

FDA CFSAN

USDA


Stakeholders

Researchers

Arsenic, Cadmium, Mercury, Lead

<b>As</b> Arsenic 33 74.922	<b>Cd</b> Cadmium 48 112.41	<b>Cu</b> Copper 29 63.546	<b>Fe</b> Iron 26 55.845	<b>Hg</b> Mercury 80 200.59	
<b>Mn</b> Manganese 25 54.938	<b>Ni</b> Nickel 28 58.693	<b>Pb</b> Lead 82 207.2	<b>Se</b> Selenium 34 78.96	<b>Sn</b> Tin 50 118.71	<b>Zn</b> Zinc 30 65.39

**Known toxicants, non-essential, no known safe level**



**FDA**

**CLOSER TO ZERO**

**ACTION PLAN PUBLIC MEETING**

**Impacts of Toxic Element Exposure and Nutrition at Different Crucial Developmental Stages**

November 18, 2021  
10:00 a.m. to 4:00 p.m. (EST)

# Climate Change: impacts on iAs and other metals in rice



Flooded fields



# **CONSUMER GUIDANCE**





# Risk Communication Challenges

- Arsenic is recognizable as a poison
- Specific details can be confusing
- Most media outlets can't contextualize exposure
- Mixed messages from experts, NGOs, government and industry
- Clinicians lack clear guidance re: giving patient advice
- Avoid unintended consequences





# INDUSTRY ROLE

- Consumer pressure on food manufacturers (Lundberg Farms, Nature's Way)
- USDA- e.g. rice cultivars with less arsenic uptake



The screenshot shows the top navigation bar of the Lundberg Family Farms website. The logo is on the left, followed by links for SHOP, PRODUCTS, RECIPES, ABOUT US, and BLOG. A search icon and a user profile icon are on the right. Below the navigation is a hero image of rice stalks with a blue-bordered box containing the text "A LETTER FROM THE CEO".

We have updated our arsenic testing page with results of our 2020 crop. Overall, the levels remain in the range we have seen over the nine years we have been monitoring inorganic arsenic in our products.

Below the text is the "NATURE'S PATH ORGANIC" logo. To the right of the logo are links for SHOP, OUR PATH, and BLOG & REI.

< ASK

**PLEASE ADDRESS MY CONCERNS ABOUT ARSENIC IN THE RICE PORTION OF YOUR CEREALS. I HAVE STOPPED EATING THEM UNTIL I KNOW THAT IT IS SAFE. I REALLY ENJOY ALL OF YOUR PRODUCTS.**

Asked by Larry from Springfield on March 11, 2019

# HEALTH CARE PROVIDER OUTREACH

THE JOURNAL OF PEDIATRICS • www.jpeds.com

CO



## Arsenic and Rice: Translating Research to Address Health Providers' Needs

Pui Y. Lai, MD<sup>1,2,3</sup>, Kathryn L. Cottingham, PhD<sup>4,5</sup>, Craig Steinmaus, MD, MPH<sup>6</sup>, Margaret R. Kara and Mark D. Miller, MD, MPH<sup>3</sup>

American Academy  
of Pediatrics

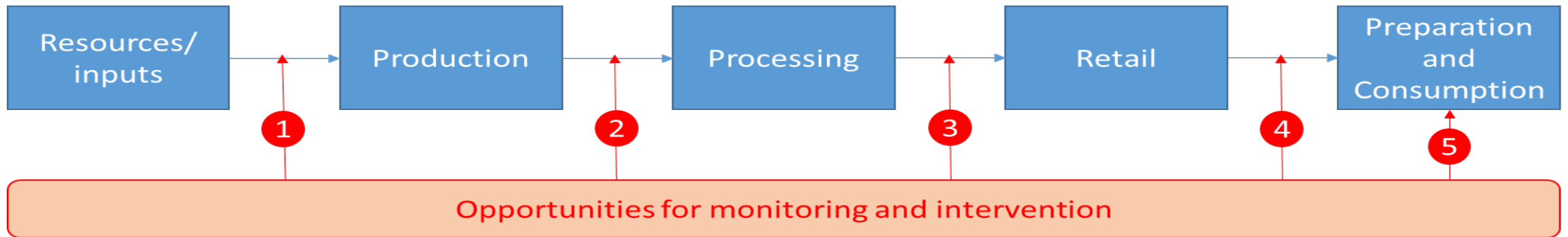


- *Introduce solid foods around 6 months of age*
- *Expose baby to a wide variety of healthy foods*
- *Also offer a variety of textures*

### Table. Potential strategies for reducing exposure of arsenic in rice\*

1. Diversify the diet
  - Eat a well-balanced diet and a variety of grains<sup>†,‡,§</sup>
  - Identify children at risk for high consumption of rice and rice products (eg, gluten-free diets, highly allergic)
2. Consider alternatives to rice for first food
  - Start infants on barley, oats, or other grains<sup>†,‡</sup>
  - If rice cereal must be used for infants, limit to 1 serving per day<sup>§</sup>
3. Adopt strategies that help minimize exposure
  - Rinse rice in a colander prior to cooking<sup>§</sup>
  - Cook rice like pasta, with plenty of extra water<sup>§</sup>
  - Choose lower-arsenic varieties of rice (eg, basmati)<sup>§</sup>
  - Avoid or limit use of rice milk or other rice beverages for infants<sup>†</sup> and children under 5 years old<sup>§,¶</sup>
  - Read labels of processed foods: choose alternatives to foods sweetened with brown rice syrup or thickened with rice products<sup>17</sup>
4. Regulatory action
  - Federal agencies should establish regulatory limits for arsenic content in rice and rice products<sup>§</sup>

# Mitigating Dietary Arsenic Exposure: Opportunities for Monitoring and Intervention



1. Agricultural practice, plant biology/science to prevent/reduce arsenic in rice
2. Production practices that could reduce arsenic content, such as organic brown rice syrup
3. Intervention post processing/ pre-market to divert high-arsenic foods
4. Retail level- power of the consumer/ food substitutions, consumer guides
5. Preparation – cooking practices that can reduce arsenic content, etc.

# www.ArsenicandYou.org



***Arsenic and You*** provides users with:

- a centralized web-based information resource for families, caregivers and vulnerable populations;
- easy access on mobile devices and tablets;
- recommendations to reduce arsenic exposure;
- resource links for helpful tools, videos and more detailed information.



# Arsenic and You

Information on Arsenic in Food, Water & Other  
Sources



[www.dartmouth.edu/~arsenicandyou](http://www.dartmouth.edu/~arsenicandyou)

Produced by the Dartmouth Toxic Metals Superfund Research Program

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# DIETARY ADVICE FOR PARENTS

## Diet Choices

- If you use a private well, **test your drinking water.**
- Talk to your doctor about breast-feeding your infant or toddler. Studies have found lower levels of arsenic in breast milk than in infant formula.
- If you choose formula for your baby, ask your doctor to recommend one that isn't made with **rice or rice products** such as **brown rice syrup**.
- Avoid rice milk for babies and young children.
- If your child is eating infant cereals, offer a variety of fortified infant cereals such as **oat, barley, or multigrain** instead of only rice cereal.
- **Limit how much fruit juice your child drinks.** Even better, give your child whole fruits instead. Drinking a lot of juice can be bad for health and teeth.
- **Check with your pediatrician** to make a list of healthy and low-arsenic food choices.
- Check ingredients of snack foods and avoid those containing rice or rice products.
- Eat a varied diet.

<https://sites.dartmouth.edu/arsenicandyou/what-you-can-do/>

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# DIETARY ADVICE FOR GLUTEN FREE

## Diet Choices

- If you use a private well, **test your drinking water.**
- **Eat less rice and rice-based foods**
- **Vary your grains.** Other naturally gluten-free grains provide better nutrition and do not take up arsenic when they grow. For instance: *Quinoa, Oats, Corn, Flax, Amaranth, Teff, Millet, or Buckwheat.*
- **Choose foods with less rice.** When you buy packaged foods, be sure to check the ingredients label for the word “rice” and especially brown rice bran and brown rice syrups, because these products contain the highest concentrations of inorganic arsenic.
- **Switch out your rice.** Some types of rice have less arsenic than others. When you want to eat rice, choose:
  - Quick-cooking rice
  - Instant rice
  - Sushi rice
  - Basmati rice from India, Pakistan, or California
- **Eat a whole food diet.** If/when you can, avoid processed foods and choose whole, single ingredient natural foods.

<https://sites.dartmouth.edu/arsenicandyou/what-you-can-do/>

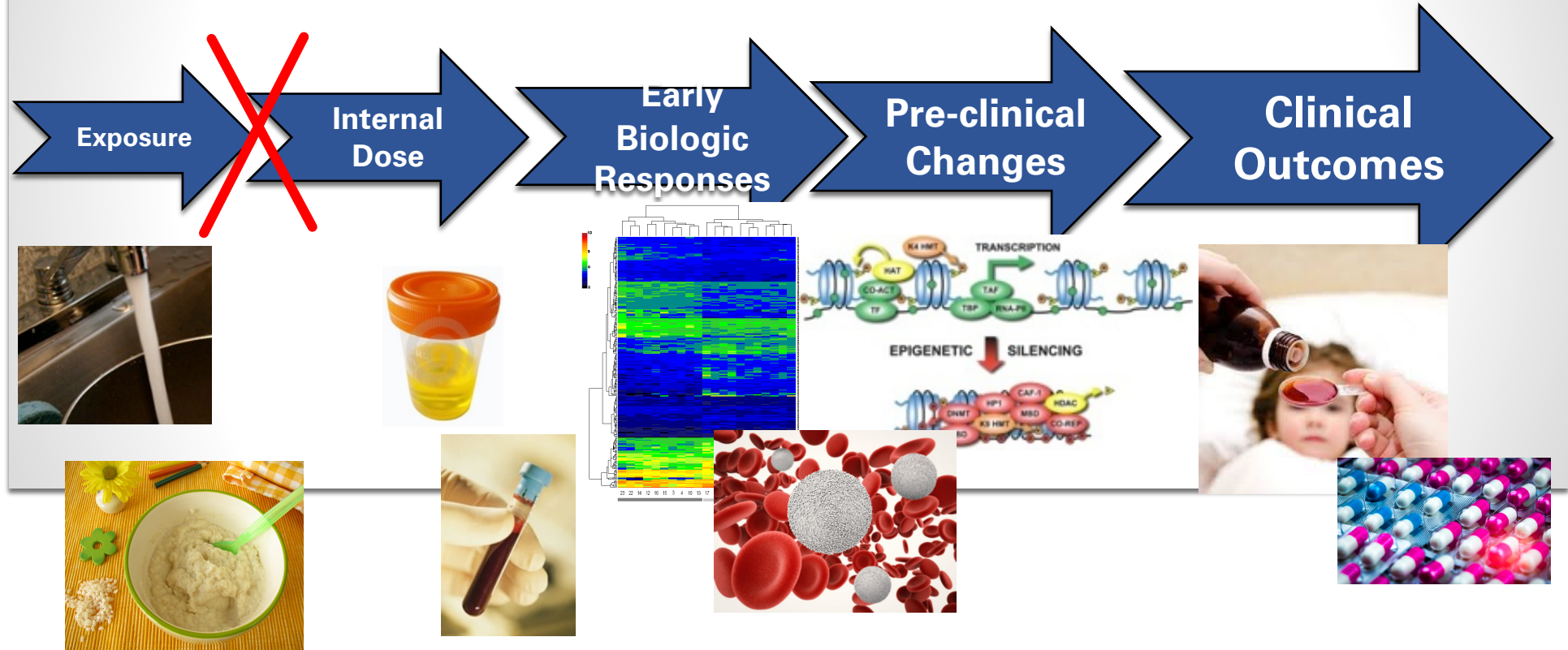
# CONSUMER REPORTS SUGGESTED SERVINGS

Rice Product	Infant Cereal	Hot Cereal	Ready-to-eat Cereal	Rice Drink	Rice	Rice Pasta	Rice Crackers	Rice Cakes
Approximate serving size uncooked	¾ cup	¼ cup	1 cup	1 cup	¼ cup	2 oz.	16-18 crackers	1-3 cakes
Children	1 per day	1 ¾ per week	1 ½ per week	--	1 ¼ per week	1 ½ per week	½ per day	1 per week
Adult	NA	2 ½ per week	3 per week	½ per day	2 per week	3 per week	1 per day	2 ½ per week

<http://www.consumerreports.org/cro/magazine/2012/11/arsenic-in-your-food/index.htm>



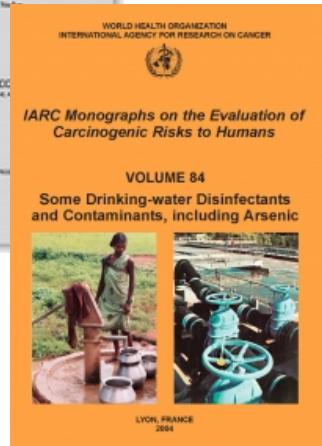
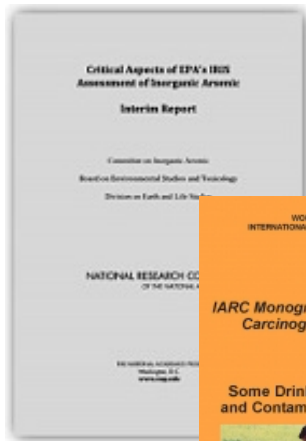
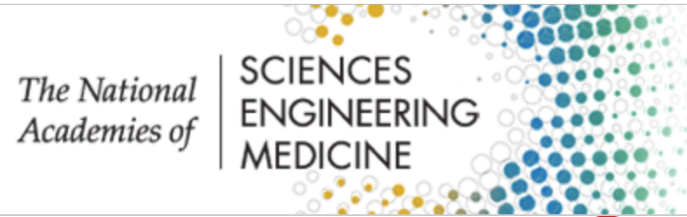
# ENVIRONMENTAL MEDICINE IS PREVENTIVE MEDICINE



Primary

Secondary

Tertiary Prevention



American Academy of Pediatrics



ConsumersUnion®



The New York Times







Thank you!

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Instagram: @dartmouth\_cchc

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Facebook: @childrensenvironmentalhealthdartmouth

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Twitter: @CEHCdartmouth

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carolyn.murray@dartmouth.edu





# RESOURCES

## ACOEM GUIDANCE STATEMENT

### Arsenic Exposure, Assessment, Toxicity, Diagnosis, and Management

#### *Guidance for Occupational and Environmental Physicians*

*Beth A. Baker, MD, MPH, Victoria A. Cassano, MD, MPH, and Carolyn Murray, MD, MPH,  
ACOEM Task Force on Arsenic Exposure*

**JOEM Volume 60, Number 12, December 2018**

JOURNAL OF THE TOTAL ENVIRONMENT 2017-2018 (60 (12)) 221-236



Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: [www.elsevier.com/locate/scitotenv](http://www.elsevier.com/locate/scitotenv)



Mitigating dietary arsenic exposure: Current status in the United States  
and recommendations for an improved path forward

Keeve E. Nachman<sup>a,b,c,d,\*</sup>, Gary L. Ginsberg<sup>e</sup>, Mark D. Miller<sup>f</sup>, Carolyn J. Murray<sup>g,h</sup>,  
Anne E. Nigra<sup>a</sup>, Claire B. Pendergrast<sup>i</sup>



**Science of the Total Environment 581–  
582 (2017) 221–236**



# Collaborators

**Principal Investigator: Margaret Karagas** Investigators/*Trainees*: Emily Baker, *Courtney Carignan*, Kathy Cottingham, *Matt Davis*, *Diane Gilbert-Diamond*, *Shohreh Farzan*, Carol Folt (USC), *Dennis Fei*, *Anala Gossai*, *Joann Gruber*, Anne Gatewood Hoen, *Caitlin Howe* (USC), Brian Jackson, Juliette Madan, Carmen Marsit, Hillary Morrison (MBL), Carolyn Murray, Kari Nadeau (Stanford), Zhigang Li, *Devin Koestler*, Susan Korrick (Harvard), Thomas Palys, *Antonio Signes-Pastor*, Tracy Punshon, David Robbins, Vicki Sayarath, Mitch Sogin (MBL), the families and staff of the New Hampshire Birth Cohort Study and many others



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New  
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Study

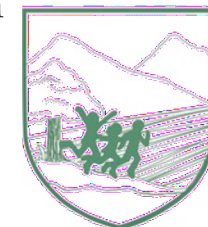


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**ECHO**  
Environmental influences  
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A program supported by the NIH

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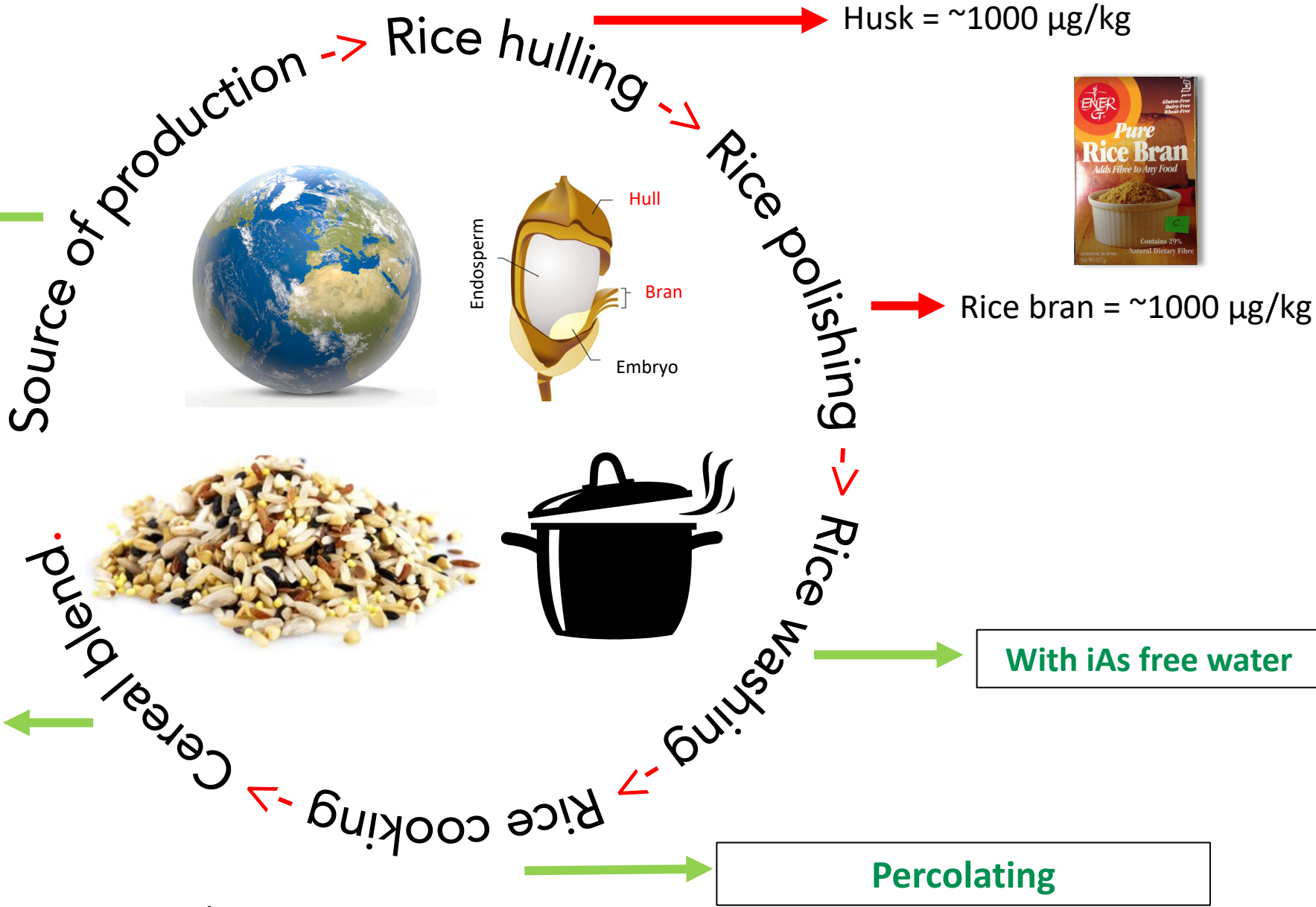
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# EXTRA SLIDES

# Reducing the inorganic arsenic burden in rice/rice products

Polished (white) rice  
Median inorganic arsenic ( $\mu\text{g}/\text{kg}$ )

Argentina	61
Bolivia	66
North Brazil	62
Central Brazil	73
South Brazil	77
Chile	60
Paraguay	107
Uruguay	67
Ghana	65
Cote d'Ivoire	49
Mali	70
<b>Malawi</b>	<b>5</b>
<b>Tanzania</b>	<b>3</b>
Egypt	48
France	114
Italy	92
Central Spain	64
South Spain	75
Turkey	78
Bali	13
China	82
Java	35
Malaysia	80
South Korea	64
Sri Lanka	36
North Vietnam	69
Mexico	91
Australia	58



Carey, 2015, 2018,, 2019; Signes-Pastor 2007, 2008ab, 2017