

# Arsenic in the Environment: Health Effects and Risk Assessment

Charles O. Abernathy, Ph.D.  
Toxicologist, Office of Water  
US EPA  
Washington, DC

The background of the slide is a close-up photograph of water with concentric ripples. The ripples are centered in the lower half of the frame, creating a circular pattern that expands outwards. The water has a light blue-green hue, and the ripples are most pronounced in the center, fading towards the edges.

Characteristics  
Sources  
Uses

# Arsenic Characteristics

- Most natural waters contain inorganic species
  - As (III) or arsenite predominant in ground waters  
 $\text{H}_3\text{AsO}_3$
  - As (V) or arsenate in surface waters  $\text{H}_2\text{AsO}_4$  &  
 $\text{HAsO}_4^{-2}$

# Natural Arsenic Levels

Crystalline Rock	Avg. 2 ppm
Soil	1-40 ppm
Ground Water	0.01 – 800 ppb As high as 40,000 in hot springs
Surface Water	2.38 – 65 ppb As high as 22,000 in river water

# Some Arsenic Uses/Anthropogenic Sources

- Smelting of metals
- Pharmaceutical industry (medicines)
- Pesticide manufacture (very limited)
- Wood preservative – CCA [in phase out]
- Cattle and sheep dips
- Feed additives
- Dye stuffs
- Petroleum, coal, and wood burning
- Semiconductor manufacture
- Waste incineration

# Toxicokinetics

The background of the slide is a close-up photograph of water with numerous concentric ripples. The ripples are most prominent in the lower half of the image, where they form a large, circular pattern. The water is a light, pale blue color, and the ripples create a textured, wavy appearance across the entire surface.

# Toxicokinetics

- Absorption
  - Soluble forms
    - Humans – 40 % to complete absorption
    - Animals – 50% to complete absorption
  - Insoluble forms
    - Limited absorption

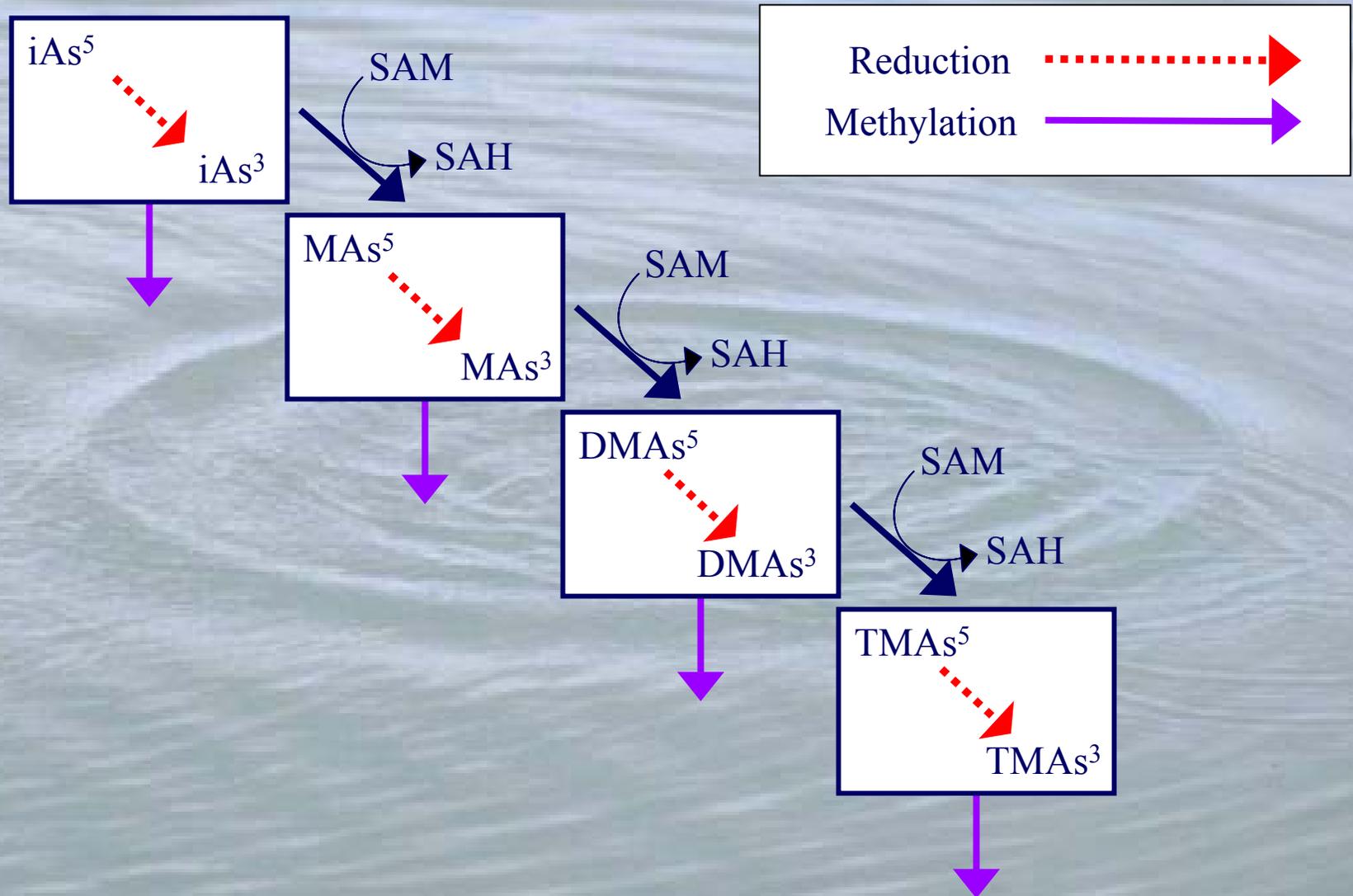
# Toxicokinetics cont.

- Distribution
  - Found in all humans – Blood conc. (1-5 ppb)
    - Smokers (2 – 10 ppb)
    - Occupational exposure (~ 10 ppb)
    - Taiwan (20 – 60 ppb)
    - Poisonings (1,000 – 2,000 ppb)

# Distribution

- Highest levels (ppb)
  - Nails (0.89)
  - Hair (0.18)
  - Bone (0.07 – 0.12)
  - Heart, kidney, liver, lung (0.03 – 0.05)

# Metabolism of Inorganic Arsenic



# Excretion

- Primarily via urine
  - 60% - 95% in 5 days
- Fecal excretion low

# Adverse Health Effects

Non-Cancer

# Acute Toxicity

<u>Animal</u>	<u>LD<sub>50</sub> (mg/kg)</u>
Rats	15 - 293
Mice	26 - 43
Guinea pigs	9
Humans	1 - 4 (approx)

# Acute Effects – Humans

(est. LD<sub>50</sub> ~ 1-4 mg/kg)

- Peripheral neuropathy
- Anemia
- Renal and liver dysfunction
- Skin pigmentation
- EKG abnormalities
- Severe GI effects

# Chronic Toxicity: Humans

## Vascular

- Taiwan
  - Blackfoot disease
- Poland
  - Vintners
  - 6 cases of gangrene
- Chile
  - Raynaud's disease

# Chronic Toxicity: Humans

- Nervous system
  - Peripheral neuropathy – legs and arms
- Cranial nerves
  - Loss of hearing in Japanese infants

The background of the slide is a close-up photograph of water with concentric ripples. The ripples are centered in the lower half of the frame, creating a circular pattern that expands outwards. The water is a light, pale blue color, and the ripples are slightly darker, creating a textured, organic feel.

# Adverse Health Effects

Cancer

# Countries Reporting Tumors After Arsenic Exposure

- Taiwan
- Mexico
- Argentina
- Chile
- China
- Mongolia
- Japan

# Cancers Associated with Exposure to Arsenic in Drinking Water

- Skin
- Bladder
- Lung
- Kidney
- Liver
- Prostate

# Lifetime Risk of Cancer (per 1000)

