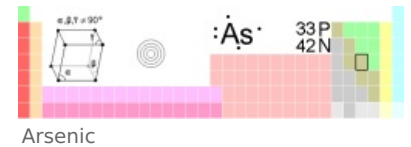


# Arsenic

Chemical symbol **As**, atomic number **33**, element in the 7th group of Mendeleev's chemical table. We do not find it in its pure form. *Metallic arsenic is not toxic*, but it is converted into toxic compounds in the body. Arsenic is part of low-quality brown coal and is formed together with arsenic oxide and other arsenic compounds during its combustion.



Arsenic is a ubiquitous metalloid found in nature in organic and inorganic forms.

The toxicity of arsenic depends on its form (inorganic vs. organic) and its oxidation state. Inorganic and organic arsenic have different bioavailability. Inorganic arsenic is significantly more toxic than organic arsenic. Inorganic arsenic is considered a carcinogen (group 1, i.e. a proven carcinogen), which increases the risk of various cancers, for example skin, bladder, lung, kidney, liver and prostate, upon long-term exposure. Its exposure also alters gastrointestinal, cardiovascular, hematological, pulmonary, neurological, immunological, and reproductive/developmental functions. The development of cancer and lung disease is described in children highly exposed to inorganic arsenic.<sup>[1]</sup>

Organic arsenic is contained in seafood and undergoes only minimal biological transformation after ingestion and is excreted almost unchanged. Conversely, inorganic arsenic is found in water in certain geographic areas and in rice and rice products. The concentration of arsenic varies depending on the soil in which the rice was grown and the type of rice. The high arsenic content of rice compared to cereals is attributed to anaerobic cultivation in flooded rice fields and the unique physiology of this plant, which allows it to take up and accumulate arsenic from the environment. The highest concentration of inorganic arsenic is in rice bran, so brown rice contains more arsenic than white rice. Rice drinks, rice crackers and cereals are made from rice grains, including bran.<sup>[1]</sup>

## Toxic effects of arsenic

### Acute poisoning

It disturbs breathing and blood vessels. **A 200 mg** oral dose kills.

- *The first symptoms of poisoning:* digestive problems, nausea, vomiting, bloody diarrhea. Inhalation causes chest pain, irritating cough and bronchitis.

Arsenic compounds are poisonous because the brain is not sufficiently supplied with blood.

### Chronic arsenic poisoning

Ingestion of a small dose of arsenic can lead to habituation. It can cause neurological disorders, blood formation disorders or skin cancer.

Chronic arsenic poisoning can be recognized on illuminated parts of the body (eg: hair, nails, liver, bones).

Arsenic compounds replace phosphates and inhibit metabolic pathways, arsenic compounds cause disruption of substrate phosphorylation in glycolysis (formation of 1-arseno-3P phosphoglycerate instead of 1,3-bisphosphoglycerate and heat generation instead of ATP).

## Treatment of poisoning

- *Antibody:* dimercaprol (2,3-disulfanyl-1-propanol)

## Properties

It consists of two modifications:

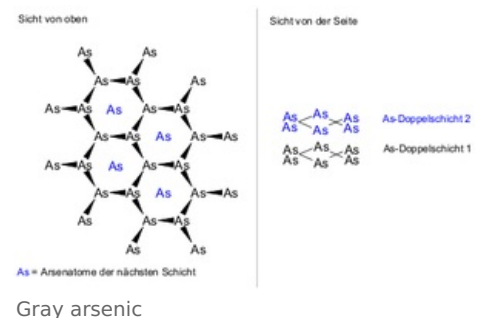
- **Gray (metallic) arsenic** is a permanent modification that can be easily ground into a powder.
- **Yellow arsenic** is produced by the rapid cooling of arsenic vapors, it is not stable, it changes to a gray modification. Easily combines with sulfur and hal elements. When ignited in air, it burns to form arsenic oxide, which forms the dimer  $\text{As}_4\text{O}_6$ .

## Production

By thermal decomposition of arsenopyrite at 700 °C:



Arsenic escapes in vapors.

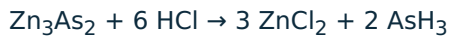


# Oxygen-free compounds

File:Gelbes arsen.png  
Yellow arsenic

**AsH<sub>3</sub>** arsen – a strongly poisonous gas smelling like garlic. When heated, it decomposes into As and H<sub>2</sub>. This is the basis of the Marsh-Liebig test for the determination of As compounds in forensic medicine.

**Arsenides** are compounds of arsenic with metals. They react with acids to form AsH<sub>3</sub>:



## Arsenic sulphides

**As<sub>2</sub>S<sub>3</sub>** – yellow precipitate, formed by the reaction of arsenites with H<sub>2</sub>S in an acidic environment:



**As<sub>2</sub>S<sub>5</sub>** – is also yellow and is created similarly:



Arsenic sulfides dissolve in Na<sub>2</sub>S and (NH<sub>4</sub>)<sub>2</sub>S<sub>x</sub>. Reactions in progress:



Trithioarsenates and tetrathioarsenates are decomposed by the action of acids:



## Oxygen compounds

As<sub>4</sub>O<sub>6</sub> **arsenic oxide** is a white powder, highly poisonous.

The fatal dose is 0.1 g. It is produced by the oxidative roasting of arsenopyrite:

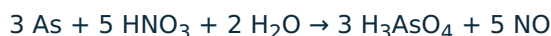


As<sub>2</sub>O<sub>5</sub> **arsenic oxide** is a white crystalline substance. It is formed by dehydration of H<sub>3</sub>AsO<sub>4</sub>:

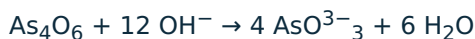


H<sub>3</sub>AsO<sub>3</sub> **trihydrogenarsenic acid** is a very weak acid that exists only in aqueous solution.

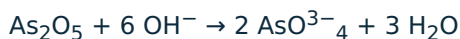
H<sub>3</sub>AsO<sub>4</sub> **trihydrogenarsenic acid** is a strong acid, it is formed by dissolving As in HNO<sub>3</sub>:



Arsenites and arsenates are formed by dissolving arsenic oxides in solutions of alkali metal hydroxides:



and



## Using

Due to the inorganic arsenic content, it is not recommended to give rice drinks to small children.<sup>[1]</sup>

Arsenic compounds are used in medicine and in agriculture as pesticides. Some arsenides are important in electrical engineering.

In **the past**, arsenic was used **in dentistry to sedate the pulp**, e.g. in the therapy of acute pulpitis and also as an organoarsenic combat agent.

## Links

## References

- ŠRÁMEK, Vratislav. *Chemie obecná a anorganická*. 2. edition. Nakladatelství Olomouc, 2005. ISBN 80-7182-099-7.
  - MATOUŠ, Bohuslav. *Základy lékařské chemie a biochemie*. 1. edition. Galén, 2010. ISBN 978-80-7262-702-8.
1. HOJSAK, Iva – BRAEGGER, Christian – BRONSKY, Jiri. Arsenic in rice: a cause for concern. *J Pediatr Gastroenterol Nutr* [online]. 2015, vol. 60, no. 1, p. 142-5, Available from <<https://doi.org/10.1097/MPG.0000000000000502>>. ISSN 0277-2116 (print), 1536-4801.