Heavy Metals in Food Commodities

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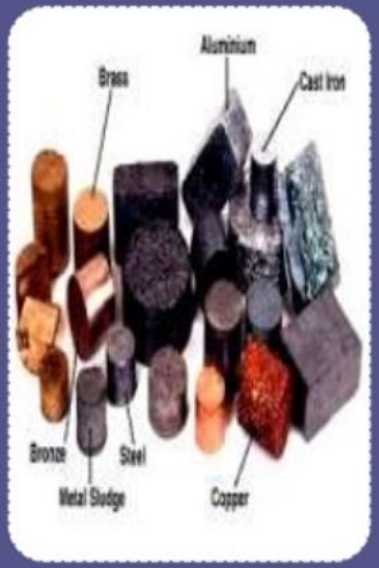
Definition



Heavy metal

- Refers to any metallic chemical element that has a high specific gravity and high relative atomic mass.

- relatively high density and is toxic or poisonous at low concentrations.
- specific gravity of 5.0 g/cm3 or greater
- Big Five" heavy metals (i.e., As, Cr, Cd, Hg & Pb)

Lead

Atomic Number 82

Atomic weight 207.19

Specific gravity 11.34

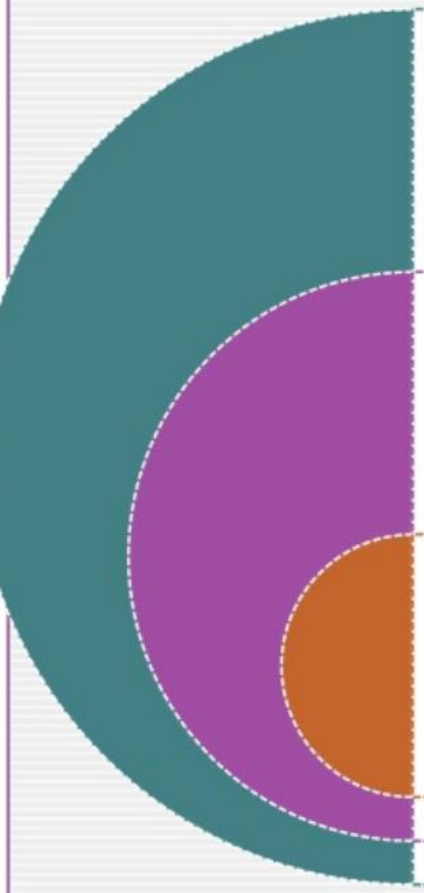
Melting point 327.5 ° C

Boiling point 1740 ° C

Bluish-grey metal

- Cd, Cr and Pb are natural components of the earth's crust and are typically present in our environment at various concentration levels.
- They enter the human body via food, drink and air.
- Some of these heavy metals, the so-called trace elements such as Cr, Fe, Co, Cu, Mn, Zn and Sn are in low concentrations essential to the human body, as they are important for the metabolism.
- At higher concentrations however, they are toxic and harmful to humans.

Metals

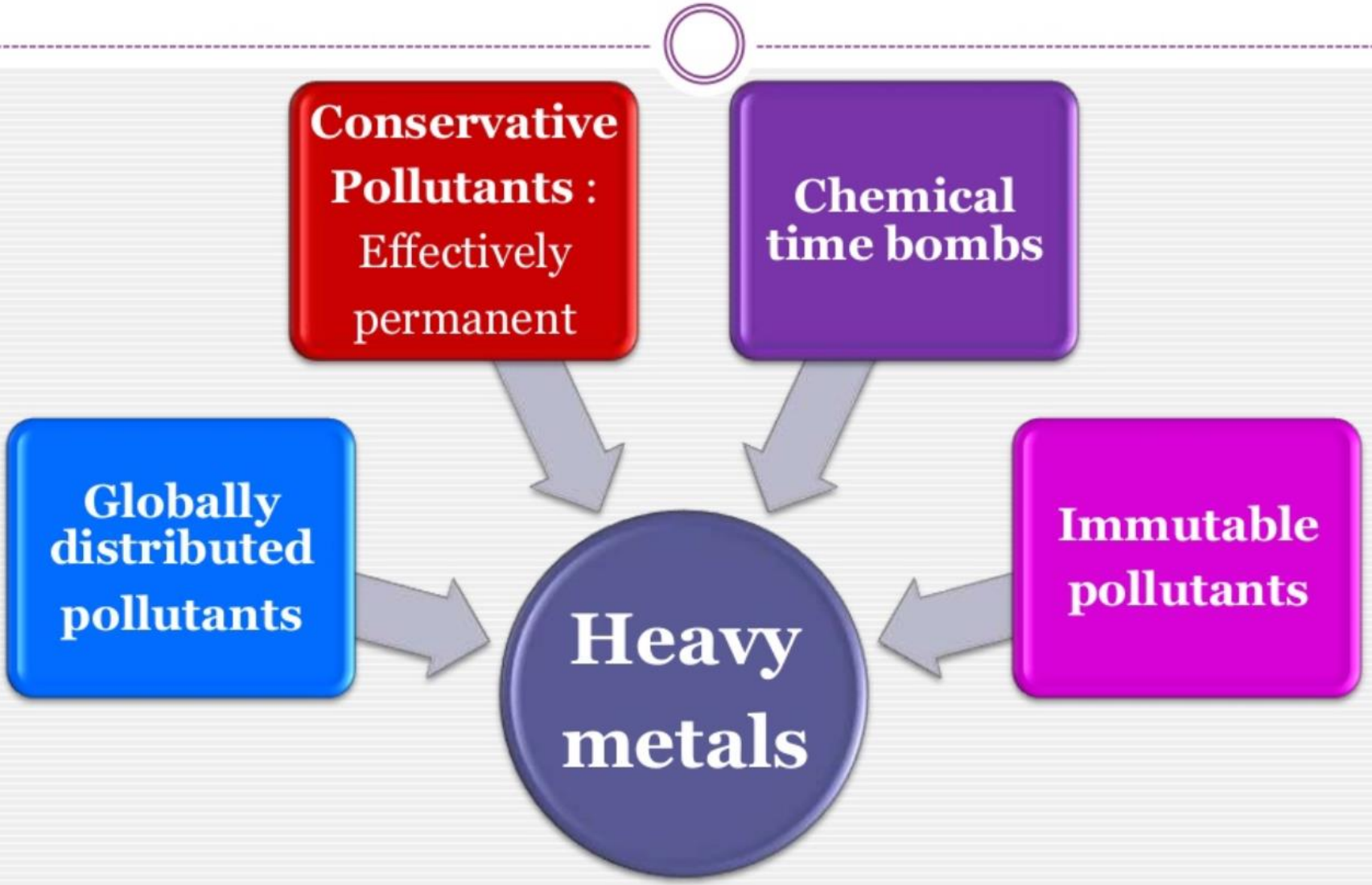


Essential	• Iron, zinc, copper, chromium, cobalt • Molybdenum, selenium
beneficial	• Silicon, manganese • Nickel, boron, vanadium
Detrimental	• Mercury,cadmium, • lead • Arsenic, chromium

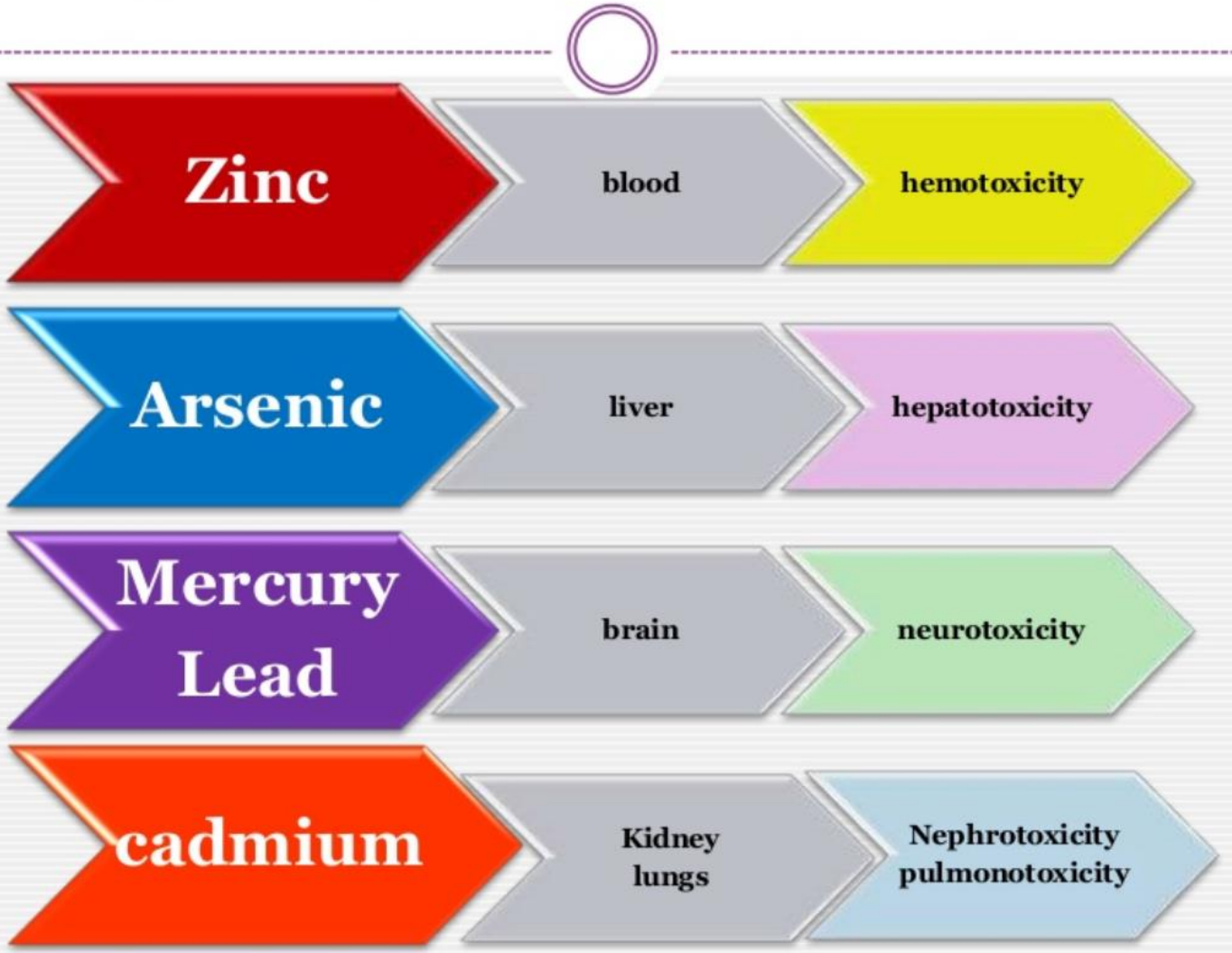
Heavy metals

Macro-nutrient elements	• cobalt (Co), copper (Cu) • zinc (Zn) and iron (Fe).
Micronutrient elements	• copper (Cu), nickel (Ni), • chromium (Cr) and iron (Fe)
Highly toxic elements	• cadmium (Cd), lead (Pb), • silver (Ag) and mercury (Hg)
Precious elements	• platinum, silver and gold

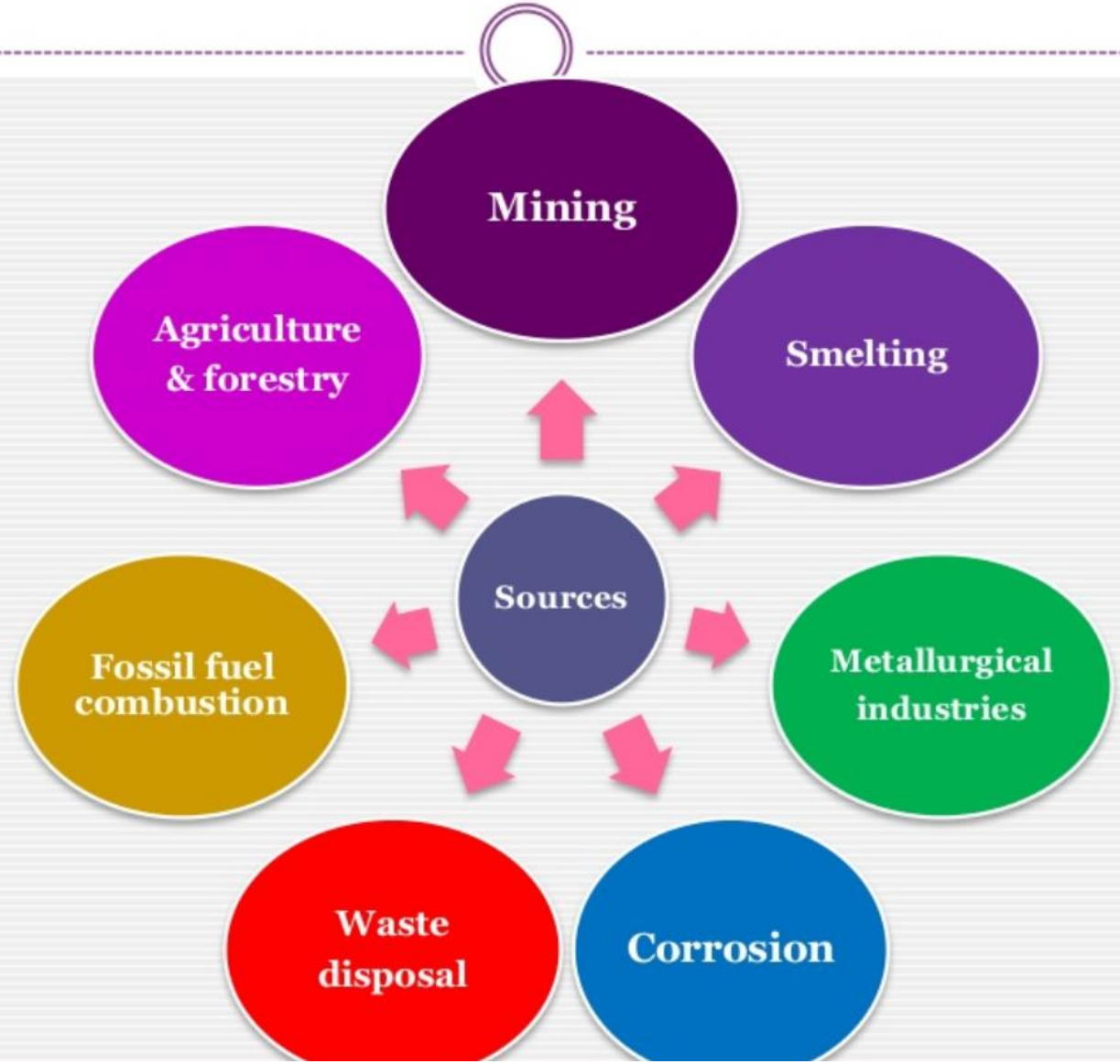
Distinguishing properties of metals



Target organ toxicity of metals



Sources of heavy metal pollutants



HEAVY METALS

CHARGE: NEUROTOXIC EFFECTS

televisions

paints

costume jewelry

ceramics

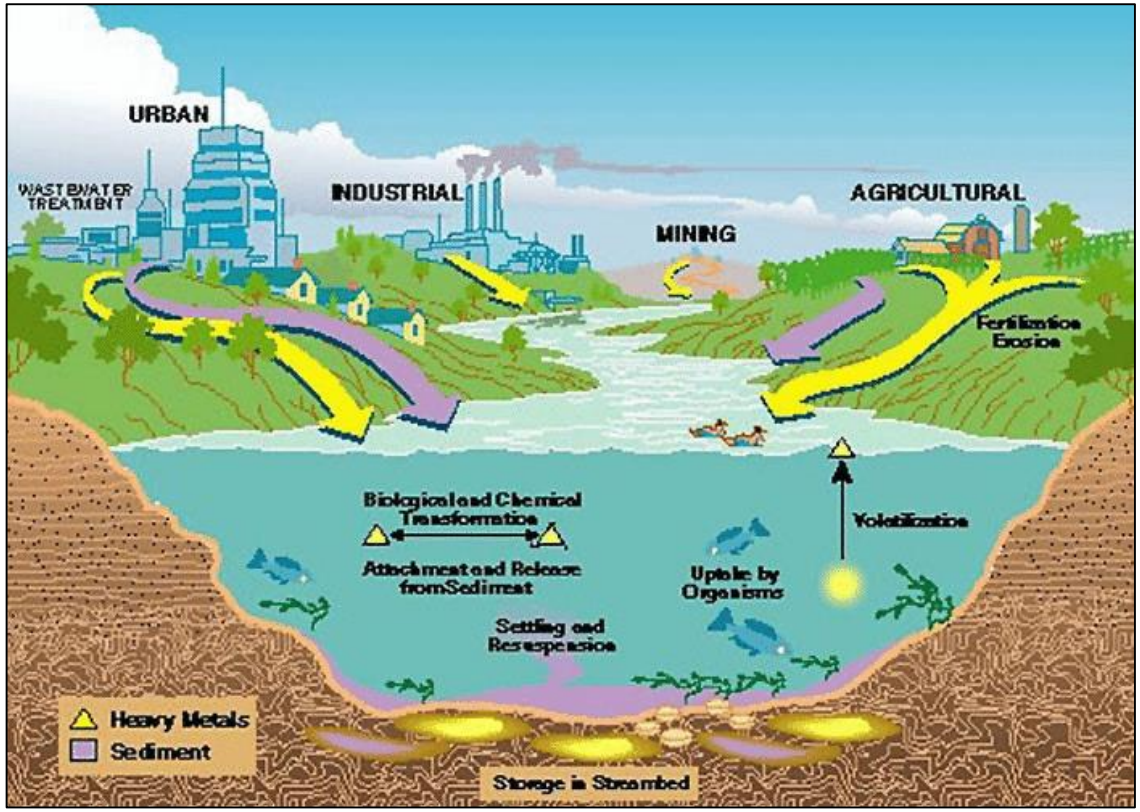
electronics

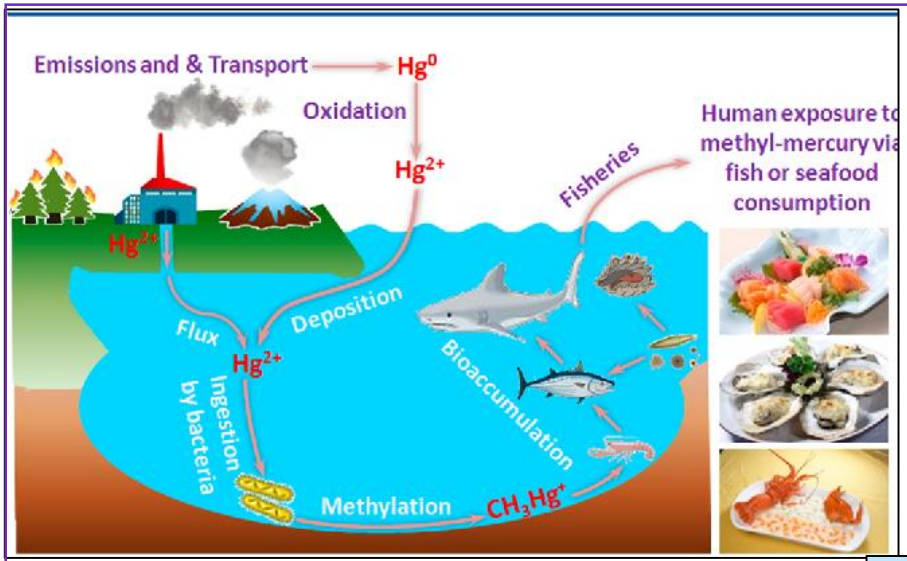
batteries

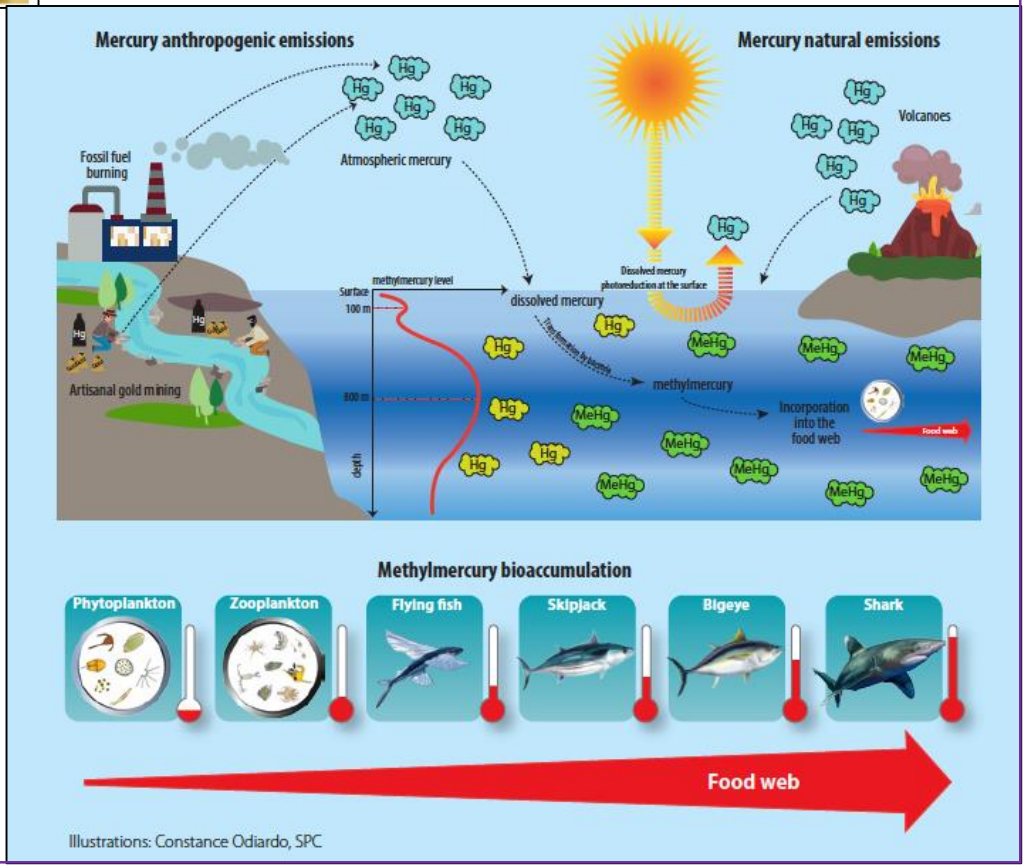
lipstick

Photos: Alan_D, Windell Oskay, Garry Wilmore, Robert Parviainen _Frankenstein_, Klara Kim, mbettik,


SOURCES FOR
HEAVY METALS
IN YOUR
KITCHEN
Calcium Pills: Lead
Cacao Powder: Cadmium
Coffee: Cadmium
Herbal Supplements: Lead
Fish: Mercury
Rice Grain: Arsenic
Baking Powder: Aluminum
Dog Treats: Lead
Tea Bags: Lead
Grass Juice Powders: Lead
Rice Protein: Lead, Cadmium and Tungsten
Sea Vegetables: Lead and cadmium
Cabinet Handles: Lead and Nickel (in brass)
Flatware: Lead and Cadmium
Tap Water: Lead and Copper
Cooking Pans: Aluminum
Cooking Spices: Lead
Clams: Lead
Fluorescent Lights: Mercury
Learn more at www.NaturalNews.com and see more heavy metals product testing results at:

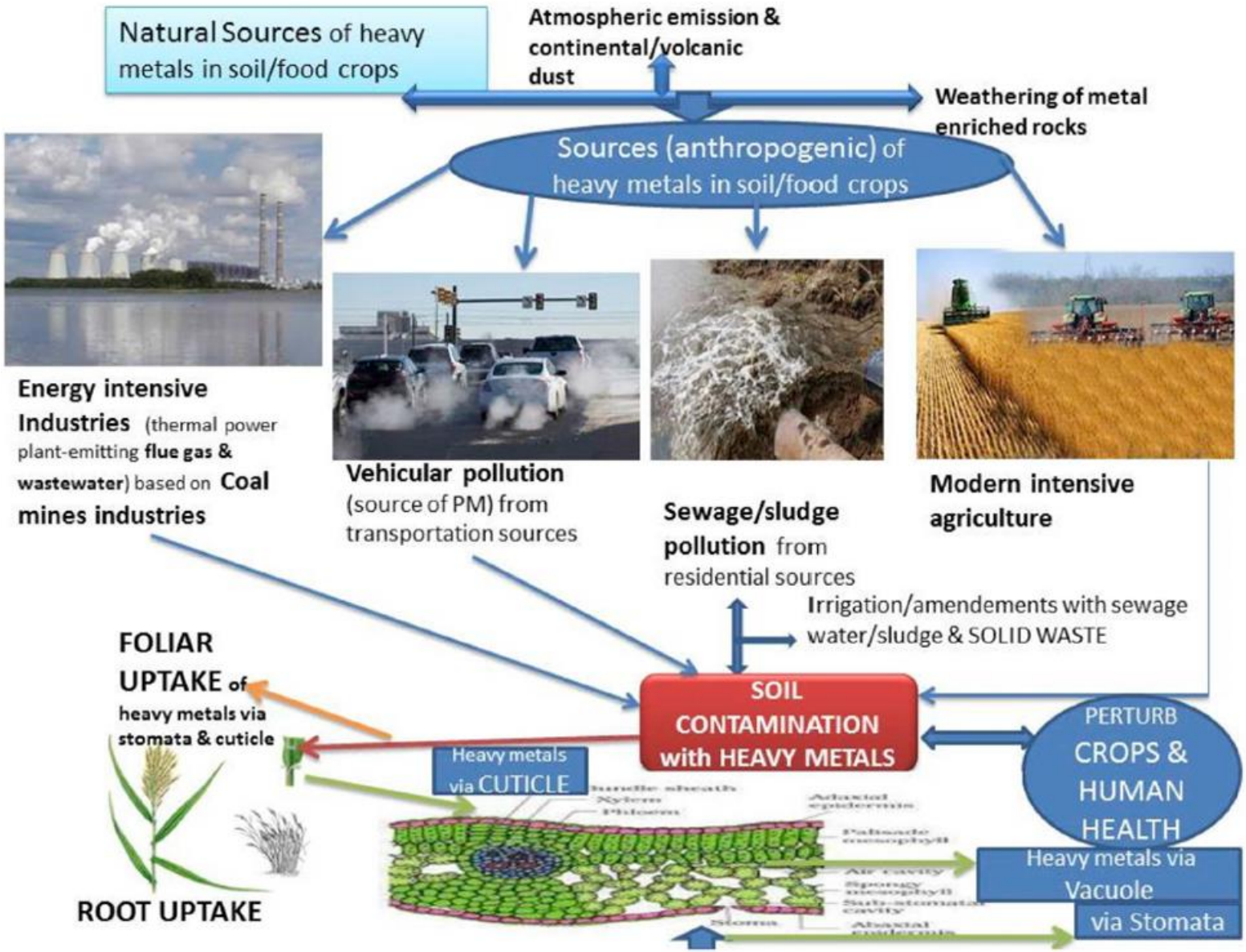

URBAN
WASTEWATER TREATMENT
INDUSTRIAL
MINING
AGRICULTURAL
Fertilization
Erosion
Biological and Chemical Transformation
Attachment and Release from Sediment
Uptake by Organisms
Volatilization
Settling and Resuspension
Heavy Metals
Sediment
Storage in Streambed



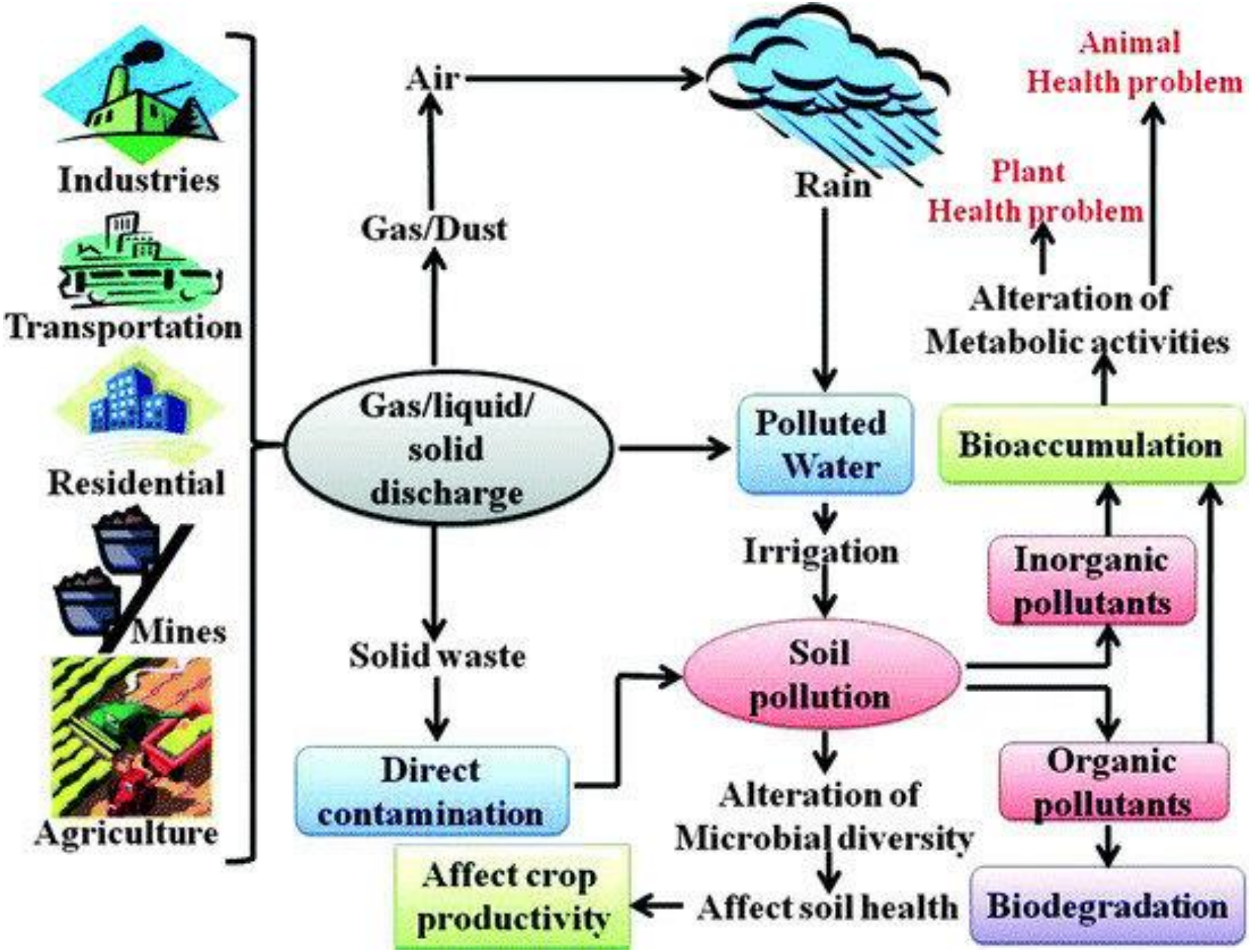


Illustrations: Constance Odiardo, SPC

Pathway of metal transfer from food production to human consumption



Mechanisms of entrance for heavy metals in food crops


Industries
Transportation
Residential
Mines
Agriculture
Air
Gas/Dust
Rain
Gas/liquid/
solid
discharge
Solid waste
Direct
contamination
Affect crop
productivity
Polluted
Water
Irrigation
Soil
pollution
Alteration of
Microbial diversity
Affect soil health
Animal
Health problem
Plant
Health problem
Alteration of
Metabolic activities
Bioaccumulation
Inorganic
pollutants
Organic
pollutants
Biodegradation

Toxicological properties of heavy metals

Persistence-long residual and half life

Soil residence time ->1000 years

Acute Toxicity- plants, animals, microorganisms

Bioaccumulation and biomagnification- thro' food chain

Chronic and sub-lethal effects at low conc.

Synergistic effects

Teratogenic and carcinogenic properties

Fate of heavy metals

Anthropogenic and Industrial activities

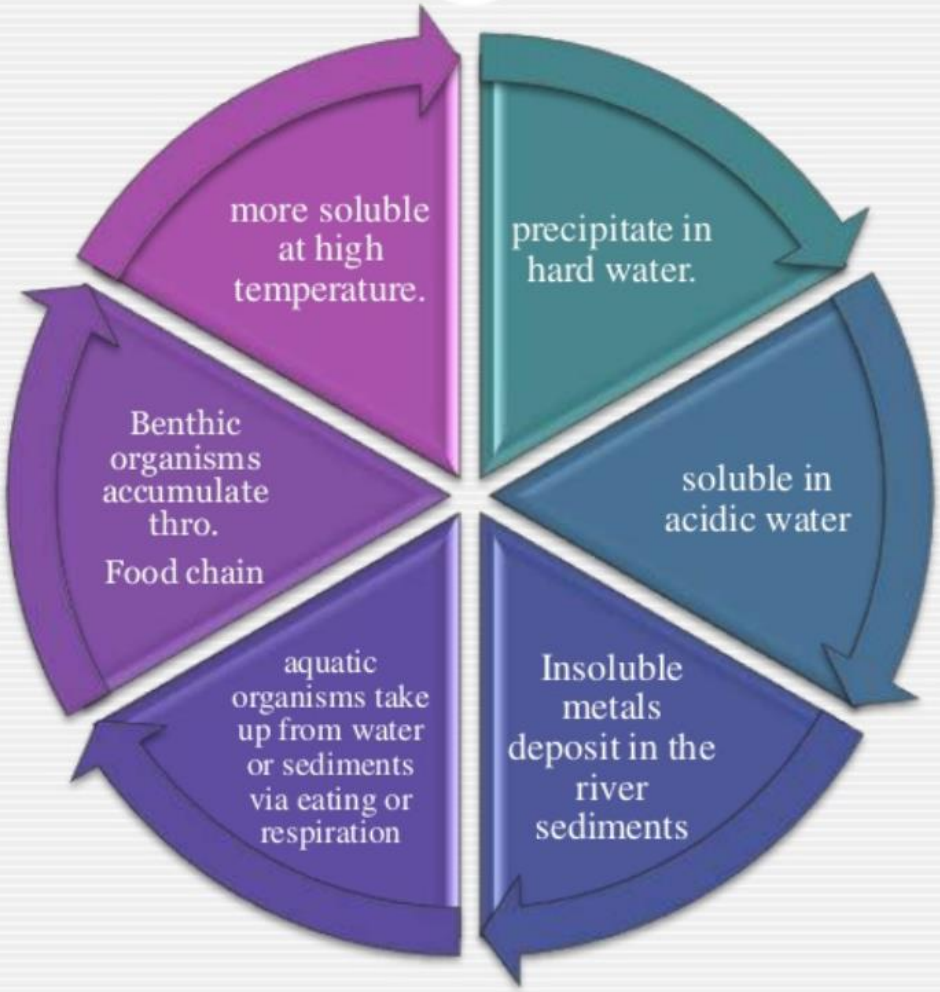
Waste metal pollutants
(Volatilization, Leaching)

Environment-
ecological effects

Human system-
exposure via food intake, water consumption, ingestion, dermal contact, inhalation.

Human health effects

Fate of metals in aquatic environment



Heavy metals

The Daily Star

Tuesday, September 17, 2019

YOUR RIGHT TO KNOW

12:00 AM, July 24, 2010 / LAST MODIFIED: 12:00 AM, July 24, 2010

Toxic poult

Tannery waste used in producing

Helemul Alam

The use of tannery waste in pou
hazardous waste has the possib

Tuesday, September 17, 2019

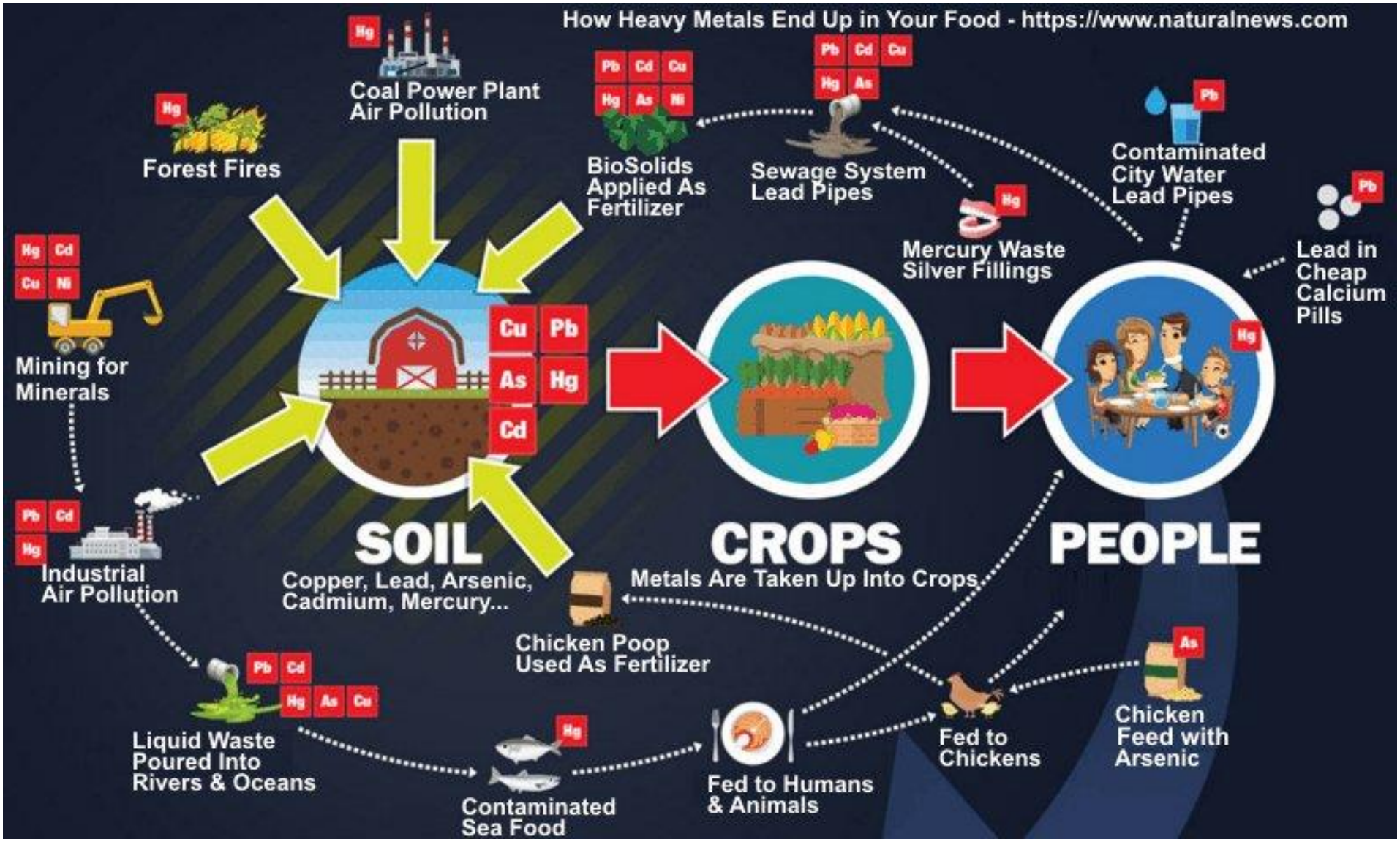
NEWAGE Opinion

Govt must stop use of tannery waste in poultry feed

Published: 00:05, Feb 03,2018 | Updated: 01:41, Feb 03,2018

IT IS alarming that the use of toxic tannery wastes containing heavy metals such as chromium and cadmium as poultry and fish feed is growing, with the government taking no action to enforce the ban on the practice. Green activists, as New Age reported on Thursday, expressed concern about the practice at a discussion hosted by Bangladesh


Arsenic Lead
Does your Rice have loads of.....
heavy metals
EARTH'S BEST
ORGANIC
WHOLE GRAIN
RICE CEREAL
GLUTEN FREE
BROWN RICE FARINA
HOT CEREAL
Brown Rice
Flour
Rice
ORIGINAL
BROWN RICE
PASTA
Barefood
Angel


How Heavy Metals End Up in Your Food - https://www.naturalnews.com
Coal Power Plant Air Pollution
Forest Fires
BioSolids Applied As Fertilizer
Sewage System Lead Pipes
Contaminated City Water Lead Pipes
Mercury Waste Silver Fillings
Lead in Cheap Calcium Pills
Mining for Minerals
Industrial Air Pollution
SOIL
Copper, Lead, Arsenic, Cadmium, Mercury...
CROPS
Metals Are Taken Up Into Crops
PEOPLE
Chicken Poop Used As Fertilizer
Liquid Waste Poured Into Rivers & Oceans
Contaminated Sea Food
Fed to Humans & Animals
Fed to Chickens
Chicken Feed with Arsenic

Toxic diseases of heavy metals

Aluminium has been associated with Alzheimer's and Parkinson's disease, senility, and presenile dementia.

Arsenic exposure can cause cancer, abdominal pain, and black foot disease.

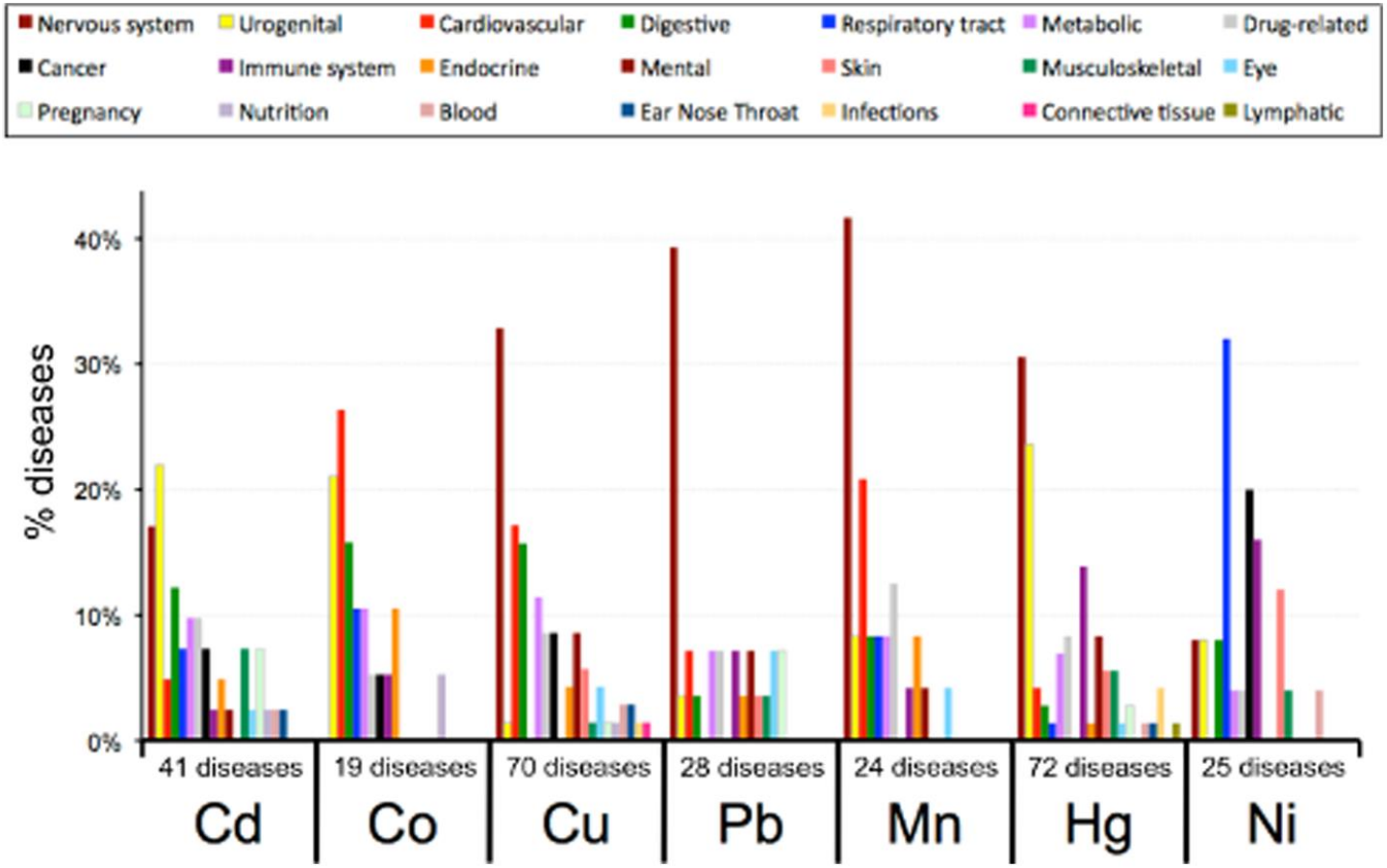
Cadmium exposure produces kidney damage and hypertension

Lead and mercury may cause joint diseases and ailments of the kidneys, circulatory system, and nervous system

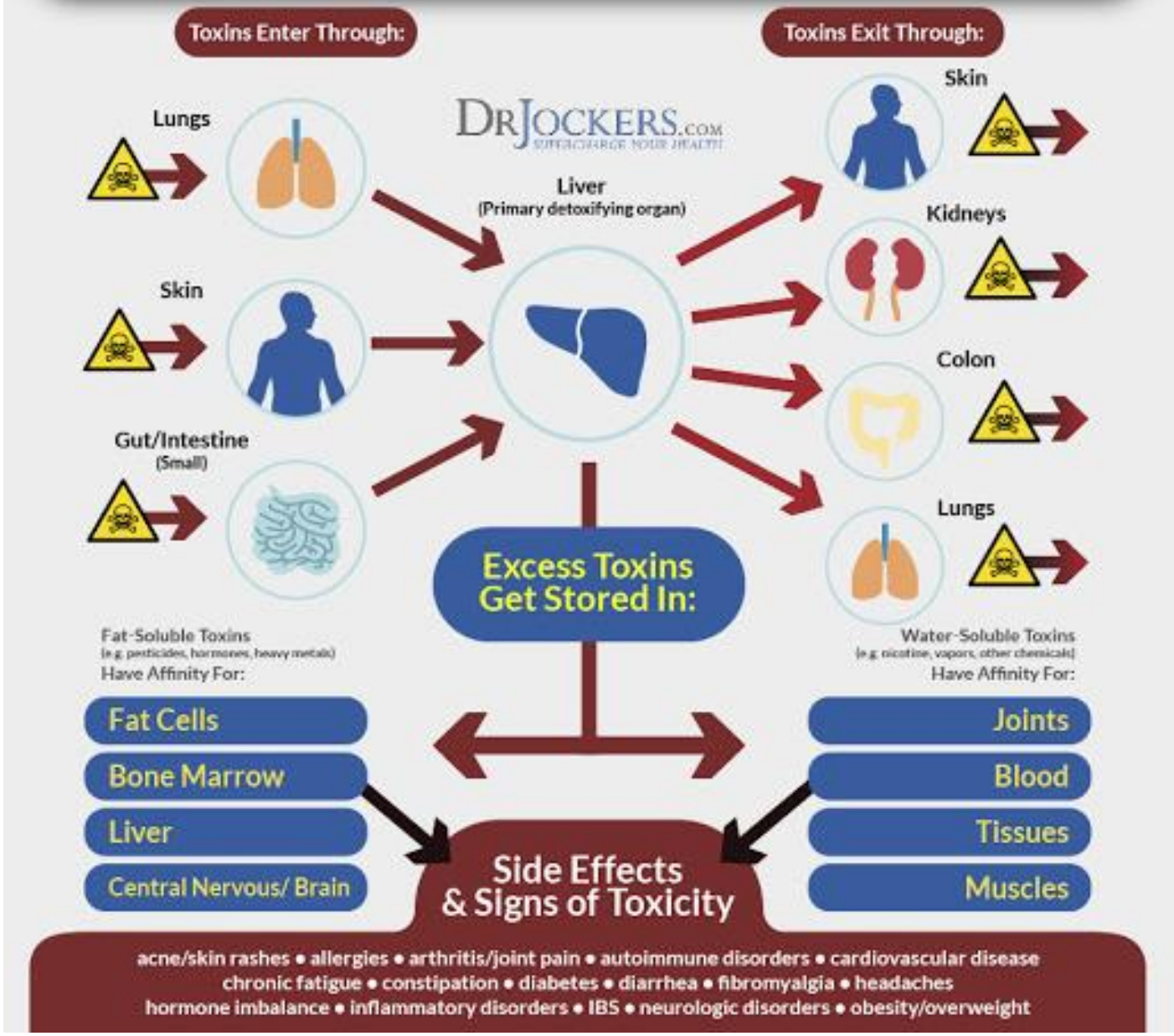
Nickel can cause damage to lung, liver and kidney.

Chromium can cause lung damage and cancer.

Element	Acute exposure *usually a day or less*	Chronic exposure *often months or years*
Cadmium	Pneumonitis (lung inflammation)	Lung cancer Osteomalacia (softening of bones) Proteinuria (excess protein in urine; possible kidney damage)
Mercury	Diarrhea Fever Vomiting	Stomatitis (inflammation of gums and mouth) Nausea Nephrotic syndrome (nonspecific kidney disorder) Neurasthenia (neurotic disorder) Parageusia (metallic taste) Pink Disease (pain and pink discoloration of hands and feet) Tremor
Lead	Encephalopathy (brain dysfunction) Nausea Vomiting	Anemia Encephalopathy Foot drop/wrist drop (palsy) Nephropathy (kidney disease)
Chromium	Gastrointestinal hemorrhage (bleeding) Hemolysis (red blood cell destruction) Acute renal failure	Pulmonary fibrosis (lung scarring) Lung cancer
Arsenic	Nausea Vomiting Diarrhea Encephalopathy Multi-organ effects Arrhythmia Painful neuropathy	Diabetes Hypopigmentation/Hyperkeratosis Cancer


Nervous system
Urogenital
Cardiovascular
Digestive
Respiratory tract
Metabolic
Drug-related
Cancer
Immune system
Endocrine
Mental
Skin
Musculoskeletal
Eye
Pregnancy
Nutrition
Blood
Ear Nose Throat
Infections
Connective tissue
Lymphatic
% diseases
40%
30%
20%
10%
0%
41 diseases
Cd
19 diseases
Co
70 diseases
Cu
28 diseases
Pb
24 diseases
Mn
72 diseases
Hg
25 diseases
Ni

The Process of Detoxification and Elimination



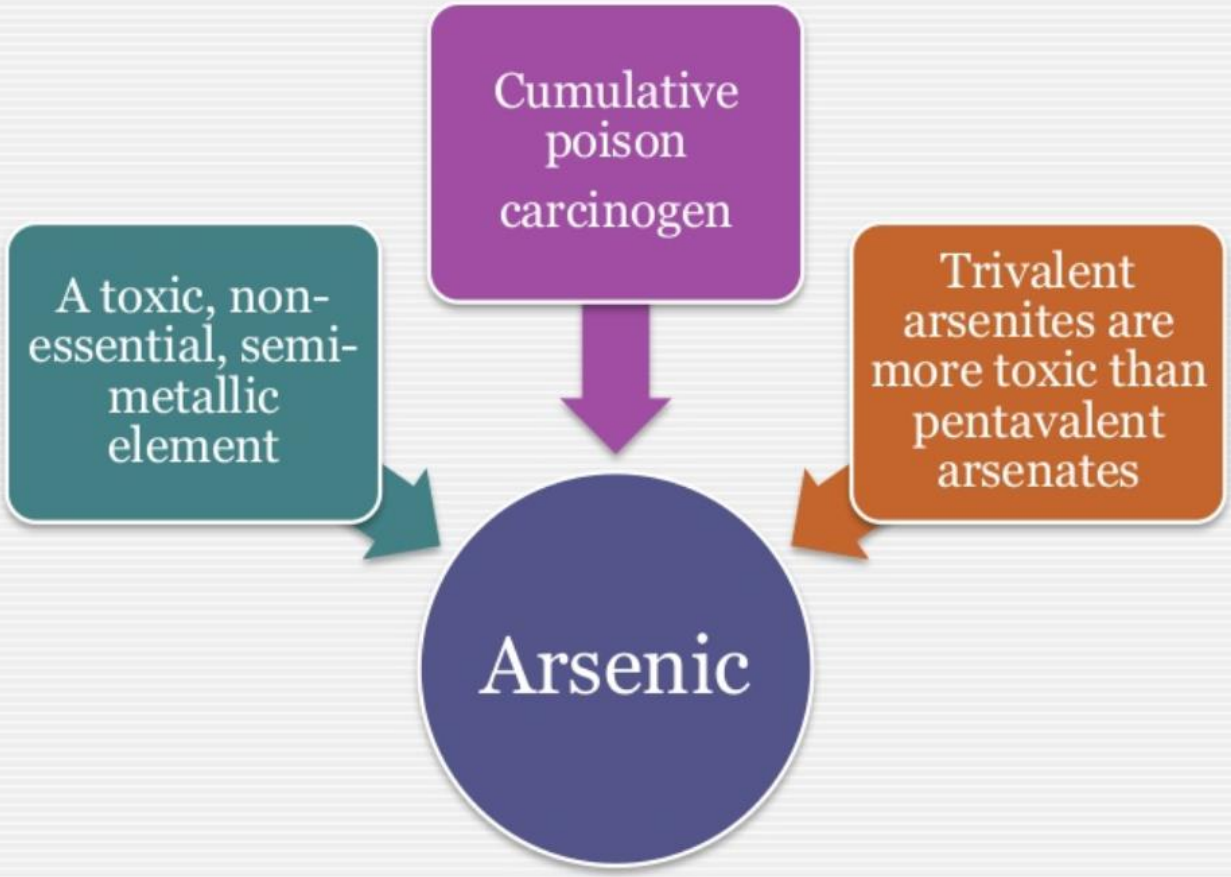
Arsenic(As)

Melanosis on palms (Adapted from Islam and Islam, 2010).

Keratosis on soles (Adapted from Smith et 2000).

Spotted Keratosis on palm (Adapted from Mandal et al., 1998)

Arsenic contamination



Arsenic Toxicity to human body

- The twentieth most abundant element on earth
- Semi metallic property
- Prominently toxic and carcinogenic
- Extensively available in the form of oxides or sulfides or as a salt of iron, sodium, calcium, copper, etc.
- Cardiovascular problems
- Highly carcinogenic and can cause cancer of lungs, liver, bladder and skin.
- Drinking water may get contaminated by use of arsenical pesticides, natural mineral deposits or inappropriate disposal of arsenical chemicals
- FAO/WHO guideline of As in food:

Food/Product	As Level (mg/Kg)
Edible fats and oils	0.1
Natural mineral water	0.01
Salt, food grade	0.5

Sources of Arsenic contamination

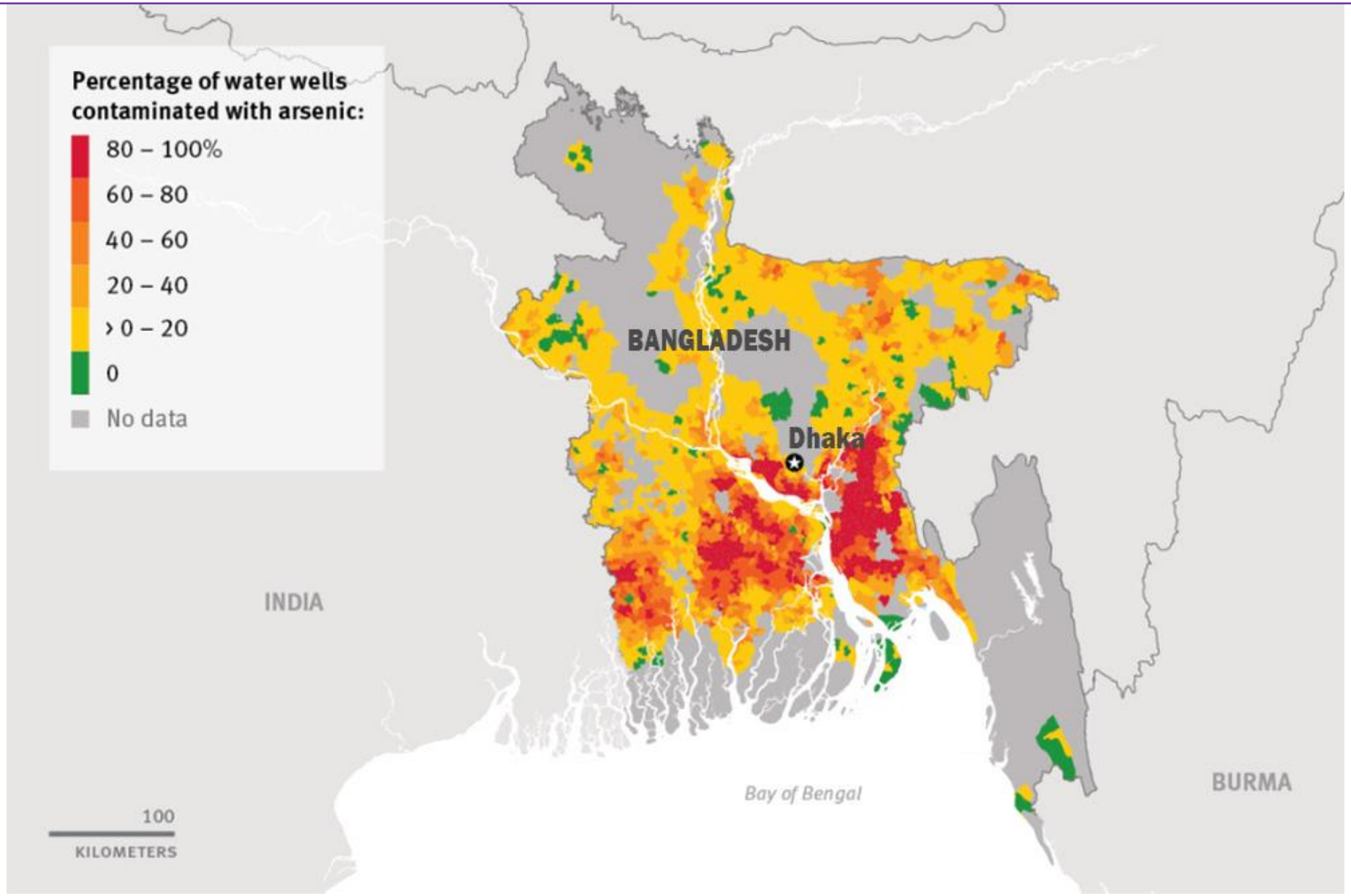
- Pesticides, herbicides
- Combustion of coal
- Mining, smelting of gold, lead, copper and nickel
- Production of iron and steel
- Leachate from abandoned gold mines
- A wood preservative
- Tobacco smoke

Arsenic threat in Bangladesh

Mounting evidence suggests that high levels of arsenic in water used to grow crops could degrade soils, reduce yields – and find its way into food...

Little research has been done on arsenic behaviour in the flooded plant-soil systems typical of rice production

Arsenic contamination of groundwater in Bangladesh threatens the health of up to 30 million people. The problem originates in arsenic-rich bedrock of the Brahmaputra river basin that filters drinking water pumped to the surface through millions of tubewells. Levels of arsenic in drinking water are so high that WHO describes arsenic contamination of Bangladesh's water supply as "the largest poisoning of a population in history".

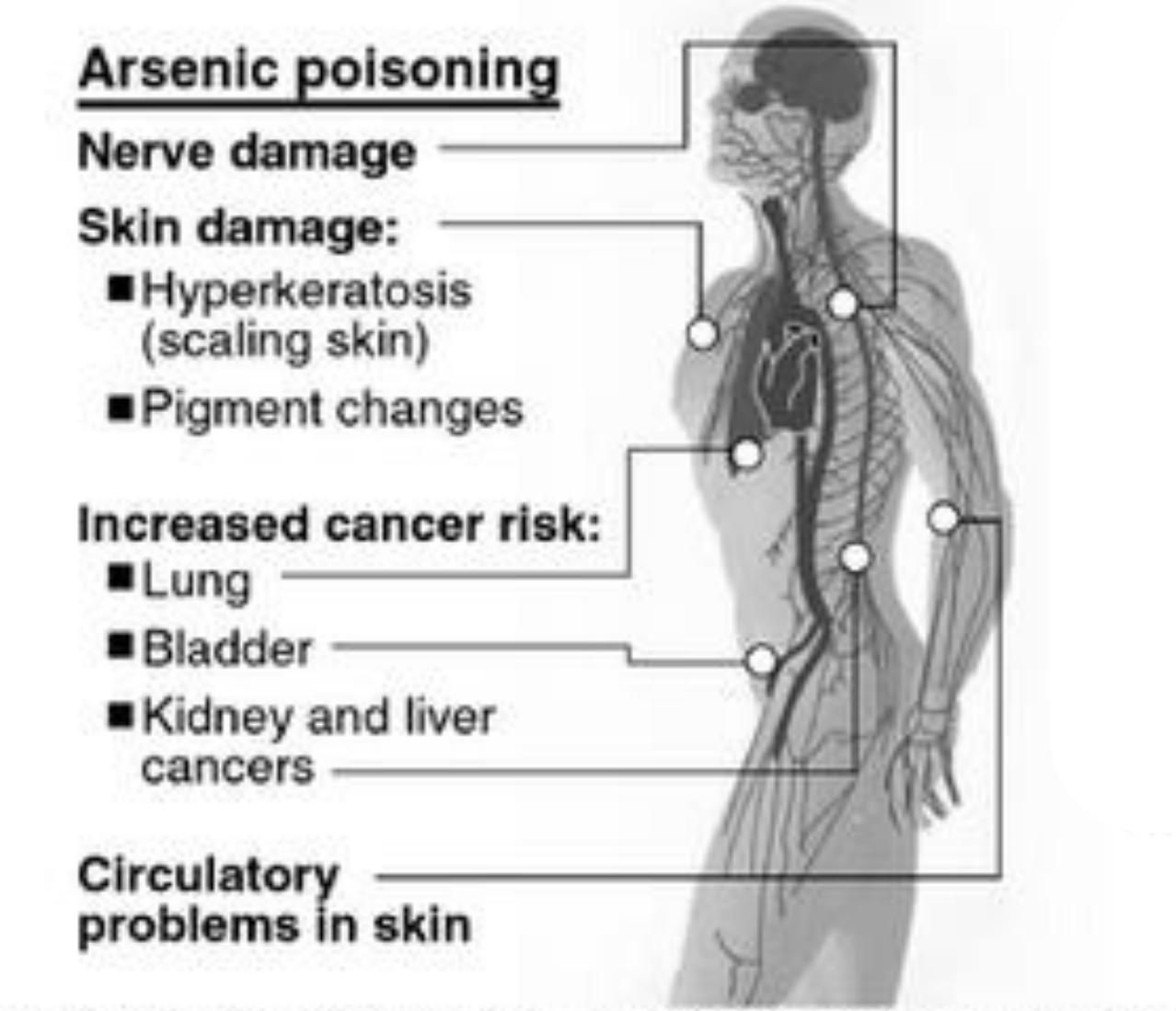


The Bangladeshi government has largely downplayed the problem. The government has still not adjusted its arsenic safety level to meet the decades-old WHO standard. *Visual: Human Rights Watch*

Human health effects

- Birth defects
- Carcinogen: Lung cancer, Skin and liver cancer, cancers of the bladder and kidneys
- Gastrointestinal damage
- Severe vomiting
- Diarrhea
- Death

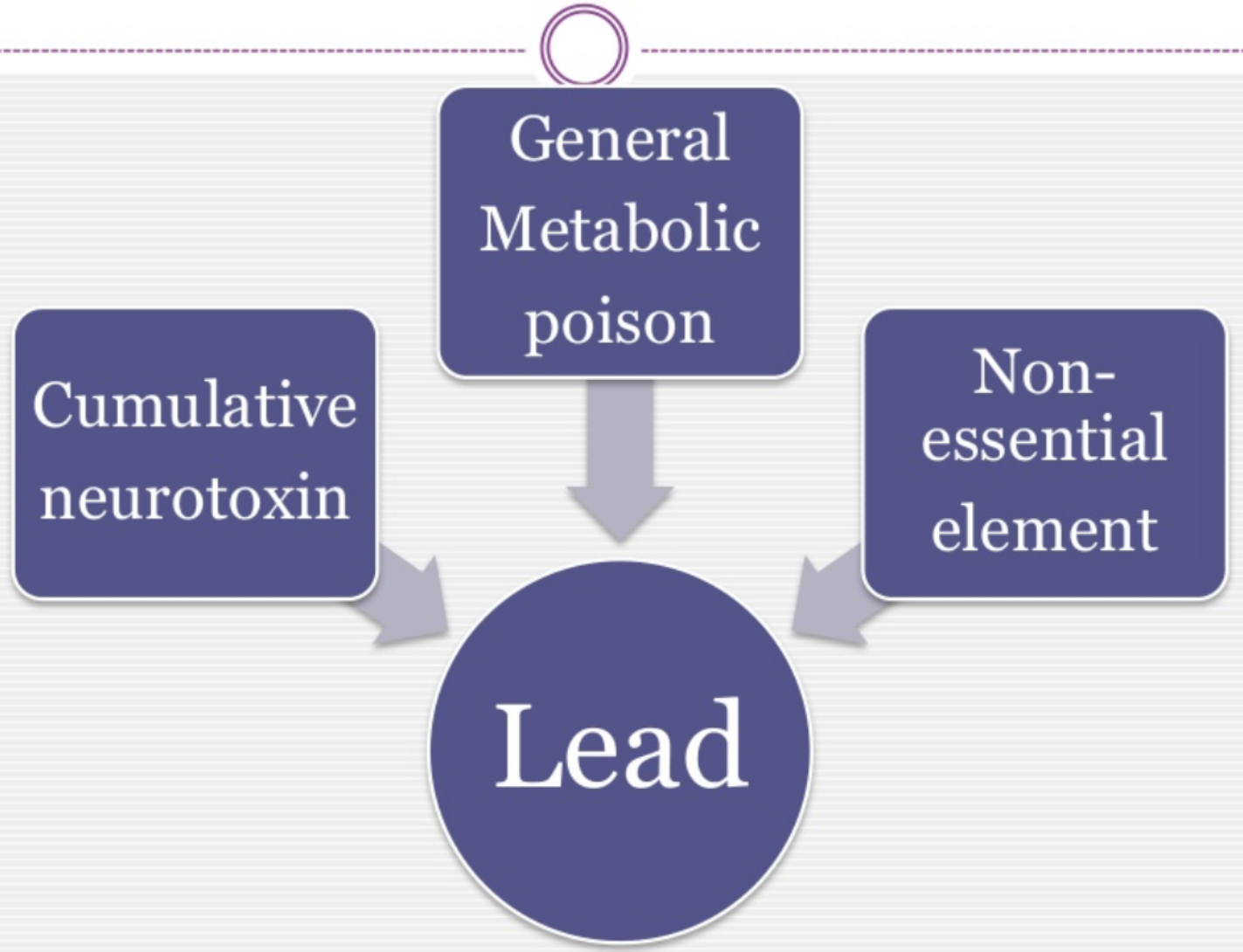
Dangers of lead and arsenic poisoning



Sources: Alliance to End Childhood Lead Poisoning and news wires

Lead(Pb)

Lead contamination



Lead

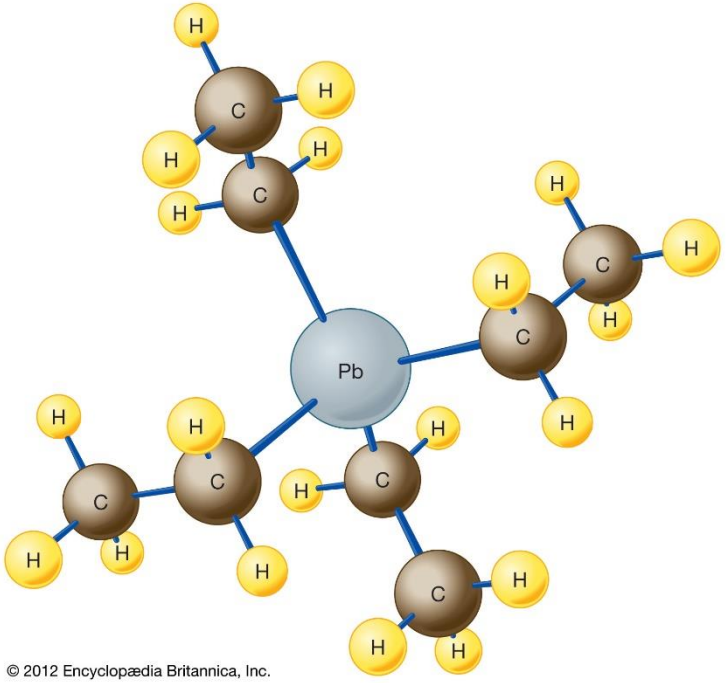
•Highly toxic metal
•It begins to tarnish on contact with air, thereby forming a complex mixture of compounds
•The half-life of Pb is 27 years in cortical bone and 16 years in cancellous bone (vertebral **bones** in the spine)

•FAO/WHO guideline of Pb in food:

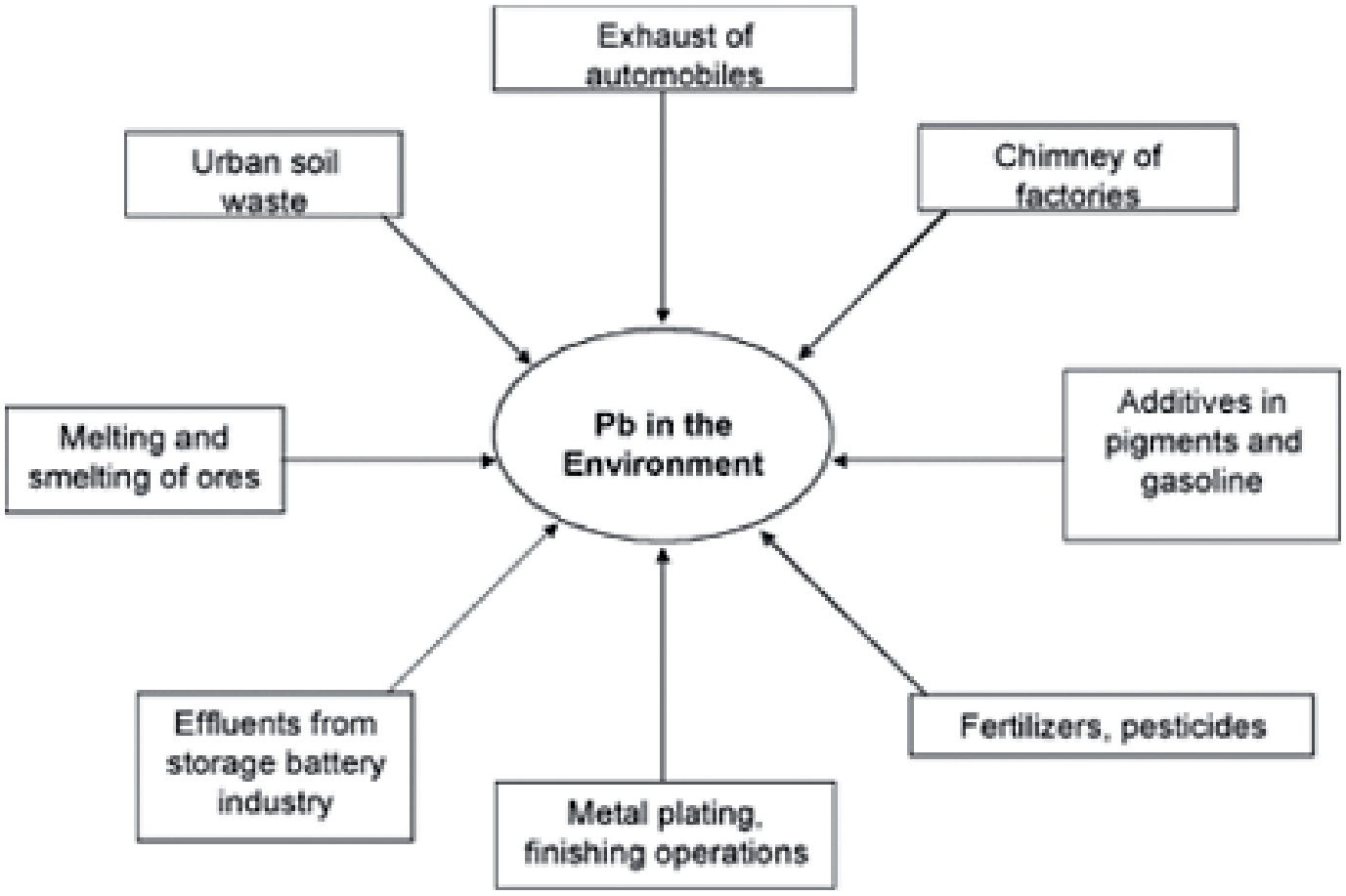
Food/Product	Pb Level (mg/Kg)
Natural mineral water	0.01
Salt, food grade	2
vegetables	0.1 ~ 0.3
Potato, Pulses, Cereal grains	0.2
Infant formula	0.02
Milk and milk products	0.02
Fish	0.3
Meat and poultry meat	0.1
Fruits	0.1
Vegetable oil	0.1

- Foods such as fruit, vegetables, meats, grains, seafood, soft drinks and wine may contain significant amounts of lead
- Cigarette smoke also contains small amounts of lead

Tetraethyl lead is one of the most significant heavy metal contaminants in recent use.



Sources of lead contamination

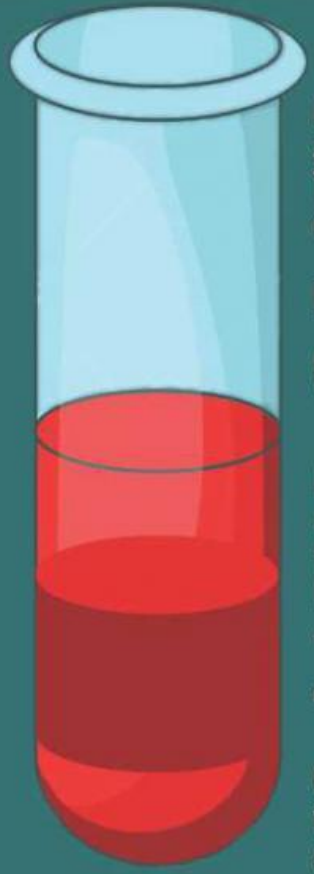


TheScientist
EXPLORING LIFE, INSPIRING INNOVATION

Yellow Dye in Turmeric Linked with Lead Poisoning in Bangladesh

Scientists track the spice from the soil to the market to pinpoint the source of contamination in pregnant women's blood.

DO WE HAVE A PROBLEM?



In 2009, 99% of pre-school and school age children in Tongi had elevated levels of lead in blood.

Highest reading was

64 µg/dL.

In 1999, children from high risk areas within Dhaka were found to have blood lead levels as high as

22.4µg/dL

Cut-off is 5 µg/dL, according to Centers of Disease Control and Prevention.

A 2016 study showed chromium intake via milk.

Amounts in adults:

0.413 mg/day

In children, the value is higher.

Permissible value: 0.2 MG/DAY (adults)

An abdundance of studies over the years show unsafe levels of lead and chromium in milk, eggs, vegetables, poultry and fish.

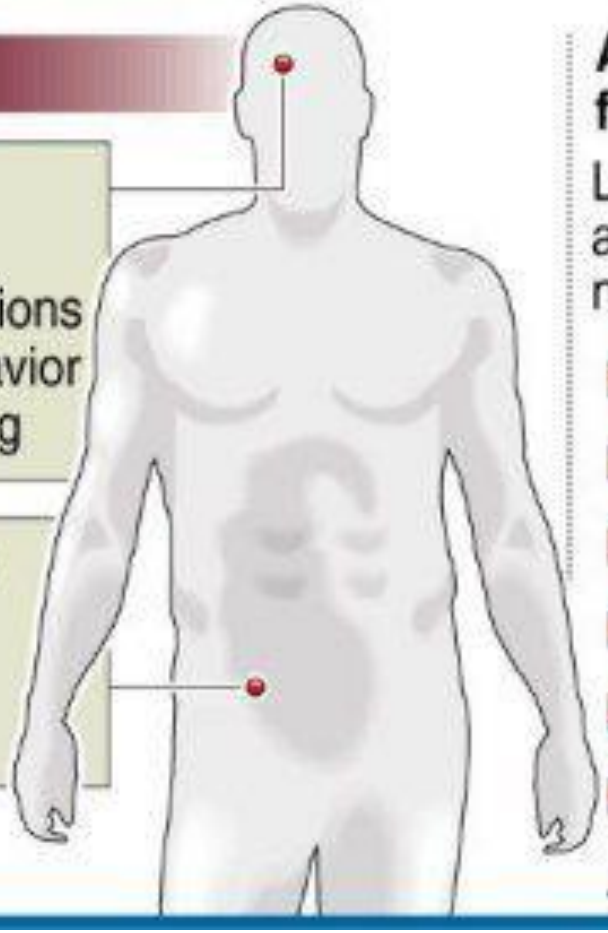
In 2015, PRAN's license for turmeric powder was suspended for unsafe lead levels.

SOURCE: International Journal of Environmental Research and Public Health. For others, see article.

INFOGRAPHIC: SHAER REAZ

Lead poisoning

Lead buildup in the body causes serious health problems



Symptoms

- Headaches
- Irritability
- Reduced sensations
- Aggressive behavior
- Difficulty sleeping

- Abdominal pain
- Poor appetite
- Constipation
- Anemia

Additional complications for children:

Lead is more harmful to children as it can affect developing nerves and brains

- Loss of developmental skills
- Behavior, attention problems
- Hearing loss
- Kidney damage
- Reduced IQ
- Slowed body growth

AFP

Source: MedlinePlus/Mayo Clinic

Mercury(Hg)

Mercury:

- Very toxic and
- Exceedingly bio accumulative
- Mercury exists mainly in three forms: metallic elements, inorganic salts and organic compounds, each of which possesses different toxicity and bioavailability.
- The half-life of Hg is about 70–80 days

Mercury is the only common metal which is liquid at ordinary temperatures.
It rarely occurs free in nature and is found mainly in cinnabar ore (HgS) in Spain and Italy.

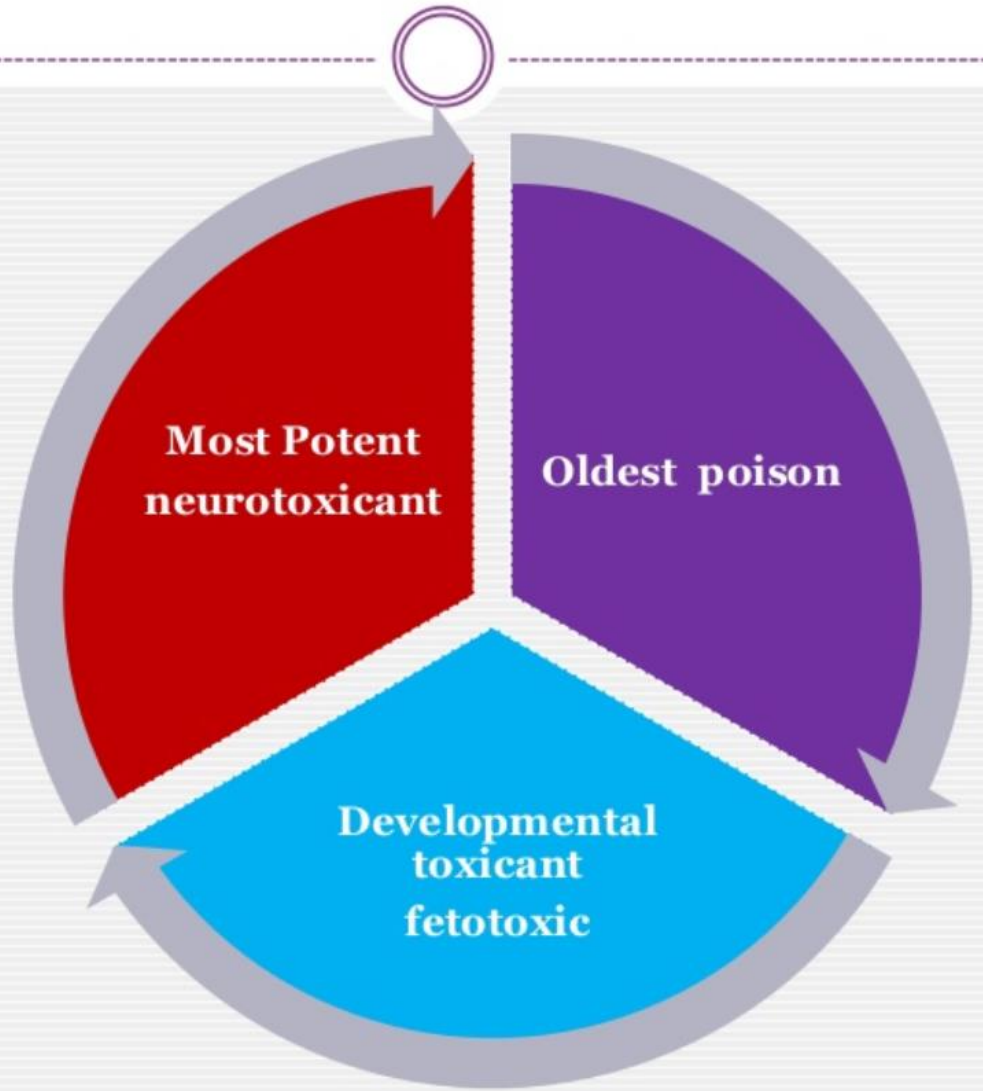
FAO/WHO guideline of Hg in food:

Food/Product	Hg Level (mg/Kg)
Natural mineral water	0.001
Salt, food grade	0.1
Fish	0.5

Mercury contamination

- All forms of mercury are poisonous
- Mercury is persistent and cycles globally
- Continues to be widely used
- Can be toxic to CNS, lungs and kidneys

Hg as Toxic contaminant



History of mercury poisonings

Minamata Bay, Japan

- In the 1950's, large amounts of organic mercury were dumped into Minamata Bay in Japan.
- Mercury-contaminated fish were consumed by pregnant women.
- many children that were born from these women had severe nerve damage.
- later referred as Fetal Minamata Disease.

Iraq

- children born to mothers who consumed grain contaminated with organic mercury, the effects showed the children walking at a later age than non-exposed children.

Faroe Islands

- Mercury exposure was caused by contaminated whale meat.
- Children born to mothers with high body levels of mercury scored lower on brain function tests than mothers with low body levels.

Forms of mercury

Elemental mercury

- 'Quick silver', natural element,
- Silver white, odorless liquid

Inorganic mercury salts

- Mer-curic / curous chloride
- Mercury cyanide

Organic mercury compounds

- Methyl/ ethyl mercury
- phenyl mercury

Sources of mercury contamination

Natural sources

- Volcanic eruptions
- Rock weathering
- Natural fires

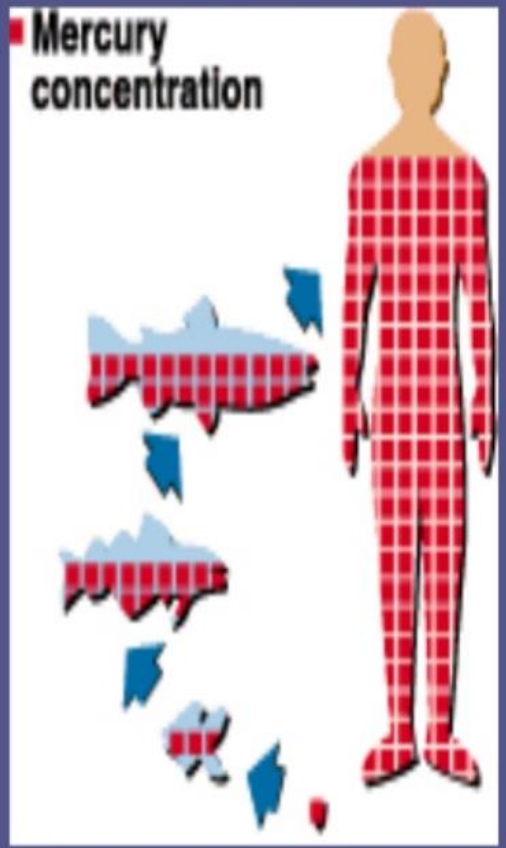
Anthropogenic intentional sources

- Folk medicines
- Cosmetics
- Dental amalgams
- Vaccines

Anthropogenic inadvertent sources

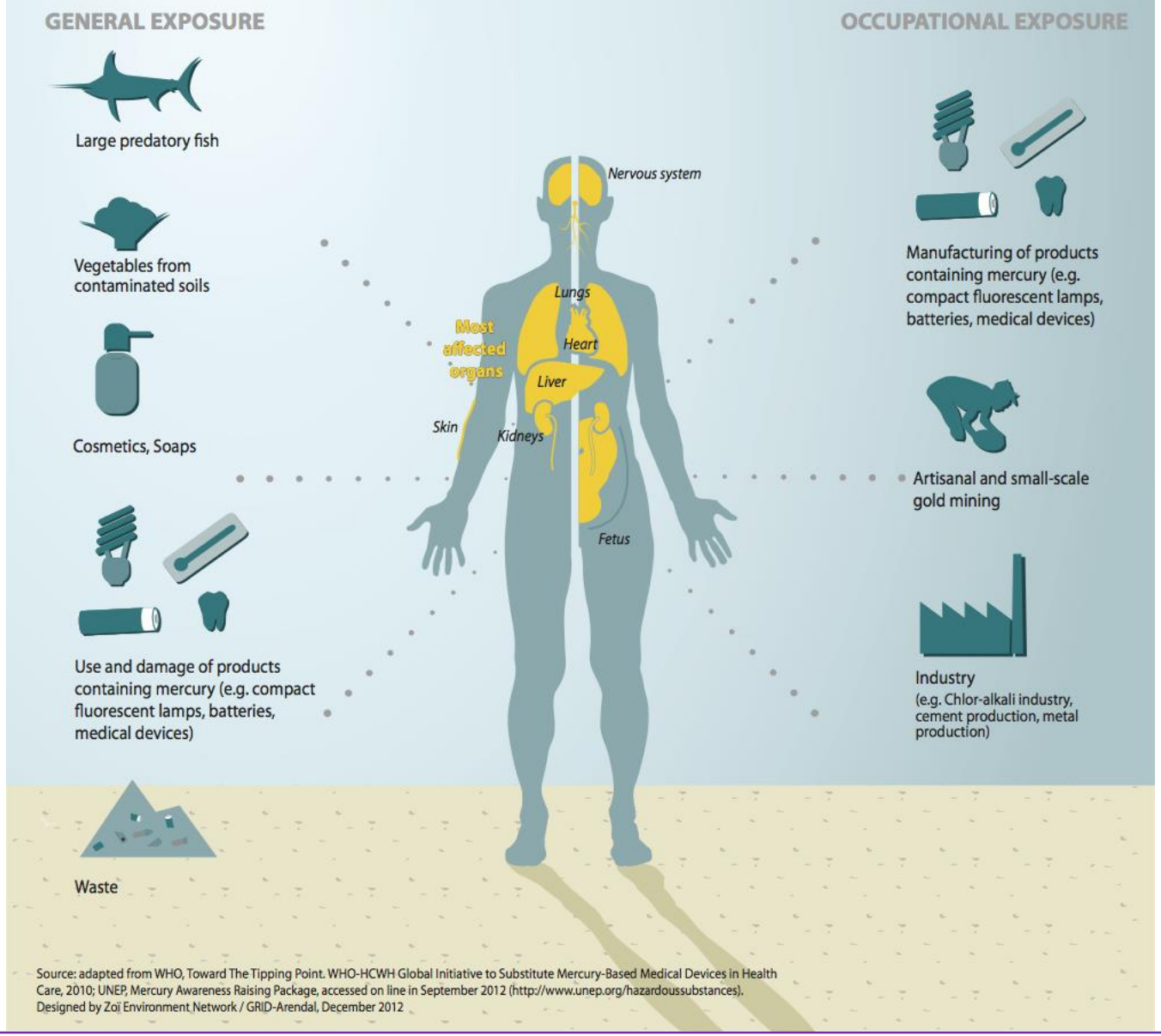
- Mercury mining, smelting and use.
- Burning fossil fuels
- Coal-fired power plants
- Municipal / medical waste incineration
- Cement production
- Chlorine-alkali production

Methyl mercury



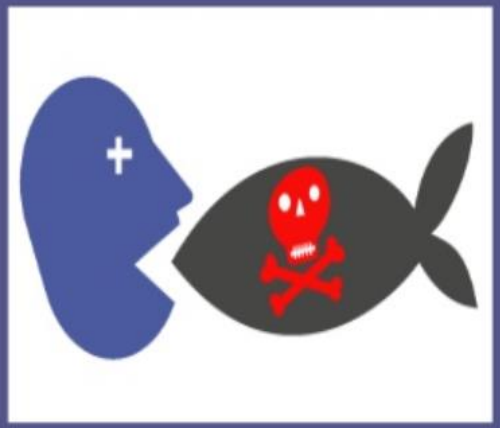
- The most dangerous form of mercury.
- Hg bio-transformed in sediments into methyl mercury by aquatic microbes.
- Bio-accumulate thro' aquatic food chain in larger predatory fishes-tuna, mackerel, shark, grouper
- Bio-persistent, lipophilic, crosses placenta and the blood-brain barrier., concentrates in CNS.
- Tightly bound to fish proteins.
- Enter human body thro' fish consumption.

Mercury and human health



Source: adapted from WHO, Toward The Tipping Point. WHO-HCWH Global Initiative to Substitute Mercury-Based Medical Devices in Health Care, 2010; UNEP, Mercury Awareness Raising Package, accessed on line in September 2012 (http://www.unep.org/hazardoussubstances).
Designed by Zoï Environment Network / GRID-Arendal, December 2012

Human exposure to mercury



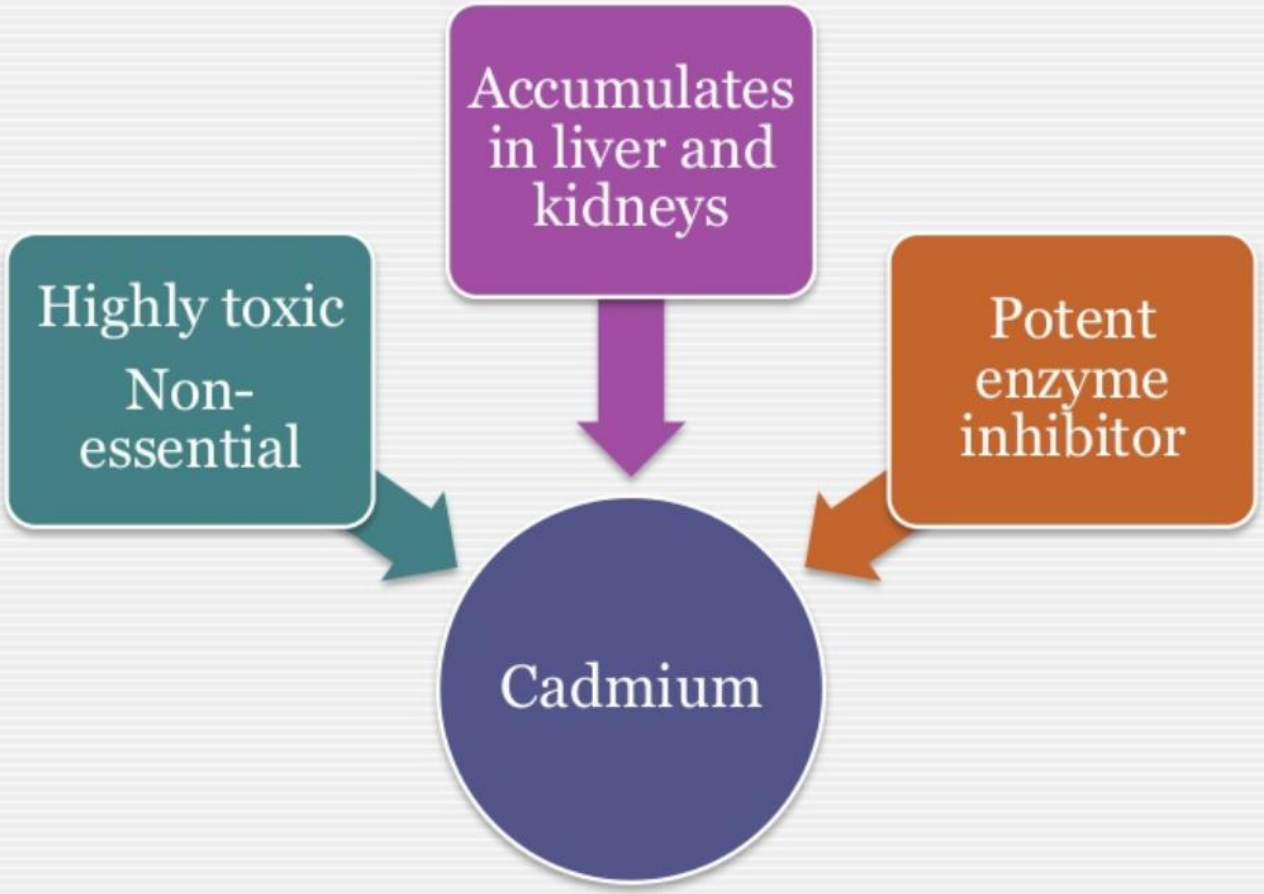
- Breathing air containing mercury vapors
- Drinking water contaminated with mercury.
- Eating fish or shell fish contaminated with mercury.
- Touching liquid mercury in the event of a spill.

Health effects of mercury

- Disruption of the central nervous system
- Damage to brain, lungs and kidneys
- Damage to chromosomes and DNA.
- Allergic reactions, resulting in skin rashes, tiredness headaches and vision problems.
- Negative reproductive effects, such as sperm damage, birth defects and miscarriages

Cadmium(Cd)

Cadmium contamination



Cadmium

•Nonessential heavy metal

•Seventh most toxic heavy metal as per Agency for Toxic Substances and Disease Registry (ATSDR) ranking

•Once this metal gets absorbed by humans, it will accumulate inside the body throughout life

•Predominantly found in fruits and vegetables due to its high rate of soil-to plant transfer

•The half-life of Cd is 10–30 years

FAO/WHO guideline of Cd in food:

Food/Product	Cd Level (mg/Kg)
Natural mineral water	0.003
Salt, food grade	0.5
vegetables	0.05
Potato, Pulses, Cereal grains	0.1
Rice	0.4
Wheat	0.2

Sources of cadmium contamination

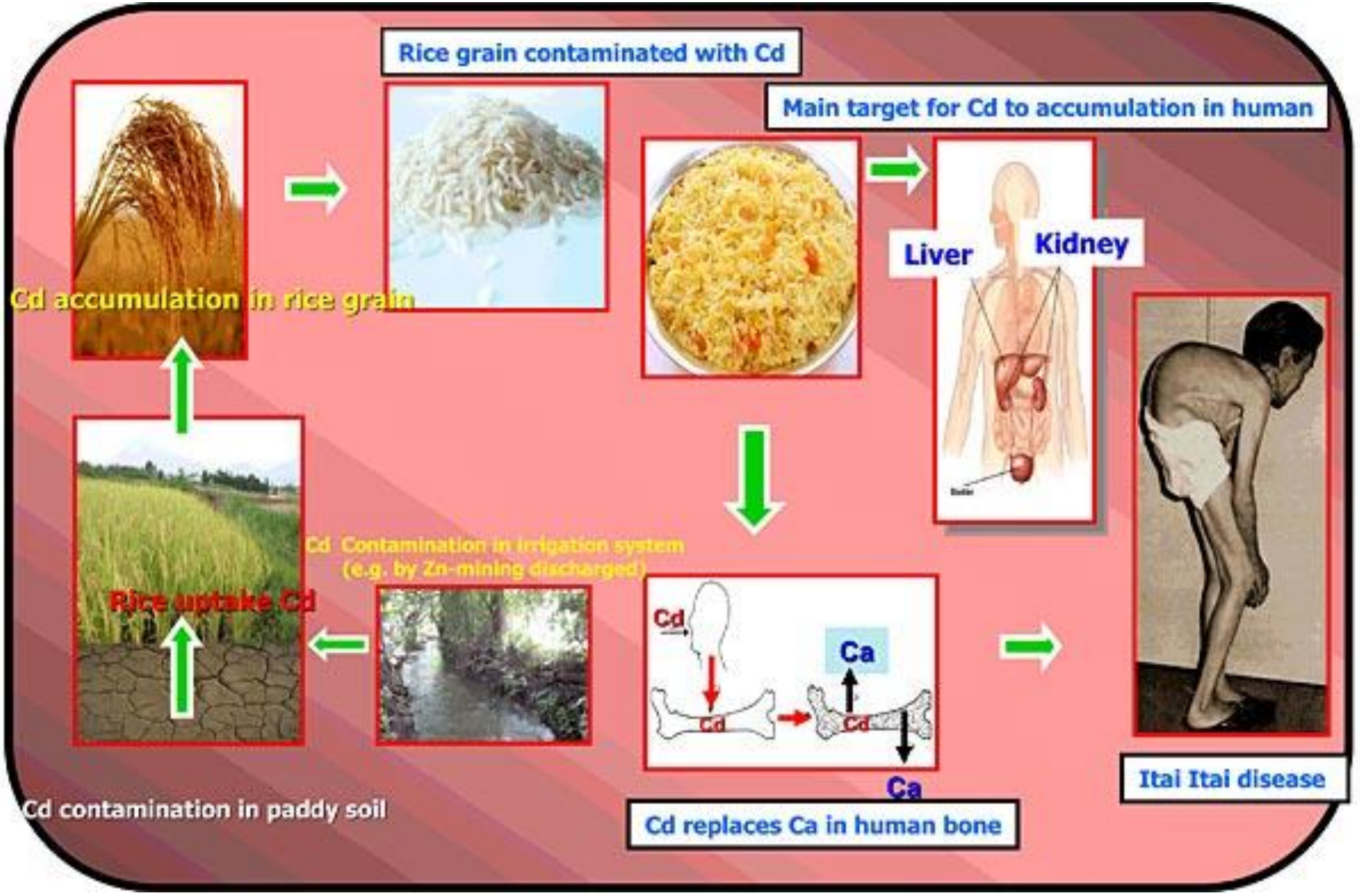
- Mining and metallurgical operations
- Electroplating industry
- Manufacturing PVC plastics
- Ni-Cd batteries, paints , pigments and dyes
- Fertilizers and pesticides
- Anti-corrosive agent for steel, iron, copper, brass and other alloys.
- Photo voltaic devices and TV screens.

Human health effects

- Cause diarrhoea, stomach pains and severe vomiting
- Itai- itai disease-bone fracture
- Kidney dysfunction-chronic renal failure
- Reproductive failure and even infertility
- Damage to the central nervous system
- Damage to the immune system
- Psychological disorders
- DNA damage or cancer development

Environmental effects of cadmium

- Cadmium -rich sludge can pollute surface waters as well as soils.
- Cadmium strongly adsorbs to organic matter in soils.
- Soils that are acidified enhance the cadmium uptake by plants.
- Cadmium can accumulate in the plant eating animals , especially when they eat multiple plants.
- In aquatic ecosystems, cadmium can bioaccumulate in mussels, oysters, shrimps, lobsters and fish.


Rice grain contaminated with Cd
Main target for Cd to accumulation in human
Cd accumulation in rice grain
Liver
Kidney
Cd Contamination in irrigation system
(e.g. by Zn-mining discharged)
Rice uptake Cd
Cd
Ca
Cd
Cd
Ca
Itai Itai disease
Cd contamination in paddy soil
Cd replaces Ca in human bone

Too much Cadmium in Bangla rice: US study

Regarding the study of the American Chemical Society, Baque said, “They [ACS] probably collected the rice samples in an arbitrary manner and conducted the research. I can vouch that there is no Cadmium in river clay and fields in the northern region of the country.”

SRDI scientist said last year they collected sample of fertilisers sold by dealers across the country and found that 50 percent of the fertilisers were adulterated.

We found many metal substances including Zinc-sulphate, Gypsum and Cadmium in the fertilisers which are really lethal for the human body, he said.

Prof Abdullahil Baque said, “Cadmium above acceptable limits in human body causes cancer, heart disease and kidney diseases.”

Chromium(Cr)

Chromium - Cr

- **Chromium is an abundant element of earth's crust.**
- **The trivalent (III) and hexavalent (VI)compounds of chromium are great industrial importance.**
- **Chromium(III) is an essential nutrient.**

Chromium

•Chromium occurs naturally by the burning of oil and coal, petroleum from ferro cromate refractory material, pigment oxidants, catalyst, chromium steel, fertilizers, oil well drilling and metal plating tanneries.
Anthropogenically, chromium is released into the environment through sewage and fertilizers.
•**The half-life of Cr (III) and Cr (VI) is 92 Days and 22 Days** respectively.

•FAO/WHO guideline of Cr in food:

Food/Product	Cd Level (mg/Kg)
Cereals and vegetables	1
Fish, crab-meat, oysters, prawns and shrimps	1
Meat of animal and poultry	1

Human health effects of chromium

- Acute chromium toxicity cause renal tubular necrosis.
- Chronic chromium toxicity cause cancers of respiratory tract.
- Upset stomachs and ulcers
- Respiratory problems-lung cancer
- Weakened immune system
- Kidney and liver damage
- Teratogenic and carcinogenic action
- Death

Environmental effects of chromium

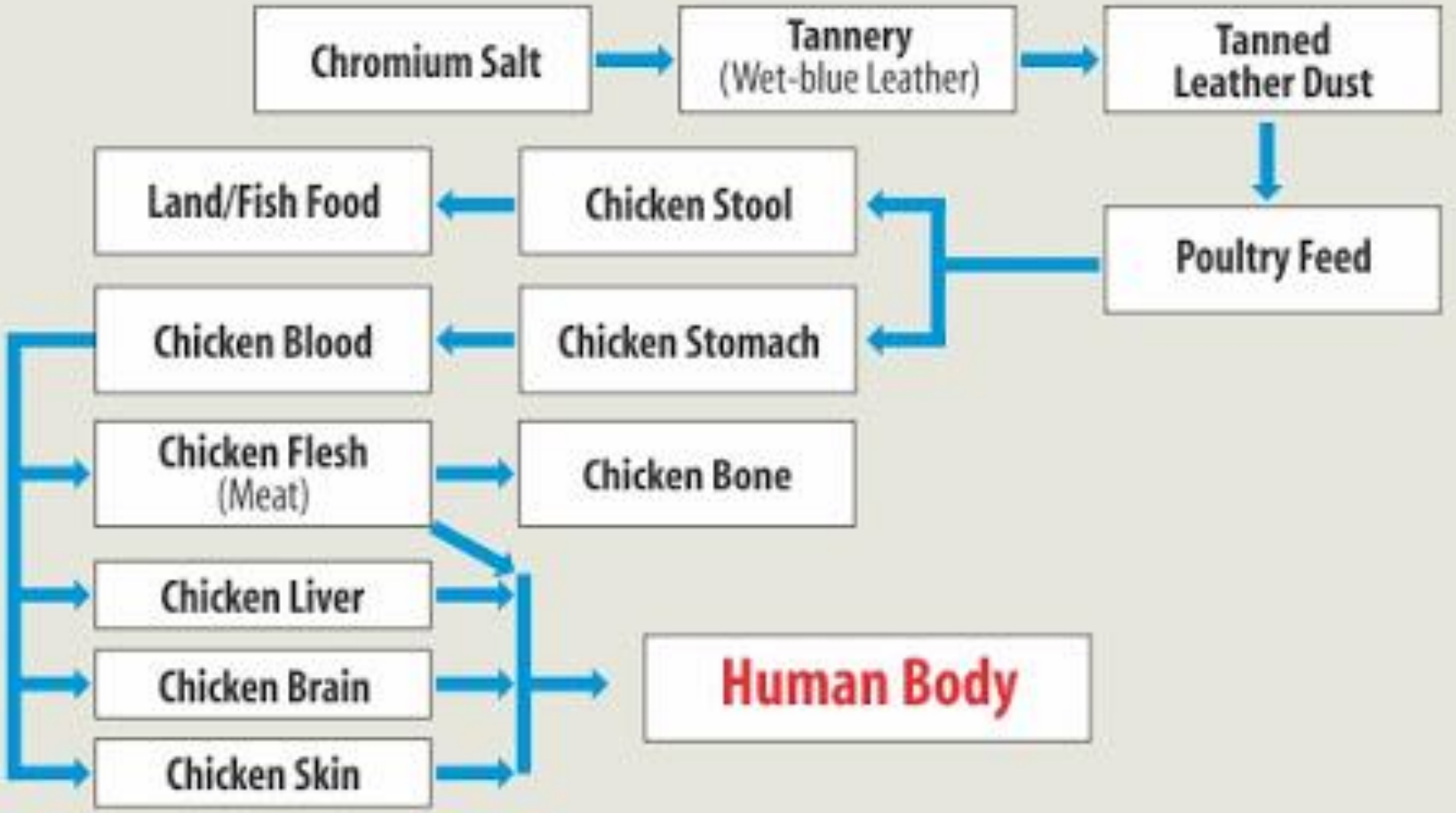
- Chromium in air will eventually settle and end up in waters or soils
- Chromium in soils adsorbs to soil particles and percolates to ground water
- Chromium may adsorb on sediments and become immobile in water .

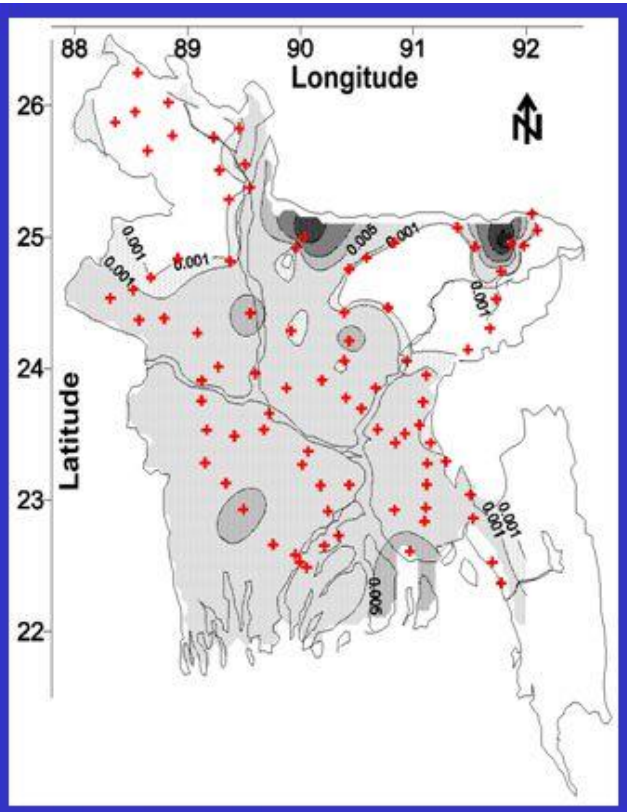
Chromium contamination in Bangladesh

- In Bangladesh, among the routes of chromium eco-toxicity, feeds and fertilizer production from tanned skin cut wastes is the most direct one leading to food chain contamination
- A study by Bangladesh livestock research institute (BLRI) found high chromium (0.53 to 0.96 ppm) in all milk samples of both brand and local vendors compared to the IAEA values (0.22 to 0.29ppm)
- A study with "Stinging Catfish" of Turag river of Dhaka found high chromium (1.46mg/Kg) in fish body
- A study with vegetable samples grown at Gazipur district showed that the concentration of chromium (21.9-22.9µg/g) was higher than the maximum allowable level (WHO-1.3µg/g)

TRANSPORT MECHANISM OF CHROMIUM

From tannery waste to human body

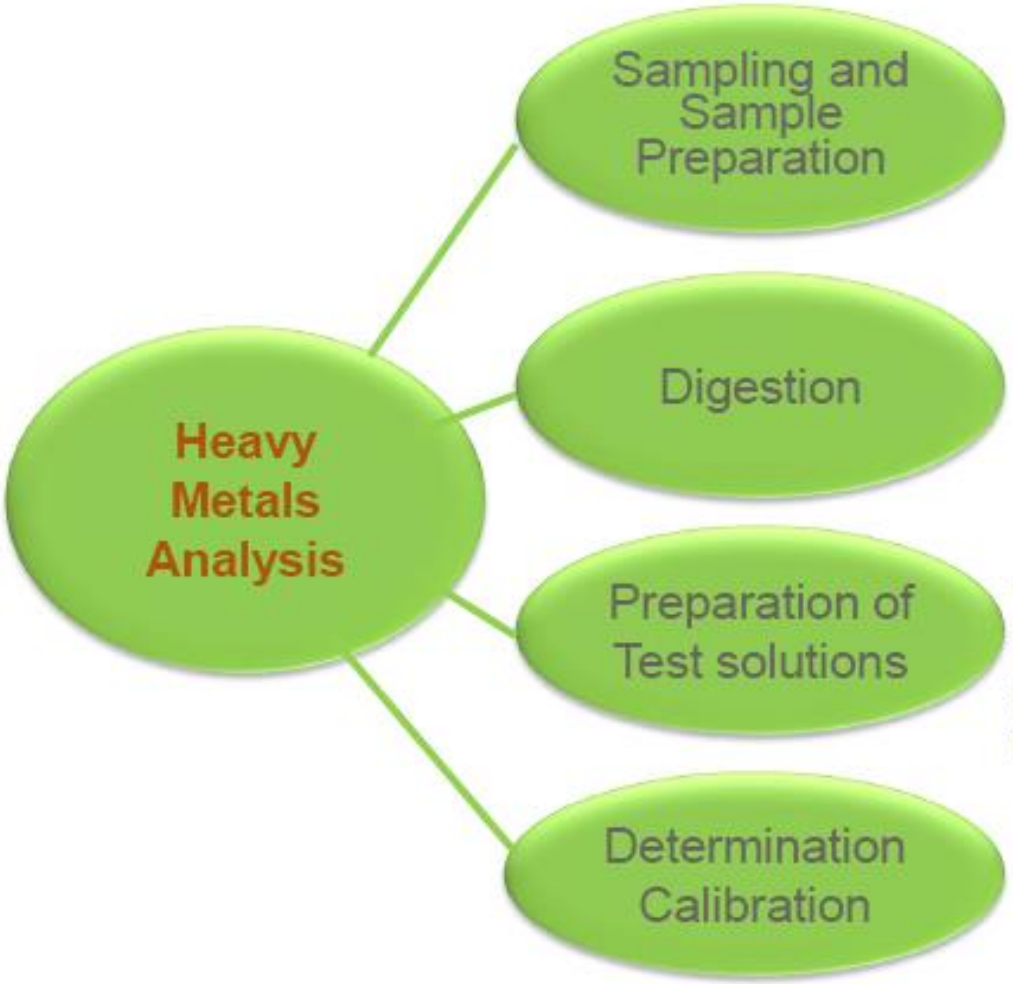




Map of total chromium concentration (mg/L).

- < 1% of Bangladesh's area contains groundwater with chromium concentrations greater than the WHO drinking water guideline.
- The International Agency for Research on Cancer categorizes Cr(VI) as "carcinogenic to humans" and Cr(III) as "not classifiable".
- However, the USEPA lists total chromium in drinking water as having "inadequate or no human and animal evidence of carcinogenicity".

Heavy Metal Analysis



Critical Points

- Avoid contamination when preparing a test portion
- Obtain homogenized representative test sample

- Use the appropriate digestion program according to the type and amount of sample.
- Avoid contamination of acids and dust
- Carry out blank test in parallel by the same procedure

- Check if digestion is complete
- Prepare the test solution with similar HNO_3, HCl, Au and IPA concentrations as those of calibrants depending on ICP-MS technologies.

- ICP-MS instrument set-up
- Check ICP-MS performance

. Types of Equipment (Atomic Spectroscopy)

Flame AAS

Graphite Furnace AAS

AAS instruments can be flame only, furnace only, or combined (switchable)

ICP-OES

ICP-MS

foods that detox and cleanse the body

GARLIC

CITRICS

GREEN TEA

BROCCOLI

CUCUMBER

TURMERIC

LENTILS

APPLES

BRUSSEL SPROUTS

SPINACH

OLIVE OIL

BEETROOT

.....for your kind attention.