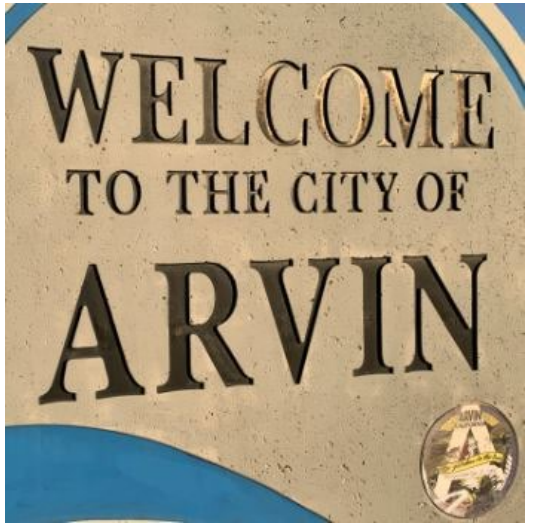
OEHHA

SCIENCE FOR A HEALTHY CALIFORNIA

# Risk Assessment of Air Contaminants

## Community Air Protection Program (AB 617)
## Arvin/Lamont Steering Committee Meeting
## August 25, 2021



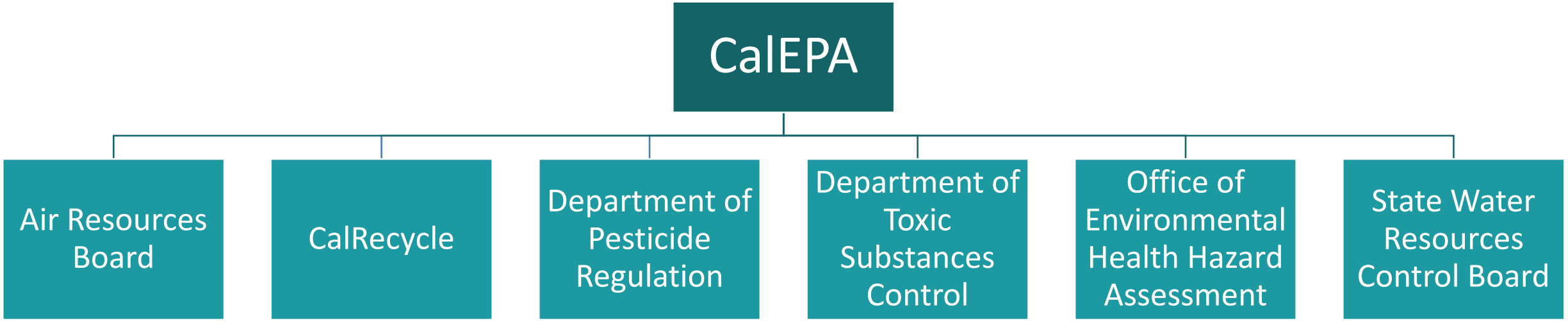
HEATHER BOLSTAD, PH.D.

STAFF TOXICOLOGIST

OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

https://www.arvin.org/CivicAlerts.aspx?AID=13
https://www.facebook.com/lamontchamberkern/


CalEPA
Air Resources Board
CalRecycle
Department of Pesticide Regulation
Department of Toxic Substances Control
Office of Environmental Health Hazard Assessment
State Water Resources Control Board

# OEHHA Assessments Support CalEPA Environmental and Public Health Activities

CalEPA Mission:

To restore, protect and enhance the environment, to ensure public health, environmental quality and economic vitality.

OEHHA Mission:

To protect and enhance the health of Californians and our state's environment through scientific evaluations that inform, support and guide regulatory and other actions.

# Outline

- Background: toxicity, exposure, risk
- How OEHHA determines toxicity
- Factors that influence toxicity
- Specific air pollutants and their health concerns
- How do improvements in air quality affect health?

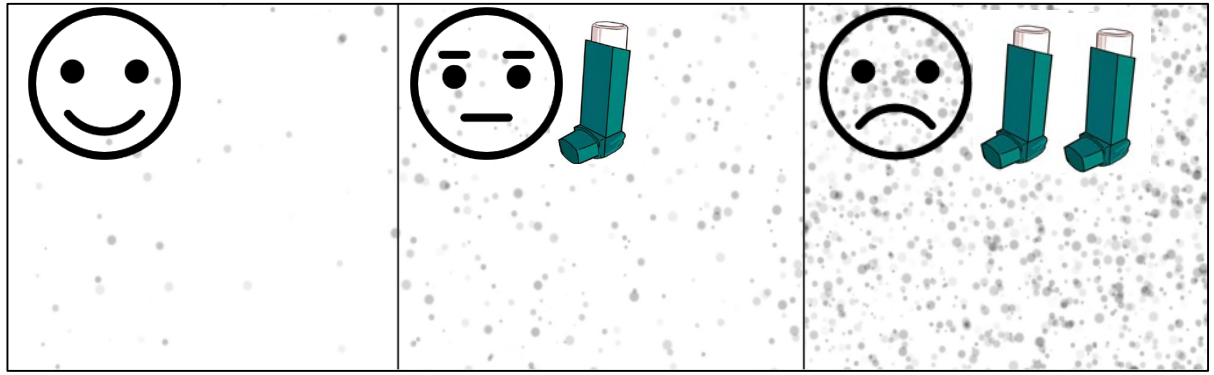
# Toxicity x Exposure = Risk

# Toxicity

- Describes the health effects associated with a compound and how much of a compound causes a health effect
- Represented by Health Guidance Values

For example: A compound makes asthma worse

At what concentration?



https://health.clevelandclinic.org/5-tips-for-managing-your-childs-asthma/
https://www.nytimes.com/interactive/2019/12/02/climate/air-pollution-compare-ar-ul.html
https://pharmaceutical-journal.com/article/ld/how-to-help-patients-optimise-their-inhaler-technique

# How do we determine the toxicity of chemicals?

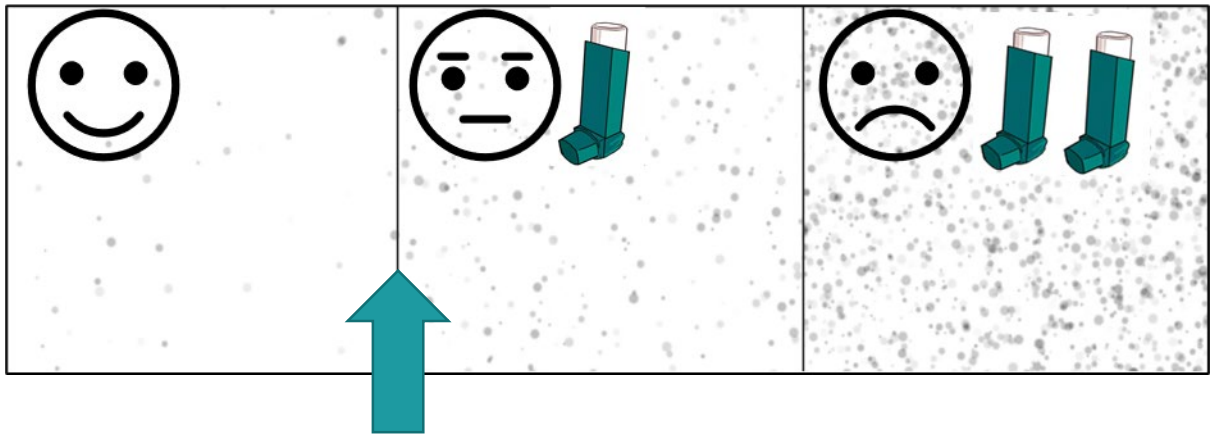
OEHHA develops benchmarks for toxicity called Health Guidance Values:

*Noncancer: Reference Exposure Levels (RELs)*

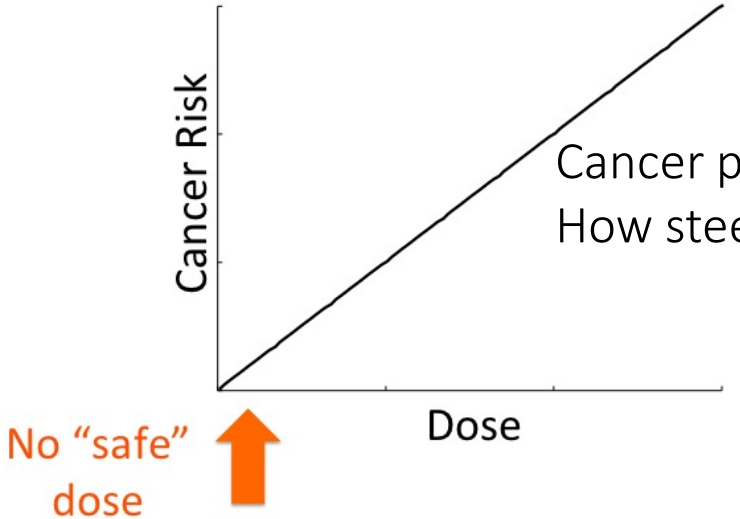
- The amount of chemical in the air that is not likely to cause noncancer health effects (like asthma) even in sensitive populations like children and pregnant women

*Cancer: Unit risks or cancer potency factors*

- Describe increase in cancer risk per unit of exposure



Reference Exposure Level




Cancer potency =
How steep is this line?

# What influences toxicity?

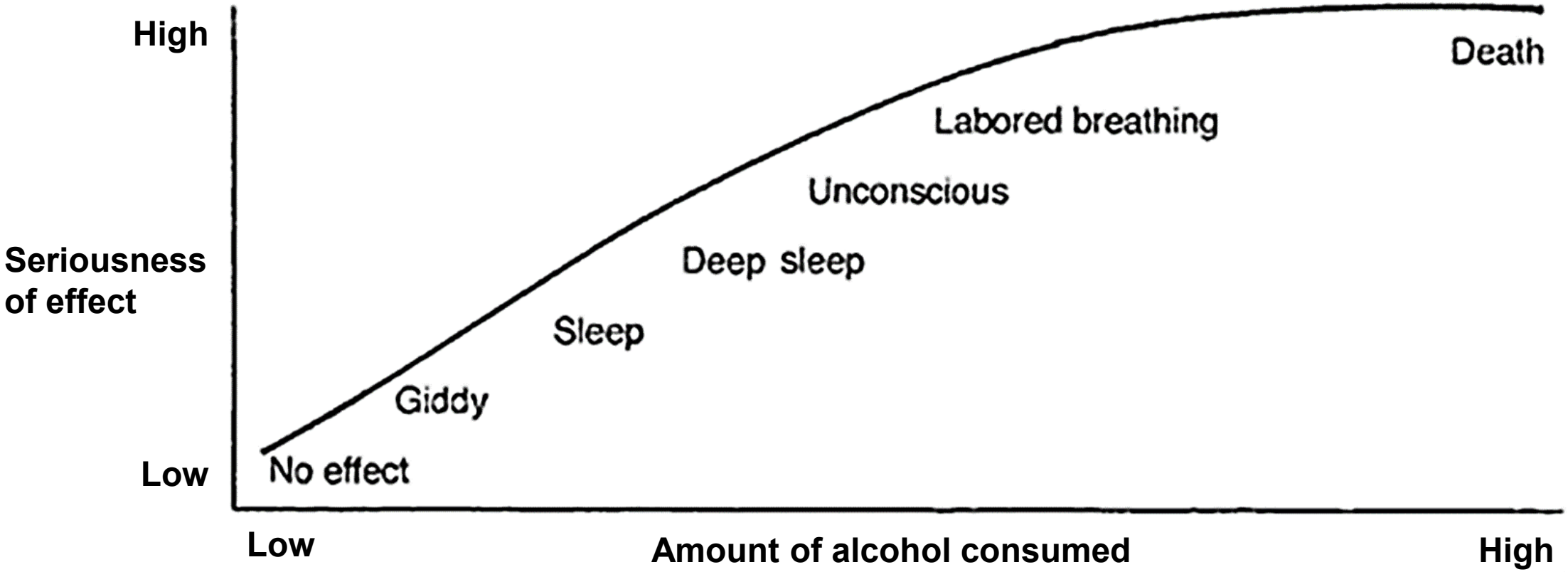
- Amount

- Length of exposure (time)

- Sensitivity

https://www.meadindoor.com/for-physicians/

# Health effects can become more serious as the amount someone is exposed to increases




https://science.education.nih.gov/supplements/webversions/Chemicals/guide/lesson3-1.html

# Toxicity depends on the amount of time someone is exposed to a chemical

OEHHA develops Reference Exposure Levels for specific amounts of time

- Brief exposure (*acute*): occasional 1-hour exposures
- Moderate exposure: repeated 8-hour exposures over a significant fraction of a lifetime
- Constant exposure (*chronic*): continuous exposures from 1 year to a lifetime

## Example: Diesel exhaust

**Acute:** Mowing the lawn for 1 hour

**Chronic:** Living next to a freeway

https://www.deere.com/en/mowers/lawn-tractors/x700-series/x758-lawn-tractor/; https://www.latimes.com/local/california/la-me-freeway-pollution-what-you-can-do-20171230-htmlstory.html

# Exposure

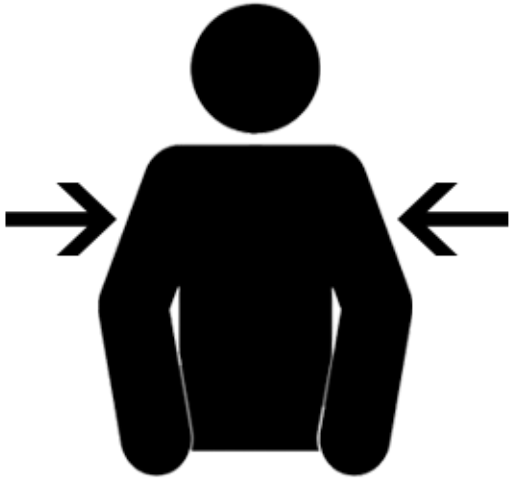
- Describes how a compound contacts or enters the body and how much
- How much can be represented by air monitoring data

## How does it contact or enter the body

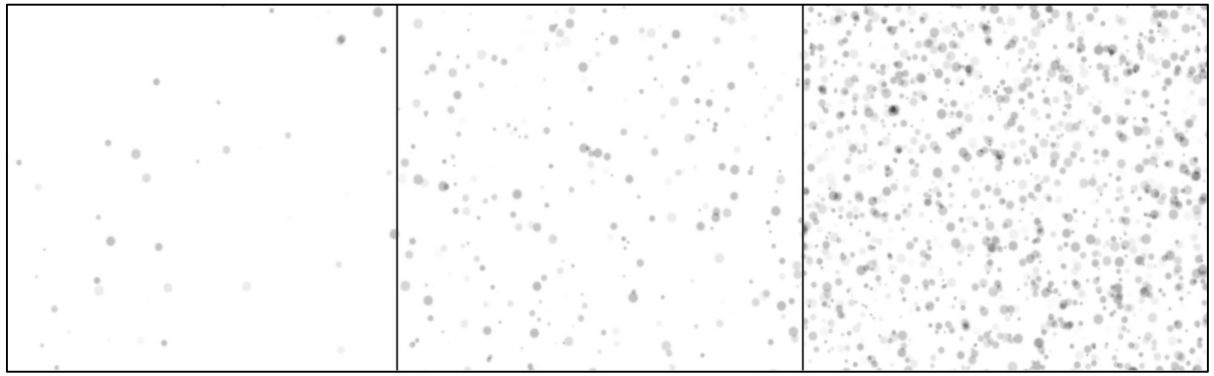
Oral (ingestion)

Inhalation

Dermal (skin)

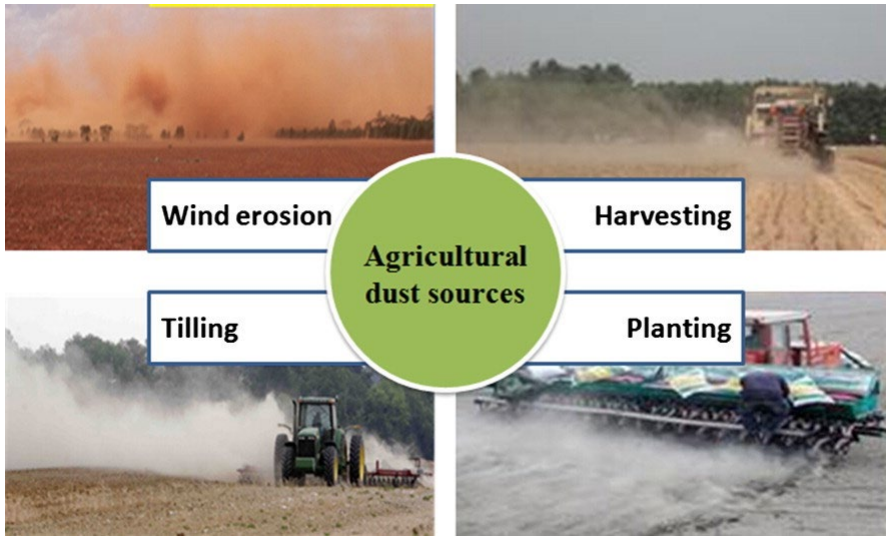


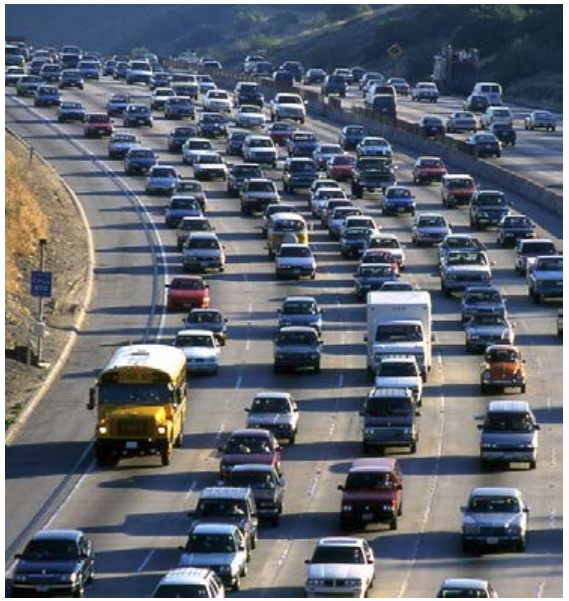
## How much contacts or enter the body

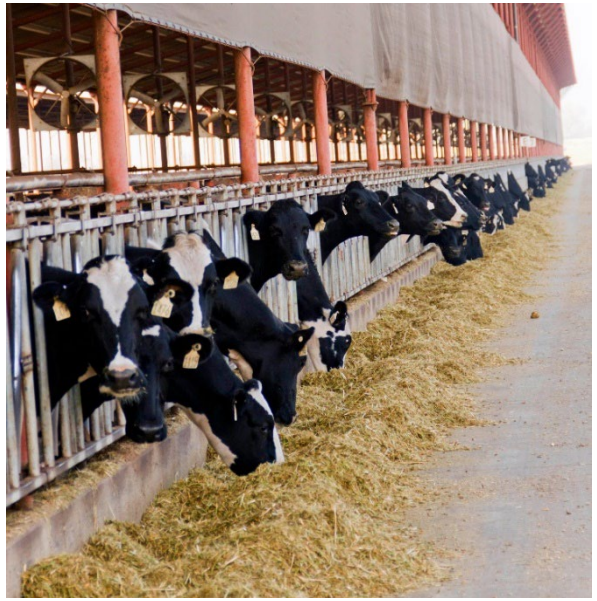


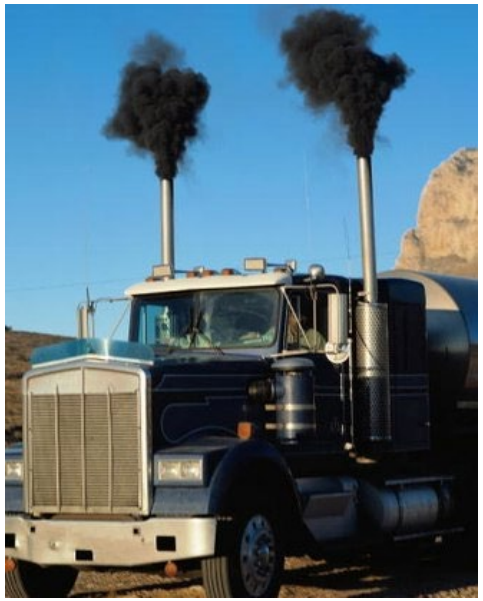

https://sphweb.bumc.bu.edu/otlt/mph-modules/exposureassessment/exposureassessment3.html
https://www.nytimes.com/interactive/2019/12/02/climate/air-pollution-compare-ar-ul.html

# Sources of Exposure to Air Pollutants







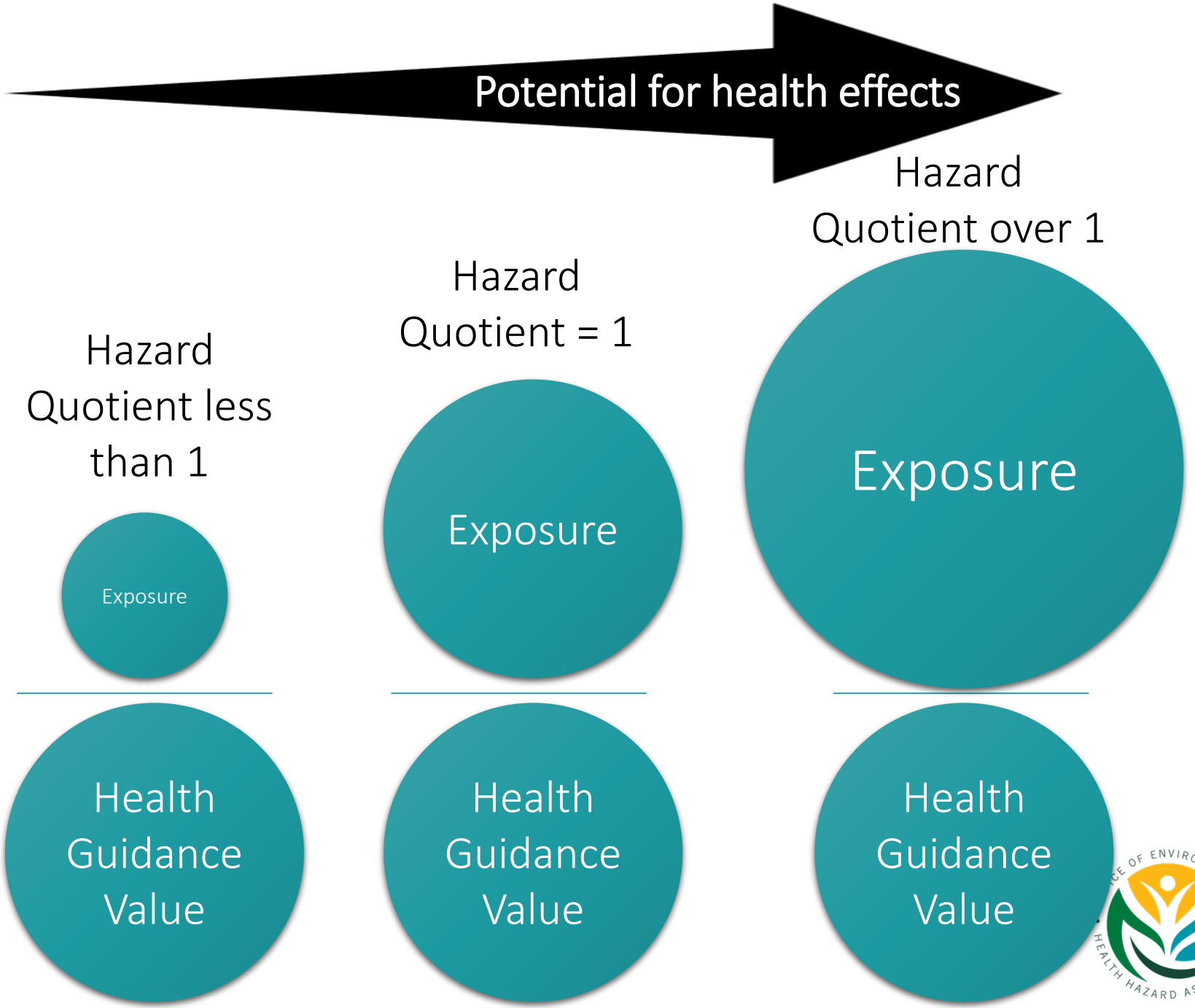


https://www.kvpr.org/post/hearings-begin-over-kern-county-ordinance-allows-70000-new-oil-and-gas-wells
https://www.nytimes.com/2015/05/04/business/energy-environment/how-growth-in-dairy-is-affecting-the-environment.html
http://www.associatesinsectary.com/about-associates-insectary/spraying-2/

https://commons.wikimedia.org/wiki/File:Diesel-smoke.jpg
https://ars.els-cdn.com/content/image/1-s2.0-S1001074216316400-fx1_lrg.jpg
http://www.whiteripleyradsafety.com/2-2

# Risk

- Describes the potential for health effects
- Represented by
  - Hazard quotient for noncancer risk
  - Cancer risk per million individuals



# How do we determine the risk from the amount of a chemical measured in air?

## Noncancer

How does the amount in air compare to the Reference Exposure Level?

▲ Higher? May be some concern

Reference Exposure Level

▲ Lower? Little concern

## Cancer

How much does the amount in air increase cancer risk by?

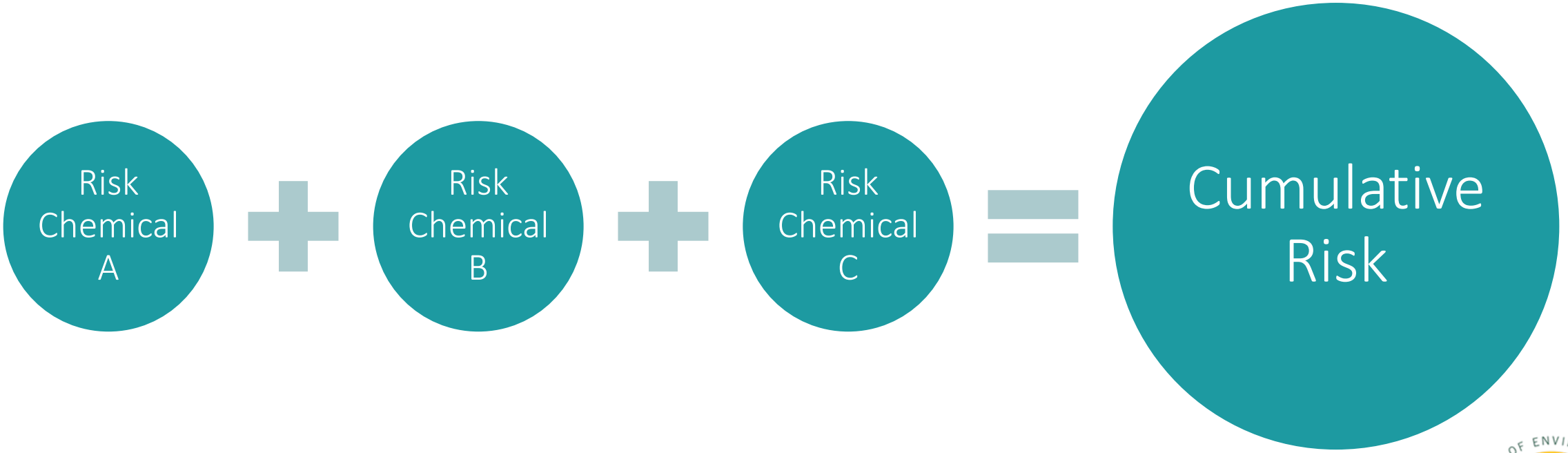
▲ Higher? Concern

Risk target (insignificant cancer risk)

▲ Lower? Less concern

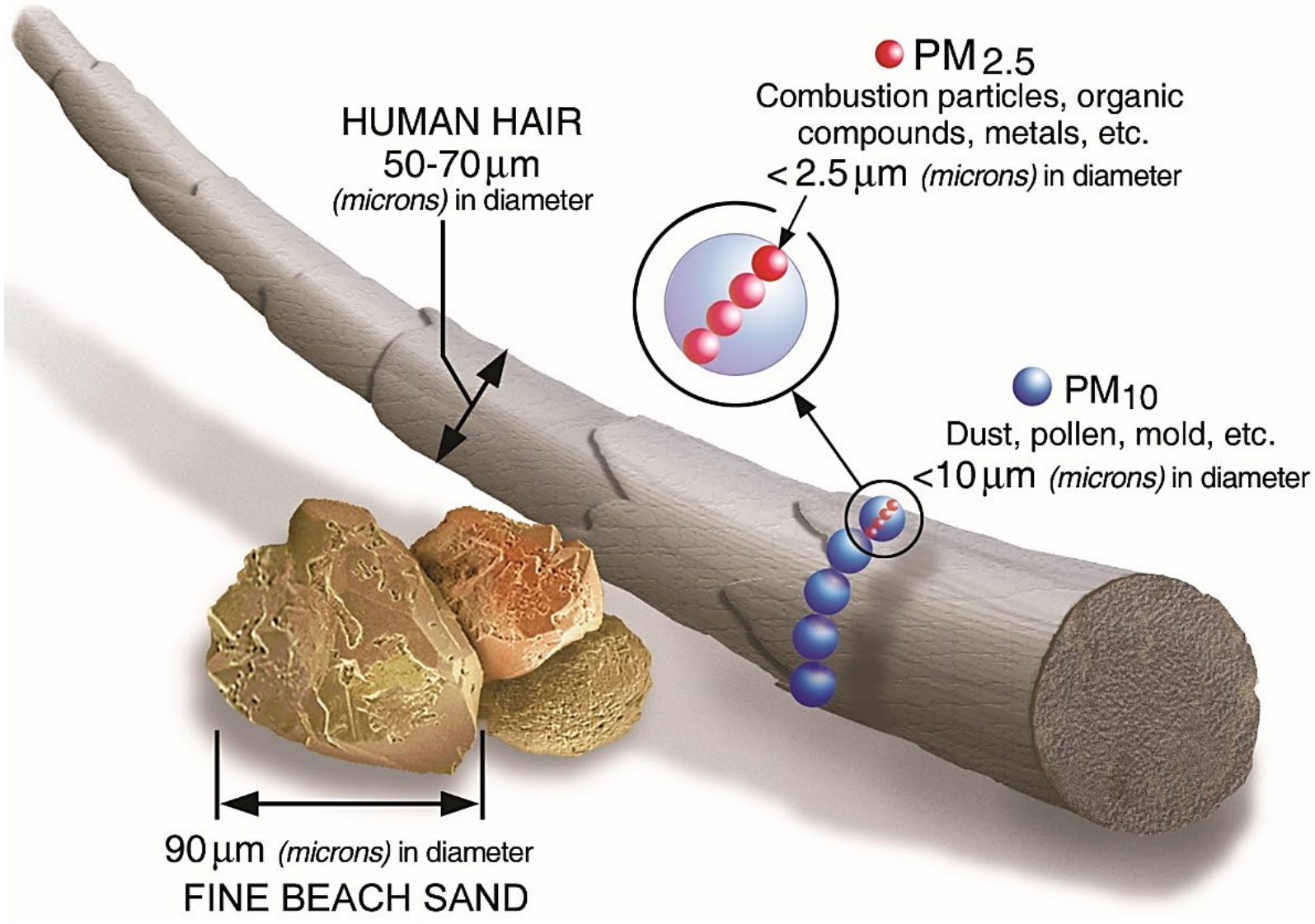
# Cumulative Risk

Addresses the fact that people are exposed to multiple compounds



# Specific air pollutants and their health concerns

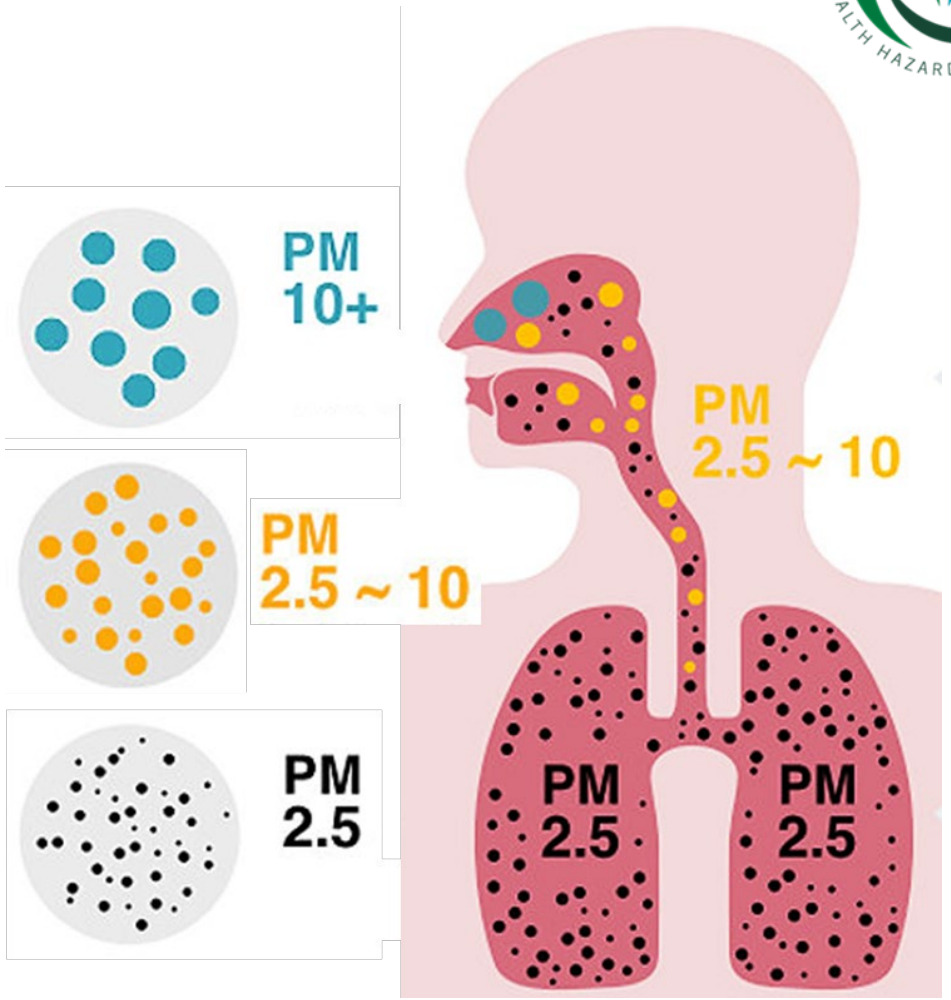
# Particulate Matter (PM)




https://www.epa.gov/pm-pollution/particulate-matter-pm-basics

# Health Concerns for $PM_{2.5}$

- Can reach deep into the lung
- *Short-term exposure*: ↑ respiratory irritation, asthma attacks, irregular heartbeat, respiratory symptoms, ↓ lung function
- *Short- and long-term exposure*: premature death, cardiovascular mortality and hospitalizations, respiratory and asthma hospitalizations, neurological outcomes
- Additional sensitive populations
  - Elderly
  - Infants/children (↑ respiratory illnesses, ↓ lung function)
  - Pregnant women (↓ birth weight, preterm birth, stillbirth)




https://www.masters.tw/wp-content/uploads/2015/07/pm2_52.jpg

# Health Concerns for Diesel Exhaust

## Noncancer

- Respiratory irritation, cough, allergies, lung inflammation
- ↑ hospitalizations, ER visits, asthma attacks, premature deaths
- Sensitive populations
  - Those with respiratory/cardiovascular conditions
  - Children
  - Elderly

## Cancer

- Increased cancer risk
- ~70% of average Californian's cancer risk from air pollution (CARB)

https://commons.wikimedia.org/wiki/File:Diesel-smoke.jpg

# Health Guidance Values for Diesel Exhaust

## Non-cancer

- Chronic REL: 5.0 µg/m$^3$
- Effect: Changes in structure of rat lung

## Cancer

- Unit risk: 0.0003 per µg/m$^3$
- Inhalation Cancer Potency Factor: 1.1 (mg/kg-day)$^{-1}$
- Effect: Lung tumors in workers
- *1 in a million risk = 0.0033 µg/m$^3$*

# Wood smoke

Contains thousands of chemicals, most concerning are:

- $PM_{10}$ and $PM_{2.5}$
- Carbon monoxide
- Irritants (nitrogen dioxide, sulfur oxides, aldehydes like acrolein and formaldehyde)
  - ➢ May play a role in smoke-triggered asthma attacks
- Carcinogens, including polyaromatic hydrocarbons (PAHs), benzene, 1,3-butadiene, formaldehyde

Contributes to indoor air pollution, particularly for PAHs

SJVAPCD program requiring reduction of residential wood burning → decreased hospitalization for cardiovascular disease (Yap & Garcia, 2015)

https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQr9ByO6xDAA_fKV5QxeuMOKWnGEKRPgcwA-yly5nCpBOUQAAdz2w

# Reduced PM Improves Health

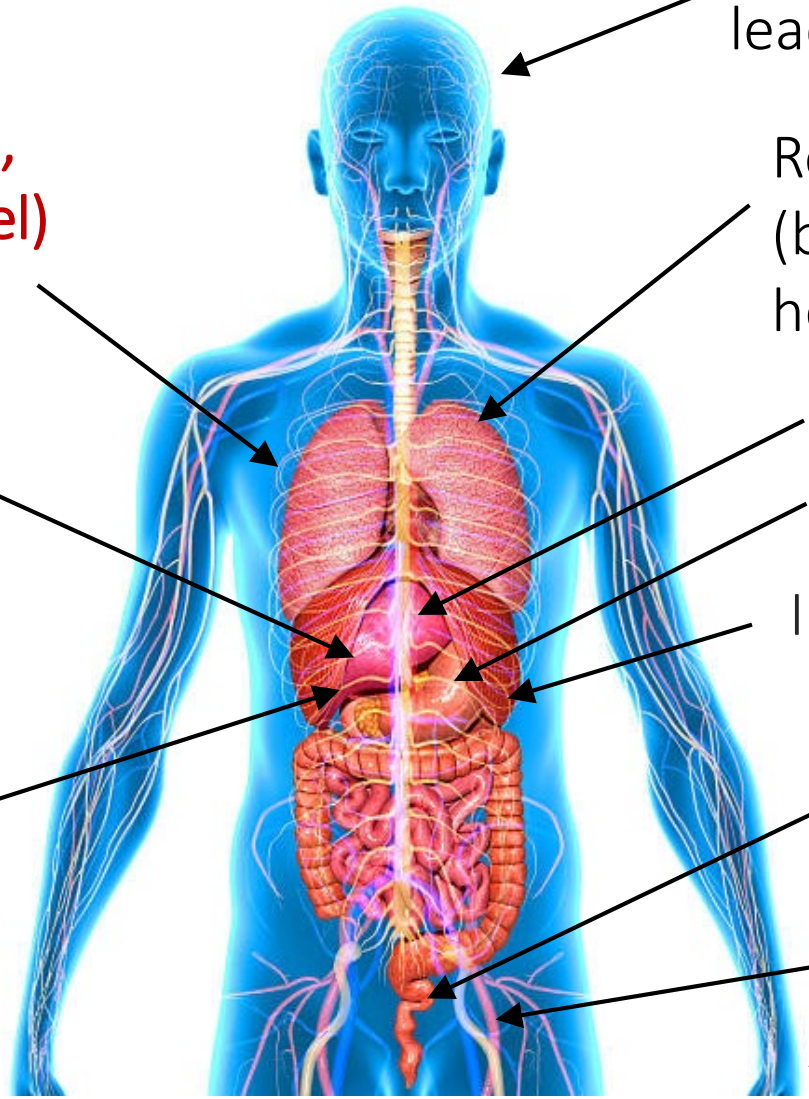
- Central Valley - reduced residential wood burning (required by Rule 4901) decreased cardiovascular disease hospitalizations (Yap & Garcia, 2015)
- California - retirement of 8 coal and oil power plants reduced preterm births and increased fertility rates (Casey et al. 2018a,b)
- Utah Valley - Steel mill shutdown reduced $PM_{10}$ and respiratory hospital admissions (Pope 1989)
- Ireland - Coal sale ban reduced PM and death from lung disease (Dockery et al. 2013)
- So. California - Children who moved to less polluted areas had improved lung function growth; those who moved to more polluted areas had decreased lung function growth (Avol et al. 2001)
- 51 U.S. metro areas - PM reductions increased life expectancy (Pope et al. 2009)
- Reduced diesel PM expected to decrease cancer risk

# Health Concerns for Metals

Lung cancer (arsenic, beryllium, cadmium, cobalt, hexavalent chromium, nickel)

Adrenal cancer (cobalt)

Kidney cancer (lead)



Nervous system (arsenic, lead, manganese, selenium)

Respiratory system (beryllium, cadmium, cobalt, hexavalent chromium, nickel)

Liver (selenium)

Kidney (cadmium)

Immune system (beryllium, nickel)

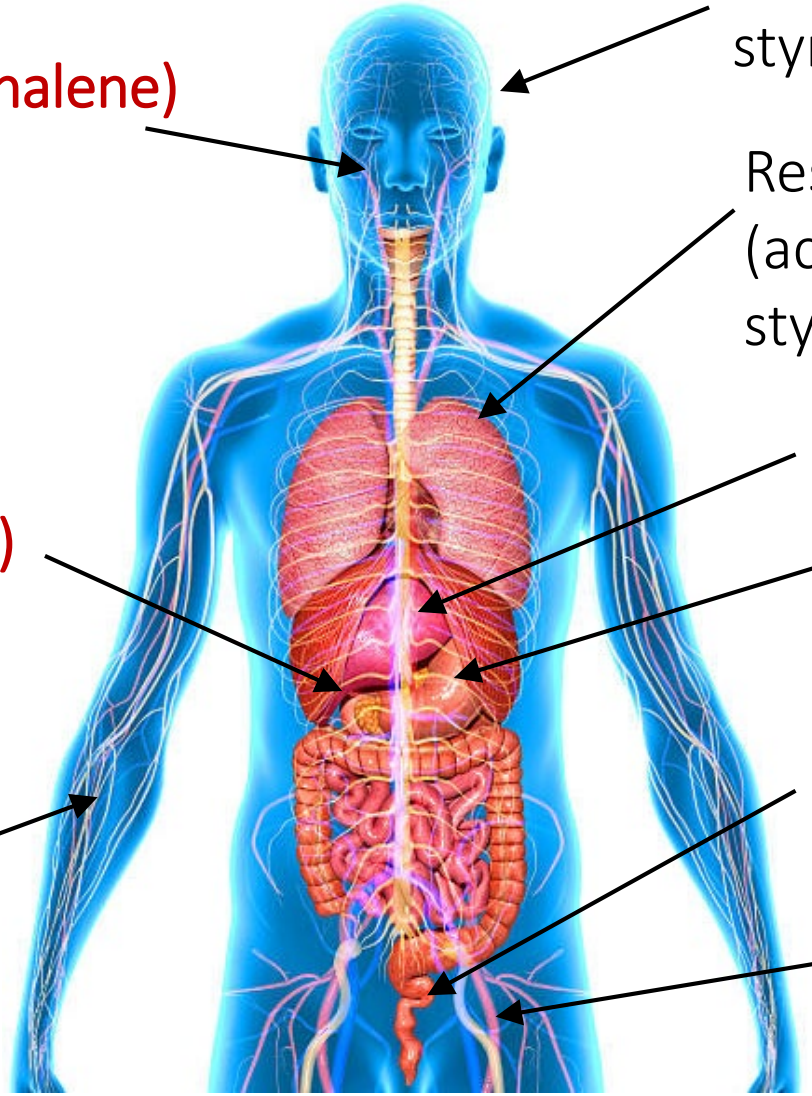
Reproduction and development (arsenic)

Blood (selenium)

Hair, skin, nails (selenium)

https://www.istockphoto.com/in/photo/human-organs-gm497303869-41750622

# Health Concerns for Volatile Organic Compounds (VOCs)



Nasal tumors (formaldehyde, naphthalene)

Nervous system (benzene, hexane, styrene, toluene, xylenes)

Respiratory system (acrolein, formaldehyde, naphthalene, styrene, toluene, xylenes)

Kidney cancer (ethylbenzene)

Liver (ethylbenzene)

Kidney (ethylbenzene)

Reproduction and development (benzene, ethylbenzene, toluene)

Leukemia (benzene)

Blood (benzene)

https://www.istockphoto.com/in/photo/human-organs-gm497303869-41750622

# Questions?

Heather Bolstad, Ph.D.

heather.bolstad@oehha.ca.gov