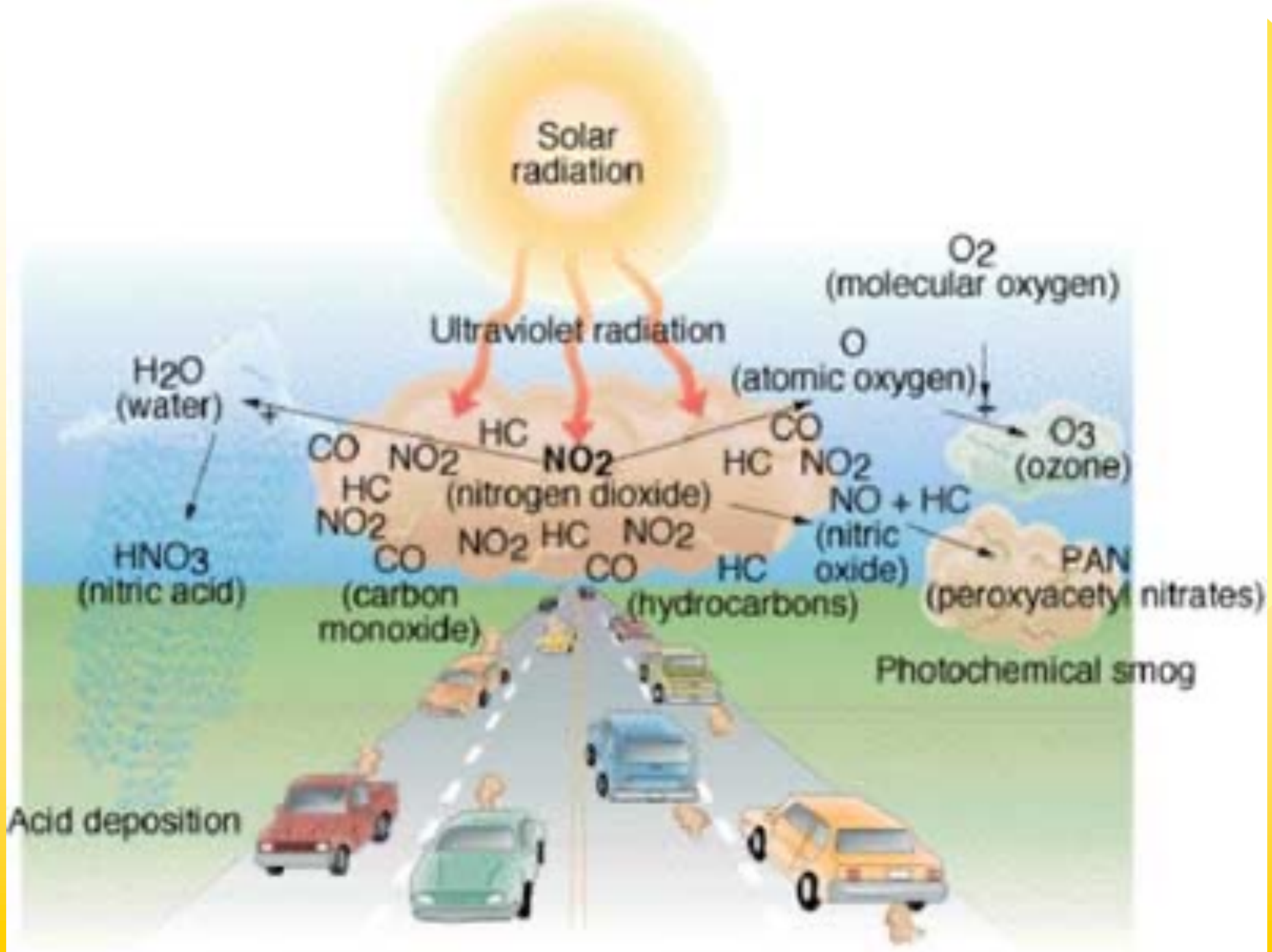
Air Pollution and Chemical Multisensitivity: What to Do

Pasquale Avino

Analytical Chemistry Group

Department of Agriculture, Environmental and Food Sciences
University of Molise, Campobasso
E-mail: avino@unimol.it


Solar radiation
Ultraviolet radiation
O2 (molecular oxygen)
O (atomic oxygen)
H2O (water)
HNO3 (nitric acid)
CO
NO2
HC
NO2
(nitrogen dioxide)
CO (carbon monoxide)
HC (hydrocarbons)
NO + HC (nitric oxide)
O3 (ozone)
PAN (peroxyacetyl nitrates)
Photochemical smog
Acid deposition

Today air pollution is generally less visible than in years past and, consequently, is a less obvious (and less discussed) problem.

Compared to 40 years ago (or any date you pick), we don't know if there are more or fewer pollutants related to these diseases in our air.

“Title V of the Clean Air Act requires major sources of air pollutants, and certain other sources, to obtain and operate in compliance with an operating permit. Sources with these "title V permits" are required by the Act to certify compliance with the applicable requirements of their permits at least annually.”
(U.S. EPA)

6 Criteria Air Pollutants: Carbon Monoxide, Ground-level Ozone, Lead, Nitrogen Oxides, Particulate Matter, and Sulfur Dioxide.

- The World Health Organization has just declared outdoor air pollution to be a Group 1, known human carcinogen.
- There are 23 known human carcinogens in compressor stations emissions, including benzene, formaldehyde and 1,3-butadiene.
- Even if health effects are known for exposure to one environmental contaminant, the effect of being exposed to multiple contaminants is uncertain. Co-exposure may have an additive effect or even a synergistic effect. What, for example is the effect of being simultaneously exposed benzene, formaldehyde and 1,3-butadiene?
- Cancer has a long latency and effects may not appear for years.

Effects of VOCs on the Nervous System

- Occupational studies report three levels of severity of VOC exposure on the brain and behavior:
  - **Organic affective syndrome:** Depression, irritability.
  - **Mild chronic toxic encephalopathy:** Fatigue, mood disturbances, memory and attention complaints.
  - **Severe chronic toxic encephalopathy:** Loss of intellectual abilities, impaired judgment and memory, personality changes.

World Health Organization

PRESS RELEASE
N° 221

17 October 2013

IARC: Outdoor air pollution a leading environmental cause of cancer deaths

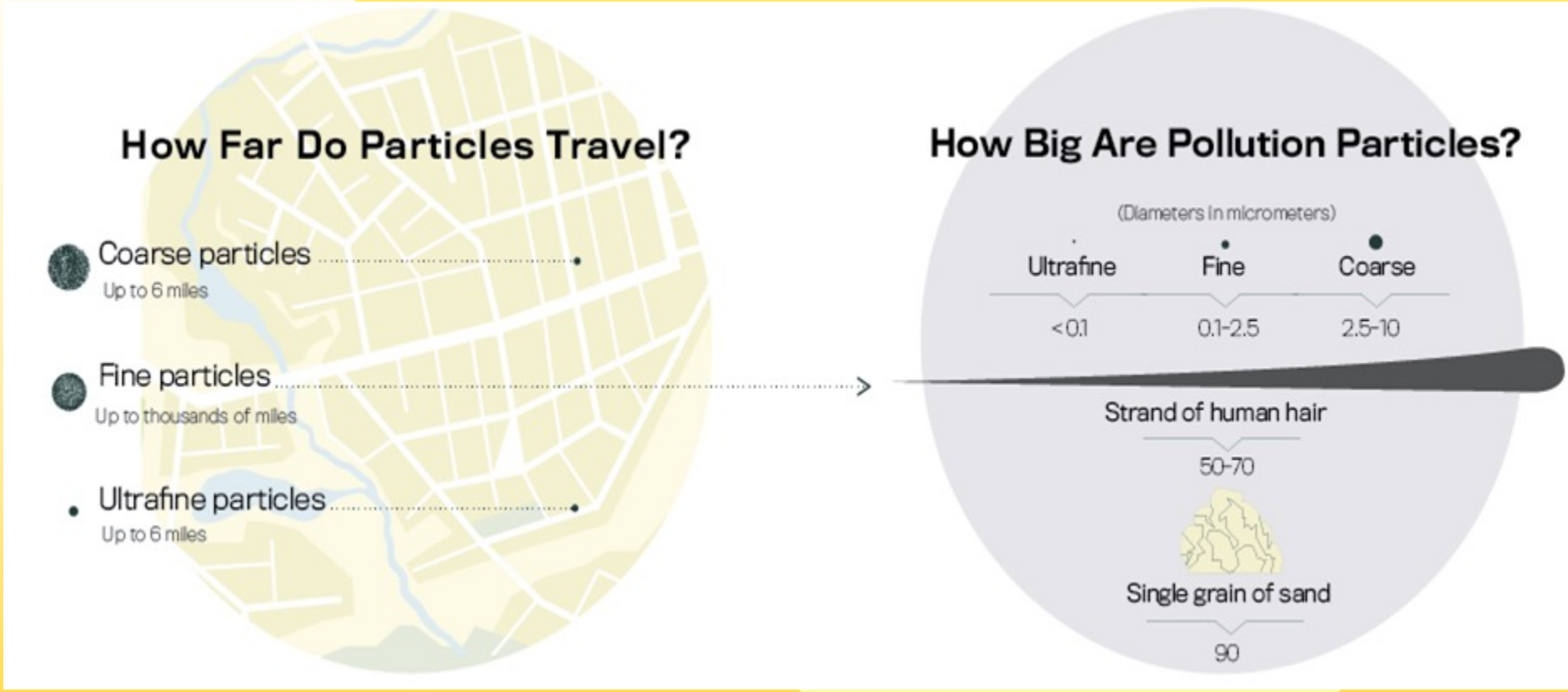
Lyon/Geneva, 17 October 2013 – The specialized cancer agency of the World Health Organization, the International Agency for Research on Cancer (IARC), announced today that it has classified outdoor air pollution as *carcinogenic to humans* (Group 1). [1]

After thoroughly reviewing the latest available scientific literature, the world's leading experts convened by the IARC Monographs Programme concluded that there is *sufficient evidence* that exposure to outdoor air pollution causes lung cancer (Group 1). They also noted a positive association with an increased risk of bladder cancer.

Particulate matter, a major component of outdoor air pollution, was evaluated separately and was also classified as *carcinogenic to humans* (Group 1).

The IARC evaluation showed an increasing risk of lung cancer with increasing levels of exposure to particulate matter and air pollution. Although the composition of air pollution and levels of exposure can vary dramatically between locations, the conclusions of the Working Group apply to all regions of the world.

PM10 PM2.5 PM1


How Far Do Particles Travel?
Coarse particles
Up to 6 miles
Fine particles
Up to thousands of miles
Ultrafine particles
Up to 6 miles
How Big Are Pollution Particles?
(Diameters in micrometers)
Ultrafine
Fine
Coarse
<0.1
0.1-2.5
2.5-10
Strand of human hair
50-70
Single grain of sand
90

IARC MONOGRAPHS

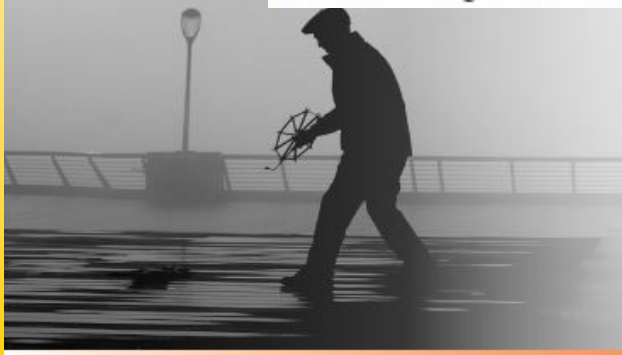
OUTDOOR AIR POLLUTION

VOLUME 109

Outdoor air pollution is *carcinogenic to humans (Group 1).*

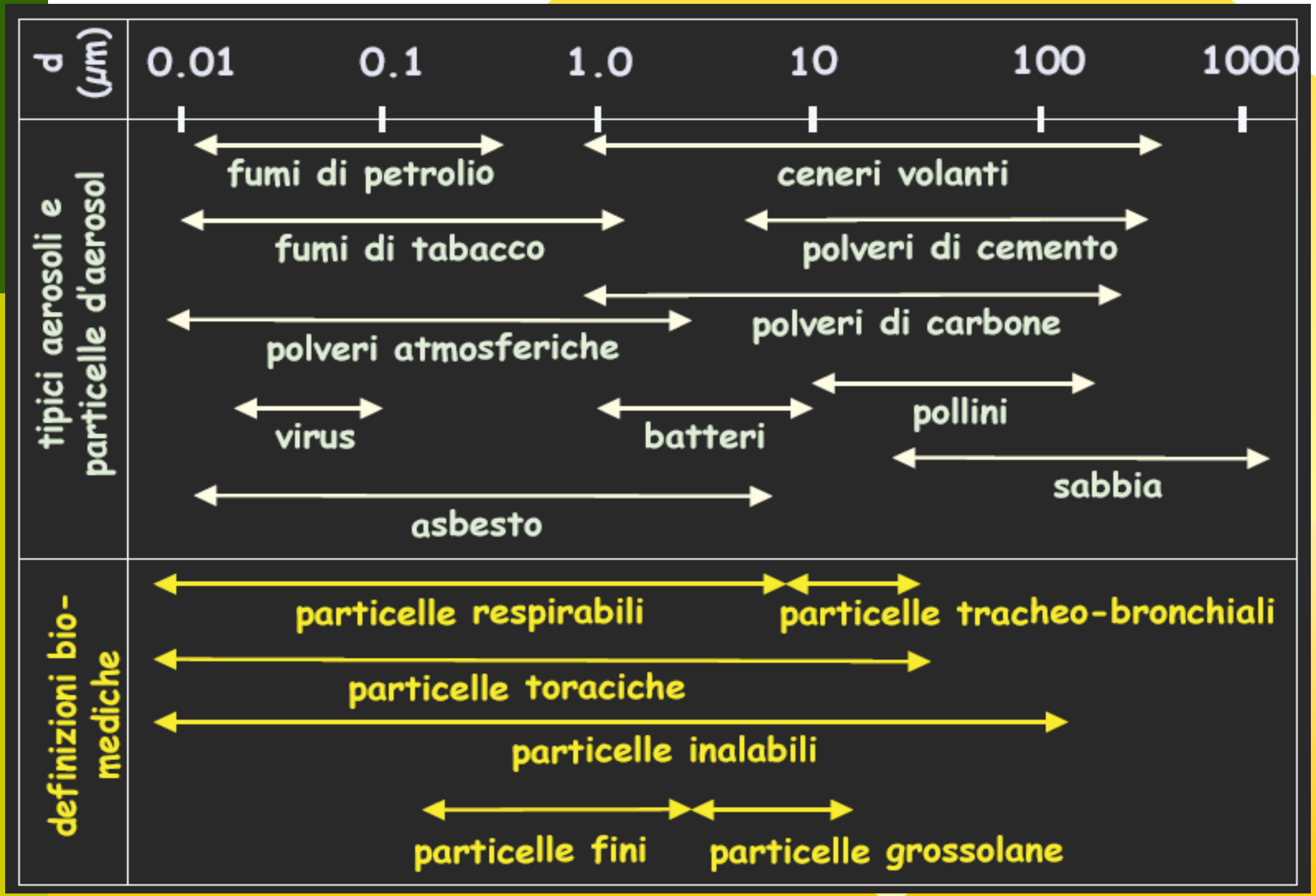
Particulate matter in outdoor air pollution is *carcinogenic to humans (Group 1).*

The sufficient evidence in humans and experimental animals was also strongly supported by the multiplicity of documented genetic and related effects in humans and experimental systems. This strong mechanistic evidence indicated that outdoor air pollution worldwide is mutagenic and is carcinogenic to humans via genotoxicity.



IARC MONOGRAPHS
ON THE EVALUATION
OF CARCINOGENIC RISKS
TO HUMANS

International Agency for Research on Cancer
World Health Organization


d (μm)
0.01
0.1
1.0
10
100
1000
tipici aerosoli e particelle d'aerosol
fumi di petrolio
ceneri volanti
fumi di tabacco
polveri di cemento
polveri di carbone
polveri atmosferiche
virus
batteri
pollini
sabbia
asbesto
definizioni bio-mediche
particelle respirabili
particelle tracheo-bronchiali
particelle toraciche
particelle inalabili
particelle fini
particelle grossolane

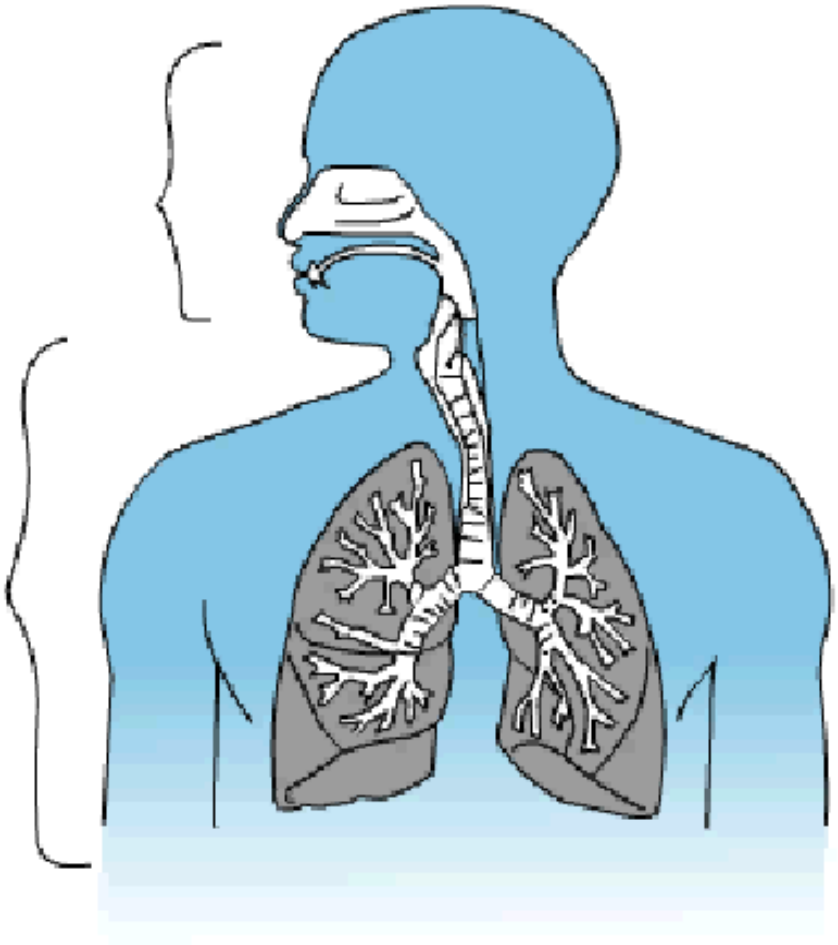
Many toxicological studies have pointed out that particles in the ultrafine size range (<100 nm) pose special problems to the lungs due to their high efficiency of deposition.

Particle Deposition in the Pulmonary Respiratory System

Head Airways
Extra Thoracic/
Nasopharyngeal
region

Lung Airways
Tracheobronchial
region

Alveolar/Pulmonary
region



Start

Instant Dose N_i

$$N_{\mathrm{i}} = \sum_{j=1}^{n} C_j \times V_t \times \mathrm{DE}_j$$

Cumulative Dose N_{tot}

$$N_{\mathrm{tot}} = \sum_{i=1}^{t} N_{\mathrm{i}}$$

ICRP, 1994. Pubblication 66: Human Respiratory Tract Model for Radiological Protection. International Commission on Radiological Protection.

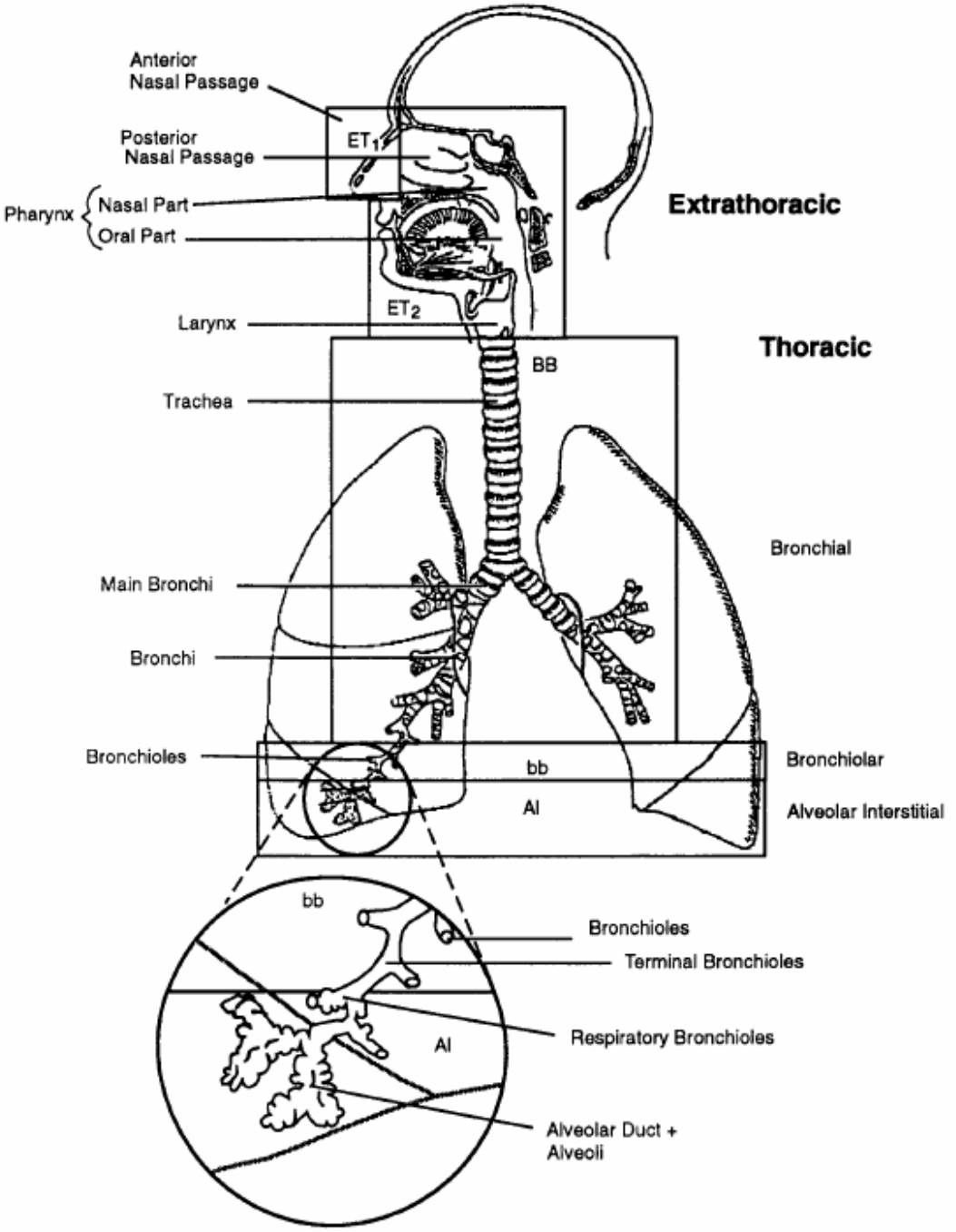
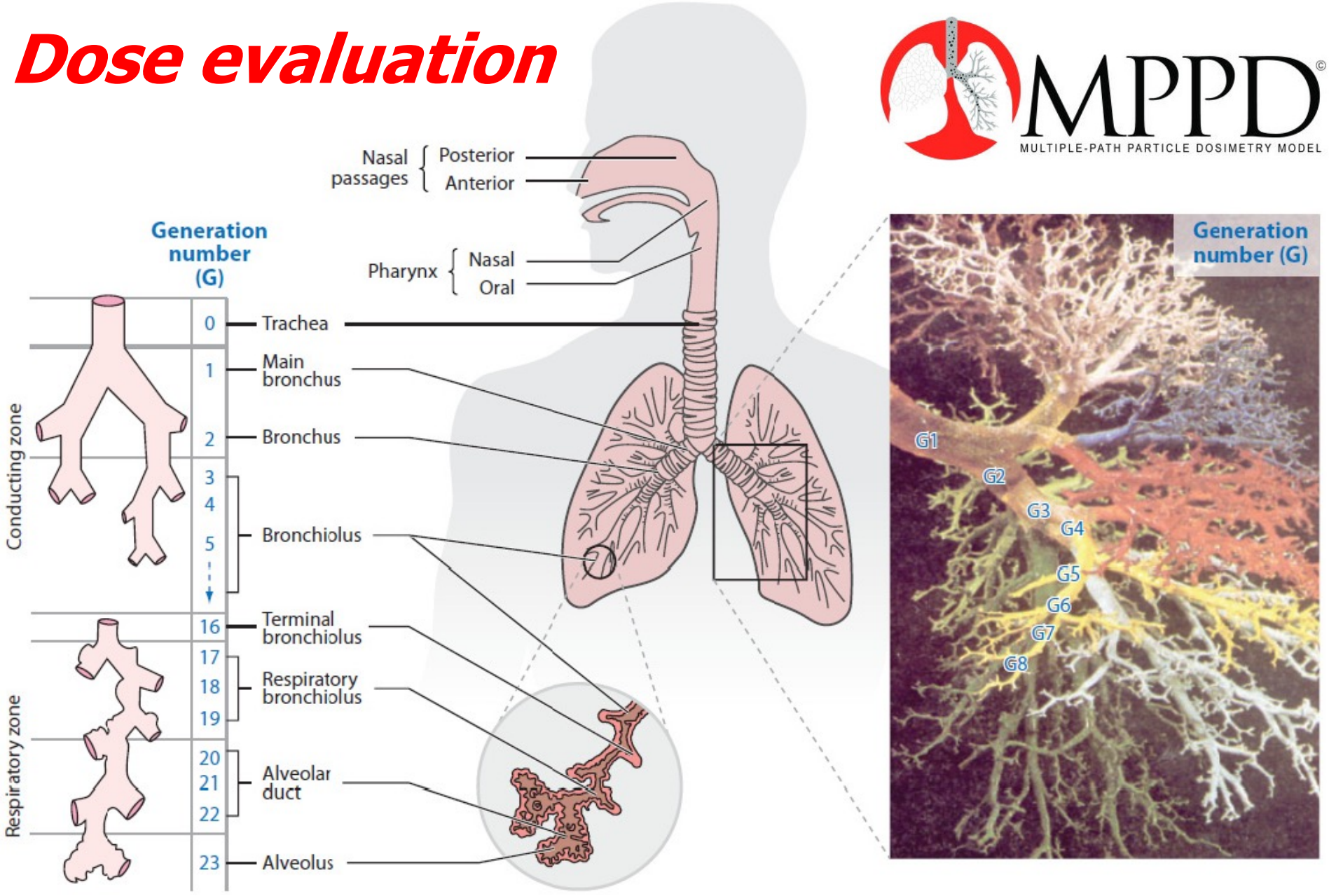


Fig. 1. Anatomical regions of respiratory tract.

Dose evaluation

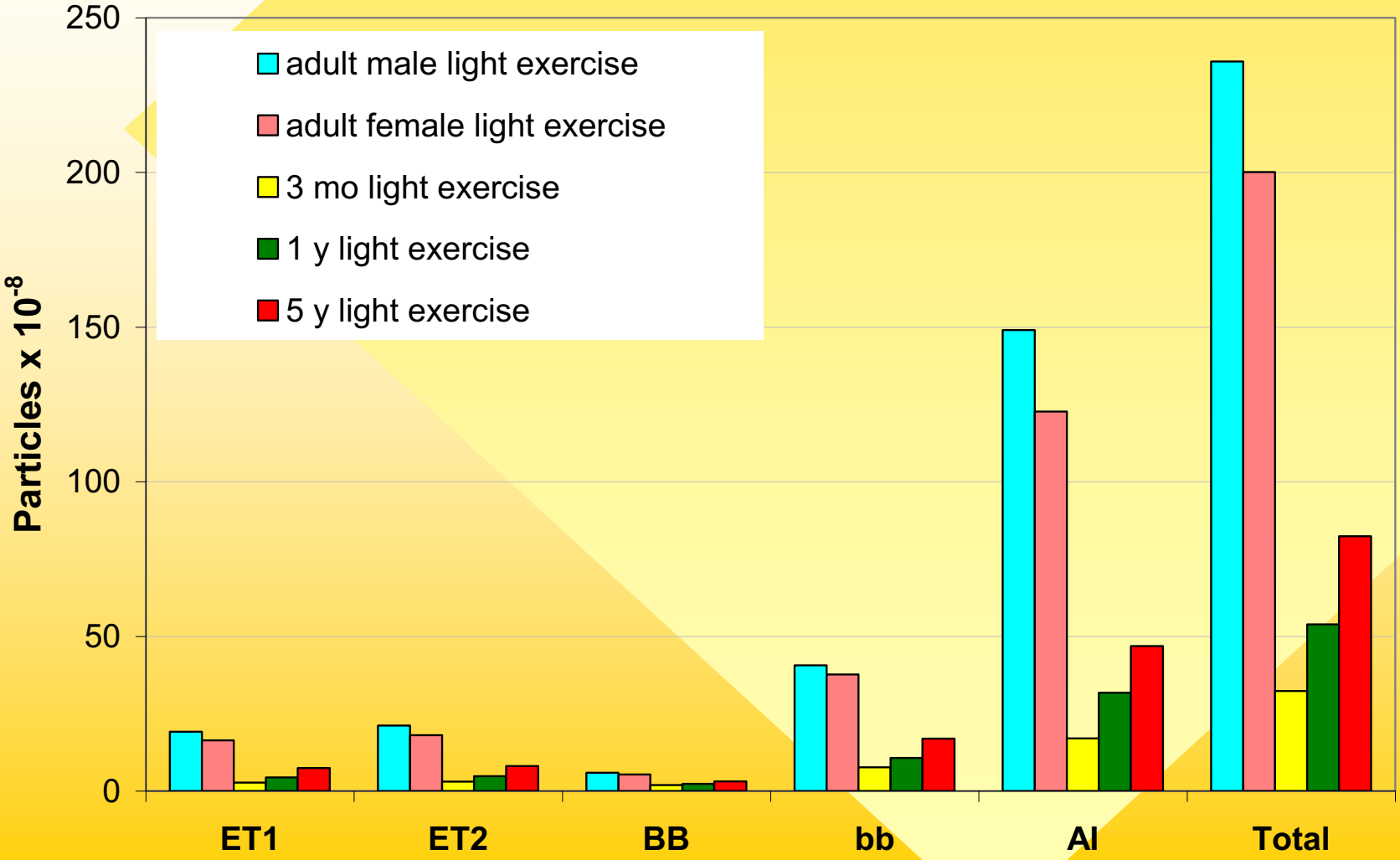
MPPD
MULTIPLE-PATH PARTICLE DOSIMETRY MODEL



Gangwal et al. Informing Selection of Nanomaterial Concentrations for ToxCastTM In Vitro Testing Based on Occupational Exposure Potential. (http://www.epa.gov/ncct/download_files/posters/Gangwal_SOT11.pdf)

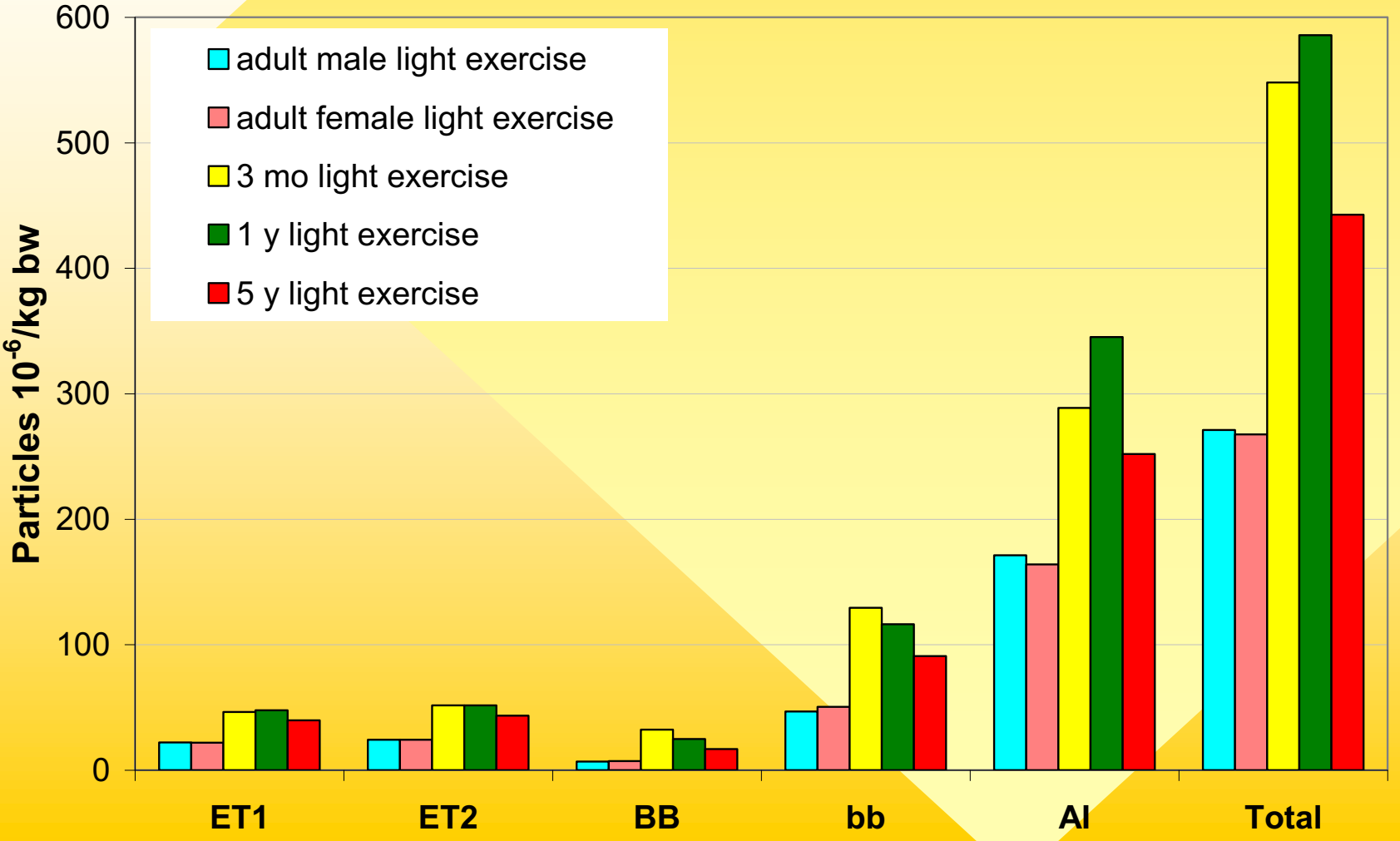
Cumulative Regional Dose

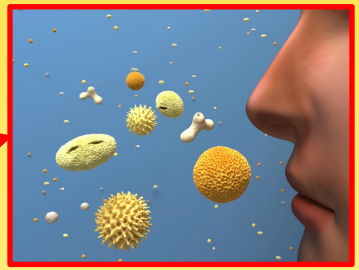
Adult males, females and infants - (Particles)



Cumulative Regional Dose

Adult males, females and infants - (Particles/kg_{BW})





Effects of Particulate Matter on the human health

It is essential to identify and characterize the emissive sources of UFPs in order to perform a full evaluation of PM population exposure

Typical indoor aerosol generation events

Non-Combustion sources

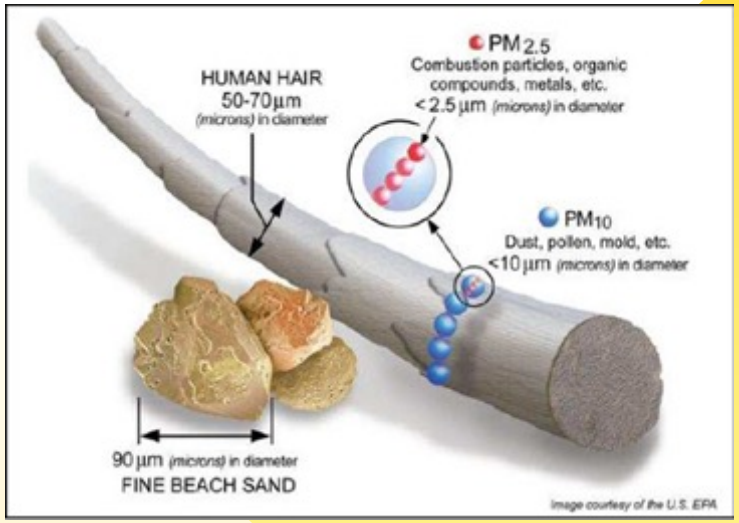
- Hair dryers
- Hot flat iron
- Electric drill
- Vacuum cleaners
- Spray air freshener

Combustion sources

- Mosquito coils burning
- Citronella burning
- Incense
- Smoking cigarettes (*second-hand* smoke)
- Cooking activities

The Scarlet Sunset

by Joseph Mallord William Turner (1830)



Thanks for your kind attention