

Why Air Quality Matters to Everyone

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CEET

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Ambient Air Pollution

EPA Criteria Air Pollution

O₃ (ozone)

PM (particulate matter)

SO₂ (sulphur dioxide)

NO_x (nitrogen oxides)

CO (carbon monoxide)

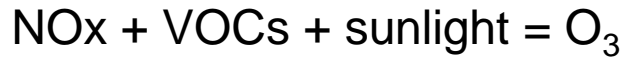
Lead

Dose-Response Relationship

◆ **“The dose makes the poison”**

Photochemical Smog (Summer Smog)

Ozone- in stratosphere occurs naturally, protects us from UV radiation



Nitrogen oxides (NO_x): fuel combustion (motor vehicles, coal power plants)

Volatile Organic Compounds (VOCs): Paints, Pesticides, Gasoline vapors and naturally occurring



Ozone Health Effects

- ◆ **Respiratory symptoms- wheezing, coughing, chest discomfort, bronchoconstriction, decreased lung function**
- ◆ **Mucous membrane irritation- throat, sinus, eye**
- ◆ **Long-term exposure may cause asthma**
- ◆ **Children particularly vulnerable- high respiratory rate**

Geography: Its Effect on Air Pollution

- ◆ **Urban areas surrounded by mountains or in a bowl type geographical depression are most at risk**
- ◆ **Examples: London, Los Angeles, Mexico City, Bogata, Santiago**

Winter Smog: Inversion

Cold air at
high altitude



Warm polluted
air trapped



Cold air at
ground level



Acute Air Pollution Episodes and Attributed Mortality

- ◆ Meuse Valley of Belgium 1930- **60 deaths** during thermal inversion
- ◆ Denora, PA 1948- **20 deaths** during thermal inversion (steel mills, coke ovens, zinc production, sulfuric acid manufacturing)
- ◆ Great Smog of London 1952- **4000 deaths** in 2 weeks



Sulfur Dioxide (SO₂)

- ◆ Created in combustion of fuels containing sulfur (coal, oil)
- ◆ Created when gasoline is extracted from oil; and metals extracted from ore
- ◆ SO₂ reacts in air to form sulfuric acid
- ◆ SO₂ combines with particulates (PM) to forms acidic complexes

Sulfur Dioxide (SO₂) Health Effects

- ◆ Reduced lung function, bronchoconstriction
- ◆ Asthma exacerbation: high levels/ brief periods
- ◆ Cardiovascular- myocardial infarction
- ◆ Exacerbation of respiratory disease
- ◆ Eye, nasal, sinus irritation
- ◆ Adverse pregnancy outcomes
- ◆ Mortality

Nitrogen Oxides (NO_x)

- ◆ Created by fuel combustion in motor vehicles (especially), coal power plants etc
- ◆ Generates ozone with VOCs and sunlight
- ◆ In atmosphere forms reactive nitrogen compounds, nitric acid, nitrates, and acid aerosols

Nitrogen Oxides (NO_x) Health Effects

- ◆ Irritation eyes, nose and throat
- ◆ Short term decreases in lung function
- ◆ Bronchoconstriction
- ◆ Possible increase in respiratory infections in children

Health Effects of Ozone, SO₂ and NO_X are Similar and Additive

Particulate Matter (PM)

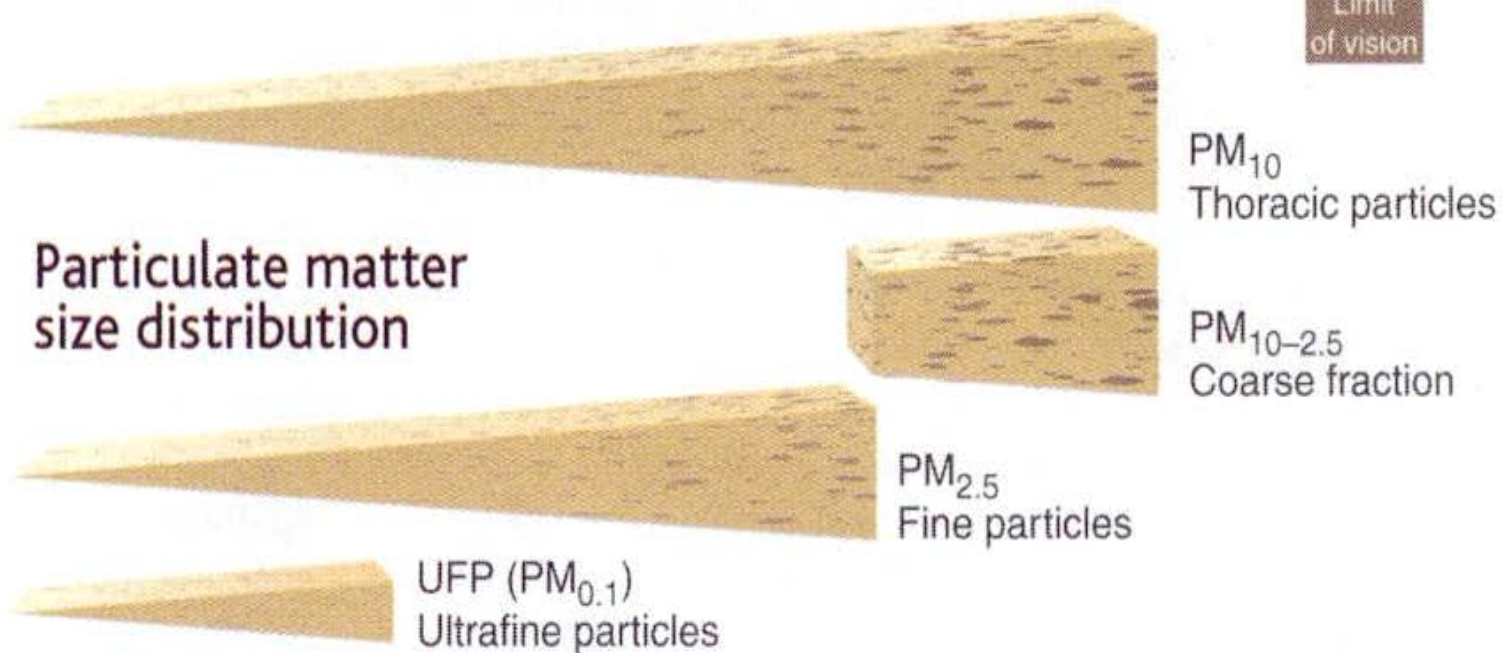
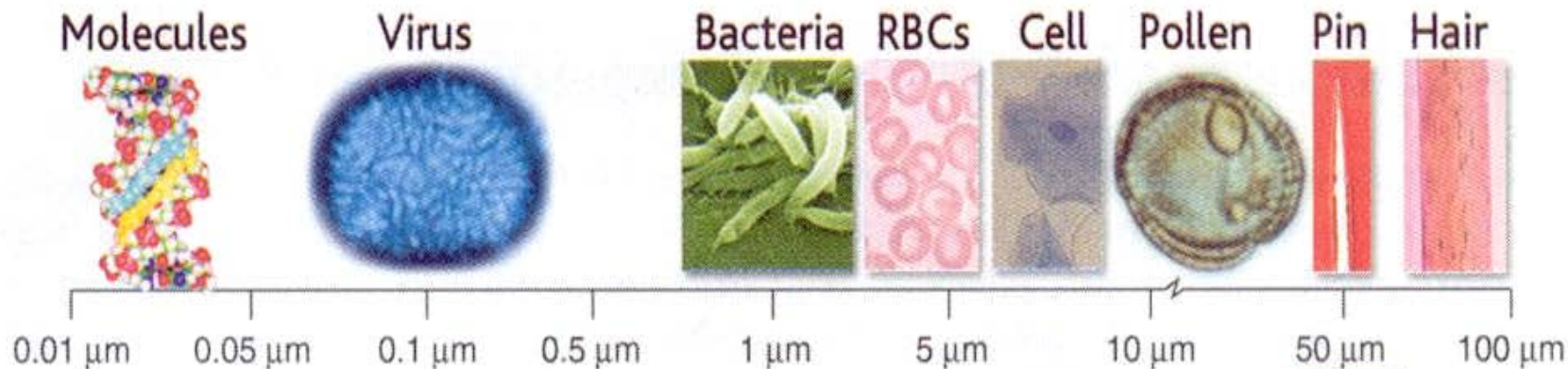
Mixture of solid particles & liquid droplets

PM 10: airborne particles ≤ 10 μm

PM 2.5: fine airborne particles that are ≤ 2.5 μm

Ultrafine particles are ≤ 0.1 μm

Main sources: gasoline/diesel engines, power plants, incinerators, wood burning, natural -pollens, fires etc.



Absorption from Inhalation

Particles	Deposition site
Size	
Large	Upper Tract
Small	Lower Tract

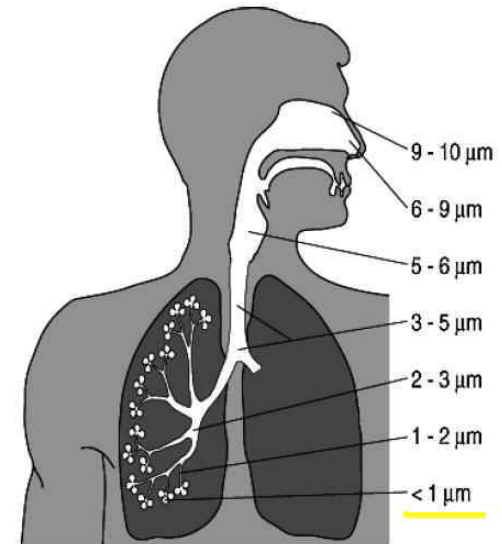
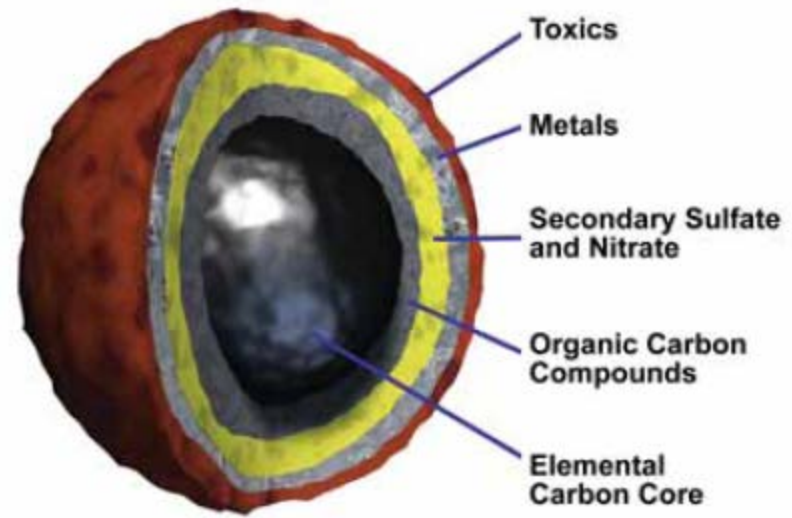


Figure 2 Particle deposition in respiratory system

Composition of Diesel Exhaust



◆ Particulate phase

- Mostly elemental carbon (soot)
 - 20% to 40% adsorbed organic compounds
- Sulfates, nitrates, metals, other trace elements
- The most toxicologically relevant adsorbed **compounds (less than 1% of PM by mass):**
 - PAHs
 - Nitro-PAHs
 - Oxidized PAH
- 92% of mass is in particles smaller than 1 micron

Health Effects of Fine and Ultrafine Particles

- ◆ **Increased mortality from cardiac/ respiratory problems in populations exposed to fine particulates such as in diesel exhaust (Bruske-Holfeld et al, 2005)**
- ◆ **Changes in cardiovascular physiology (arterial diameter and cardiac rhythm)**
- ◆ **Coal miners accumulate ultrafine dust in the liver and the spleen. Accumulation higher in miners exhibiting pulmonary problems
(Donaldson, 2005)**

Epidemiologic Studies

- **Harvard Six Cities (Dockery et al 1993)**
 - PM_{2.5} associated with mortality (1.26 (95%CI: 1.08-1.47))
 - Elevated risks for lung cancer and cardiopulmonary disease
 - Lower risks for other air pollutants, sulfates similar
- **ACS (Pope et al 2002, 2004)**
 - Each 10- $\mu\text{g}/\text{m}^3$ elevation in PM_{2.5} associated with
 - 4% increased risk of all-cause mortality
 - 6% increased risk of cardiopulmonary mortality
 - 8% increased risk of lung cancer mortality

Asthma in Children

- ◆ **Between 1980 and 1995 the prevalence of asthmatic children in the USA increased from 2.3 million to 5.5 million**
- ◆ **Sharpest prevalence increases – urban minority children under 5 years of age**
- ◆ **Atopy (familial allergy to common allergens) with IgE antibody production is the most reliable predictor of asthma development**
- ◆ **Air pollutants potentiate the tendency toward allergy**

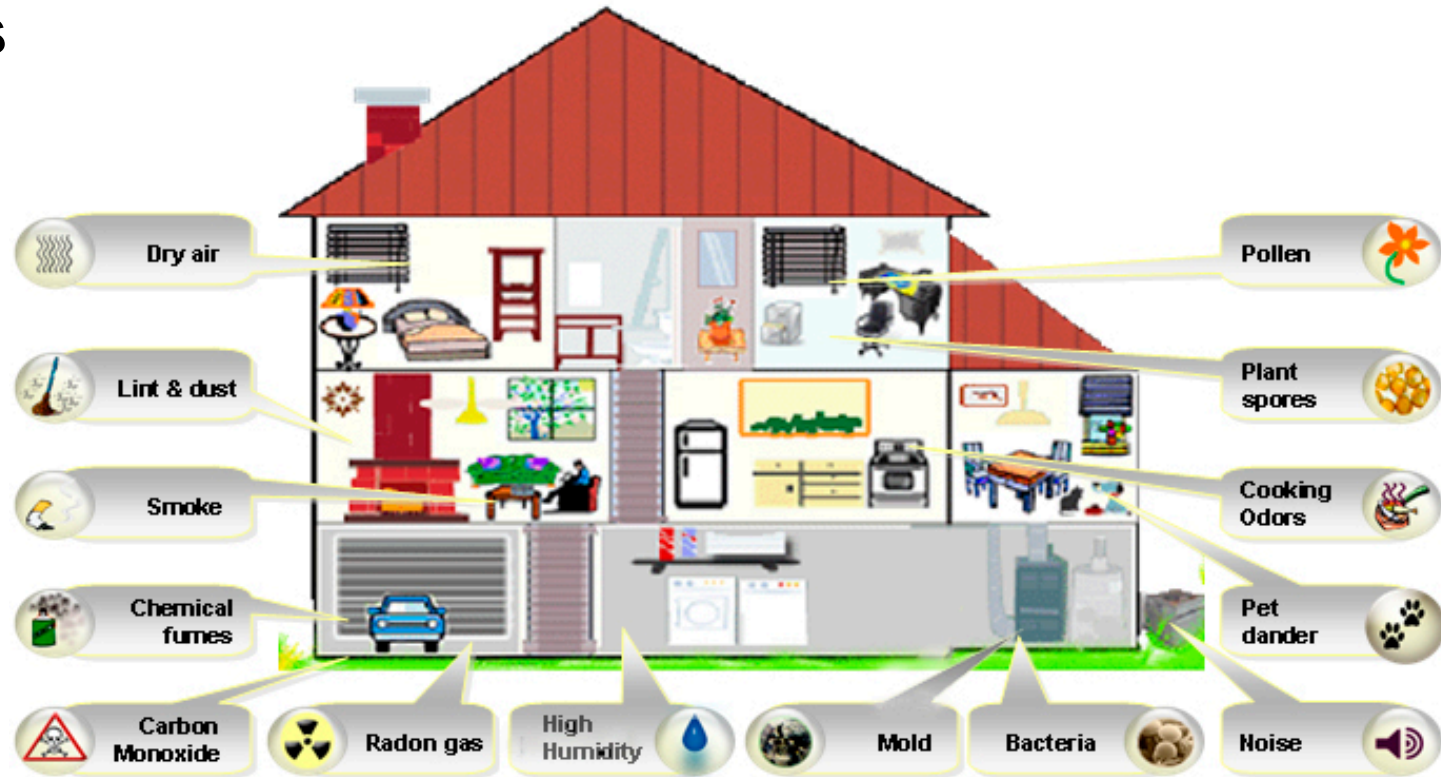
National Ambient Air Quality Standards (NAAQS)

- ◆ **December 14, 2012 EPA revised PM 2.5 standard from 15ug/m³ to 12 ug/m³**

- ◆ **Expected to save thousands of ER visits for exacerbation of cardiac and pulmonary conditions**

Indoor Air Contaminants

- ◆ Biologic Agents
- ◆ Combustion Products
- ◆ Particulates
- ◆ Pesticides
- ◆ Radon
- ◆ VOCs



Health Effects Attributed to Poor IAQ

- ◆ Irritation of mucous membranes
- ◆ Headache
- ◆ Lethargy
- ◆ Sinus congestion
- ◆ Allergy
- ◆ Asthma

Mold and the Illness it Can Cause

- ◆ **Anyone can become sensitized (allergic to mold proteins) if the exposure is great or long lasting**
- ◆ **Atopic individuals are more likely to become sensitized to mold**
- ◆ **Hypersensitivity pneumonitis occurs with large inhalation exposure only**
- ◆ **Exacerbation of allergy leading to asthma can occur with ongoing exposure**

Mold grows in large amounts only when there is water intrusion and humidity remains >50%



Summary: Why Air Quality Matters

- ◆ **Significant health effects of poor outdoor and indoor air quality**
- ◆ **Vulnerable populations are particularly at risk: children, elderly, those with underlying heart and lung conditions**
- ◆ **Improving air quality saves lives and improves health**