

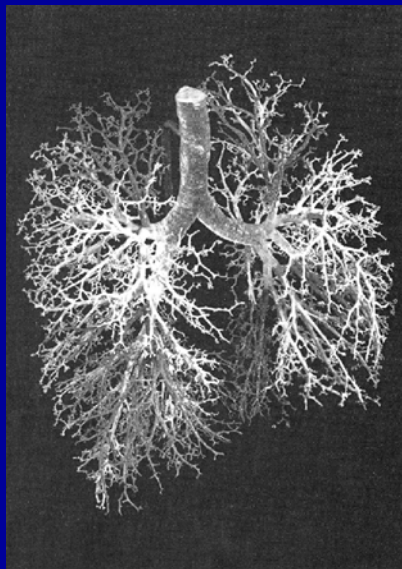
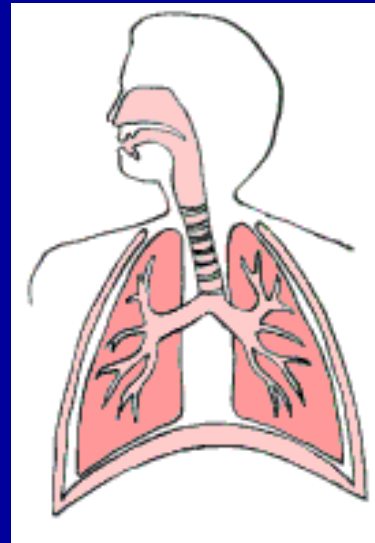
Health Effects of Fine Particles

Particles - Characterized

- **Physical features**
 - Mass on filter ($\mu\text{g}/\text{m}^3$), size 2.5 (greater surface area) or 10 micrometers
- **Sources (primary and secondary formation)**
 - wind-blown dust and diesel exhaust (primary)
 - reaction of sulfates/nitrates released from power plants (secondary)
- **Chemical composition/mode of action**
 - Chemical irritants (acids, nitrates, sulfates, organic carbon compounds, peroxides, acid aldehydes)
 - Catalysts in rxtns (nickel, vanadium, copper)
 - Immunologic stimulus (bacterial endotoxins, pollen, fungal spores, animal dander, dust mite and cockroach antigen)

Particle Deposition

- Larger particles ($> PM_{10}$) deposit in the upper respiratory tract, nose and throat
- Smaller, inhalable particles ($\leq PM_{10}$) penetrate into the lungs ($PM_{2.5}$ more so)



- Smallest particles (ultrafines, $PM_{0.1}$) may enter bloodstream
- Deposited particles may accumulate, react, be cleared or absorbed

Types of Studies

- **Epidemiology/field**
 - Real-world exposures (short- and long-term), including sensitive groups
 - Potential confounders (co-pollutants) need to be addressed
 - Most PM studies this type
- **Controlled human exposure**
 - Exposures and confounders controlled
 - only Healthy subjects; few members of sensitive groups
 - Addresses least severe health endpoint for ethical reasons
- **Animal**
 - Exposures and confounders controlled
 - Extrapolation to humans; high dose exposures

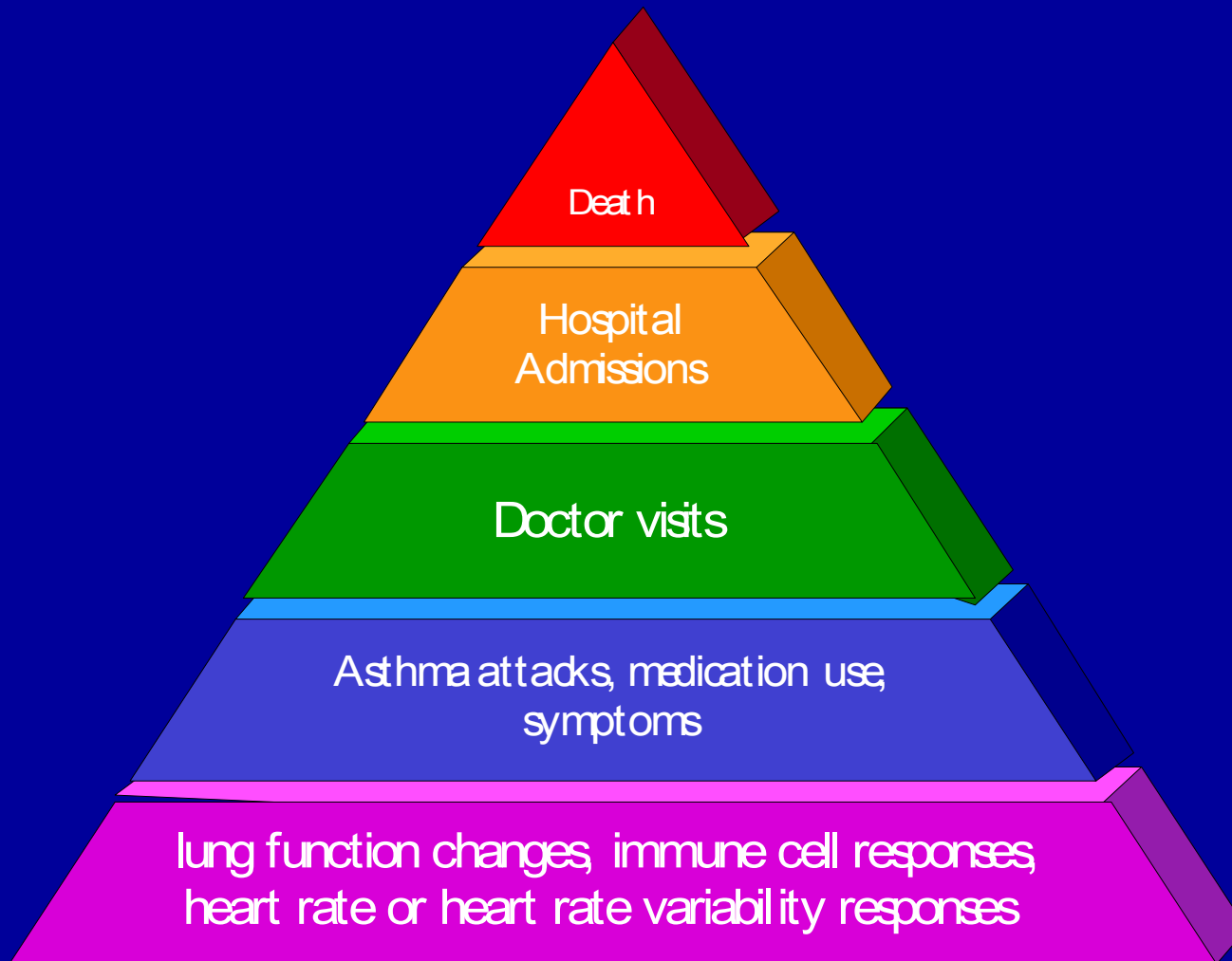
Interpretation of Evidence

- Consistency Across Studies

Similar PM health effects observed in numerous studies with diverse populations, environments, pollutant mixes

- Similar respiratory and cardiovascular effects

“Pyramid of Effects”



Effects on Public Health

- Premature deaths from heart and lung disease
- Hospital and emergency room admissions
- Doctor office visits
- School and work absences
- Medication usage
- Emerging evidence
 - Lung cancer mortality
 - Infant mortality
 - Developmental effects in children (e.g., low birth weight, slowed lung function growth)

Respiratory System Effects

- Adverse effects
 - Increased cases of chronic bronchitis
 - Increased asthma attacks and bronchitis
- Indicators of increased risk
 - Respiratory symptoms
 - Decreased lung function
 - Inflammation of airways

Cardiovascular System Effects

- Adverse effects
 - Heart attacks
 - Cardiac arrhythmias
- Indicators of increased risk
 - Cardiac arrhythmias
 - Heart rate, heart rate variability
 - Blood component changes
 - C-reactive protein
 - Fibrinogen

Groups At Risk

- People with heart or lung disease
 - Conditions make them vulnerable
 - Greater particle deposition with COPD
- Older adults
 - Greater prevalence of heart and lung disease
- Children
 - More likely to be active
 - Greater particle deposition than adults
 - Developing bodies make them vulnerable

Air Quality Index for PM_{2.5}

| Descriptors Values | PM_{2.5} ($\mu\text{g}/\text{m}^3$) | Cautionary Statements |
|--|---|---|
| Good 0 – 50 | 0 – 15 | None |
| Moderate 51 – 100 | 16 – 40 | Unusually sensitive people should consider reducing prolonged or heavy exertion. |
| Unhealthy for Sensitive Groups 101 – 150 | 41 – 65 | People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion. |
| Unhealthy 151 – 200 | 66 – 150 | People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce |
| Very Unhealthy 201 – 300 | 151 – 350 | prolonged or heavy exertion. People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion. |