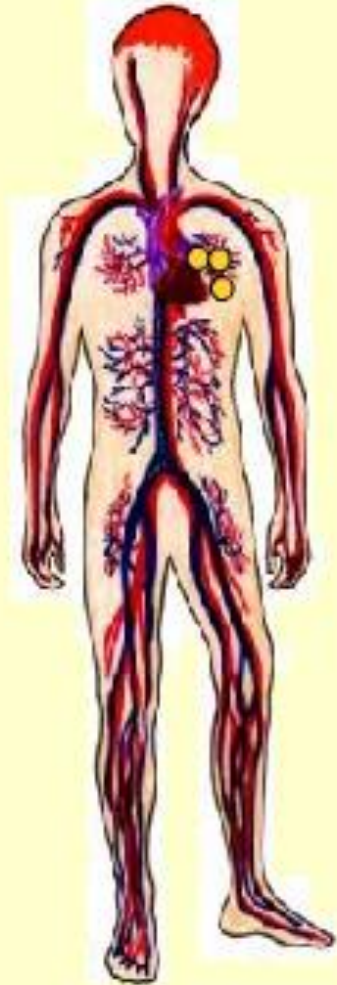
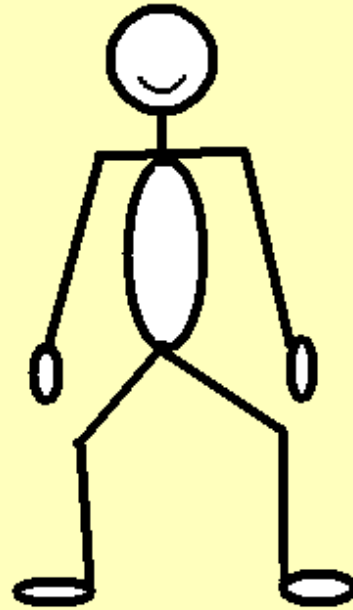


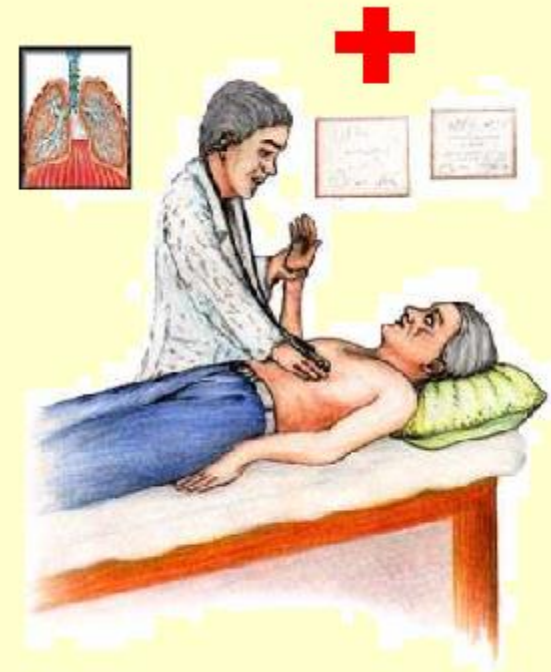
Lack of Oxygen Leads to

- Breathlessness
- Headache
- Dizziness
- Irritability
- Nausea
- Vomiting
- Mental Fatigue
- Bluish Tinge on the Skin, Nails, Lips
- **Even Death**



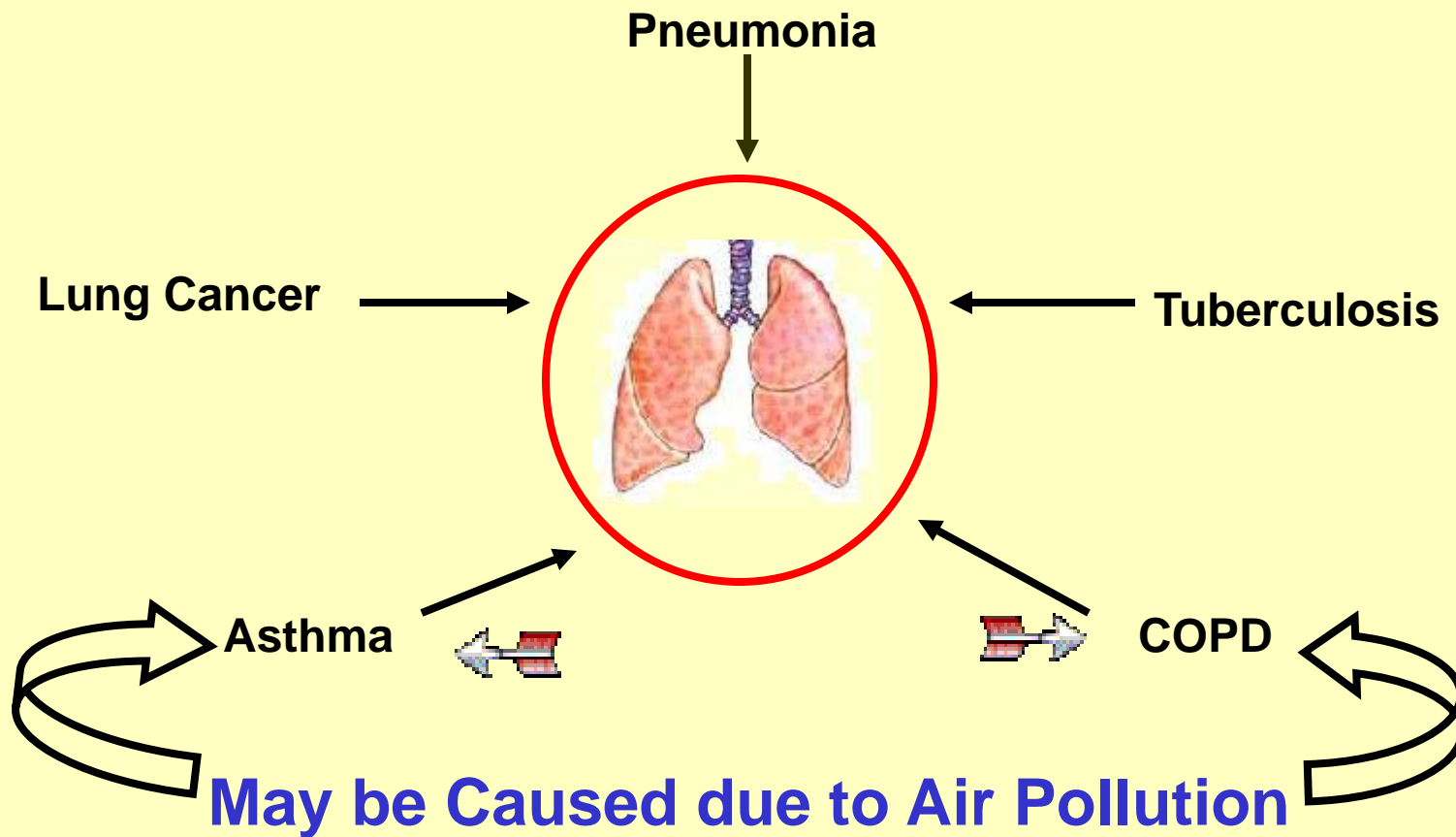
Health Issues – Respiratory System

- COPD (Chronic Obstructive Pulmonary Disease)
- Asthma
- Pneumonia
- Lung Cancer
- Tuberculosis
- Genetically Induced



Air Pollutants Affecting Human Health

- **Fine Particulate Matter** - **Respiratory System**
- **Carbon Monoxide** - **Hemoglobin**
- **Oxides of Nitrogen** - **Lung Cleansing**
- **Sulfur Dioxide** - **Lung Cleansing**
- **Hazardous Pollutants**
Attached to Particulates - **Respiratory,
Cardiovascular and
Other Organs**

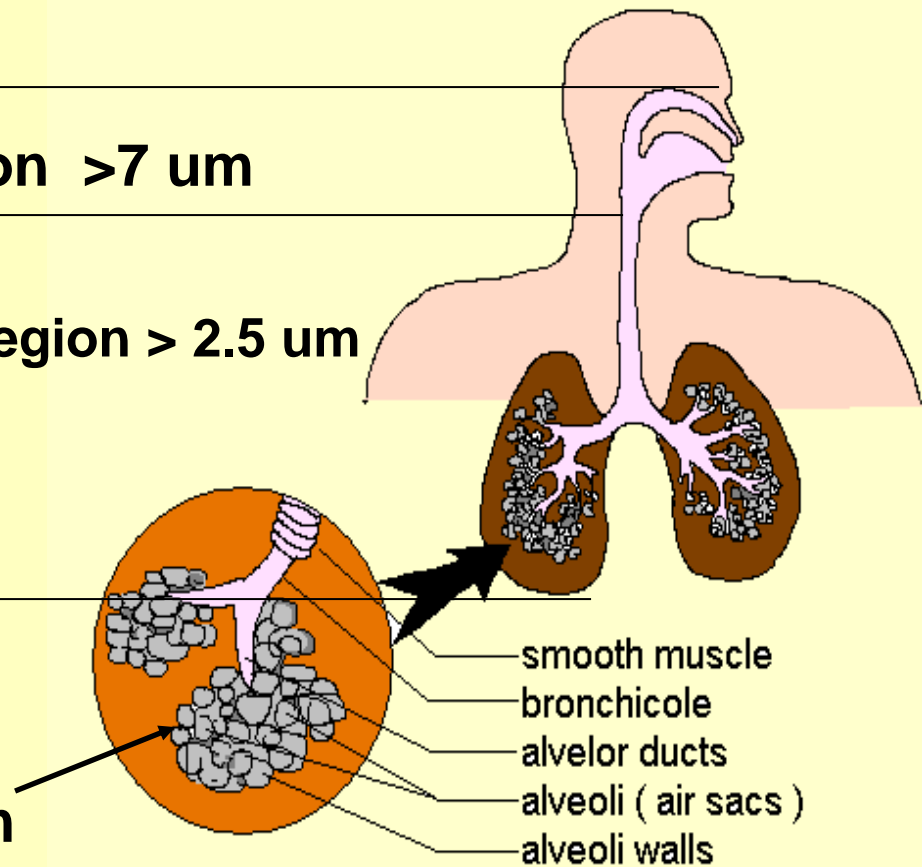


Deposition

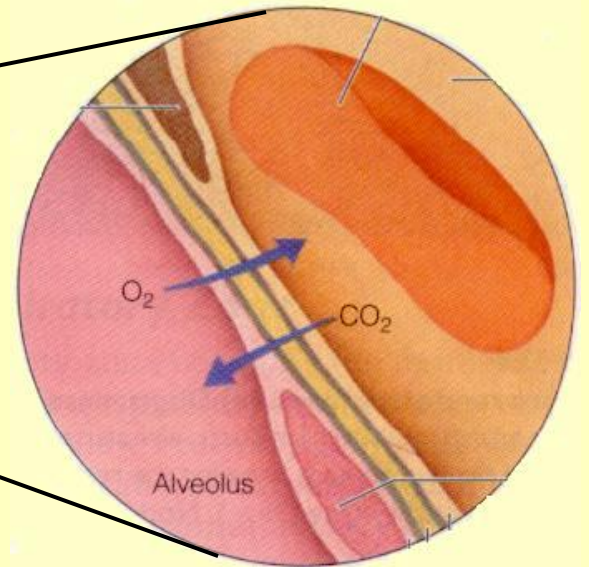
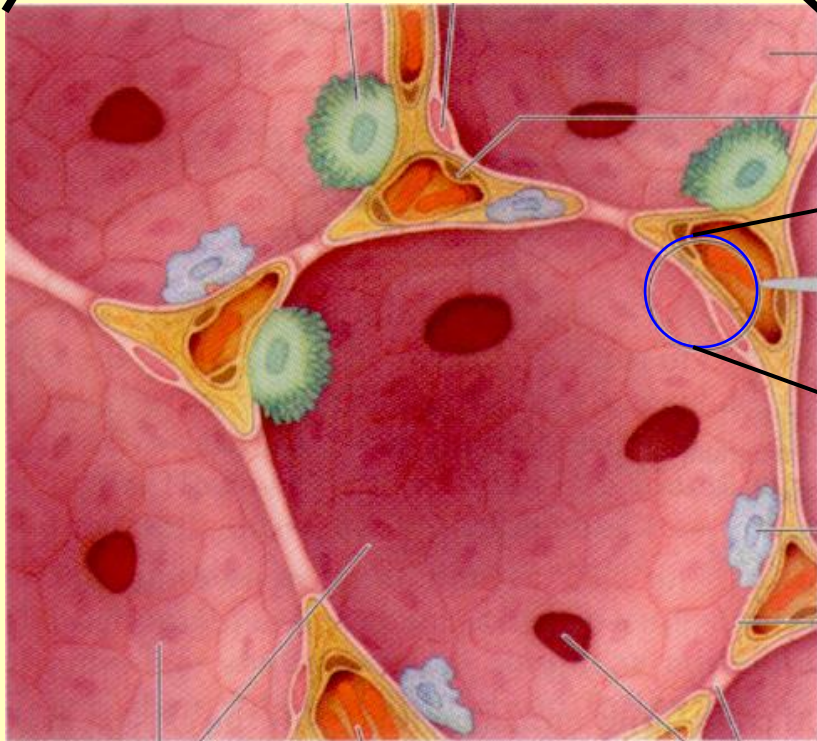
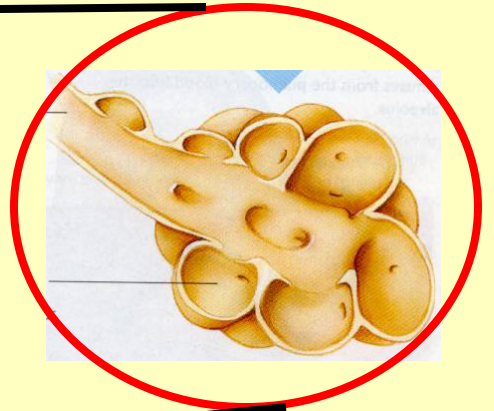
Extra Thoracic Region $>7 \mu\text{m}$

Tracheobronchiole Region $> 2.5 \mu\text{m}$

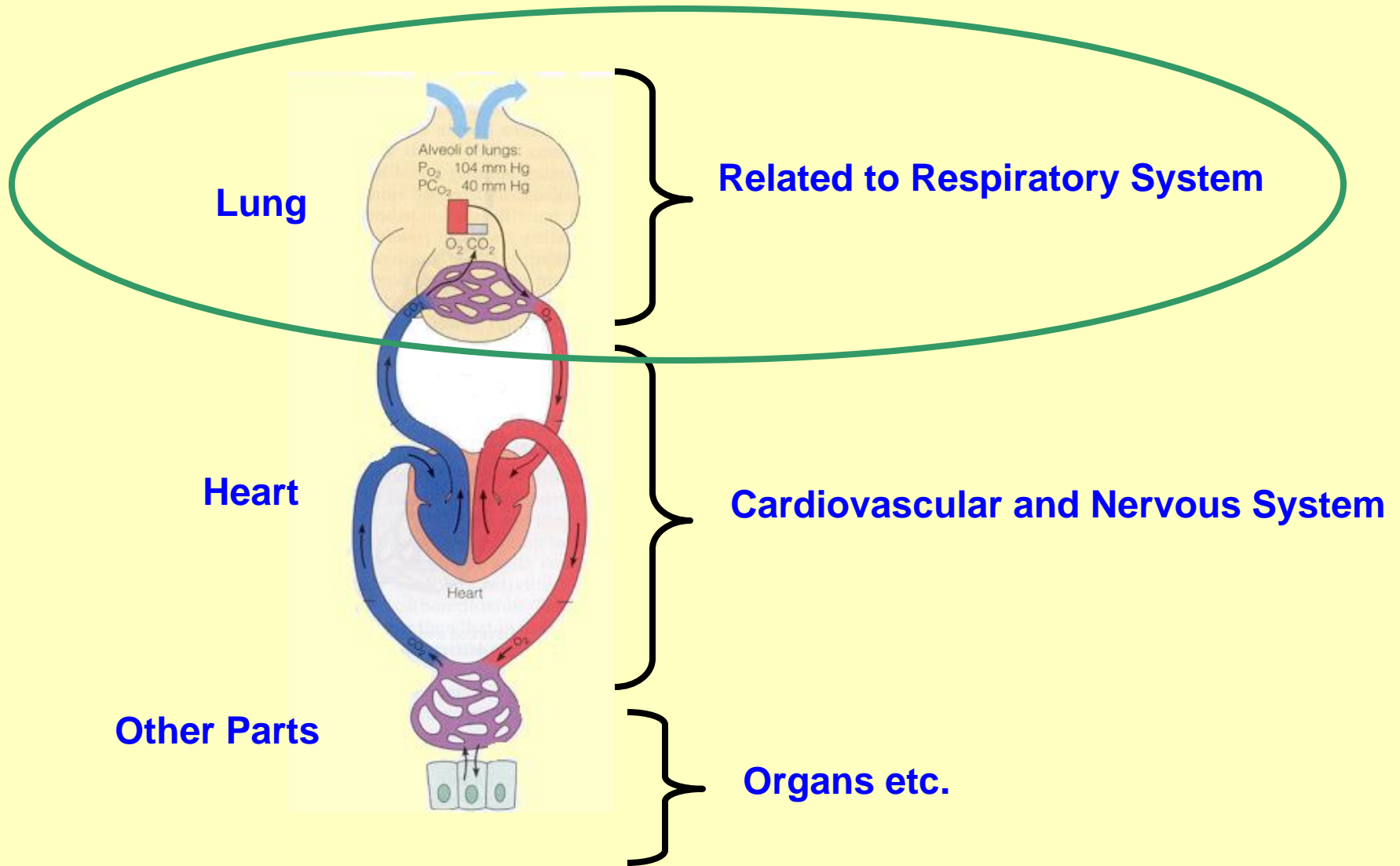
Alveolar Region $>0.45 \mu\text{m}$



- Particles less than 1 micron are settled in the alveolus
- Macrophages have a major role in cleaning them



Hierarchy of Air Pollution Health Effects

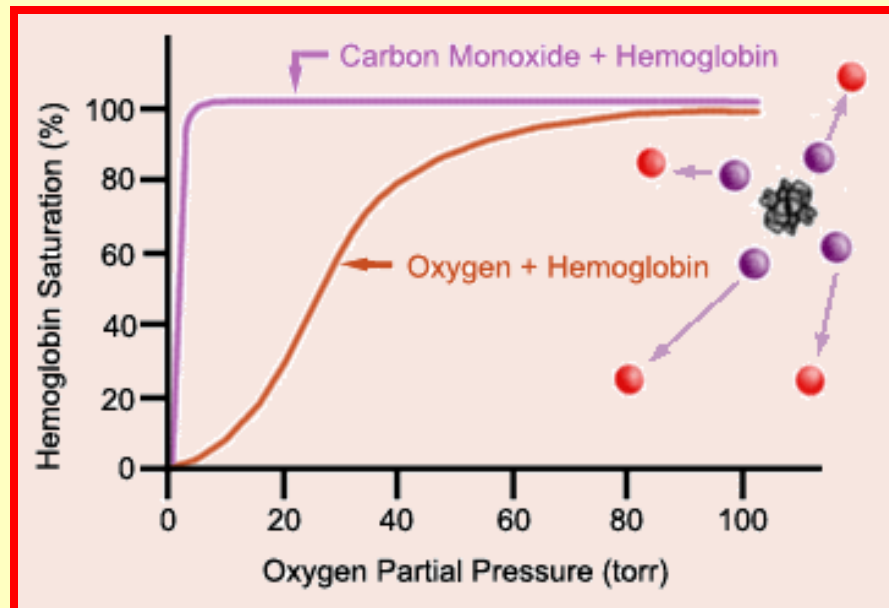


Air Pollutants Affecting Human Health

- **Fine Particulate Matter** - **Respiratory System**
- **Carbon Monoxide** - **Heamoglobin**
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- **Sulfur Dioxide** - **Lung Cleansing**
- **Hazardous Pollutants Attached to Particulates** - **Respiratory, Cardiovascular and Other Organs**

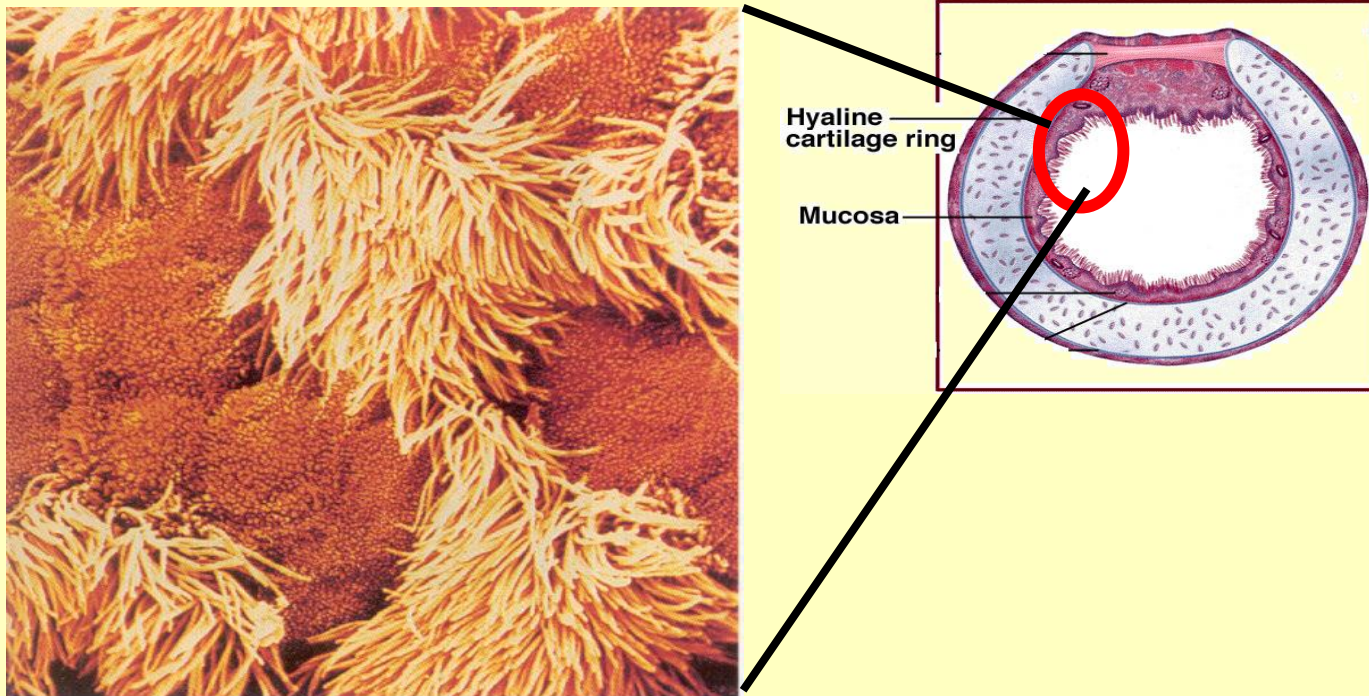
Health Effects - Carbon Monoxide

- CO binds with hemoglobin at the same sites as O₂, but with about 200 times more the affinity.
- CO is thus extremely toxic because it destroys the O₂ carrying capacity of the blood
- The LC(50) in rats is 1807 ppm for 4 hours [NIOSH 1993].



Health Effects - Oxides of Nitrogen

- **Effecting Mucociliary Mechanism - mucus and cilia**
– exposure to 6ppm for 6 weeks

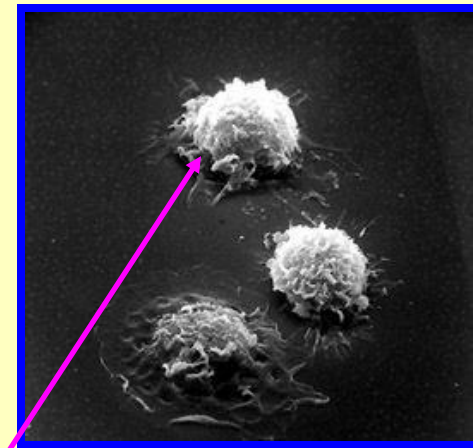
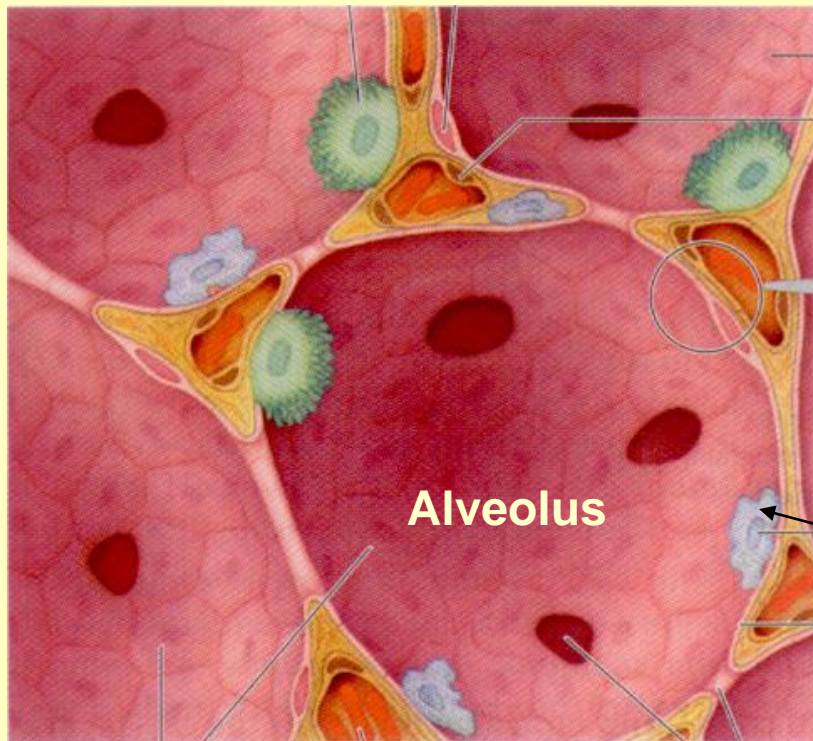


Mucociliary Escalator?

Health Effects - Oxides of Nitrogen

Destroying the cleaning mechanism of Macrophages

leads to accumulation of bacteria and resulting to
Pneumonia and Tuberculosis



Macrophages

Health Effects - Oxides of Nitrogen

Adverse Health Effect	Concentration at which Effect was Observed	Averaging Time
	NO _x (ug/m ³)	
Increase Mortality	-	-
Aggravation of Asthma	>1000	Annual
Acute Respiratory Disease	150-280	Annual
Increased Chronic Bronchitis	150-280	Annual
Primary Standard (USEPA)	80	Annual
Primary Standard (India-CPCB)	80	24 hours

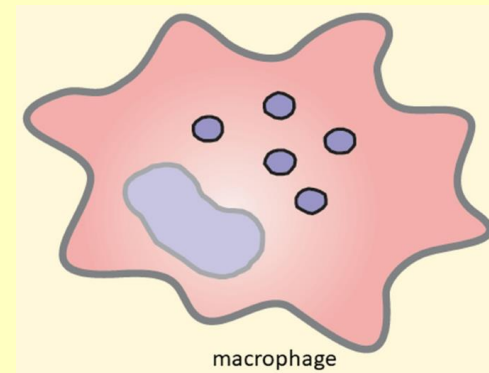
Criteria Document for NO₂ Source USEPA 1974

Health Effects - **Sulfur Dioxide**

Effects are Similar to that of Oxides of Nitrogen

- **Effecting Mucociliary Mechanism**
- **Destroying the cleaning mechanism of Macrophages**
 - **leads to accumulation of bacteria and resulting to Pneumonia and Tuberculosis**

Macrophages - white blood cell that surrounds and kills microorganisms, removes dead cells, and stimulates the action of other immune system cells.

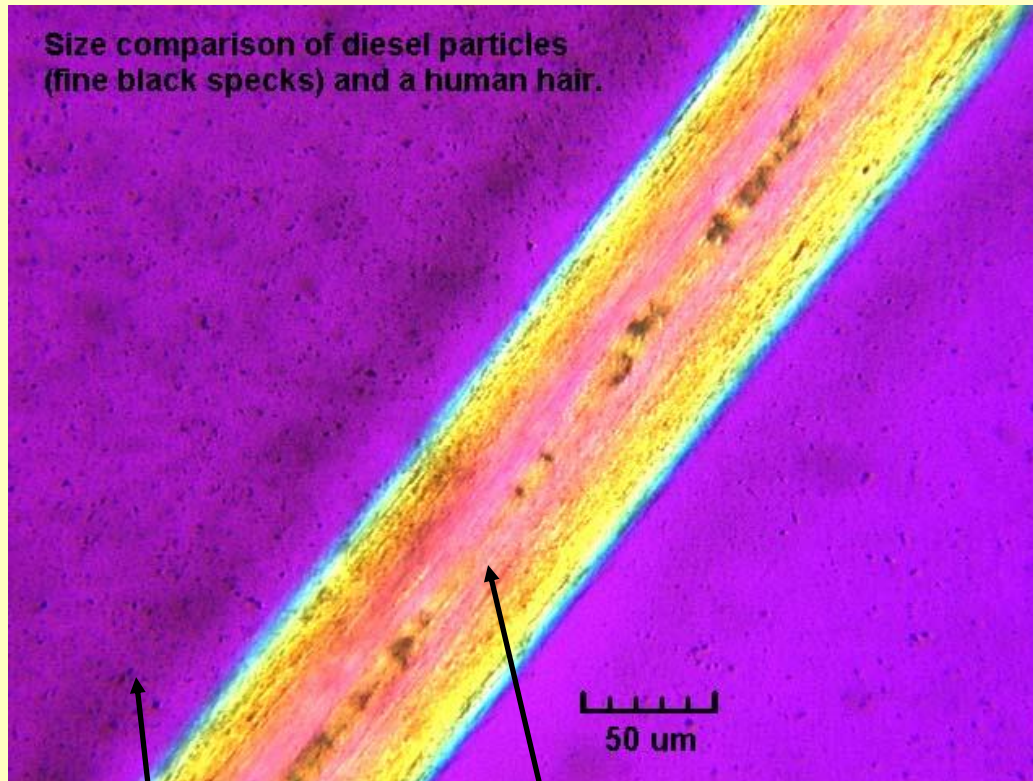


Health Effects - Sulfur Dioxide

Adverse Health Effect	Concentration at which Effect was Observed	Averaging Time
	SO ₂ (ug/m ³)	
Increase Mortality	300-400	24 hours
Aggravation of Asthma	180-250	24 hours
Acute Respiratory Disease	90-100	Annual
Increased Chronic Bronchitis	95	Annual
Primary Standard (USEPA)	80	Annual
Primary Standard (India-CPCB)	80	24 hours

Criteria Document for SO₂ Source USEPA 1974

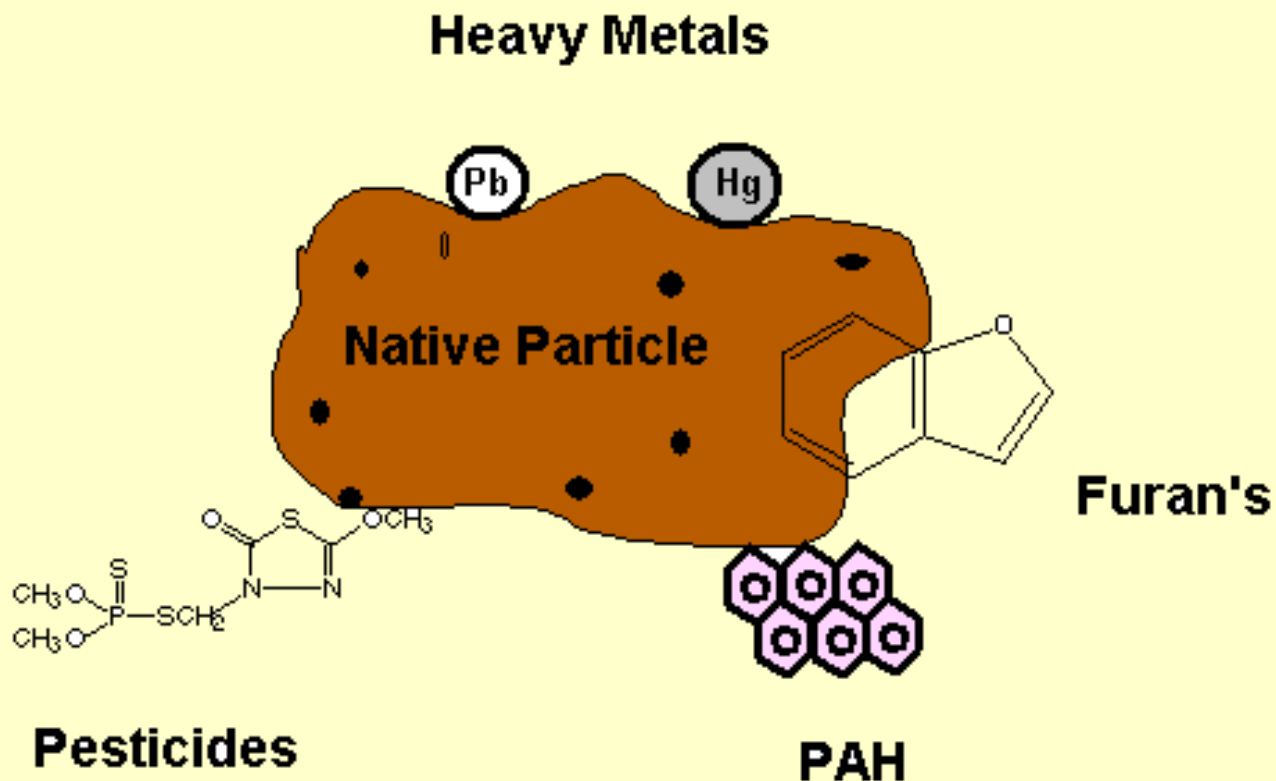
Diesel Engine Particulate Emissions



Human hair ~100 microns

Diesel particles <0.5 microns

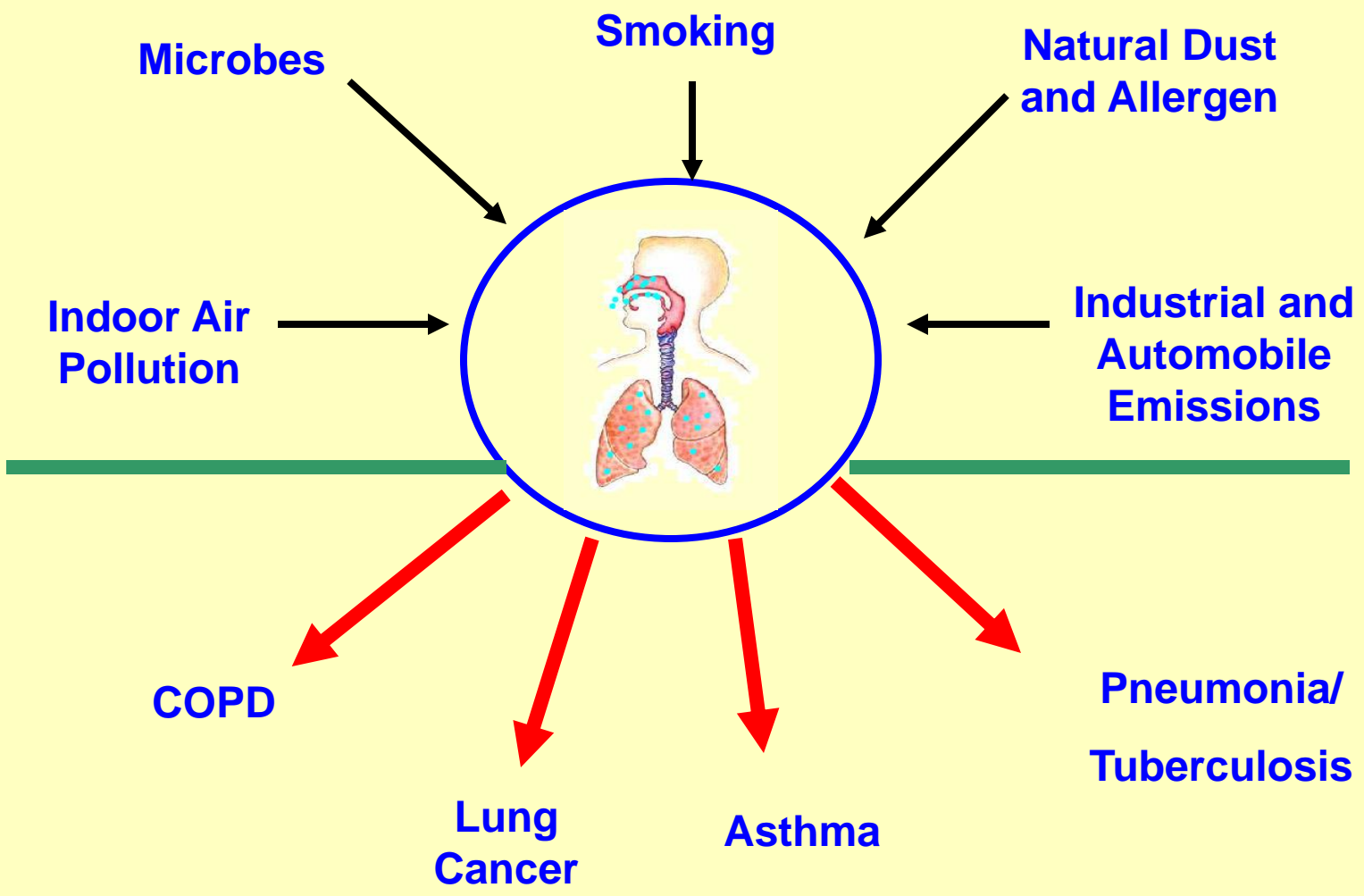
Hazardous Air Pollutants in Particulate Matter



- Surface area (Smaller the Size more the HAPS)
- Elemental Carbon (more adsorption of HAPS)

Respiratory Diseases





Chronic Obstructive Pulmonary Disease (COPD)

**Chronic Obstructive Pulmonary
Disease (COPD) is Common
Disease of the lungs, affecting
millions of people**



Causes of COPD

Constituent	Weight (mg/Cigarette)	% of total effluent
Particulate Matter	40.6	8.2
Nitrogen	295.4	59.9
Oxygen	68.8	13.4
Carbon Monoxide	16.2	3.2
Carbon Dioxide	68.1	13.6
Hydrogen	0.7	0.1
Argon	5.0	1.0
Methane	1.3	0.3
Water vapor	5.8	1.2
Hydrocarbons	2.5	0.5
Carbonyl Compounds	1.9	0.4
Hydrogen cyanide	0.3	0.1
Other Toxic trace elements	1.0	0.2

Composition of Cigarette Smoke



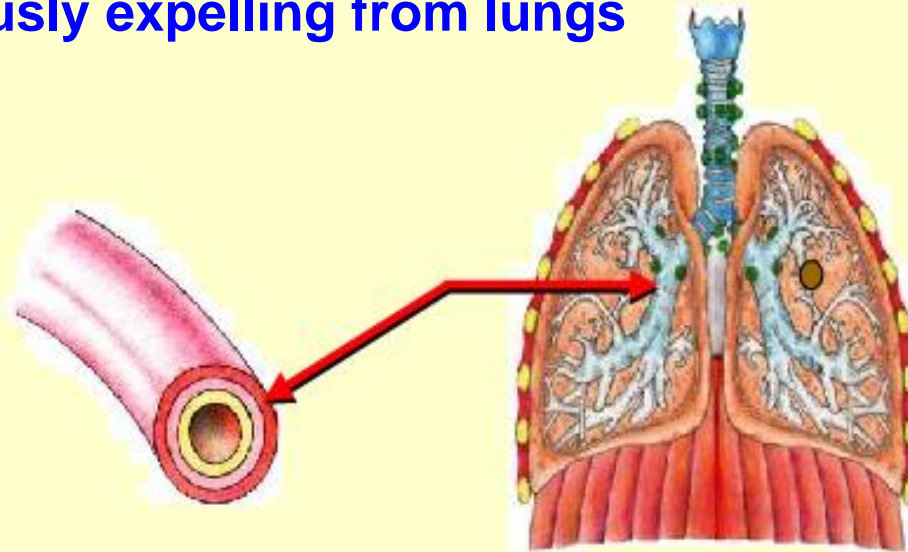
•Source: USEPA – Hazardous Air Pollutant Survey

Tobacco Smoke – Aromatic Fraction

Compound	Concentration (ppm)
Carbon Monoxide	42,000
Carbon Dioxide	92,000
Alkanes	87,000
Alkenes	31,000
Formaldehyde	30
Acetaldehyde	3200
Acrolein	150
Methanol	700
Acetone	1100
Methyl, Ethyl ketone	500
Ammonia	300
Methyl nitrile	200
Hydrogen Sulfide	40
Hydrogen Cyanide	1600
Methyl Chloride	1200

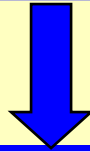
Area Affected & Mechanism

- Inner lining of bronchial tubes secretes special substance called mucus
- Mucus helps trapping the dust from air
- Mucus is continuously expelling from lungs



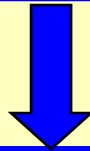
1

Chronic infection of bronchi and destroying normal protective system



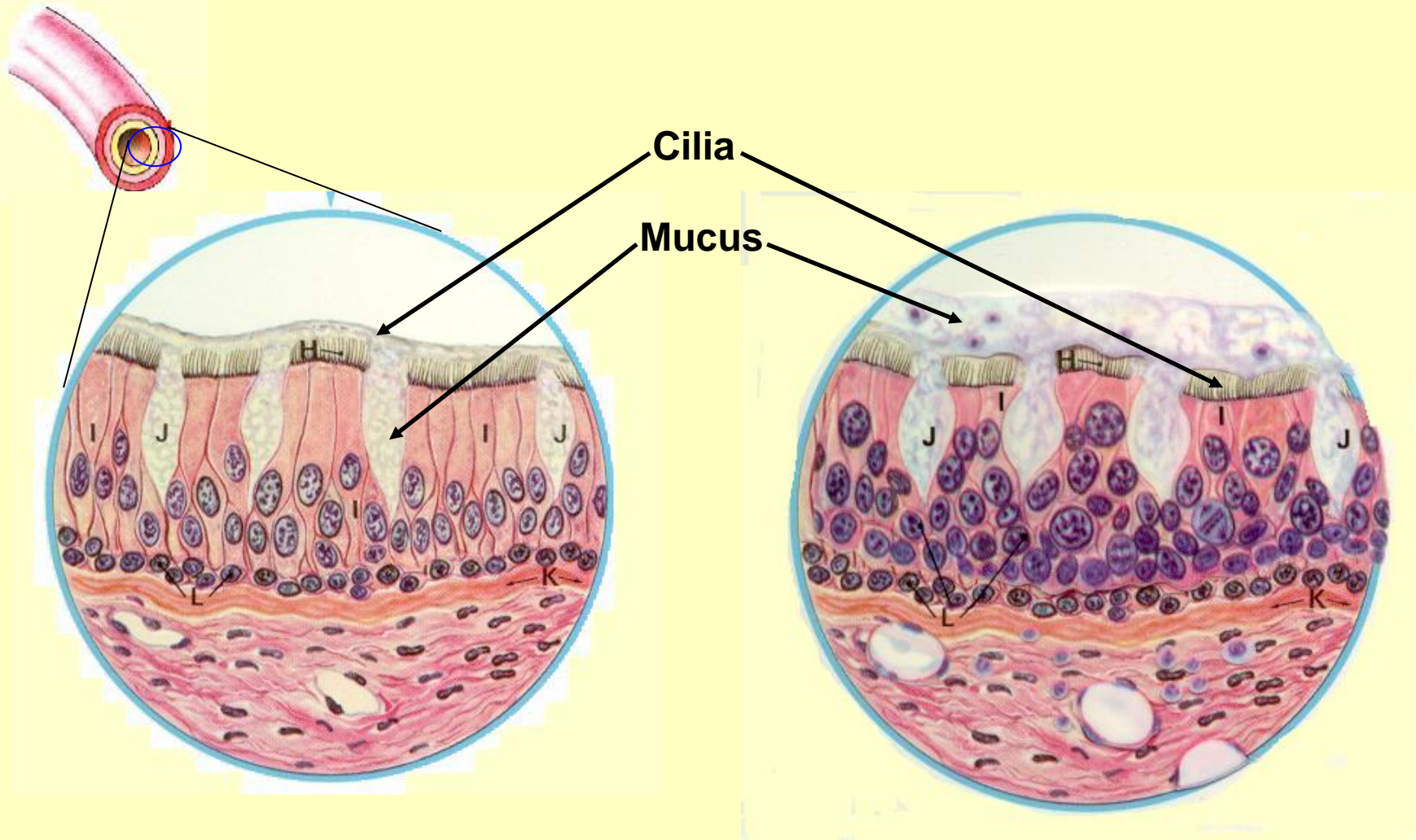
2

Excess mucus and inflammatory edema in bronchi leads to obstruction



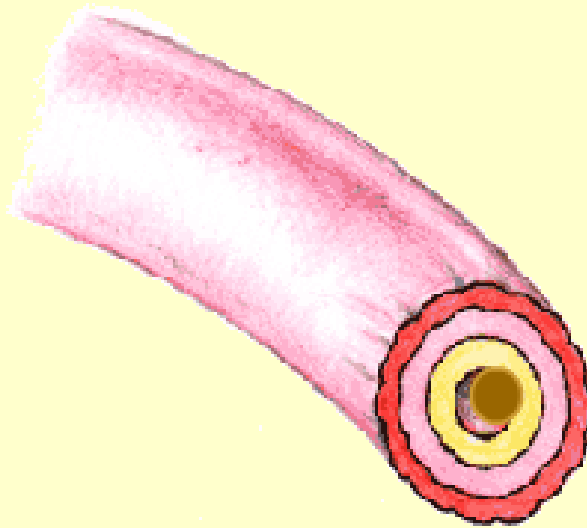
3

Entrapment of air in alveoli and destruction of alveolus walls, reduction in lung capacity



Inner lining of normal Bronchi

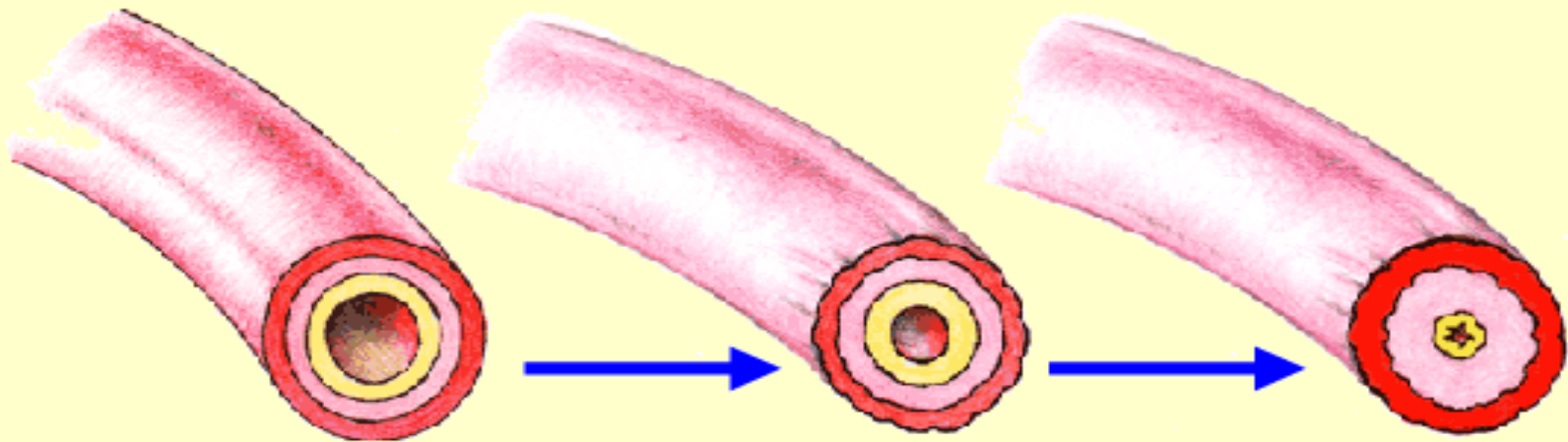
Excess mucus in Smoker's lung



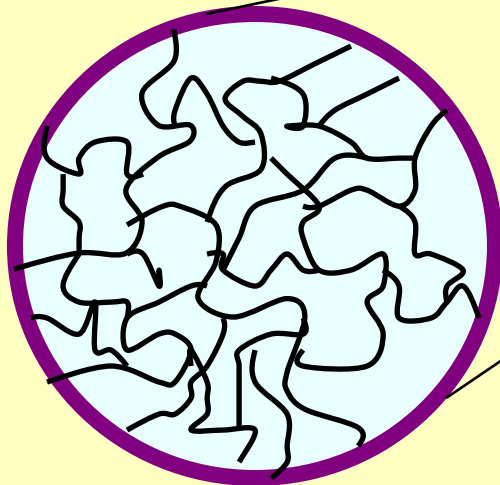
- **The Cilia also becomes unable to expel the dirt accumulated in the lungs.**
- **This causes thick sputum to develop, which cannot be coughed out easily**

Excess mucus and inflammatory edema in bronchi leads to obstruction

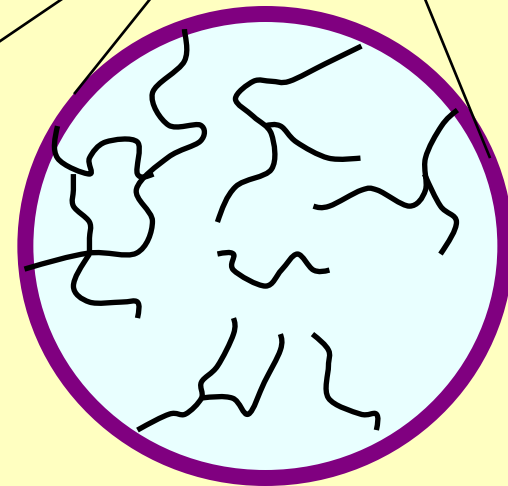
- Inflammation causes thickness of the bronchial tubes and alveoli.
- This causes narrowing of the inside of these tubes and a decrease in the capacity of lungs to exchange oxygen and CO₂



**Entrapment of air in alveoli and
destruction of alveolus walls, reduction
in lung capacity**

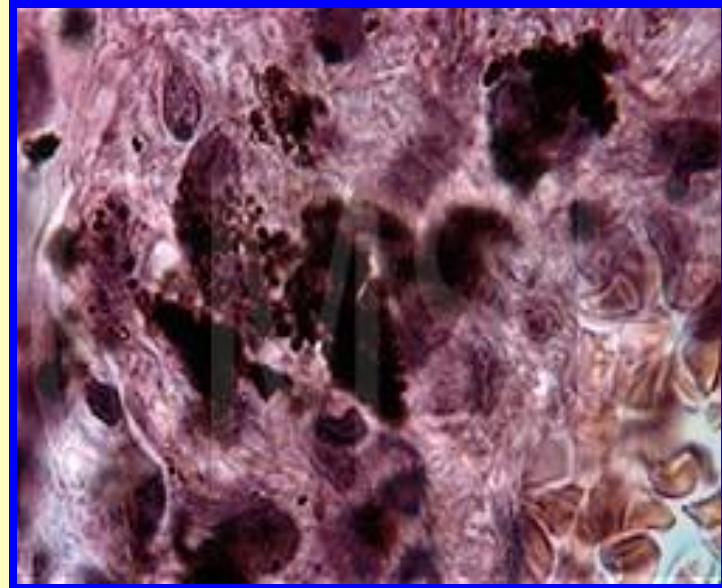
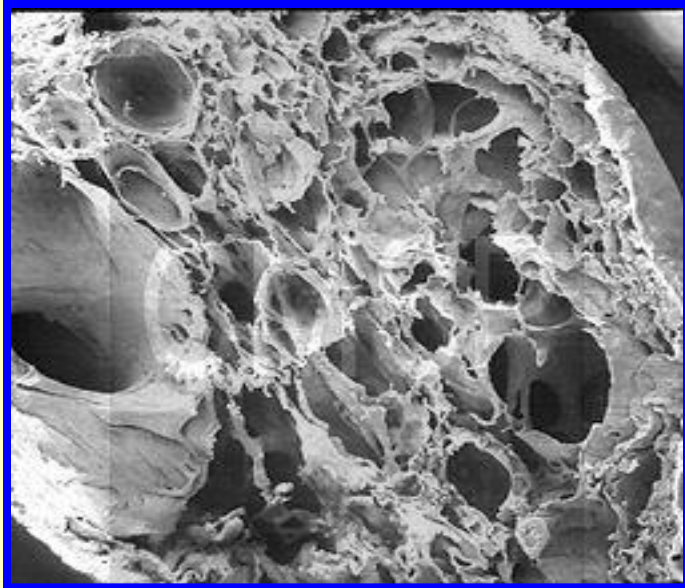


Normal Alveoli



Effected with COPD

Destruction of alveolus walls, reduction in lung capacity





**non-smoker city
dweller's lung**



**smoker's lung with
COPD**

...Lead ?



- Versatile heavy metal
- Extensively used
- Cheap, useful, easy to mine, physical properties - ubiquitous in air, food, water and soil
- Cumulative Neurotoxin, no known biological function
- one of most hazardous substances (ATSDR)

Health Effects of Lead

Gametotoxic – Effects on Cell

Embryotoxic – Effect on Embryo

Carcinogenic – Effect on cell growth and character

Teratogenic – Effect on embryo –producing abnormal species

Effects of Lead

- Damage Central Nervous System
- Causes reduction in IQ and attention span
- Affects mental and physical development
- Reading and learning disabilities, hyperactivity and other behavioral problems
- Impairs formation of Hemoglobin, thus Anemia
- Irreversible brain damage
- Even death at higher concentration

Who is more susceptible?

Children have greater sensitivity

- Greater lead intake per unit body weight
- Greater net respiratory intake
- Greater absorption and retention in digestive system
- Certain incompletely developed defence mechanism

Expectant mothers and their unborn babies

- Miscarriages
- Still Birth
- Death of new born

However...

Lead continues to be in environment after several years of unleaded gasoline (Morisawa *et al.* 2001) – Why?

After phaseout of lead from gasoline:

- Immediate drop in air
- Exposure continues
 - ✓ Food
 - ✓ Water
 - ✓ Soil
 - ✓ Air ???

PBPK Model for Lead

