

### Air Pollution Related Cellular Changes in The Lung in Kolkata and Delhi

*Twisha Lahiri*

Chittaranjan National Cancer institute, Kolkata

### Urban Air Pollution in India is a matter of grave concern

- \*285 million urban Indians are exposed to alarmingly high level of pollutants
- \*Health risks of air pollution exposure are well recognized
- \*Dimension of the problem in India is relatively unknown

### In all major cities of India the pollutant levels over the last 10 years were far above NAAQS

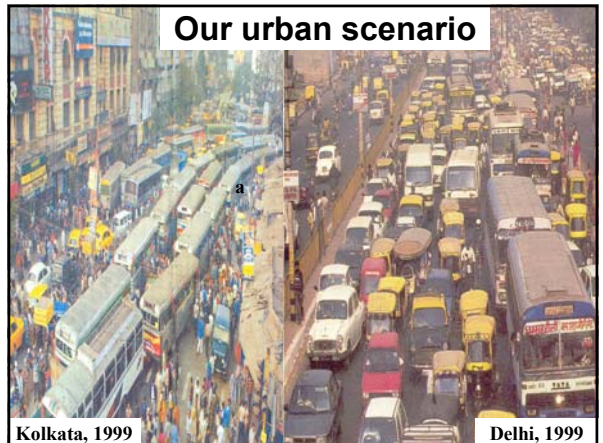
Mean annual conc. of  $PM_{10}$  in Indian cities  $>150\mu g/m^3$ , 2.5-times over the standard

**Vehicular emission** contribute **50-70%** of urban pollution load - aggravated by

- sharp rise in no. of vehicles
- old & ill-maintained vehicles
- low traffic speed & traffic jams
- poor fuel quality
- adulterated fuel


*If the pollutant levels in Indian cities are brought down to the standards, more than 40,000 premature deaths per year could be avoided (World Bank, 1998).*

### Our urban scenario



Kolkata, 1999

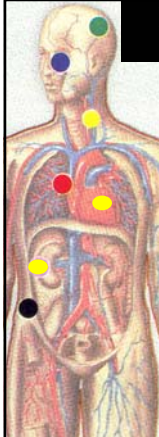
Delhi, 1999



### The Poison Cocktail

**Gases:** CO, NO<sub>x</sub>, SO<sub>2</sub> etc  
**VOC :** Benzene, Toluene  
**PAH :** Benzo-a-pyrene  
 Benz anthracene  
**Heavy metals:** Pb, Fe, Cd, Zn, Ni etc.  
**Particulate matter**  
 Of different size & composition

*Health effects are the impact of this complex mixture rather than a particular pollutant*



### Health Impacts of Air Pollution

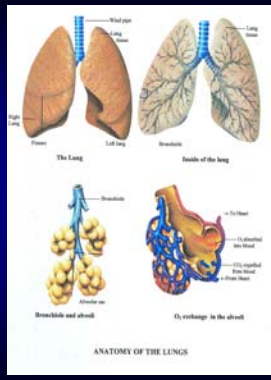
- **Increase in mortality**  
500,000 deaths annually worldwide due to urban air pollution
- **Induction or revival of diseases**
  - **Respiratory illness / disorders**
  - **Genotoxicity leading to cancer**
  - **Systemic & Immune alterations**
  - **Cardiovascular problems**
  - **Brain damage**
  - **Retardation of fetal growth**

### Response Pattern

Air pollutants are likely to have similar adverse effects on diverse human population but responses may differ due to

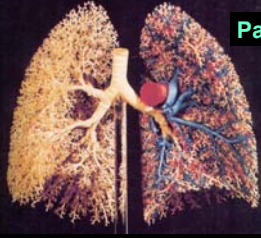
- extent of exposure
- co-exposure of different pollutant mixtures
- population structure
- socio-economic status
- nutritional status
- susceptibility factors

*Real dimension of the problem has not been evaluated in India till date*



### Route of Invasion

- Lung - the main entry point of air pollutants
- Target organ is the alveolus (300 million alveoli in human lungs)
- 10,000 – 15,000 lit of air enters the adult lung every day
- Increase in concentration of pollutants cause parallel increase in toxic insult to the lungs. *At 160 µg/m<sup>3</sup> PM<sub>10</sub> level, 404 µg particles deposit in lung/day*
- From alveolus, pollutants travel via lymph or blood to different organs



**Particulate Matter (PM)**  
**- the single best indicator of potential harm**


It is a complex mixture of variable size (0.01-100µm), **composition** (Metals, nitrates, sulfate, PAH, VOC etc.), & **concentration**

**The Branching Airways**

**Particle deposition depends on** Breathing patterns, Particle size and Airway geometry

**Determinants of particle toxicity**

<b>Less toxic</b>	-----	<b>More toxic</b>
Increasing size	-----	Decreasing size
Soluble	-----	Insoluble
Less free radicals	-----	More free radicals
Less transitional metals	-----	More transitional metals



**Chittaranjan National Cancer Institute, Kolkata**

Health effects of chronic air pollution exposure are being assessed in a 10-year study using pollution-sensitive biomarkers

**Objectives**

- To prepare a database on air pollution related respiratory and systemic changes in
  - children of urban and rural areas
  - adult residents of Kolkata & Delhi of different age, sex, occupation & socio-economic status
- To explore the underlying mechanism of health effects for development of intervention strategies

**Children - the 'soft' target**

Both in rural & urban areas, children are the most vulnerable group due to

- Lower breathing zone
- Greater oxygen consumption
- More susceptible target organs
- Immunity not fully operational



Air pollution related respiratory symptoms have been assessed through specially designed questionnaires & lung function tests

12,000 - rural & suburban areas of West Bengal  
 3,200 - Kolkata; 3,500 - Delhi

Age groups - 8-16 years

**Study approach**

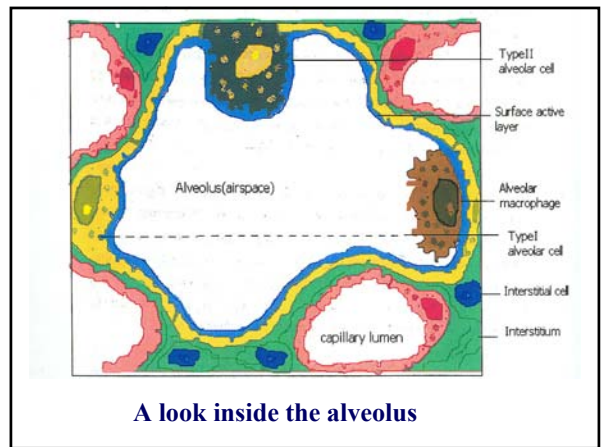
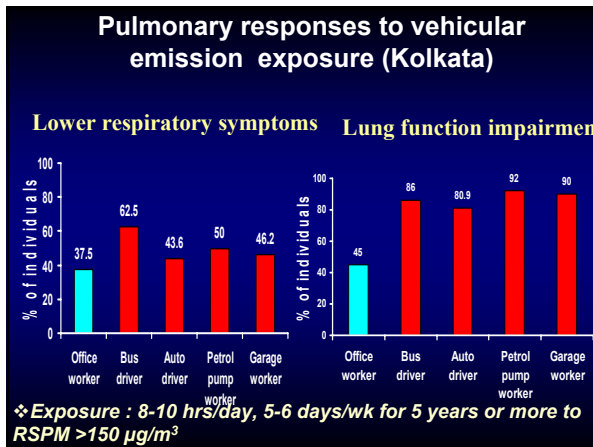
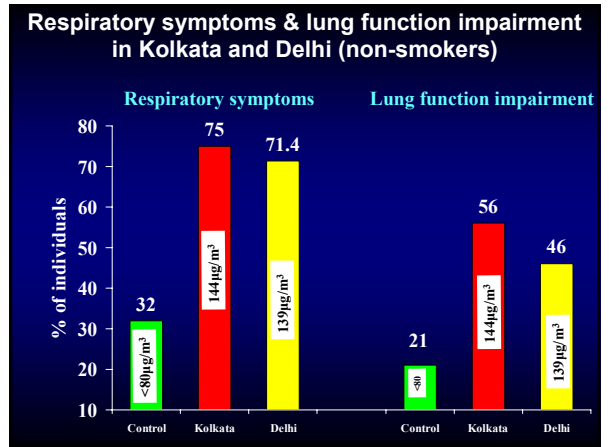
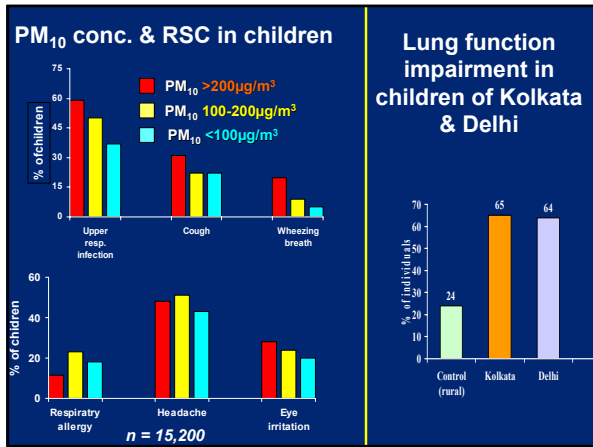
**Air quality data** - obtained from WBPCB & CPCB

**Health data** from apparently healthy adults through

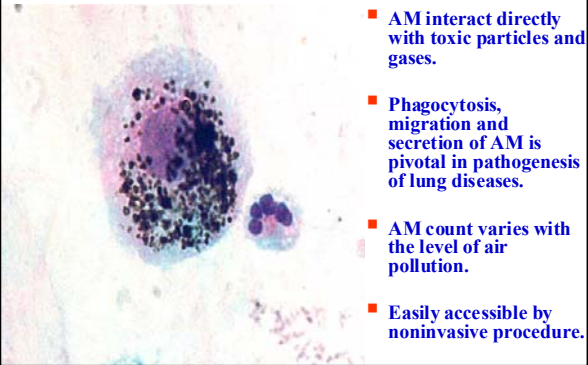
- questionnaires for detailed personal history - age, sex, occupation, exposure, & respiratory symptoms
- clinical examination & lung function by spirometry
- sampling and detailed analysis of sputum & blood by appropriate techniques

**Statistical analysis** - data analyzed in the Dept. of Medical Statistics using the software SYSTAT 9.0 (SPSS INC Chicago, USA)

Statistical tests & mathematical models- bivariate correlation, logistic regression, multiple regression have been used as per requirements

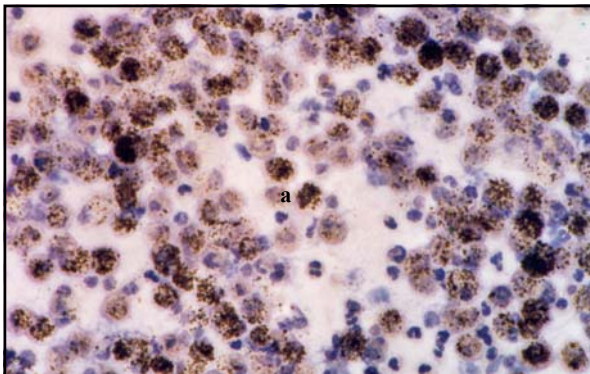
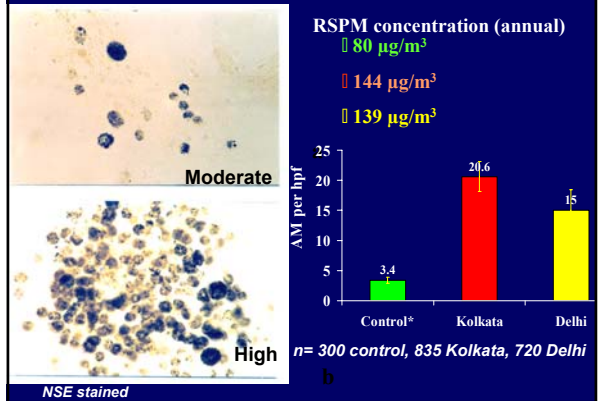


### Alveolar macrophage - the biomarker of air pollution exposure

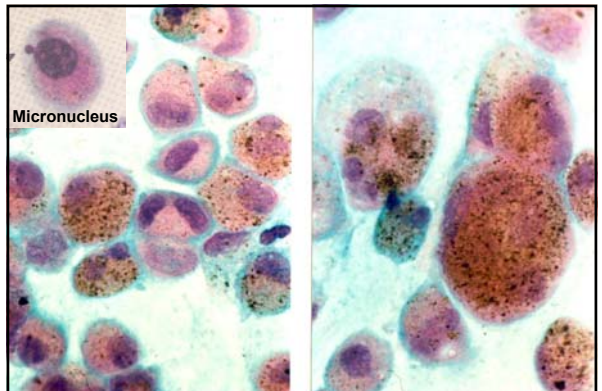


- AM interact directly with toxic particles and gases.
- Phagocytosis, migration and secretion of AM is pivotal in pathogenesis of lung diseases.
- AM count varies with the level of air pollution.
- Easily accessible by noninvasive procedure.

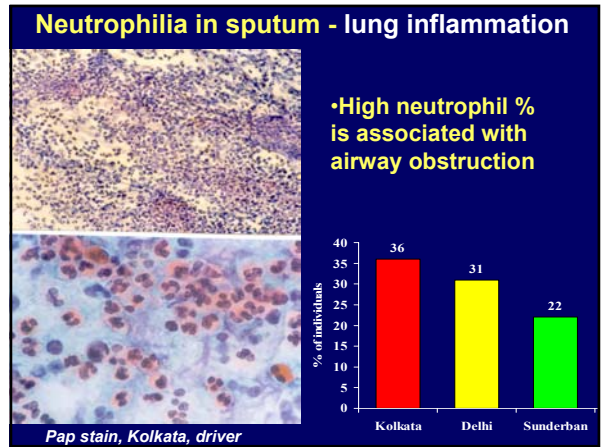
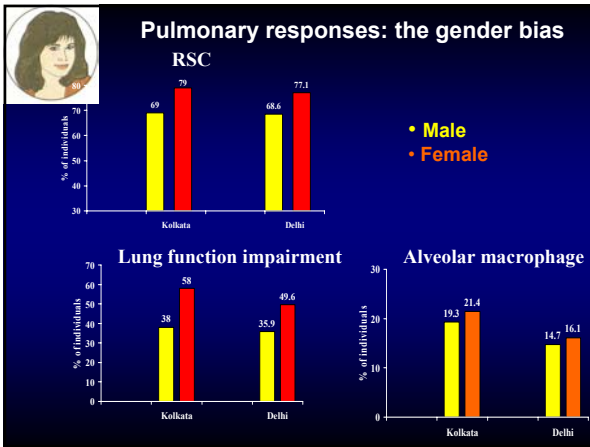
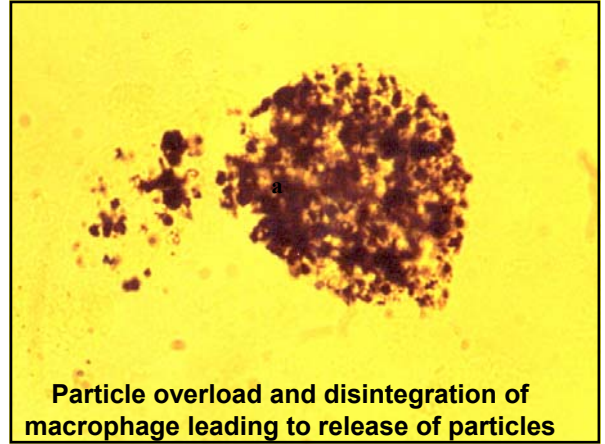
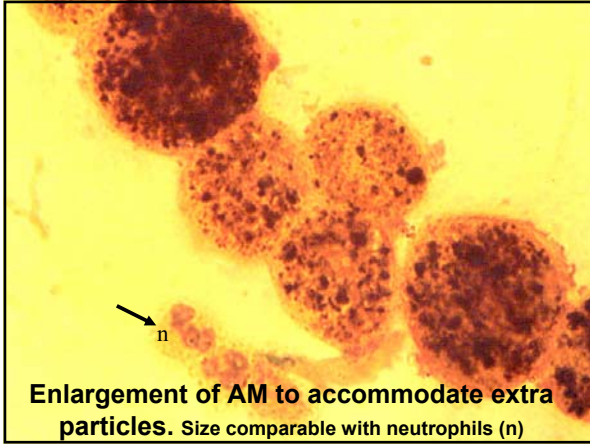
### Alveolar macrophage distribution in sputum

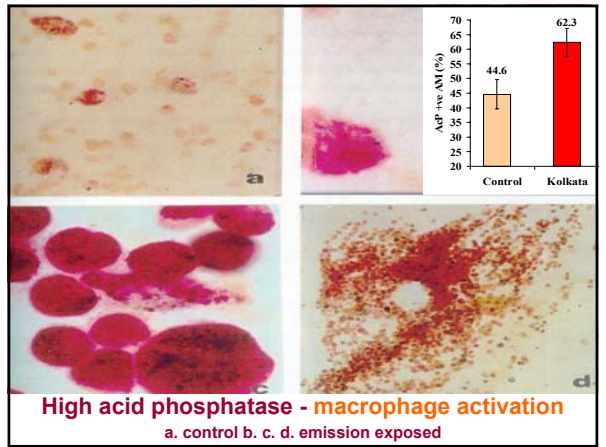
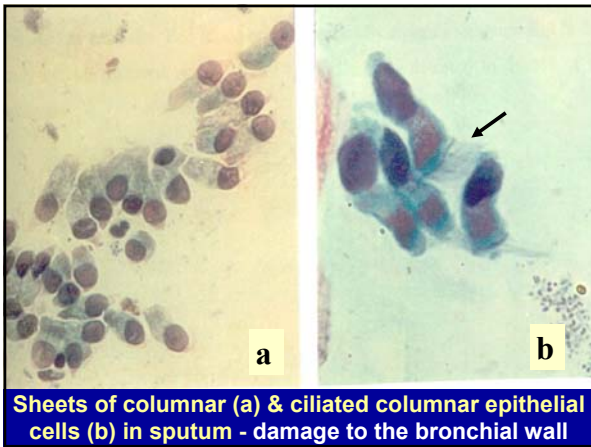
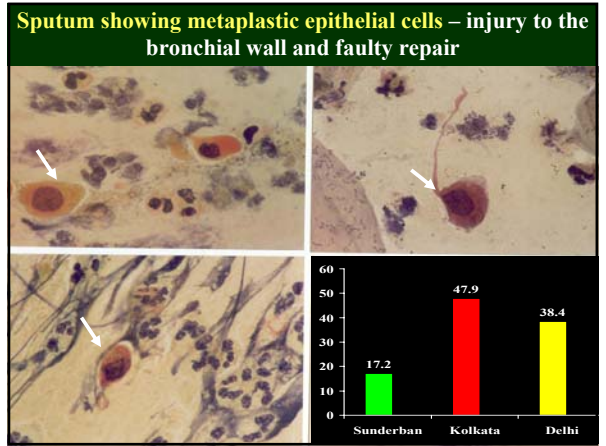
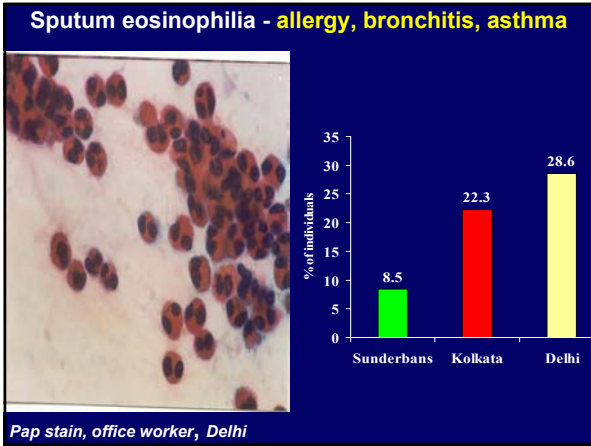


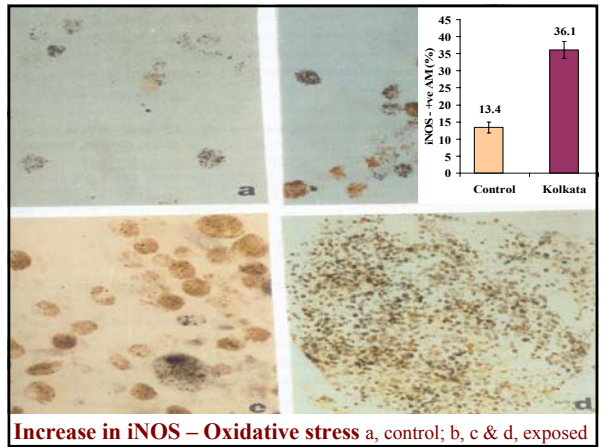
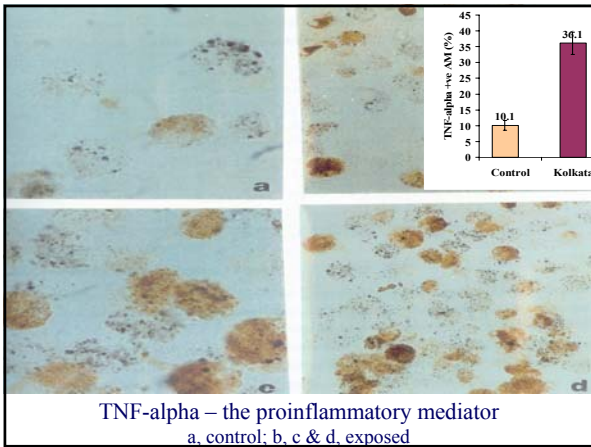
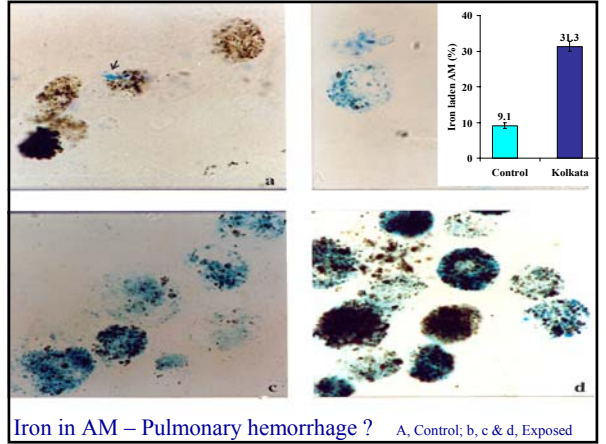
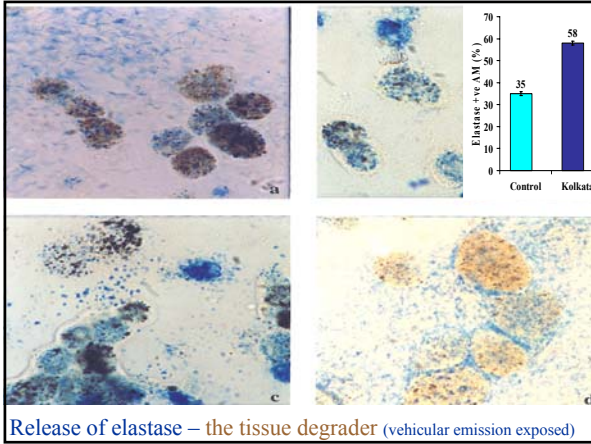
Sputum of taxi driver showing marked increase in particle laden macrophage (Pap stain)



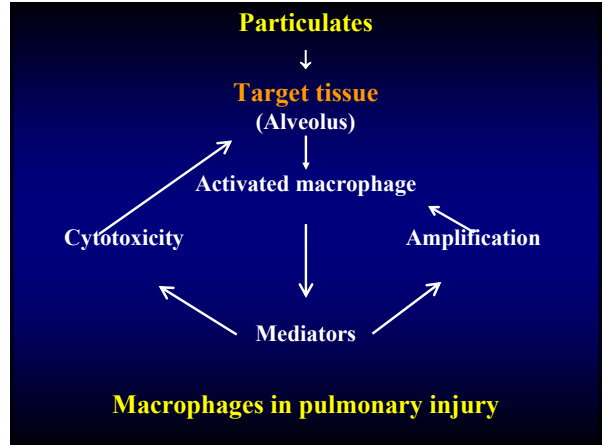
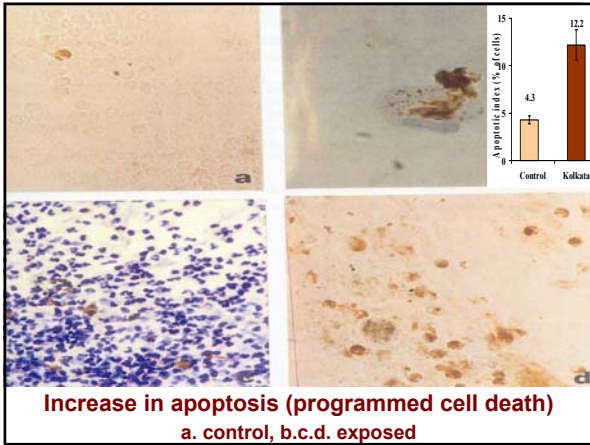
Sputum smear of a resident of Delhi showing marked heterogeneity in size, particle deposition & nuclear structure (PAP stain)











**Summary**

*RSC in children correlate with  $PM_{10}$  values*

*Exposure to vehicular emissions causes significant increase in :*

- » Respiratory symptoms
- » Lung function impairment
- » Numerical, structural & functional alteration of AM
- » Cellular indicators of lung inflammation & airway injury
- » Genotoxicity & Systemic alterations

*Adverse effects are more pronounced in women, low socio-economic group and persons exposed to vehicular emissions*

The study warrants immediate measures by all concerned to abate the alarmingly high vehicular pollution in Indian cities

Otherwise, we should be prepared for a disaster in not too distant future

