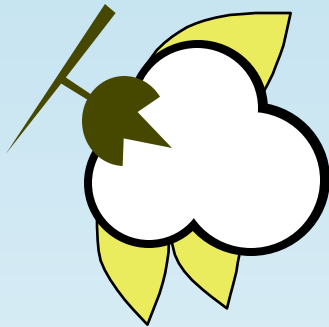
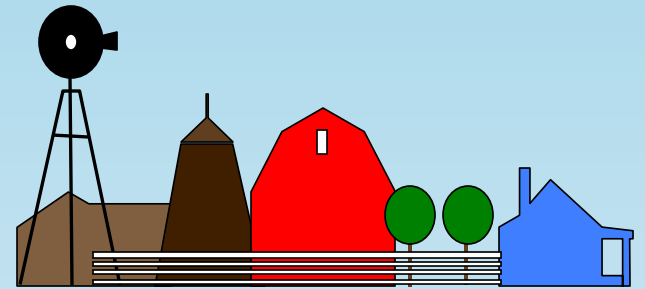
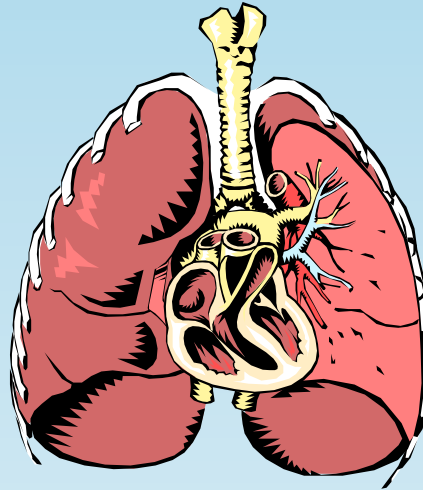
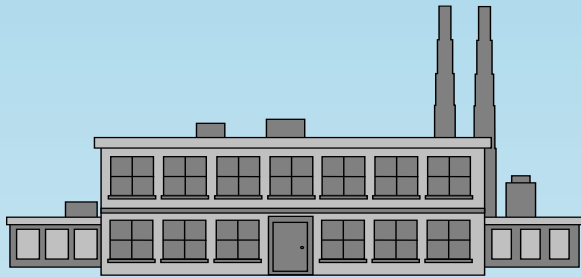


# Occupational lung disease



# Categories of occupational lung disease

- ▶ Pneumoconiosis
- ▶ Occupational asthma
- ▶ Reactive airways dysfunction syndrome– RADS
- ▶ Byssinosis
- ▶ “Inhalation fever(s)”
- ▶ Hard metal lung disease
- ▶ Others
  - Industrial bronchitis
  - Toxic inhalations
  - Hypersensitivity pneumonitis
  - Lung cancer
- ▶ IPF (Idiopathic pulmonary fibrosis)

# Pneumoconiosis

(Lung Dust)

- ▶ Refers to the pulmonary manifestations of exposure to a variety of dusts or aerosols

1. Asbestosis

2. Silicosis

3. Coal workers pneumoconiosis

4. Berylliosis

5. Siderosis

# Pneumoconiosis

- ▶ **Pathophysiology** – poorly understood
  - Direct injury
  - Activation of resident cells
    - a. Macrophages
    - b. Epithelial cells
    - c. Fibroblasts
  - Affected by
    1. Dose
    2. Duration of Exposure
    3. Size (1–5 Mm)
    4. Shape
    5. Buoyancy: قابلية الطفو في الماء
    6. Solubility of Particles

# Particulate Matter (PM) Definition

Tiny, discrete solid or aerosol particles in the air.

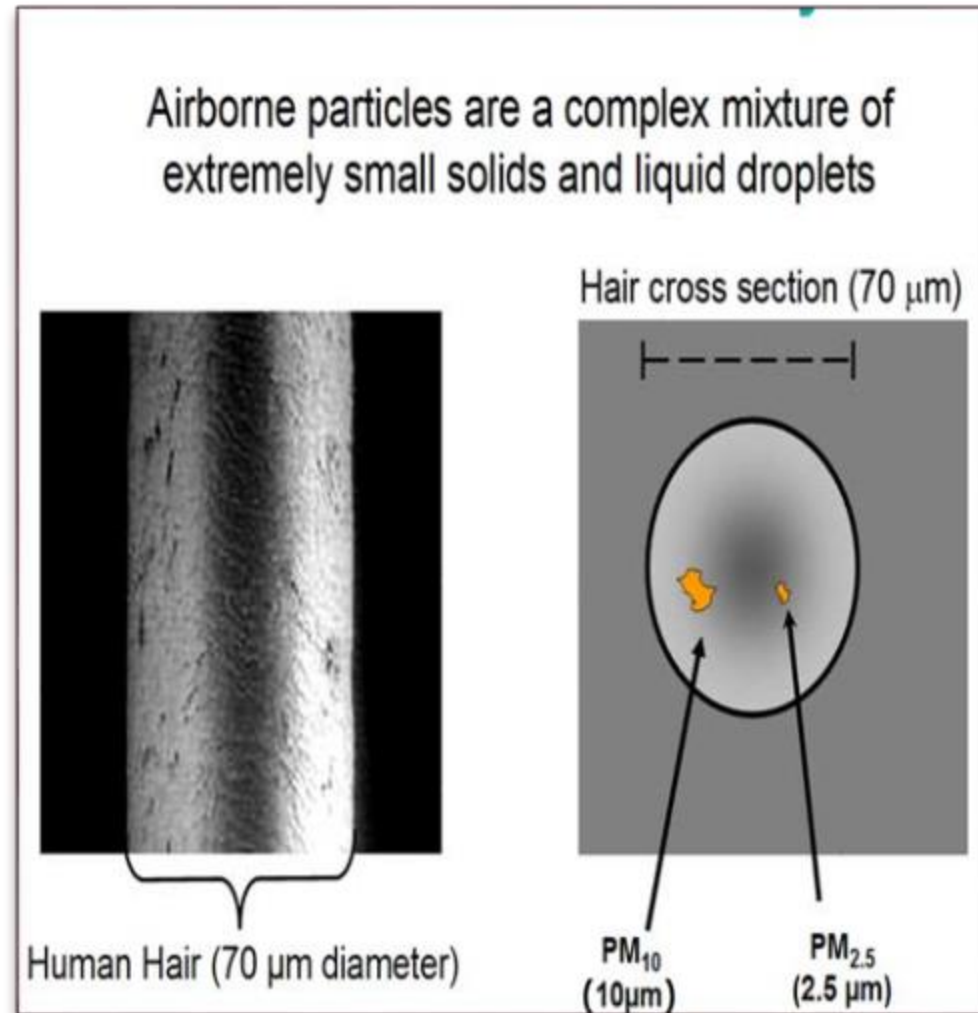
Composed of inorganic and organic materials.

They are different in term of:

1. Size.
2. Formation Mechanism
3. Source.
4. Chemical Composition.

Aerodynamic diameter is an expression of a particle's aerodynamic behavior as if it were a perfect sphere with unit-density and diameter equal to the aerodynamic diameter.

- ✓ dot (.) = 615 microns.
- ✓ The eye can see particles  $\geq 40$  microns.
- ✓ One micron is one-millionth of a meter.



M. Lipsett, California Office of Environmental Health Hazard Assessment

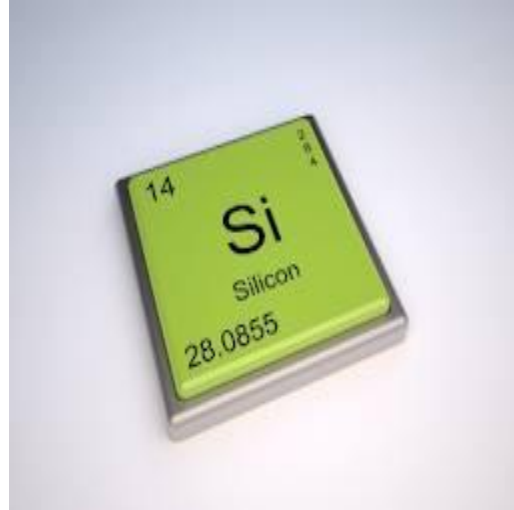
# ▶ Silicosis

## ▶ What Is Silicosis?

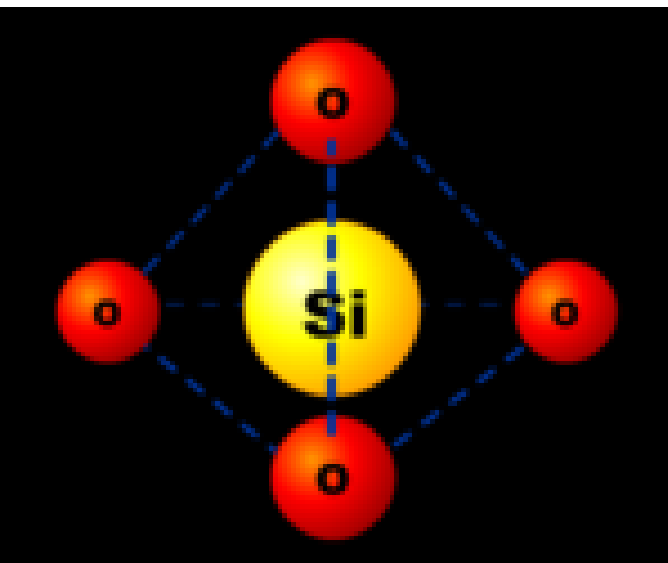
- Silicosis is a disabling, nonreversible and sometimes fatal lung disease caused by overexposure to respirable crystalline silica.

# Silicosis

- ▶ Crystalline silicon dioxide (quartz)
- ▶ Most prevalent occupational disease in the world
- ▶ Sandblasters, mine workers
- ▶ Desert lung disease
  
- ▶ Pneumonoultramicroscopicsilicovolcanoconiosis  
the Longest Word Ever To Appear In An English Language Dictionary.



Pure silicon dioxide



Tetrahedral coordination of silica ( $\text{SiO}_2$ ), the basic building block of the most ideal glass former.



Quartz sand (silica) as main raw material for commercial glass production



Bundle of optical fibers composed of high purity silica.

# Silicosis

## ▶ Risk factors

Crystalline silica is one of the most common substances in the earth's crust

1. Mining or quarrying
2. Ceramics (dry pottery, kiln operator, china industry)
3. Foundry work
  - Molten steel is poured into a mold, or over a cast made of quartz bonded by clays and resins (coremakers)
  - Respirable silica occurs in creating/breaking the mold, and polishing the resulting steel surfaces
4. Abrasives (sandblasting or furnace cleaning)

# Silicosis–Clinical patterns

There are three types of silicosis, depending upon the airborne concentration of crystalline silica to which a worker has been exposed:

- ▶ Small rounded opacities
    - Several forms of disease
    - A. Chronic** (>20 year exposure)
    - B. Accelerated** (5–15 years, higher quartz content)

Both may progress to “PMF” (conglomerate silicosis)

  - C. Acute** (months, high level exposure, similar to alveolar proteinosis)
- ▶ Varies from asymptomatic to progressive respiratory failure
  - ▶ High risk of tuberculosis (especially in accelerated forms or acute forms)
  - ▶ **symptoms**
    - a. Weight loss
    - b. Fever
    - c. Hemoptysis
    - d. Cavitation
  - ▶ **Fibrosis** can (& usually does) progress after cessation of exposure



# Chronic silicosis

- The most common form of the disease, may go undetected for years in the early stages; in fact, a chest X-ray may not reveal an abnormality until after 15 or 20 years of exposure.
- The body's ability to fight infections may be overwhelmed by silica dust in the lungs, making workers more susceptible to certain illnesses, such as tuberculosis.
- As a result, workers may exhibit one or more of the following symptoms:
  1. shortness of breath following physical exertion
  2. severe cough
  3. fatigue
  4. loss of appetite
  5. chest pains
  6. fever

# What is Silica?

- Silica is the second most common mineral in the earth's crust and is a major component of sand, rock, and mineral ores.
- Overexposure to dust that contains microscopic particles of crystalline silica can cause scar tissue to form in the lungs, which reduces the lungs' ability to extract oxygen from the air we breathe.
- Typical sand found at the beach does not pose a silicosis threat.

- **What are the other health effects due to Silica?**

- In addition to silicosis, inhalation of crystalline silica particles has been associated with other diseases, such as bronchitis and tuberculosis.
- Some studies also indicate an association with lung cancer.

- **Who Is at Risk?**

- Working in any dusty environment where crystalline silica is present potentially can increase a person's chances of getting silicosis.

# What type of occupations are at risk?

1. construction (sandblasting, rock stone cutting (sawing, abrasive drilling, masonry work, jack blasting, chipping, grinding) hammering, tunneling)
2. glass manufacturing mining (cutting or drilling through sandstone and granite)
3. agriculture (dusty conditions from disturbing the soil, such as plowing or harvesting)
4. foundry work (grinding, moldings, shakeout, core room)
5. shipbuilding (abrasive blasting)
6. ceramics, clay, and pottery
7. railroad (setting and laying track)
8. manufacturing of soaps and manufacturing and use of abrasives detergents

# How Can Workers Determine If They Have Silicosis?

- A medical examination that includes a complete work history and a chest X-ray and lung function test is the only sure way to determine if a person has silicosis.
- Workers who believe they are overexposed to silica dust should visit a doctor who knows about lung diseases.
- It is recommended that medical examinations occur before job placement or upon entering a trade, and at least every 3 years thereafter.

# How Can Silicosis be Prevented?

1. Substitution
2. Engineering
3. Work Practices
4. Personal Protective Equipments

# Substitution

- ▶ Substituting the silica means using a different, safer material in place of the silica-containing substance.
- ▶ It is true that in some cases it is not possible to use a substitute in place of silica, but for many operations, such as abrasive blasting, there are many possible substitutes, including:

- **Aluminum Oxide**
  - Ambient Polycarbonate*
  - Cryogenic Polycarbonate*
  - EmeryGarnet*
  - Glass Beads*
- Melamine Plastic**
  - Novaculite*
  - Polycarbonate*
  - Silicon Carbide*
  - Stainless Cast Shot*
  - Steel Grit*
  - Steel Shot*
  - White Aluminum Oxide*
  - Zircon*

# Engineering Controls Keep silica out of the air

- ▶ If silica products must be used, engineering controls to be used wherever possible.
- ▶ This type of control involves a mechanical process to eliminate exposure to silica dust. Some of these controls may be very simple, as can be seen in the examples below:
  1. Install a water hose to wet down the dust at the point of generation
  2. Install local exhaust ventilation
  3. During rock drilling, flow water through the drill stem
  4. Install dust collection systems onto machines or equipment that generates dust
  5. Use concrete/masonry saws that provide water to the blade

# Work Practices

## What employees can do to reduce silica intake

If workers know about silica and understand the severity of its health hazard, they will be more likely to do the following:

- ▶ Know **which work** operations can lead to silica exposure
- ▶ Participate in any air monitoring or training programs offered by the employer
- ▶ If possible, change into disposable or washable work clothes at the worksite; shower (where available) and change into clean clothing before leaving the worksite.
- ▶ Do not eat, drink, use tobacco, products, or apply cosmetics in areas where there is dust containing crystalline silica.
- ▶ Wash your hands and face before eating, drinking, smoking, or applying cosmetics outside of the exposure area.
- ▶ If using respirators, do not alter the respirator in any way.
- ▶ **Use positive pressure abrasive blasting respirators for sandblasting**

# Personal Protective Equipment

- ▶ PPE against silica includes **respirators and masks**.
- ▶ Respirators should be used only when the dust controls cannot keep dust levels below the Recommended Exposure Level.\*
- ▶ There are many types of respirators, from air-purifying to air-supplying and from a nose and mouth covering to a full body respirator.

\* The lifetime risk of silicosis and lung cancer at an exposure level of 0.1 mg/m<sup>3</sup> is high. Lowering exposures to the NIOSH recommended limit of 0.05 mg/m<sup>3</sup> may have substantial benefit.



**WARNING!**

**CRYSTALLINE SILICA WORK AREA**

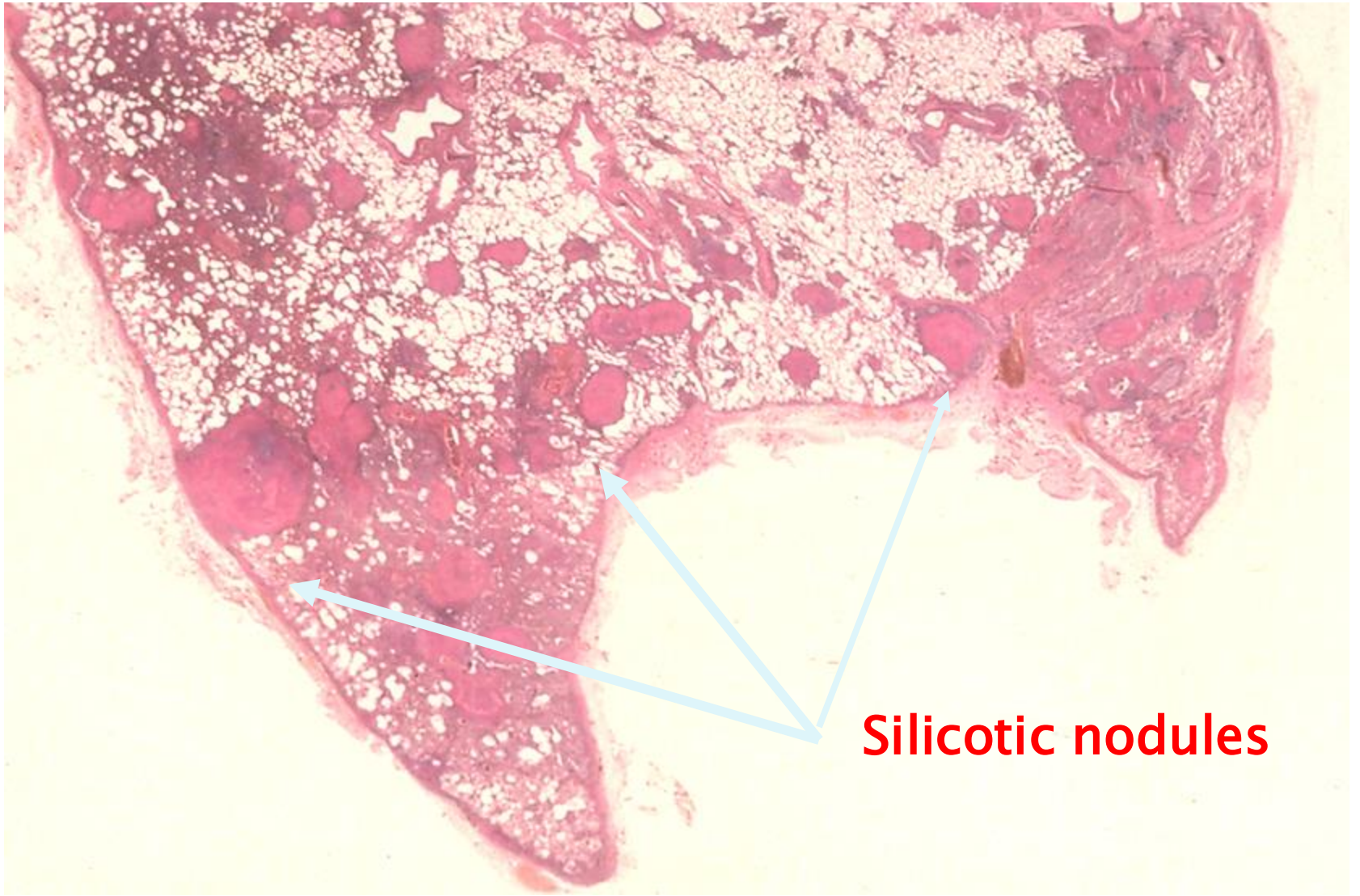
**Exposure may cause silicosis  
(a serious lung disease),  
cancer, and death**

**RESPIRATOR REQUIRED**

# Silicosis

Slowly  
progressive  
nodular, fibrosing  
pneumoconiosis

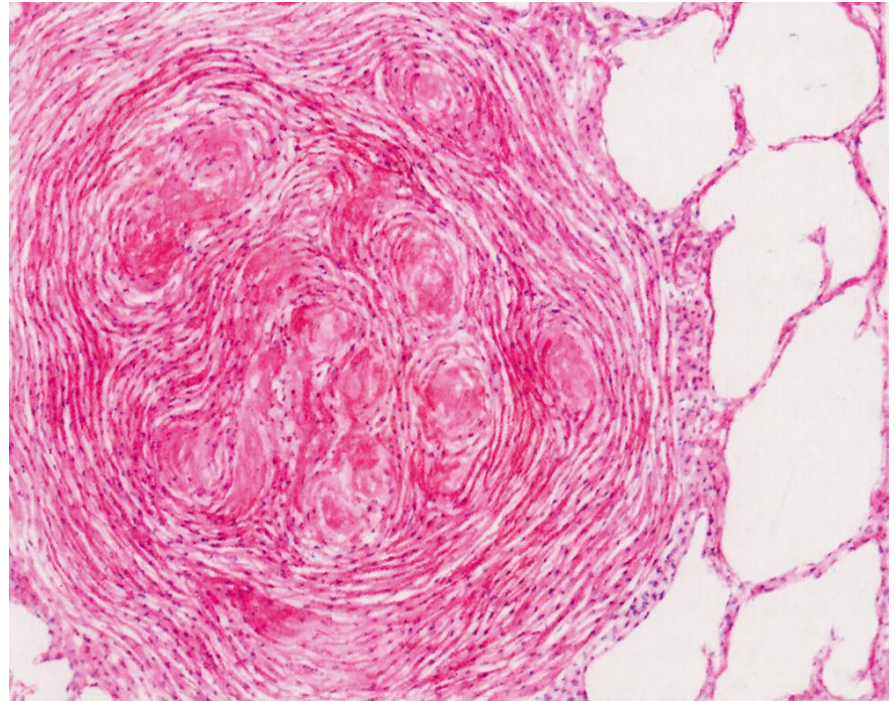




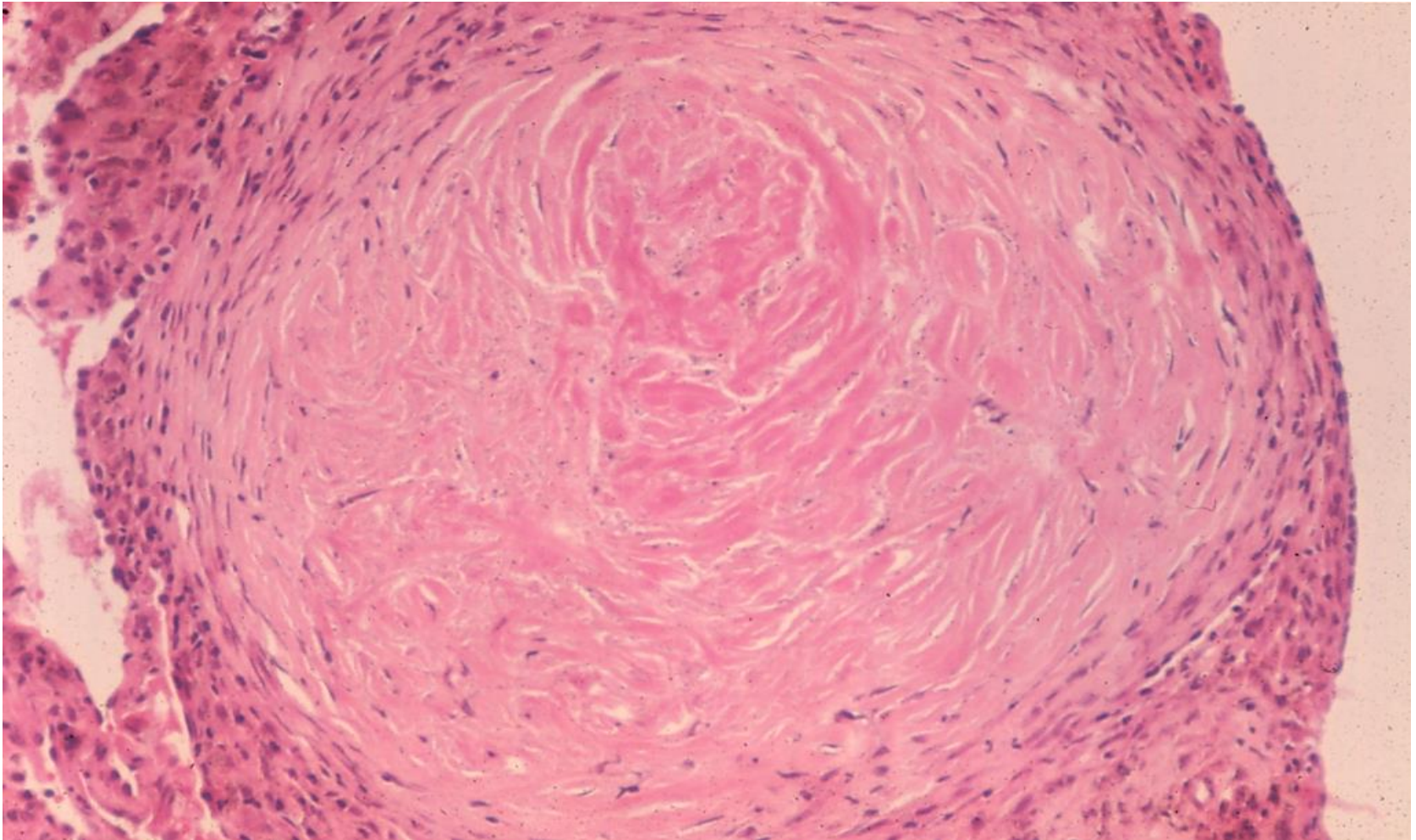
**Silicotic nodules**

# Silicosis

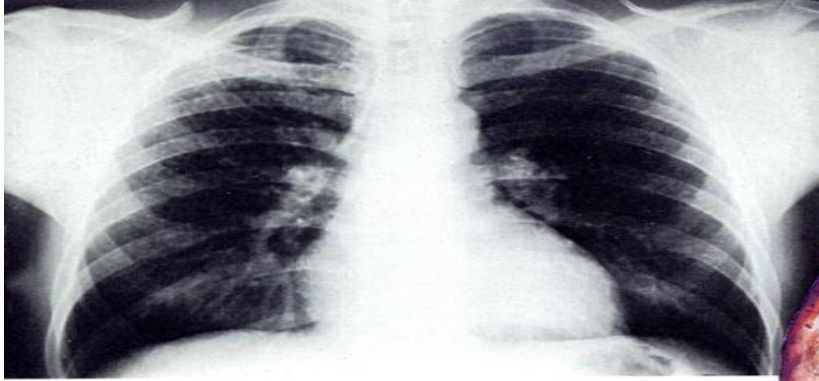
- ▶ 1 micrometer particles
- ▶ Early lesions
  1. more fibrotic
  2. less cellular



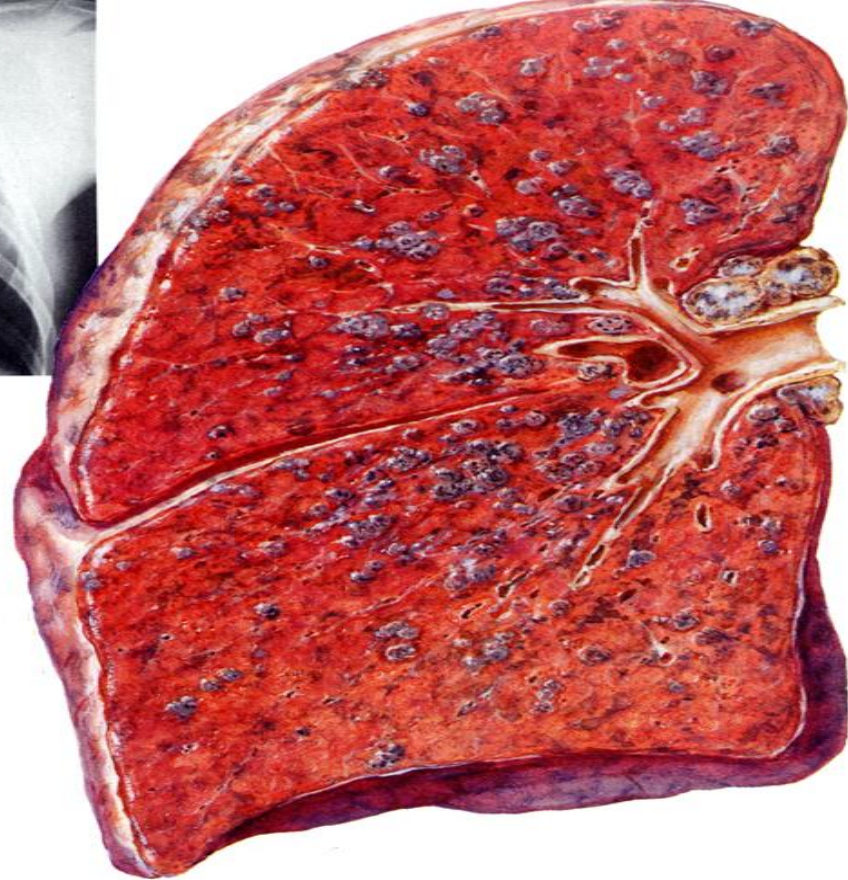
# Silicotic Nodule



# Silicosis: Clinical



**Routine CXR**



# Clinical Case

1. Upper lung zones
2. Nodular fibrosing pneumoconiosis
3. Increased Tb
4. Eggshell calcifications - thin sheets of calcification of lymph nodes
5. PMF (Progressive Massive Fibrosis, characterized by the development of large conglomerate masses of dense fibrosis (usually in the upper lung zones), can complicate Silicosis and Coal worker's pneumoconiosis
6. No increase in bronchogenic cancer

# Pathophysiology

- ▶ When small silica dust particles are inhaled, they can embed themselves deeply into the tiny alveolar sacs and ducts in the lungs, where oxygen and carbon dioxide gases are exchanged. There, the lungs cannot clear out the dust by mucous or coughing.
- ▶ When fine particles of silica dust are deposited in the lungs, macrophages that ingest the dust particles will set off an inflammation response by releasing **tumor necrosis factors, interleukin-1, leukotriene B4 and other cytokines**. In turn, these stimulate fibroblasts to proliferate and produce collagen around the silica particle, thus resulting in fibrosis and the formation of the nodular lesions.
- ▶ Characteristic lung tissue pathology in nodular silicosis consists of fibrotic nodules with concentric "onion-skinned" arrangement of collagen fibers, central hyalinization, and a cellular peripheral zone, with lightly birefringent particles seen under polarized light. The silicotic nodule represents a specific tissue response to crystalline silica. In acute silicosis, microscopic pathology shows a periodic acid-Schiff positive alveolar exudate (alveolar lipoproteinosis) and a cellular infiltrate of the alveolar walls