

OCCUPATIONAL HEALTH

9+10

Chemical Hazards



14th May 2023

PROF. DR. WAQAR AL-KUBAISY

Pneumoconiosis

contents

- Definitions
- Pathogenesis
- Types

Preventive measures

- Individual diseases
 - Silicosis
 - Asbestosis
 - Anthracosis



silicosis



Silica crystals



Crocidolite
(blue)



Amosite
(brown)



Chrysotile
(white)



- **Silica exists in 2 forms**

1. Crystalline and
2. Amorphous forms.

- ❖ **Crystalline silica** not bound to other materials is called **FREE SILICA**, when bound it is referred as **combined** (silicates).
- ❖ **Amorphous silica** have relatively **non toxic** pulmonary properties.

- **Silicosis**

refers to a spectrum of pulmonary diseases due to inhalation of various forms of **FREE crystalline silica** (SiO_2).

silicosis

Among the occupational diseases,

□ **silicosis** is the **major cause of**

➤ **permanent disability and mortality.**

□ Develops with **repeated** and usually **long-term exposure**

➤ to **crystalline silica (silica dust)**

□ It is caused by **inhalation of dust containing free silica** or

✓ **silicon dioxide free crystalline silica (SiO₂)**

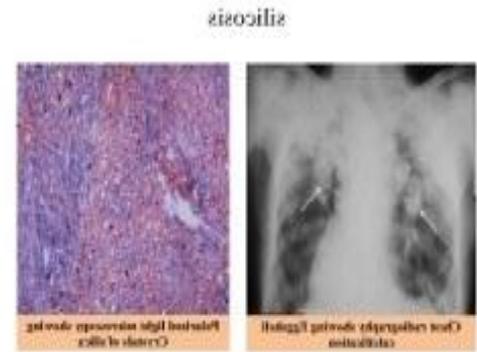
□ The silica dust causes **irritation & inflammation** of the airways & lung tissue.

□ **Scar tissue forms** when the inflammation heals, resulting

□ in **fibrosis** that gradually overtakes healthy lung tissue.

□ **The fibrosis continues extending** through the lungs

□ **even after exposure ends.**



The incidence of silicosis depends upon

1. the **chemical composition** of the dust,
2. **size** of the particles,
3. **duration** of exposure and
4. individual **susceptibility**



- ✓ The **higher** the concentration of **free silica** in the dust, **the greater the hazard.**
- ✓ Particles between **0.5 to 3 micron** are the most dangerous because they reach the interior of the lungs **with ease.**
- ✓ The longer the duration of exposure, the **greater the risk** of developing silicosis.
- *the latent period may vary from a*



□ *the latent period may vary from a*
✓ few months up to ≥ 20 years of exposure,
depending upon the above factors.

The particles are ingested by the phagocytes which
accumulate and block the lymph channels.

Pathologically,

- silicosis is characterized by
- ❖ **Fibrosis** is initiated by silicic acid
- ❖ leading to a dense "nodular" **nodular fibrosis**,
- the nodules ranging from **3 to 4 mm** in diameter in
- ❖ the **upper part** of the lung .
- **Emphysema** , and **right heart failure** ,
- **Pulmonary TB** may intervene in **50%** of cases



● **The presentation and severity of silicosis depend on:**

➤ **Dust factors:**

**concentration or
duration of exposure**

➤ **Host factors:**

**genetic factors,
cigarette smoking, and
presence of other pulmonary disease**

Occupations with **risk of** exposure to silica dust

Mining

Tunneling

Quarrying **Stone Quarries**: محاجر الحجر

Sandblasting

Ceramics

Brick-making

Silica flour manufacture

Slate Pencil Industry

Agate Industry **صناعة العقيق**

Quartz Grindin gmillers,
pottery workers,

glass makers

abrasive **كاشط** worker



■ **Presentation and clinical picture:**

■ Spectrum of silicosis include:

Classic silicosis (simple) and complicated
Progressive massive fibrosis (PMF)

Accelerated (simple) and complicated (PMF)

Acute

I) Classic silicosis Chronic silicosis:

the most common form,

results from long-term exposure (10 to 20 years or longer)

- ❖ Result from low to moderate exposure to dust containing
- ❖ less than 30% silica content
- ❖ but may occur with shorter exposure.
- In early case patient may complain of cough, expectoration and if dyspnea is present it is not due to silicosis but is related to industrial bronchitis or concurrent smoking.
- ❖ By time dyspnea is apparent and is now related to silica exposure (simple silicosis). Late symptom
- ❖ Simple silicosis is a risk for development of complications



❖ X-ray:

The characteristic pattern of simple silicosis is

- **small round opacities** that range in size from **1-10 mm**.
- **common in upper lung zones** (snow storm appearance).
- **Hilar lymph** nodes are usually **enlarged** or may **calcify circumferentially** producing the so called eggshell pattern of calcifications.
- *Similar x-ray picture are seen in: Sarcoidosis, Scleroderma, Amyloidosis,....., However the background of **small opacities** reinforces the clinical diagnosis of silicosis.*

The silicotic nodule is the pathologic hallmark



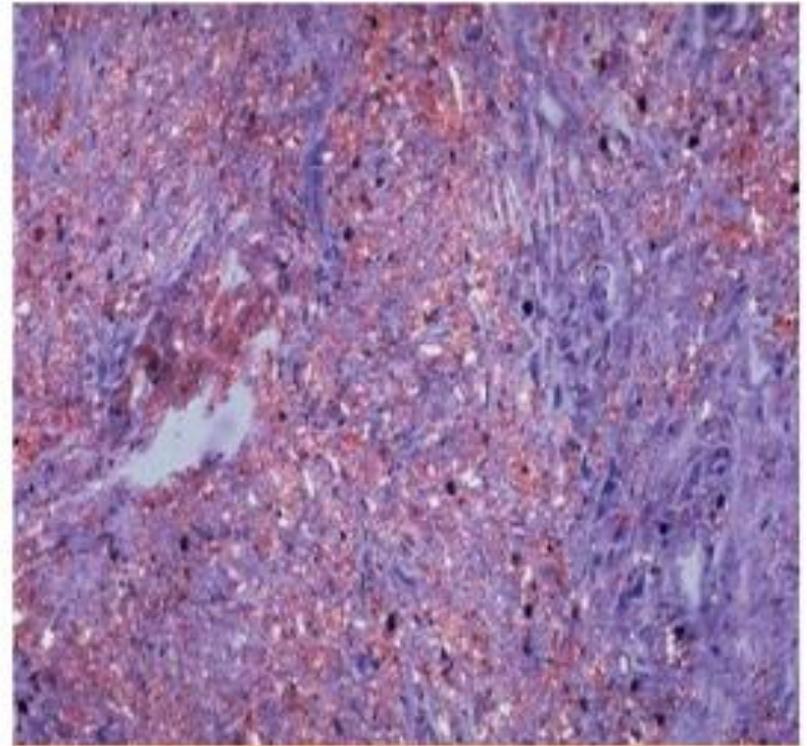
- The silicotic nodule is the pathologic hallmark of silicosis,
- Large opacities retract toward the hilum resulting in subpleural areas of air space enlargement (appear as bullae).
- Large opacities **combine** in the **upper** lung zones result in
 - loss of upper zone volume and elevation of both hila
 - and
 - development of basilar emphysema

"Eggshell" calcification, when present, is strongly suggestive of silicosis

silicosis



Chest radiography showing Eggshell calcification



Polarized light microscopy showing Crystals of silica



■ **Diagnosis:**

- History of silica exposure
- Chest radiographic abnormalities
- Pulmonary function tests show **obstructive lesion**.
- Absence of other illnesses that mimic silicosis as Military T.B,

❖ **Lung function:** In general when the radiographs **show only small rounded opacities** of low profusion of **simple silicosis** →

■ **no significant impairment in lung capacity** is associated.

➤ **But later**, shows a **restrictive pattern** lung changes

➤ **decreased FEV1 /FVC %)**

(forced expiratory volume in one second/ forced vital capacity
significant lung function loss

Lung function tests: ↓ [FVC](#), ↓ TLC, ↓ FEV1, ↓ [FEV1/FVC ratio](#) → findings indicate a mix of restrictive and obstructive lung disease



Simple silicosis is a risk for development of complications

(1) Cardiorespiratory complications:

- Progressive massive fibrosis (**PMF**).
- About **three fold risk** of pulmonary and extra pulmonary **T.B.**
- Core pulmonale and Rt. side heart failure.
- Basilar emphysema associated with P.M.F increases the risk of **spontaneous pneumothorax**.
- The **stiff lung** and **inability to expand** well eventually lead **to Death** due to progressive respiratory insufficiency

(2) Immune mediated complications:

- Disseminated sclerosis (DS).
- Scleroderma.
- Rheumatoid arthritis and caplan's syndrome.

(3) Renal complication (a spectrum of nephropathy):
Glomerulonephritis or nephrotic syndrome
Tubular damage

(4) Cancer: by crystalline silica exposure.



II) Accelerated silicosis

- ❑ Results from exposure to **higher concentration** of silica
- ❖ over a period of **5-10 years**.
- ❖ Due to a high exposure to **fine dust** of high silica content.
- ❑ clinical autoimmune connective tissue diseases are frequently **associated**.

✓ Scleroderma

✓ Rheumatoid arthritis

✓ Lupus erythematosis (LE)

❑ Condition is **progressive even** if worker is **removed from exposure**

▪ Spectrum of silicosis include:
Classic silicosis (simple) and (PMF)
Accelerated (simple) and complicated (PMF)
Acute

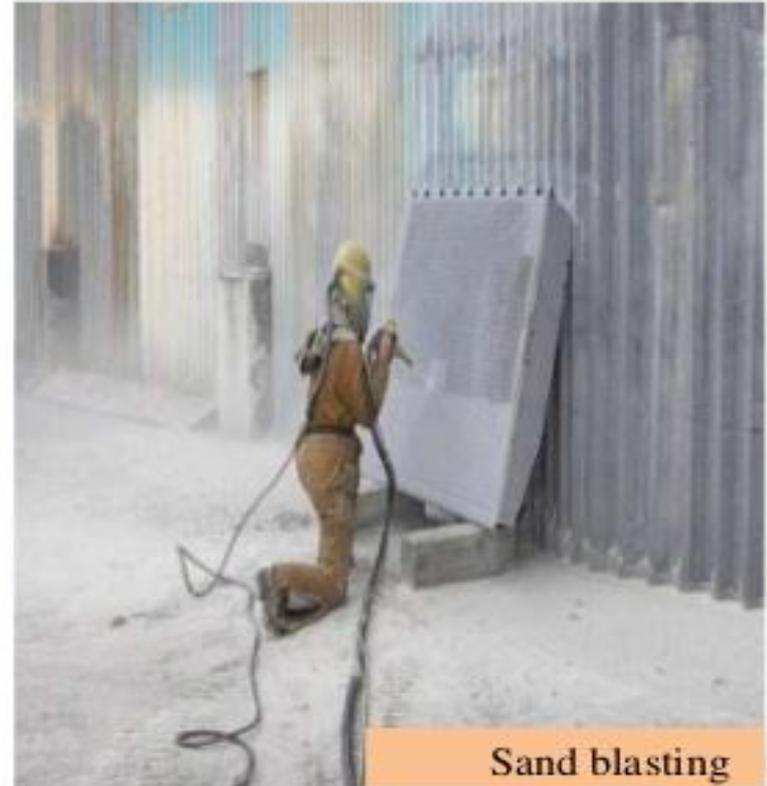
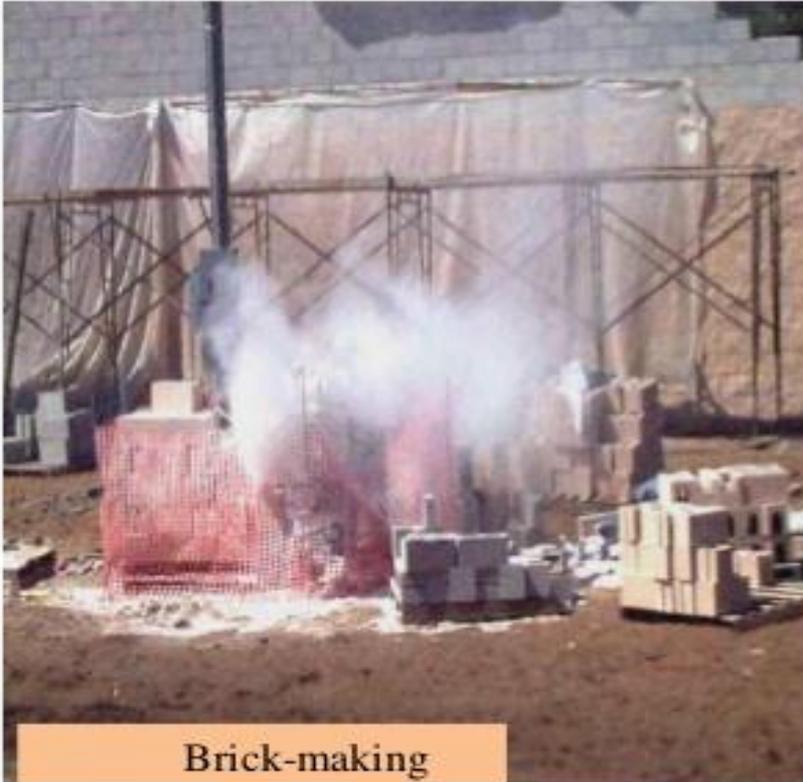


(III) Acute silicosis

- ❑ Results from **overwhelming**(massive)**excessive concentrations**
- ❖ **very heavy exposure** to **fine dust** for months,
- shows **symptoms** within **weeks to months** of exposure
- ❑ **80%** of cases occur as little as **few years or even 1 year** &
- ❑ **End in death** within **several years** due to respiratory failure.
- **Fever , weight loss ,cough and dyspnea.**
- ❑ It occurs **more frequent** in industrial activities
- where silica is **fractures or crushed** such as in
- ✓ **sand blasting** or rock drilling.

silicosis

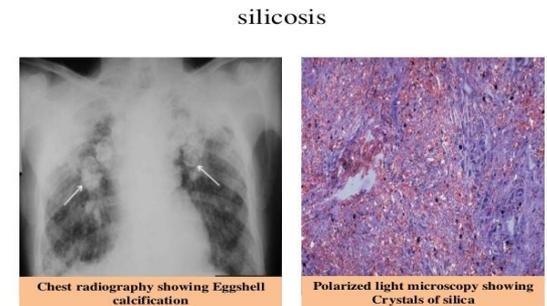
silicosis



silicosis Brick-making Sand blasting

Clinical features:

- Chronic **irritant** cough
- Dyspnea (shortness of breath) that **worsens** with exertion.
- Fatigue
- Loss of appetite
- Chest pains
- **With more advanced disease,**
- **impairment of total lung capacity (TLC) is commonly present**
- Acute silicosis patients may also have **fever** and
- rapid, **unintended weight loss.**



- ❖ Chest X-ray of the shows "**snow-storm**" appearance
- the hallmark of silicosis is the **silicotic nodule**
- Chest radiography showing **Eggshell calcification**
- On histopathology
- Polarized light microscopy showing **Crystals of silica**



Silico tuberculosis:

- ❖ Silicosis is progressive and what is more important is
- ❖ that silicotics are prone to pulmonary tuberculosis, a condition called "**silico-tuberculosis**."
- ❖ Pulmonary tuberculosis **occurs in about 25%** of patients with acute or classic silicosis
- ❖ in silicotuberculosics sputum rarely shows tubercle bacilli

TREATMENT:

- ❖ There is no specific **effective** treatment for the silicosis,
- ❖ **Fibrotic changes** that have already taken place **cannot be reversed.**
- ❖ There is no known method of intervention to prevent the condition's progression
- ❖ **the only way** that silicosis can be **controlled is by:**
 - (a) rigorous dust control measures, e.g.,**
substitution, complete enclosure, isolation,
hydroblasting,
good house-keeping, personal protective measures and



Cont. ... TREATMENT:

- good house-keeping, personal protective measures and
- (b) regular physical examination of workers**
 - **Silica exposure** has to **be stopped** to prevent further damage to the lungs,
 - **Smokers** should quit smoking.
 - **TB positive** patients need to be put on anti- **TB** treatment
 - The course of progression often extends over decades **even after cessation of exposure.**
- Prevention remains the most effective therapeutic approach

A decorative card with a black background covered in white stars. The central area is a cream-colored rectangle with a blue and white striped border. The words "THANK YOU!" are written in large, blue, stylized, 3D block letters. The text is surrounded by a vibrant floral border of various colorful flowers (yellow, pink, purple, red, blue) and green leaves.

THANK
YOU!

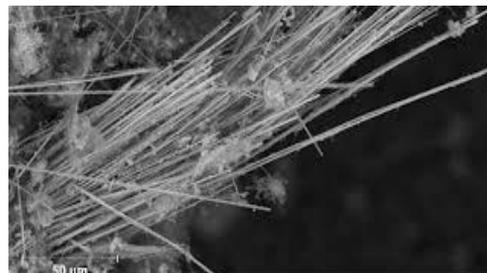
Asbestos Diseases 2

Asbestosis

- Scarring of lung tissue reducing ability to take oxygen.
- Dose related disease ;repeated regular exposures.
- Debilitating disease and can be fatal.
- Latency period 10-20 years



Asbestos fibers



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10

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MAY 2023

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- Asbestosis is **diffuse interstitial pulmonary fibrosis** that occurs secondary to the inhalation of asbestos fibers.

Asbestos

is the commercial name given to certain types of fibrous materials.

Asbestos is a naturally occurring fibrous silicate mineral

They are silicates of varying composition;

the silica is combined with **such bases** as **magnesium, iron, calcium, sodium** and aluminium.

Formed of fibrous *magnesium silicate*.

- **Asbestos Posses thermal ,noise , water and chemical resistance,**
- **flexible and high tensile strength**

Asbestos fibres are usually from

20 to 500 μ in length and

0,5 to 50 μ in diameter.

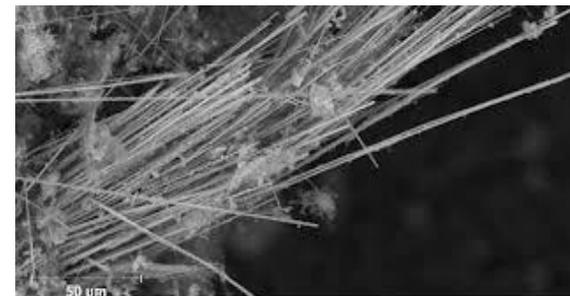
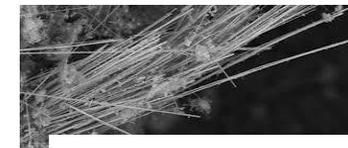


Figure: SEM of Asbestos

Asbestos fibers

● Uses:

- Due to its physical properties, it is used in manufacture of
- fire proof textile,
- wire insulation,
- friction materials (brake lining),
- roofing and floor products,
- ship construction and
- paints.



ASBESTOSIS

Serpentine (93% of commercial use)	Amphibole (7% of commercial use)
Chrysotile	Actinolite, Amosite, Anthophyllite, Crocidolite, Richterite, Tremolite

Asbestos is used

- in the manufacture of asbestos cement,
- brake lining بطانة الفرامل,
- gaskets and
- several other items.



- **Asbestos is classified into two groups:**

- **Serpentine (93% of commercial use)** which is hydrated magnesium silicate
Chrysotile fibers have **curved appearance** (white asbestos)
- **Amphibole.** (7% of commercial use) **contains little magnesium.** chain silicate **with straight line**, This type occurs in different varieties, e.g.
 - Chrysolite Actinolite, Amosite (**brown asbestos**) , Anthophyllite, Crocidolite (**blue asbestos**), Richterite, TremRichterite, Tremolite

	
Serpentine (93% of commercial use)	Amphibole (7% of commercial use)
Chrysolite	Actinolite, Amosite, Anthophyllite, Crocidolite, Richterite, Tremolite

ASBESTOSIS



Serpentine (93% of commercial use)	Amphibole (7% of commercial use)
Chrysolite	Actinolite, Amosite, Anthophyllite, Crocidolite, Richterite, Tremolite

• Types of exposures:

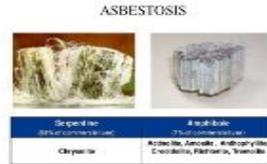
1) Direct:

primary → miners and millers

Secondary → manufacturing plants

2) Indirect:

bystander (observer) exposure تعرض المتفرجين and household contact



■ At risk groups:

- plumbers, السباكين،
- insulation workers، عمال العزل،
- carpenters، نجارين،
- welders، الحام،
- Miners and millers of asbestos.

Prevalence increase with

- length of employment (dose response)
- **Smokers and x smokers** carry greater risk and **higher mortality**

ASBESTOSIS

- **Asbestos enters** the body by **inhalation**, and the fine dust may be deposited in the alveoli.
- The fibers are insoluble.
- The dust deposited in the lungs causes **pulmonary fibrosis** leading to **respiratory insufficiency** and **death**;



- ❖ The **fibrosis in** asbestosis is due to **mechanical irritation**, and
- ❖ is **peribronchial**, **diffuse in character**, and **basal in location** interstitium (**peribronchial**, **diffuse** and **basal fibrosis**).
- ❖ **in contrast** to silicosis in which the fibrosis is **nodular in character** and **present in the upper part of the lungs**.
- The **lung architecture** is **changed** leading to **honeycomb** changes and intense **peribronchial cellular reaction** may cause **narrowing** or **obstruction** of airway lumen.
- ❖ **Average latency period is 20-30 years**
- **carcinoma of the bronchus**;

carcinoma of the bronchus;

ASBESTOSIS

- ❖ **carcinoma** of the bronchus;
- The **risk of bronchial cancer** is reported to **be high** if occupational exposure to asbestos is combined **with cigarette smoking**
- ❖ **mesothelioma** of the pleura or peritoneum;
- ❖ In Great Britain, an **association** was reported **between mesothelioma and living within 1 km of an asbestos factory**
- ❖ **Mesothelioma**, a rare form of cancer of the pleura and peritoneum,
- ❖ has been shown to have a strong **association with the**
- ❖ **crocidolite** (blue asbestos) variety of asbestos .
- ❖ The disease does not usually appear until **after 5 to 10 years** of exposure **and**
- cancer of the **gastro-intestinal tract**.



❑ **Clinically the disease is characterized by**

- Dyspnoea gradually increases
- Cough
- Chest pain
- .Bilateral late inspiratory crepitation on posterior Lung bases

❖ **In advanced cases,** there may be

- **Clubbing of fingers,**
- **cardiac distress and**
- **cyanosis.**
- **The sputum shows "asbestos bodies"** which are asbestos fibres coated with fibrin

Lung function change:

Restrictive impairment with ↓ lung volumes (FVC, TLC)

FEV1/FVC ratio is usually preserved.

X-ray picture:





❖ X-ray picture:

ASBESTOSIS

Bilateral diffuse nodular & or irregular **oval opacities** predominant in **lower lung zones**, Interstitial fibrosis and “**Shaggy heart sign**”

❖ • At histopathologic analysis,

asbestos bodies, which may consist of a single asbestos fiber surrounded by a segmented protein-iron coat, can be identified in intraalveolar macrophages

Diagnosis:

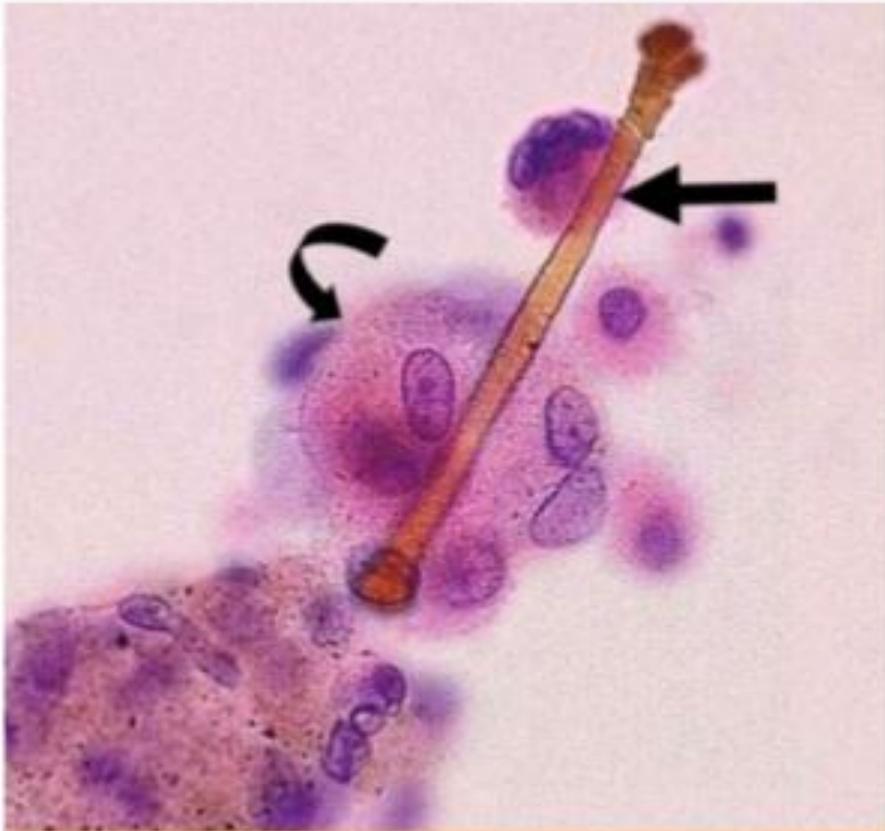
- 1- **History** of exposure: exposure over (10-20) years is usually necessary.
- 2- **Clinical picture**: particularly **dyspnea** and **clubbing** of fingers.
- 3- **X-ray picture**: **irregular basal opacities** (**ground glass**) .
- 4- **Pulmonary function**: restrictive abnormality.
- 5- **Broncho-alveolar lavage (BAL)**: **Contain Asbestos bodies**

D.D:

- **Idiopathic pulmonary** fibrosis (I.P.F): the patient **is younger**, clinically and physiological impairment is more severe and progress rapidly.
- (pseudo asbestos bodies) such as silica, kaolinite, **silicates** or **man-made mineral fibers**. They **contain no asbestos core**.

	
Serpentine (95% of commercial use)	Amphibole (% of commercial use)
Chrysotile	Actinolite, Amosite, Anthophyllite, Crocidolite, Riebeckite, Tremolite

ASBESTOSIS



Translucent asbestos fiber (straight arrow) surrounded by a protein-iron coat and an alveolar macrophage (curved arrow)



Chest x-ray showing Small, irregular oval opacities Interstitial fibrosis and "Shaggy heart sign"

Treatment Strategy:

Once established, the disease is progressive even after removal of the worker from contact

- Stopping additional exposure
- Careful monitoring to facilitate early diagnosis
- Smoking cessation
- Regular influenza and pneumococcal vaccines
- Disability assessment
- Pulmonary rehabilitation as needed
- Aggressive treatment of respiratory infections
- Health education to patient

Prevention of ASBESTOSIS

The preventive measures consists of :

- (1) use of safer types of asbestos (chrysolite and amosite);
- (2) substitution of other insulants: glass fibre, mineral wool, calcium silicate, plastic foams, etc.;
- (3) rigorous dust control;
- (4) periodic examination of workers; biological monitoring (clinical, X-ray, lung function), and
- (5) continuing research.

Permissible Exposure Limit (**PEL**) for asbestos is **0.1 fiber** per cubic centimeter of air as an eight-hour time-weighted average (TWA)

Control Measures Of Asbestos

- - PEL 0.1 fiber/CM³ (TWA8).
- - Switch to alternate material, **man-made fibers (MMF)** are considered .
- - Engineering controls include enclosure, increased ventilation, wet manufacturing.
- - Use of personal respirators.
- - Stop tobacco smoking.

❖ **Permissible** Exposure Limit (PEL) for asbestos is **0.1** fiber per cubic centimeter of air as an **eight-hour time-weighted average** (TWA),), with an excursion limit (EL) of 1.0 asbestos fibers per cubic centimeter over a 30-minute period. The employer must ensure that no one is exposed above these limits

Permissible Exposure Limit (**PEL**) for asbestos is **0.1 fiber** per cubic centimeter of air as an eight-hour time-weighted average (TWA

❖ **Man-made vitreous fibers** الألياف الزجاجية, MMVF (MM mineral fibers):

- **Constitute 3 main species:**
 - **Glass fibers** (glass wool, continuous glass filaments)
 - **Mineral wool** (rock wool and slag wool)
 - **Ceramic fiber.**
- **They used as a substitute** for asbestos since the latter were banned due to its bad health effects.
- They possess high tensile strength, perfect elasticity, thermal and electrical properties and moist and corrosion resistance.
- They have a toxic effect on peritoneal and pulmonary macrophages and structure chromosome alteration in mammalian cells.
- **TWA8 should keep below 1 fiber /CM³ as asbestos.**

Significant occupational exposure to asbestos occurs mainly in

- Asbestos cement factories
- Asbestos textile industry and
- Asbestos mining and milling.

ASBESTOSIS



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Asbestos cement factories



Asbestos textile industry



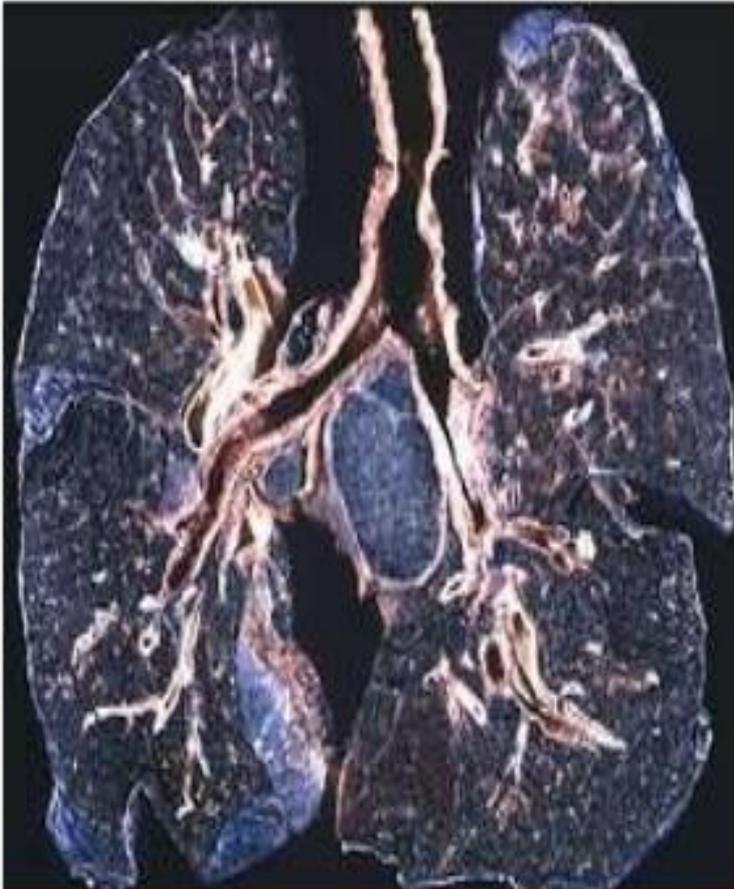
Asbestos mining

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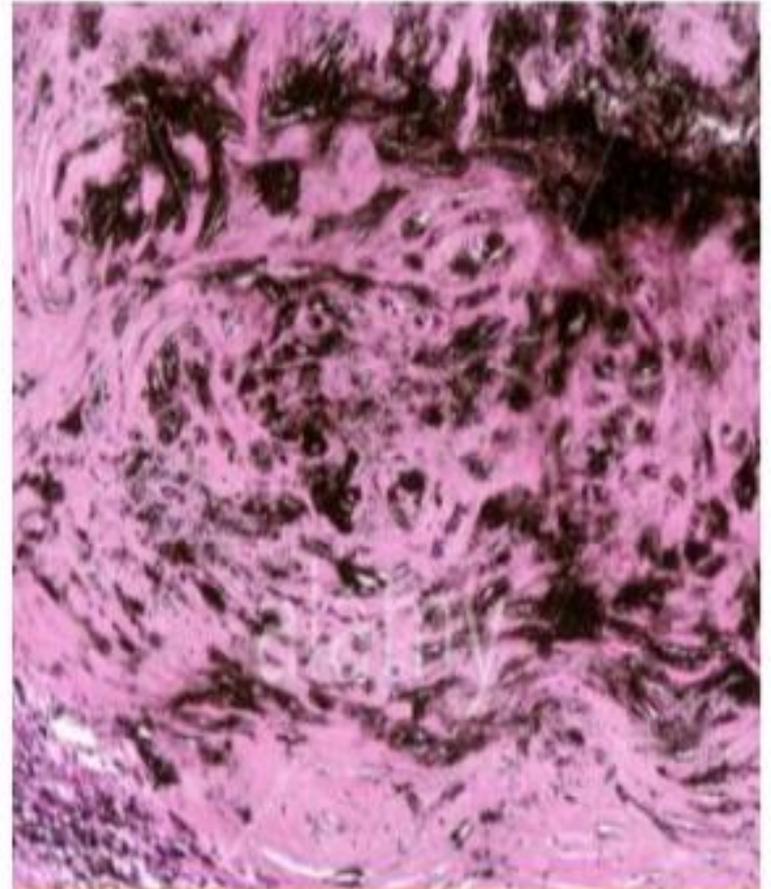
THANK
YOU!

Cut section of lungs in anthracosis On histopathological examination

Anthracosis



Cut section of lungs in anthracosis



On histopathological examination