Anatomic Alterations of the Lungs

Chronic restrictive pulmonary disorder

When fungal spores are inhaled, they may reach the lungs and germinate.

The spores produce a **frothy, yeast-like** substance that leads to an inflammatory response.

Polymorphonuclear leukocytes and macrophages move into the infected area and engulf the fungal spores.

The pulmonary capillaries dilate, the interstitium fills with fluid, and the alveolar epithelium swells with **edema fluid**.

Regional lymph node involvement commonly occurs during this period.

Because of the inflammatory reaction, the alveoli in the infected area eventually become **consolidated**.

Airway secretions may also develop at this time.

In **severe cases**, tissue necrosis, **granulomas**, and cavity formation may be seen.

During the healing process, **fibrosis** and **calcification** of the lung parenchyma ultimately replace the granulomas.

In response to the fibrosis and occasional calcification, the lung tissue retracts and becomes firm.

The **apical** and **posterior segments of the upper lobes** are most commonly involved.

Anatomic changes are similar to those seen in TB.

Major pathologic or structural changes

- Alveolar consolidation
- Alveolar-capillary destruction
- Caseous tubercles or granulomas
- Cavity formation
- Fibrosis and secondary calcification of the lung parenchyma
- Bronchial secretions

Etiology and Epidemiology

Fungal spores of various types are widely distributed throughout the **air**, **soil**, **fomites**, and **animals**, and even exist in the ***normal flora of humans***.

300 fungal species may be linked to disease in animals

In plants	fungal disease is the most common cause of death and destruction
In humans	most exposures to fungal pathogens do *not* lead to overt infection because humans have a relatively high resistance to them

Etiology and Epidemiology (cont)

Human fungal disease	***mycotic disease*** or ***mycosis***
	caused by **primary or "true" fungal pathogens** that exhibit some degree of virulence or by opportunistic
	or **secondary pathogens** that take advantage of a weakened immune defense system

Primary Pathogens [Histoplasmosis]

HISTOPLASMOSIS

	• ***Ohio Valley Fever***
	• most common fungal infection in the United States
	• dimorphic fungus ***Histoplasma capsulatum***
	• prevalence of histoplasmosis is especially high along the major river valleys of the Midwest and South (e.g., in Ohio, Michigan, Illinois, Mississippi, Missouri, Kentucky, Tennessee, Georgia, and Arkansas)
	• On the basis of skin test surveys it is estimated that **80% to 90%** of the population throughout these areas shows signs of previous infection
H. capsulatum	• commonly found in soils enriched with bird excreta, such as the soil near chicken houses, pigeon lofts, barns, and trees where starlings and blackbirds roost
	• may be carried by bats
	• an individual acquires the infection by inhaling the fungal spores that are released when the soil from an infected area is disturbed
	• incubation period for the infection is approximately 17 days

When the *H. capsulatum* organism reaches the alveoli at body temperature, it converts from its ***mycelial form (mold)*** to a **parasitic yeast form**.

Only about 40% of those infected demonstrate symptoms, and only about 10% of these patients are ill enough to consult a physician.

Primary Pathogens [Histoplasmosis] (cont)

Depending on the individual's immune system, the disease may take one of the following forms:

- **asymptomatic primary histoplasmosis**
- **acute symptomatic pulmonary histoplasmosis**
- **chronic histoplasmosis**
- **disseminated histoplasmosis**

Asymptomatic histoplasmosis

- most common form of histoplasmosis
- Normally it produces no signs or symptoms in otherwise healthy individuals who become infected.
- The only residual sign of infection may be a small, healed lesion of the lung parenchyma or calcified hilar lymph nodes.
- patient will have a positive **histoplasmin skin test** result

Acute symptomatic pulmonary histoplasmosis

- occur in otherwise healthy individuals who have had an intense exposure to *H. capsulatum*
- Depending on the number of spores inhaled, the individual signs and symptoms may range from mild to serious illness.
- Mild signs and symptoms include fever, muscle and joint pain, headache, dry hacking cough, chills, chest pain, weight loss, and sweats.
- People who have inhaled a large number of spores may develop a severe acute pulmonary syndrome, a potentially life-threatening condition in which the individual becomes extremely short of breath.
- This is often referred to as ***spelunker's lung*** because it frequently develops after excessive exposure to bat excrement stirred up by individuals exploring caves.
- During this phase of the disease, the patient's chest radiograph generally shows single or multiple infection sites resembling those associated with pneumonia.

Primary Pathogens [Histoplasmosis] (cont)

Chronic pulmonary histoplasmosis

- Infiltration and cavity formation in the upper lobes of one or both lungs.
- often affects people with an underlying lung disease such as **emphysema**
- most commonly seen in middle-aged white men who smoke
- **Signs and symptoms** include fatigue, fever, night sweats, weight loss, productive cough, and hemoptysis—similar to signs and symptoms of tuberculosis.
- Often the infection is self-limiting.
- In some patients, however, progressive destruction of lung tissue and dissemination of the infection may occur.

Disseminated histoplasmosis

- either self-limited histoplasmosis or chronic histoplasmosis
- most often seen in very young or very old patients with compromised immune systems
- Even though the macrophages can remove the fungi from the bloodstream, they are unable to kill the fungal organisms.
- As a result, disseminated histoplasmosis can affect nearly any part of the body, including eyes, liver, bone marrow, skin, adrenal glands, and intestinal tract.
- Depending on which body organs are affected, the patient may develop anemia, pneumonia, pericarditis, meningitis, or adrenal insufficiency and ulcers of the mouth, tongue, or intestinal tract.
- If untreated, disseminated histoplasmosis is usually fatal.

Screening and Diagnosis

Fungal culture

- gold standard for detecting histoplasmosis

Primary Pathogens [Histoplasmosis] (cont)

• A small amount of blood, sputum, or tissue from a lymph node, lung, or bone marrow is cultured.

• The disadvantage of this test is that it takes time for the fungus to grow—4 weeks or longer.

• not the test of choice in cases of disseminated histoplasmosis

• Treatment delays in patients may prove fatal.

Fungal stain

• a tissue sample, which may be obtained from sputum, bone marrow, lungs, or a skin lesion, is stained with dye and examined under a microscope for *H. capsulatum*

• A positive test result is 100% accurate.

• e. The disadvantage of this test is that obtaining a sputum sample can be difficult, and obtaining a sample from other sites requires invasive procedures.

Serology

• checks blood serum for antigens and antibodies

• When an individual is exposed to histoplasmosis spores (antigens), the body's immune system produces antibodies (proteins) to react to the histoplasmosis antigens.

• Tests that check for histoplasmosis antigen and antibody reactions are relatively fast and fairly accurate.

• False-negative results, however, may occur in people who have compromised immune systems or who are infected with other types of fungi.

Primary Pathogens [Coccidioidomycosis]

Coccidioidomycosis

• caused by inhalation of the spores of ***Coccidioides immitis***, which are spherical fungi carried by wind-borne dust particles

• endemic in hot, dry regions

• .In the United States, coccidioidomycosis is especially prevalent in California, Arizona, Nevada, New Mexico, Texas, and Utah.

• About 80% of the people in the San Joaquin Valley have positive coccidioidin skin-test results.

• "**California fever**," "**Desert rheumatism**," "**San Joaquin Valley Disease**," and "**Valley Fever**."

• isolated in these regions from soils, plants, and a large number of vertebrates

• When *C. immitis* spores are inhaled, they settle in the lungs, begin to germinate, and form round, thin-walled cells called **spherules**.

• The spherules, in turn, contain endospores that make more spherules (the spherule-endospore phase).

• The disease usually takes the form of an acute, primary, selflimiting pulmonary infection with or without systemic involvement.

• Some cases, however, progress to disseminated disease.

Clinical manifestations

• absent in about 60% of the people who have a positive skin-test result

• 40%: cold-like symptoms such as fever, chest pain, cough, headaches, and malaise are often present.

Primary Pathogens [Coccidioidomycosis] (cont)

• In uncomplicated cases, patients generally recover completely and enjoy lifelong immunity.

• In approximately 1:200 cases, however, the primary infection does not resolve and progresses with varied clinical manifestations.

• Chronic progressive pulmonary disease is characterized by nodular growths called ***fungomas*** and cavity formation in the lungs.

• Disseminated coccidioidomycosis occurs in about 1:6000 exposed persons.

• When this condition exists, the lymph nodes, meninges, spleen, liver, kidney, skin, and adrenals may be involved.

• The skin lesions (e.g., bumps on the face and chest) are commonly accompanied by arthralgia or arthritis, especially in the ankles and knees. This condition is commonly called "**desert bumps**," "**desert arthritis**," or "**desert rheumatism**."

Screening and Diagnosis

• The diagnosis of coccidioidomycosis can be made by direct visualization of distinctive spherules in microscopy of the patient's sputum, tissue exudates, biopsies, or spinal fluid.

• The diagnosis can be further supported by blood tests that detect antibodies to the fungus or from a culture of the organism from infected fluid or tissue.

Primary Pathogens [Blastomycosis]

Blastomycosis

• "**Chicago disease**," **Gilchrist's disease**, and **North American blastomycosis**

• caused by ***Blastomyces dermatitidis***

• occurs in people living in the south-central and midwestern United States and in Canada

• The infection occurs in 1 to 2 of every 100,000 people in these areas.

• Cases also have been reported in Central America, South America, Africa, and the Middle East.

• *B. dermatitidis* inhabits areas high in organic matter, such as forest soil, decaying wood, animal manure, and abandoned buildings.

• most common among pregnant women and middle-aged African-American men

• The disease also is found in dogs, cats, and horses.

• Primary portal of entry of *B. dermatitidis* is the **lungs**.

• The acute clinical manifestations resemble those of acute histoplasmosis, including fever, cough, hoarseness, joint and muscle aches, and, in some cases, **pleuritic pain**.

• Unlike in histoplasmosis infection, however, the **cough is frequently productive**, and the **sputum is purulent**.

• Acute pulmonary infections may be self-limiting or progressive.

• When the condition is progressive, **nodules** and **abscesses** develop in the lungs.

• Extrapulmonary lesions commonly involve the skin, bones, reproductive tract, spleen, liver, kidney, or prostate gland.

• The **skin lesions** may, in fact, be the *first signs of the disease*.

• It often begins on the face, hands, wrists, or legs as subcutaneous nodules that erode to the skin surface.

Primary Pathogens [Blastomycosis] (cont)

• **Yeast dissemination** also may cause arthritis and osteomyelitis, and involvement of the central nervous system causes headache, convulsions, coma, and mental confusion.

• Standardized serologic testing procedures for blastomycosis are not available, and neither is an accurate ***blastomycin skin test***.

• The diagnosis of blastomycosis can be made from direct visualization of the yeast in sputum smears, or the fungus can be cultured.

Opportunistic Pathogens

Opportunistic yeast pathogens such as ***Candida albicans***, ***Cryptococcus neoformans***, *and* **Aspergillus*** also are associated with lung infections in certain patients.

C. albicans	• Occurs as normal flora in the oral cavity, genitalia, and large intestine.
	• infection of the mouth, or **thrush**, is characterized by a white, adherent, patchy infection of the mouth, gums, cheeks, and throat.
	• In patients with HIV infection, *C. albicans* often causes infection of the mouth, pharynx, vagina, skin, and lungs
C. neoformans	• Proliferates in the **high nitrogen content of pigeon droppings** and is readily scattered into the air and dust.
	• Today, ***Cryptococcus*** is most often seen in patients with HIV infection and persons undergoing steroid therapy
Aspergillus	• **most pervasive** of all fungi
	• found in soil, vegetation, leaf detritus, food, and compost heaps
	• Persons breathing the air of granaries, barns, and silos are at greatest risk.
	• usually occurs in the lungs where it may present in the form of **allergic bronchopulmonary aspergillosis**, a form of asthma.
	• It is almost always an opportunistic infection and poses a serious threat to patients with HIV infection.

OVERVIEW

CLINICAL DATA OBTAINED AT THE PATIENT'S BEDSIDE

The Physical Examination	
Vital Signs	Increased Respiratory Rate (Tachypnea)
	• Stimulation of peripheral chemoreceptors
	• Decreased lung compliance–increased ventilatory rate relationship
	• Pain, anxiety, fever
	Increased Heart Rate (Pulse) and Blood Pressure
Chest Pain, Decreased Chest Expansion	
Cyanosis	
Digital Clubbing	
Peripheral Edema and Venous Distention	Because polycythemia and cor pulmonale are associated with severe fungal disease of the lungs, the following may be seen:
	• Distended neck veins
	• Pitting edema
	• Enlarged and tender liver
Cough, Sputum Production, and Hemoptysis	
Chest Assessment Findings	• Increased tactile and vocal fremitus
	• Dull percussion note
	• Bronchial breath sounds
	• Crackles, wheezing
	• Pleural friction rub (if process extends to pleural surface)
	• Whispered pectoriloquy

General Management of Fungal Disease

Amphotericin B	• treatment of choice for most fungal infections
	• However, because of the high incidence of nephrotoxicity associated with amphotericin B, the ***azole*** antifungal agents now serve as an excellent alternative.

General Management of Fungal Disease (cont)

Although **ketoconazole** was the first agent in this class, it has largely been replaced with **fluconazole** and **itraconazole**.

In addition, a new class of antifungals known as the ***echinocandins*** is now available.

Respiratory Care Treatment Protocols

Oxygen Therapy Protocol

• used to treat hypoxemia, decrease the work of breathing, and decrease myocardial work

• Because of the hypoxemia associated with the fungal pulmonary condition, supplemental oxygen may be required.

• Because of the alveolar consolidation produced by a fungal disorder, capillary shunting may be present.

• Hypoxemia caused by capillary shunting is often refractory to oxygen therapy.

Bronchopulmonary Hygiene Therapy Protocol

• Because of the excessive production and accumulation of mucus sometimes associated with fungal disease, a number of bronchial hygiene treatment modalities may be used to enhance the mobilization of bronchial secretions.

Mechanical Ventilation Protocol

• may be necessary to provide and support alveolar gas exchange and eventually return the patient to spontaneous breathing

• Because acute ventilatory failure is occasionally seen in patients with severe fungal disease, continuous mechanical ventilation may be required.

• Continuous mechanical ventilation is justified when the acute ventilatory failure is thought to be reversible.