

Distribution and Isolation of Microorganisms from Air

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Biological aerosols as a human hazard source

What types of dangers are connected to the presence of microorganisms in air?

- Infectious diseases (viral, bacterial, fungal and protozoan),
- Allergic diseases,
- Poisoning (exotoxins, endotoxins, mycotoxins).

Infectious airborne diseases



- Bioaerosols may, among other things, carry microbes that penetrate organs via the respiratory system. After settling, microbes from the air, may find their way onto the skin or, carried by hands, get into the digestive system (from there, carried by blood, to other systems, e.g. the nervous system). Fungi that cause skin infections, intestinal bacteria that cause digestive system diseases or nervous system attacking enteroviruses are all examples of the above.

Some important diseases of humans transmitted from person to person by inhaled airborne particles

Virus diseases (virus type in brackets)

Chickenpox (Varicella)

Flu (Influenza)

Measles (Rubeola)

German measles (Rubella)

Mumps (Mumps)

Smallpox (Variola)

Bacterial diseases (bacterial name in brackets)

Whooping cough (*Bordetella pertussis*)

Meningitis (*Neisseria* species)

Diphtheria (*Corynebacterium diphtheriae*)

Pneumonia (*Mycoplasma pneumoniae*,
Streptococcus species)

Tuberculosis (*Mycobacterium tuberculosis*)

Several other diseases, below, are acquired by inhaling particles from environmental sources, not directly from an infected person.

Disease	Source
Psittacosis (<i>Chlamydia psittaci</i>)	Dried, powdery droppings from infected birds (parrots, pigeons, etc.)
Legionnaire's disease (<i>Legionella pneumophila</i>)	Droplets from air-conditioning systems, water storage tanks, etc., where the bacterium grows.
Acute allergic alveolitis (various fungal and actinomycete spores)	Fungal or actinomycete spores from decomposing organic matter (composts, grain stores, hay, etc.)
Aspergillosis (<i>Aspergillus fumigatus</i> , <i>A. flavus</i> , <i>A. niger</i>)	Fungal spores inhaled from decomposing organic matter
Histoplasmosis (<i>Histoplasma capsulatum</i>)	Spores of the fungus, in old, weathered bat or bird droppings
Coccidioidomycosis (<i>Coccidioides immitis</i>)	Spores in air-blown dust in desert regions (Central, South and North America) where the fungus grows in the soil



Airborne bacterial diseases



Diphtheria

- Acute contagious disease caused by *Corynebacterium diphtheriae*
- Formation of fibrous pseudomembrane on respiratory mucosa, myocardial and neural tissue damage.
- Symptoms:
 - Sore throat
 - Low fever
 - Cutaneous lesions e.t.c.



Tuberculosis

- Caused by *Mycobacterium tuberculosis*,
- Initiated by inhalation

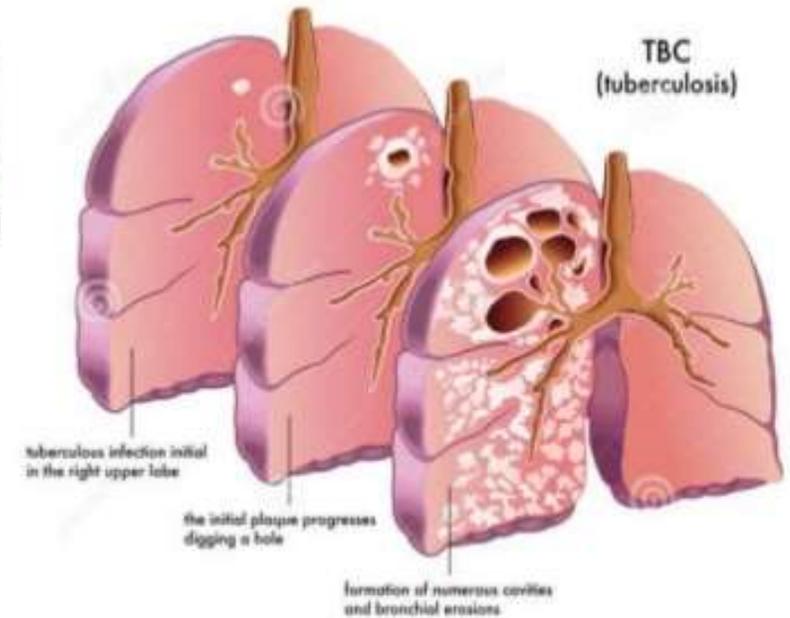
- **Symptoms:**

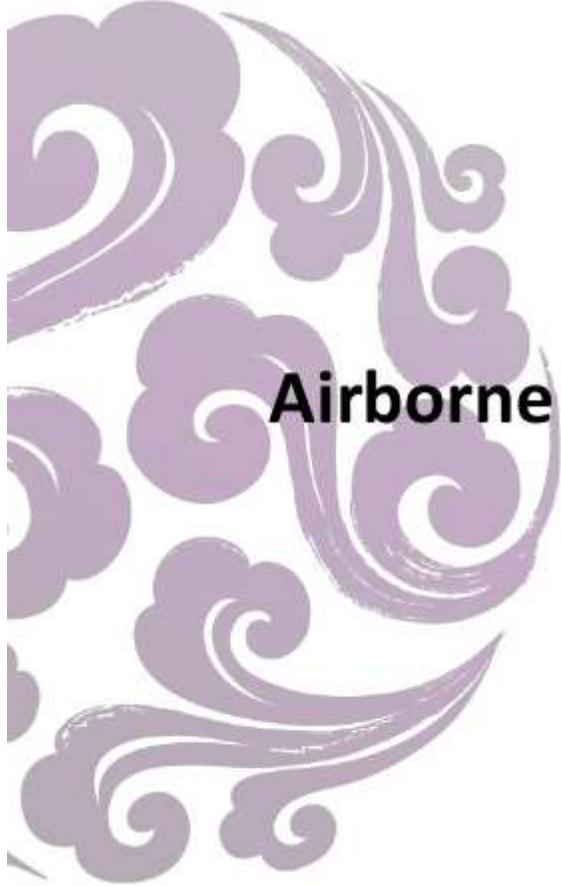
Chronic cough

Blood tinged sputum

Night sweats

Weight loss e.t.c.





Airborne Viral Diseases



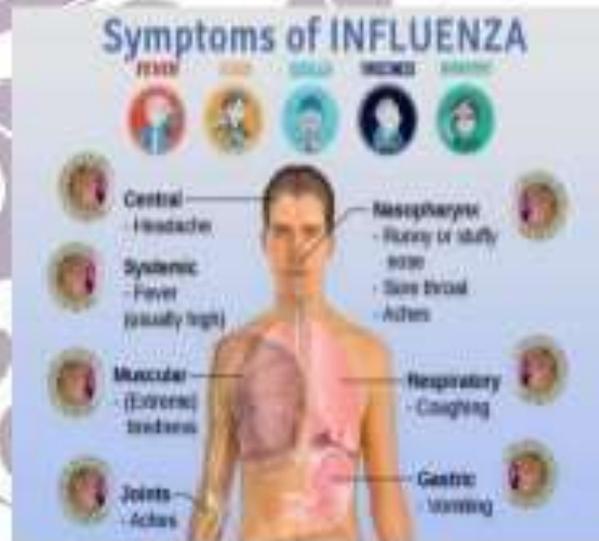
Small pox

- Caused by *poxviridae* family:
 - Variola major*
 - Variola minor*
- Localized in small blood vessels of skin and mouth.
- Rash and fluid filled blisters.



Influenza

- Acute respiratory disease characterized by fever, cough, headache, inflamed respiratory membranes caused by *myxovirus*.





Airborne Fungal Diseases



Cryptococcosis

- Infectious disease caused by *Cryptococcus neoformans*. AIDS causing disease.
- It primarily effects:
 - Lungs
 - Meninges
 - Kidneys
 - Bone
 - Skin



- Air borne Viral Disease

- Chickenpox– causes blister–like rash
 - Flu/influenza– respiratory illness
 - Measles– also known as rubeola, rash and fever
 - Rubella/German measles– rash and fever
 - Mumps– fever and swelling of salivary glands
 - Smallpox– extensive rash and high fever
 - Hantavirus pulmonary syndrome– respiratory disease from contact with infected rodents
 - Pleurodynia– chest wall pain, gastrointestinal/respiratory illness
- Common cold

- Severe Acute Respiratory Syndrome (SARS)– identified as a new disease in 2003 (An important airborne disease)

However, it is common to find throat and mouth inhabiting bacteria exemplified by Streptococcus, Staphylococcus, Pneumococcus, etc. in air

About one-third of the world's population has latent Tuberculosis.



Allergic diseases



Many microbes exist as allergens. Besides these, there are other allergenic factors such as anemophilous pollens (e.g. grass, nettle, comose), small arachnids (mites) as well as biological dust (e.g. particles of feathers, hair or droppings). Microorganisms differ in their allergenic influences. The strongest allergens are mold fungi, thermophilus actinomycetes, as well as Gram-negative chromatobars. The strength of allergenic bioaerosols depends not only on the type of microorganisms but also on their concentration.

Poisoning



Poisoning / intoxication is caused by toxins that are produced by some microorganisms. Endotoxins and mycotoxins are the most significant types of toxins in polluted air.

Endotoxins are the components of Gram-negative bacterial cell walls (A lipid fragment of lipopolysaccharides LPS outer membrane). They demonstrate toxic (and allergenic) effects on mammals. After being inhaled into the lungs, they cause acute inflammation of the lungs.

Mycotoxins are produced by various mold fungi. The most common ones are aflatoxins produced by *Aspergillus flavus*. These compounds (there are several types of them) demonstrate strong toxic, mutagenic, carcinogenic, teratogenic (cause malformation in a fetus) actions. Most often they lead to food poisonings, however it has also been indicated, that inhaling dusts which contain aflatoxins may bring about tumours of the liver and the respiratory system.

Isolation of Microorganisms from Air

There are two primary methods for microbial air sampling:

Active and Passive Monitoring

In active monitoring, a microbial air sample is used to force air into, or onto its collection medium (e.g., Petri Dish with nutrient agar based test media) over a specified period of time. The collected culture can then be incubated and analyzed (ie., count bacterial and/or fungal, colony forming units (CFU), and identify if required).

In passive monitoring, settle plates (Petri dishes) are opened and exposed to the air for specified periods of time to determine what microbiological particles may be present in the environment, as they may settle out of the ambient air, and onto the media surface of the Petri Dish.. These plates are then incubated and analyzed

INVESTIGATION OF MICROBIOLOGICAL AIR POLLUTIONS



MICROSCOPIC METHODS:

They consist of:

- letting air through a membrane filter or placing a glass coated with a sticky substance (e.g. vaseline), in the air's path
- staining of the trapped microorganisms and • microscopic testing consisting of cell counting.

Staining with acridine orange and examination under a fluorescence microscope is often applied. The final result is given as a total number of microbes in 1 m³ of air.

The advantage of the above methods is that it allows the detection of live and dead microbes in air, as well as those, which do not abundantly flourish in culture media. Due to this, the number of microbes determined is usually higher by one order of magnitude than in culture methods. In addition, it is possible to detect and identify other biological objects, e.g.: plant pollen, allergenic mites, abiotic organic dust (fragments of skin, feathers, plants, etc.).

However the methods have a serious drawback: inability to determine the species of microbes (bacteria, fungi, viruses).

☞ CULTURE METHODS:



- ☞ These methods consist of transferring microbes from air onto the surface of the appropriate culture medium. After a period of incubation at optimal temperature, the formed colonies are counted and the result is given as cfu/m³ of air (colony forming units). Because a colony can form not only from a single cell, but also from a cluster of cells, the air may contain more microbes than suggested by the CFU result. Besides, the method allows the detection of only the cells that are viable and those which are able to grow upon the medium used.

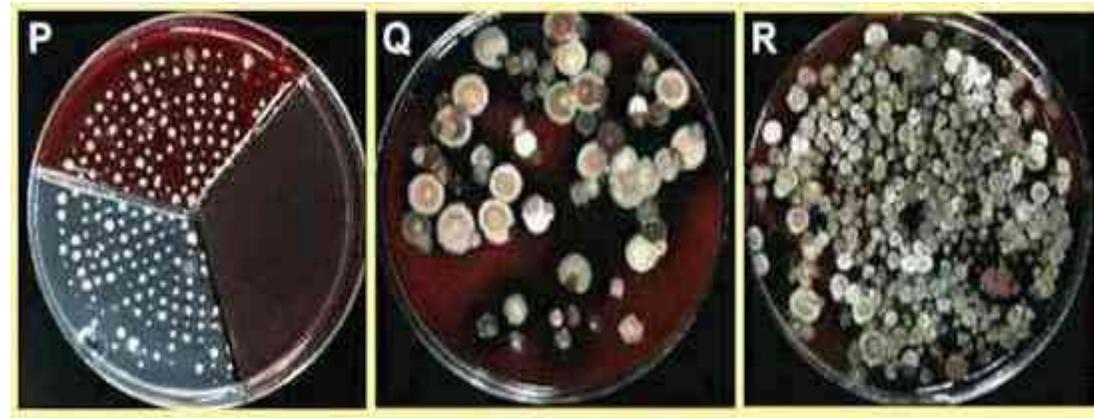
Coloured colonies of airborne bacteria on a Petri plate with agar medium



An agar plate from the bottom level of an Anderson sampler. The colonies are of thermophilic actinomycetes (*Micropolyspora faeni* or *Thermoactinomyces vulgaris*) that are common causes of **Farmer's lung disease** (extrinsic allergic alveolitis).

Actinomycete spores are very small (1-2 micrometres) so they commonly enter the lungs. They form dense, slow-growing colonies on agar, and the pattern of colonies seen on this agar plate reflects the pattern of the perforations through which the air had passed.

This Figure also shows how a divided (three-sectored) Petri dish can be filled with different agar media to detect different types of organism in the air



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