Air Microbiology

Aeromicrobiology: is the study of living microbes which are suspended in the air.

-These microbes are referred to as bioaerosols.
-There are significantly less atmospheric microorganisms than there are in oceans and in soil, there is still a
large enough number that they can affect the atmosphere.
-Once suspended in the air column, these microbes have the opportunity to travel long distances with the
help of wind and precipitation, increasing the occurrence of widespread disease by these microorganisms.
-These aerosols are ecologically significant because they can be associated with disease in humans, animals
and plants.
-Typically microbes will be suspended in clouds, where they are able to perform processes that alter the
chemical composition of the cloud, and may even induce precipitation.

Physical Environment

-There are many factors within the physical environment that affect the launching, transport and
deposition of bioaerosols.
-Particles which become suspended in the air column arise mainly from terrestrial and aquatic
environments and are typically launched by air turbulence.
-Winds are the primary means of transport for bioaerosols.
-Bioaerosols can be deposited by a number of mechanisms, including gravity pulling them down, making
contact with surfaces, or combining with rain which pulls the particles back down to earth's surface.

Atmosphere

-Along with water droplets, dust particles and other matter, air contains microbes.
-Microbes follow a particular pathway in which they are suspended into the atmosphere. First they are
launched into the air. The source of the launching of airborne microbes stems from humans, animals and
vegetation.
-then they are transported (by various methods including winds, machinery and people) and finally are
deposited somewhere new.
-The atmosphere can have a variety of physical characteristics, can be very extreme in terms of the relative
humidity, temperature and radiation. These factors play a huge role in what kinds of microbes will survive
in the atmosphere and how long they will stay alive (Pepper 2011).

Clouds

One area that bioaerosols can be found in is within clouds.

Cloud water is a mixture of organic and inorganic compounds suspended within moisture (contribution of microbial activity to clouds). The conditions in clouds are not conducive to much life, as microbes present there must withstand freezing temperatures, the threat of desiccation, and extreme UV rays. Clouds are also an acidic environment, with a pH ranging from 3 to 7. Nevertheless, there are extremophile microbes which can withstand all of these environmental pressures. Clouds serve as a transport for these microbes, dispersing them over long distances.

Microbes exist within the atmosphere, and can be transported within clouds

Physical Environment Stresses

The atmosphere is a difficult place for a microbe to survive. **Desiccation is the primary stress** that aeromicrobes face, and it limits the amount of time that they can survive while suspended in the air.

Humidity within the air is a second factor which can affect the survival of organisms. Certain bacteria, including Gram+ bacteria, are more tolerant of high humidity in the air, while others are more tolerant of desiccation and dry conditions, such as Gram+ cells. Temperature must be in an intermediate range, as too hot of temperatures can denature proteins, and too cold of temperatures can cause ice crystal formation.

Finally, **radiation poses a potential hazard** for aeromicrobes, as it can damage DNA within the cells.

(Pepper 2011)

Microbial Communities

Many different microorganisms can be in aerosol form in the atmosphere, including **viruses**, **bacteria**, **fungi**, **yeasts** and **protozoans**. In order to survive in the atmosphere, it is important that these microbes adapt to some of the harsh climatic characteristics of the exterior world, including temperature, gasses and humidity.

Many of the microbes that are capable of surviving harsh conditions can readily **form endospores**, which can withstand extreme conditions.

Many of these microorganisms can be associated with specific and commonly known diseases. Below are two tables. **Table 1 and Table 2 shows examples.**

Table 1: Examples of Airborne Plant Pathogens.

Bacterial

One such bacterial microorganism that can resist environmental stresses is *Bacillus*

anthracis. It is a gram positive rod shaped bacteria that utilizes spore formation to resist environmental stresses. The spore is a dehydrated cell with extremely thick cell walls which can remain inactive for many years. This spore makes Bacillus anthracis a highly resilient bacteria, allowing it can survive extreme temperatures, chemical contamination, and low nutrient environments. This bacteria is associated with Anthrax, which is a severe respiratory disease that infects humans.

Table 2: Examples of Airborne Human Pathogens.

Fungal

Another such microorganism that can resist environmental stresses is *Aspergillus fumigatus,* which is a major airborne fungal pathogen. This pathogen is capable of causing many human diseases when conidia. are inhaled into the lungs. While ***A. fumigatus*** lacks virulence traits, it is very adaptable to changing environmental conditions and therefore is still capable of mass infection.

Viral

An example of a viral airborne pathogen is the Avian Influenza Virus, which is a single stranded RNA virus that can infect a broad range of animal species as well as humans and cause the Avian Influenza.

Microbial Processes

The figure on the right depicts the processes that a microbe undergoes during its life cycle. The microbes undergo **the emission process**, in which they are emitted from surfaces such as water, soil or vegetation and become airborne and **transported into the airstream**. The red boxes indicate some of the harsh environmental conditions that the microbes must withstand while airborne. The microbes that are able to withstand and survive these environmental pressures are the more resistant varieties. The microbes make it into clouds, where they can begin the breakdown of organic compounds. Finally, the microbes are "rained" out of the clouds through wet deposition, and they begin colonization of their new location.

Life cycle of microorganisms in the atmosphere.

Droplet Formation

The **emission process** mentioned above, in which microbes are lifted in the air often involves microbes being **suspended in droplets**, which are large enough to keep the microbes hydrated and large enough to maintain a virulent amount of pathogen, but are still small enough to stay suspended in the air.

Current Research

Studies about bioaerosols are difficult to conduct because identifying specific microbes and fungi in the air is a
daunting task. One study conducted by Mark Hayes and associated looked into the feasibility of identifying specific
particles in the air using fingerprinting techniques. It discussed sampling and analysis techniques that can help to
identify cellular material. This is important because the particles in the air are information rich and can tell us a lot
about where they originated or certain biochemical information about the organisms (Hayes 2012).
A great deal of the research conducted on bioaerosols studies their effects on humans, since human disease is one of
the effects of bioaerosols. One such study conducted by Brandl and associates studied the distribution and dynamics of
particles within the air in a lecture hall. Knowing what is in the air is important as human mortality rates increase with
the rise of airborne particulate populations (Brandl 2008).
Additionally, people are continually spending more time **indoors**, and knowing what exists within the air they breathe
is important. This study found that bioaerosol populations were highest when there were a great deal of students in the
hallways and the lecture area, proving that humans are a vector for the transport of bioaerosols.
Another study conducted by Vinni Hansen looked into components in both greenhouses and open fields to see which
affected the levels of fungal bioaerosols. This study was conducted primarily to determine which is more detrimental
to farmworkers. The study concluded that the bioaerosol levels were related to the environment, the work tasks, and
the vegetable crops.

the origin of microorganisms in air.

- Microbes normally found in atmosphere within 300-10000 feet above from the land.
- Fungal spores which are found in air consist of *Alternaria, Cladosporium, Penecillium* and *Aspergillus*
found above 4000 feet from the land, found in both polar and nonpolar air masses.

- Organisms found below 500 feet is mainly in overpopulated area, these include spores of Bacillus and
Clostridium, ascospores of yeast and fragments of mycelium, mould, streptomycetaceae, pollen, protozoan
cysts, algae, Micrococcus and corynebacterium. Air found in school and hospital or living places of the
person suffered from infectious disease usually found microbes like tubercle bacilli, streptococci and
pneumococci.

The characteristics of atmosphere as a habitat include extreme temperature variations, light,
temperature, low amount of available water and organic water. All these characters make the atmosphere
unsuitable for growth of microorganisms. **Usually most of the organisms are found in the lower region of
atmosphere**. The air in the atmosphere is often exposed to sunlight thus it contains less moisture and higher

temperature. Thus if the microorganisms are not protected from desiccation, almost most of the organisms
will die.
The origin of the microorganisms takes place through various ways. **Soil** is one of the source to
transfer microorganisms to the air. Whenever the **wind blows** it disturbs the microorganisms and liberate
them into the air and these microorganisms remains suspended in the air for long time. Another way of
transferring microorganisms to the air is **by manmade actions** like plugging and digging. Organisms can
also be released in the form of **water droplets** or aerosols which are produced by **wind or tidal actions**.
Microorganisms **from plant and animal surfaces** are also transferred by air currents. **But the main source
of microorganisms is human beings.** These are discharged through human activities like **coughing**,
sneezing, **laughing** and **even talking**.

Air micro flora significance in human health:

Human being inhales air every moment. Even **most of the microorganisms present in air** are
harmless but still **less than 1%** of the airborne bacteria is pathogens. **Outdoor air** mostly does not contain
disease causing path1ogen whereas **indoor air** has more chances of infections especially in large gatherings
like theaters and schools.
Food processing: Microorganisms transferred through various methods in air and are settled on
various materials are involved in various fermentation products like alcoholic beverages, vinegar, dairy
products etc. **In Industrial processes which requires growth of any particular organisms, getting supply of
sterile air free from contamination is a problem**.
Food products: are either animal or plant origin. Some bacteria cause food poison. Clostridia cause
toxins in meat and meat products. Staphylococci produce infection in fish products. Salmonella cause
infection through milk, eggs and salads. All of these are happened only when **the unhygenic handling of
food stuffs**.
Microbial biofilms also act as a significant one, it appears in food and food contact surface, if
microorganisms are not removed from the surface it create biofilms will be hazard to consumers.
The microbiology of air is significant in many places such as hospitals, food processing, air
conditioning and many other places.

Air Microflora Significance in Hospitals and Source, significance, and control of indoor microbial
aerosols human health aspects both give examples of the significance.
The bio-aerosol in hospital indoor air is highly influenced by the number of occupants, their activity and the
ventilation. Since exposure levels are high, this may be an issue in the immunocompromised patients.

Significance of microbes in public health: Microorganisms produce a lot of disease, especially in hospitals
nosocomial pathogens cause nosocomial pneumonia. MRSA (methicillin resistant Staphylococcus aureaus) and
Gentamicin resistant gram negative bacteria are found to be serious in nowadays ,it transmitted either by contact or
by airborne spread