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Bretagne-Pays de la Loire
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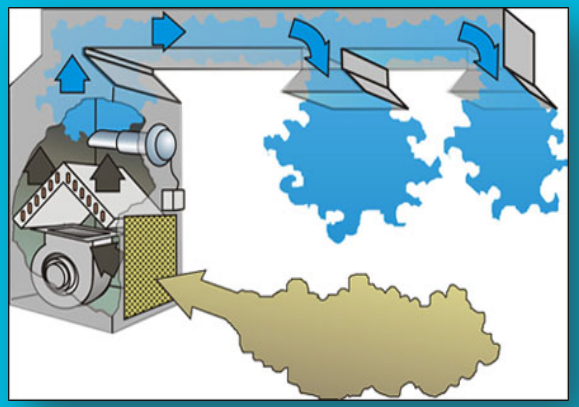
GEPEA
UMR CNRS 6144

MICROBIAL AEROSOLS BEHAVIOR IN AIR TREATMENT (FILTRATION) SYSTEMS



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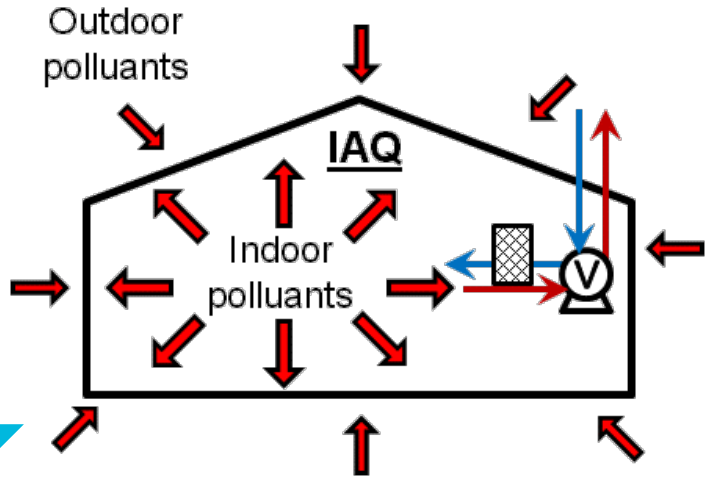
CONTEXTE

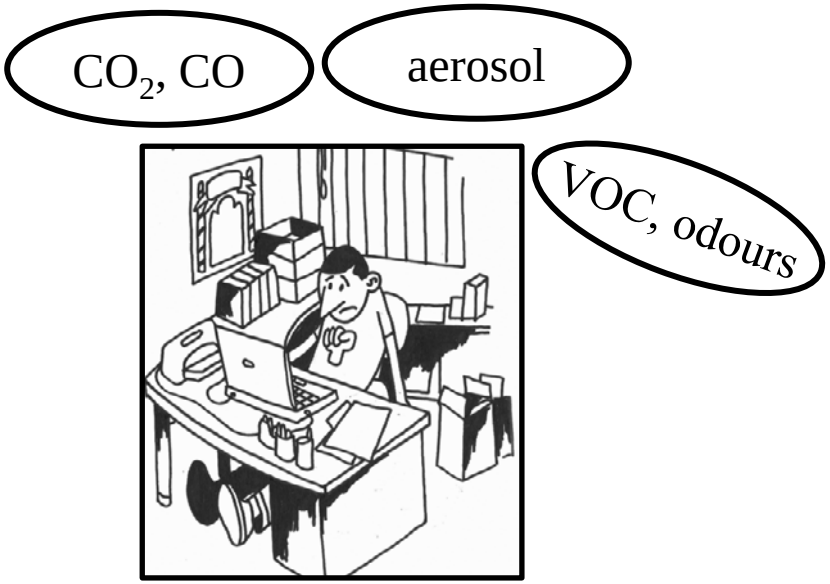
✓ We spend more than 90 % of our time in indoor environment

✓ Indoor air quality (IAQ) becomes one of the main concerns for people's health and safety

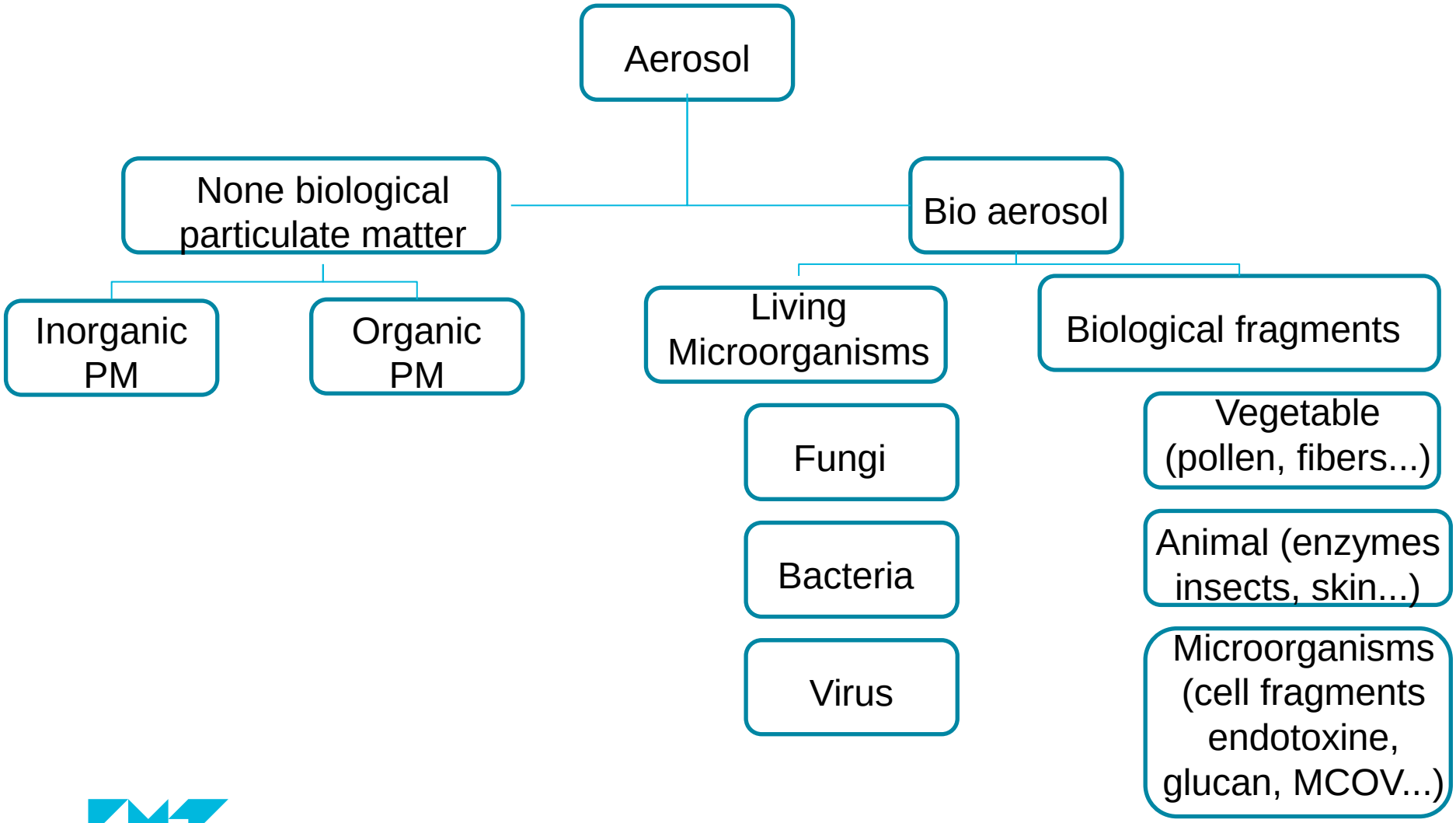
✓ Air Handling Unit are used to purify and recycle indoor air

✓ VOC as formaldehyde or toluene, NOx, PM10, PM2.5, soot, and microbial aerosol are pollutant source





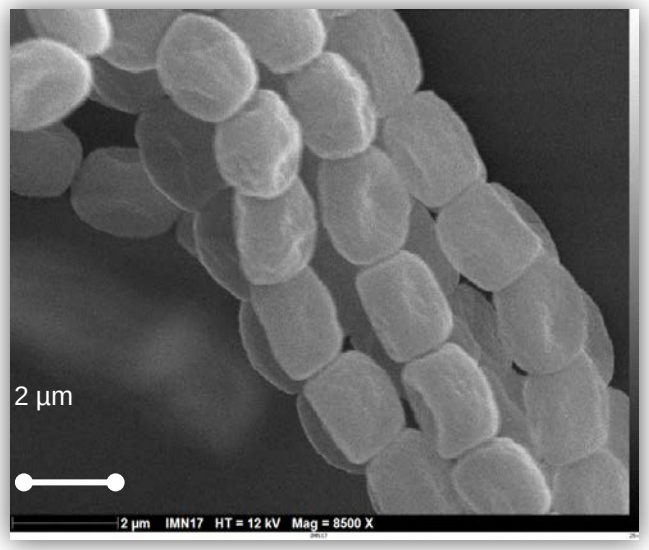
CONTEXTE

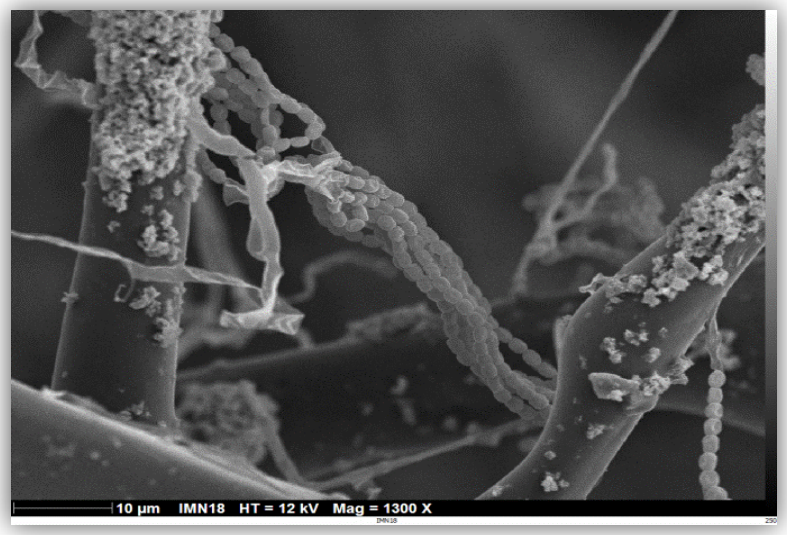

Aerosol
None biological particulate matter
Bio aerosol
Inorganic PM
Organic PM
Living Microorganisms
Biological fragments
Fungi
Bacteria
Virus
Vegetable (pollen, fibers...)
Animal (enzymes insects, skin...)
Microorganisms (cell fragments endotoxine, glucan, MCOV...)

CONTEXTE

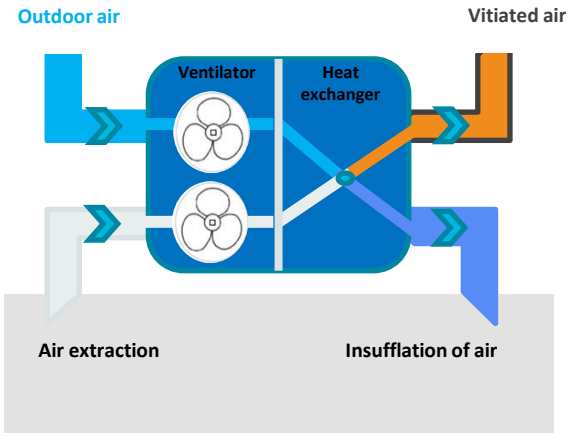
➢ Size of bioaerosol particles varies from less that 1 µm to 100 µm in aerodynamic diameter, viable bioaerosol particles can be suspended in air as single cells or aggregates of microorganism as small as 1–10 µm in size.

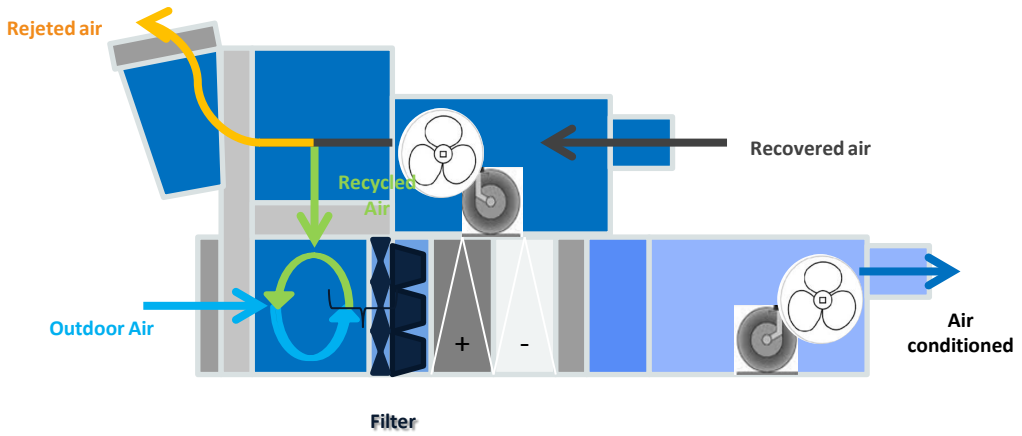
➢ Bioaerosols are potentially related to various human health effects.





CONTEXTE: INDOOR AIR TREATMENT





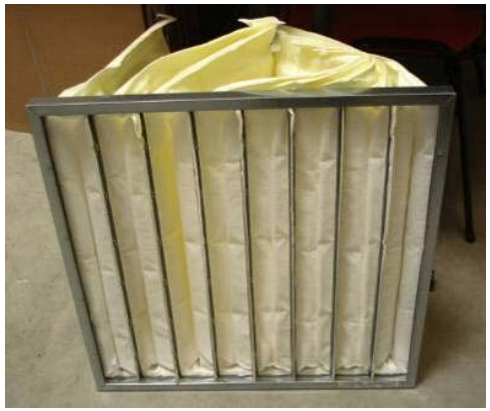
Ventilation System

Air Handling Units (AHU)

G4

F7

F9



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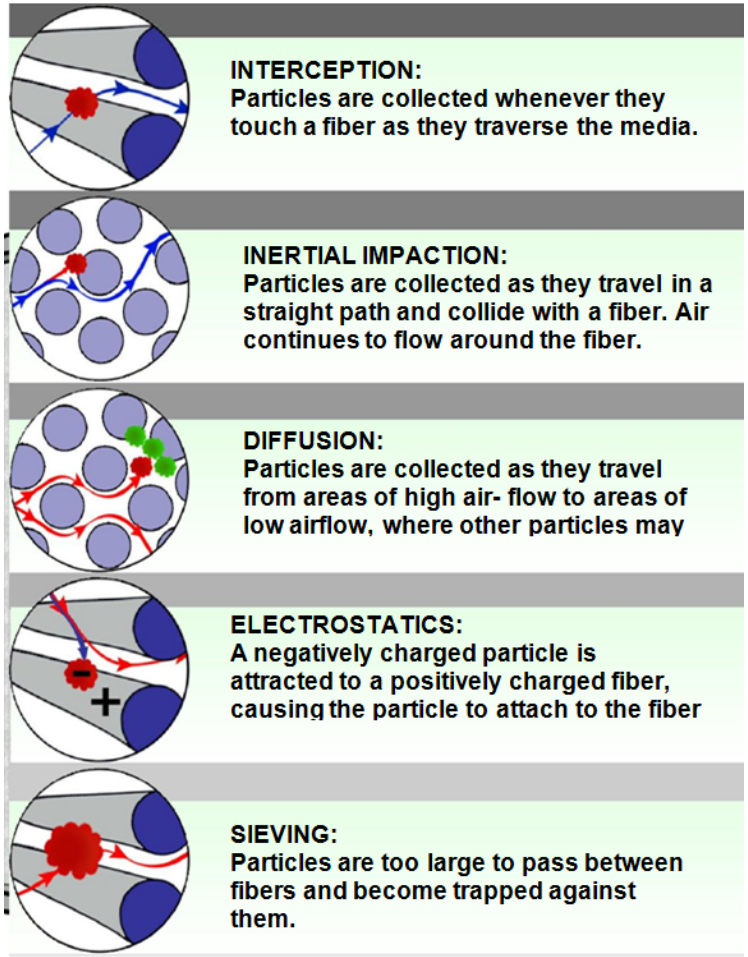
Less effective

More effective
(EN779 2012)

CONTEXTE: FILTRATION



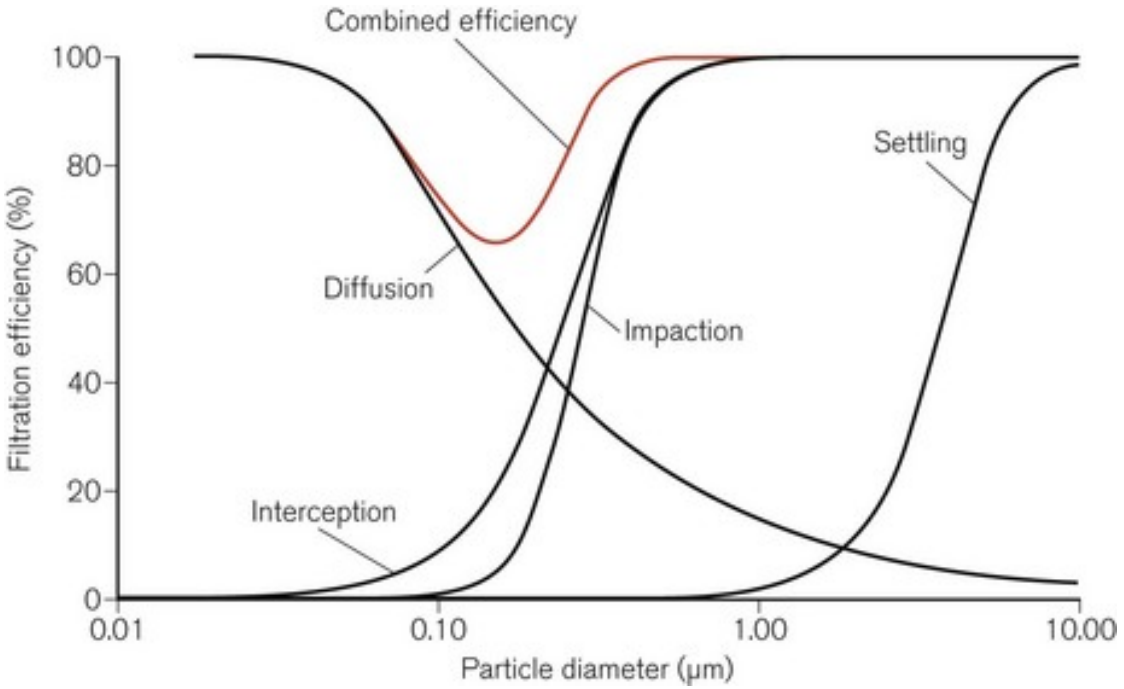
INTERCEPTION:
Particles are collected whenever they touch a fiber as they traverse the media.

INERTIAL IMPACTION:
Particles are collected as they travel in a straight path and collide with a fiber. Air continues to flow around the fiber.

DIFFUSION:
Particles are collected as they travel from areas of high air- flow to areas of low airflow, where other particles may

ELECTROSTATICS:
A negatively charged particle is attracted to a positively charged fiber, causing the particle to attach to the fiber

SIEVING:
Particles are too large to pass between fibers and become trapped against them.



Minimum efficiency between 0,1-0,4 µm Most Penetrating Particle Size(MPPS)

METHODOLOGY: BIO AEROSOL SAMPLING

Impinger

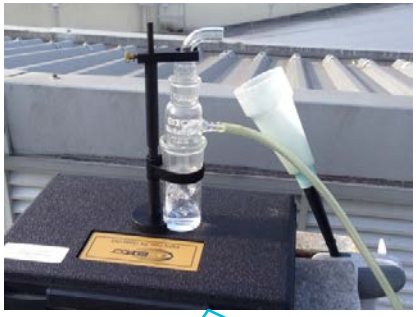
Impaction

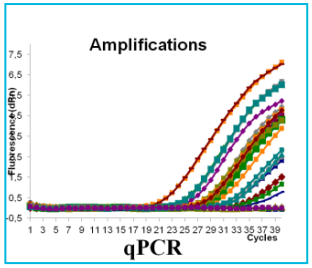
Filtration

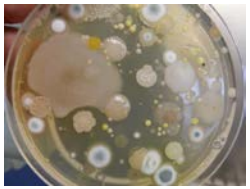
BioSampler SKC
13 L/min

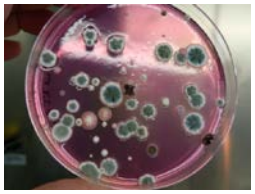
MAS-100-NT
100 L/min

Used Air Handling Unit filter

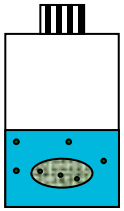




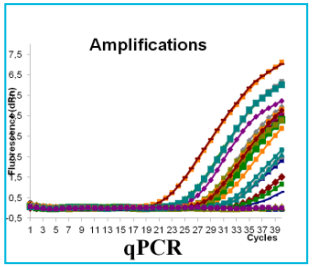




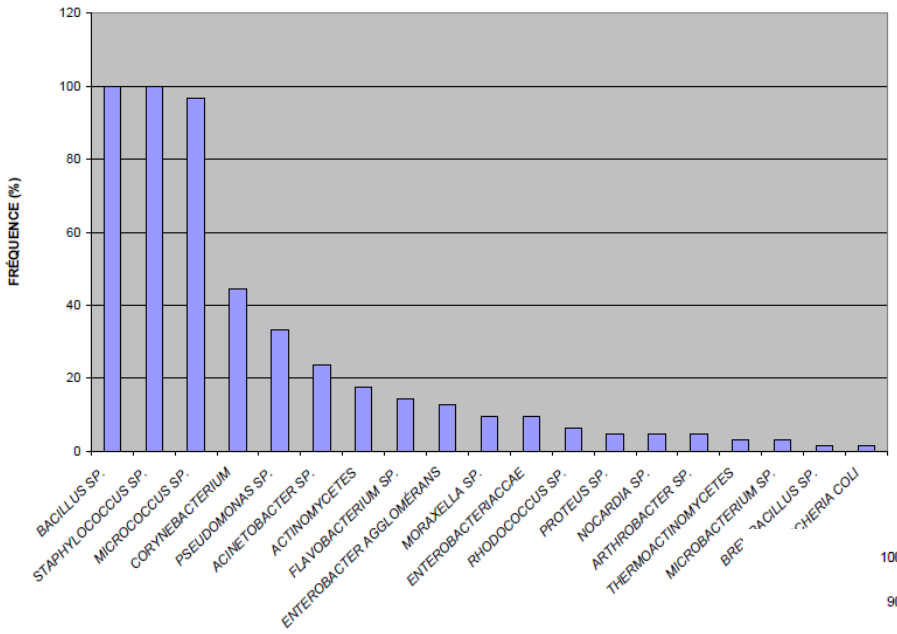
Extraction



50 mL: $MgSO_4$ +TWEEN 20

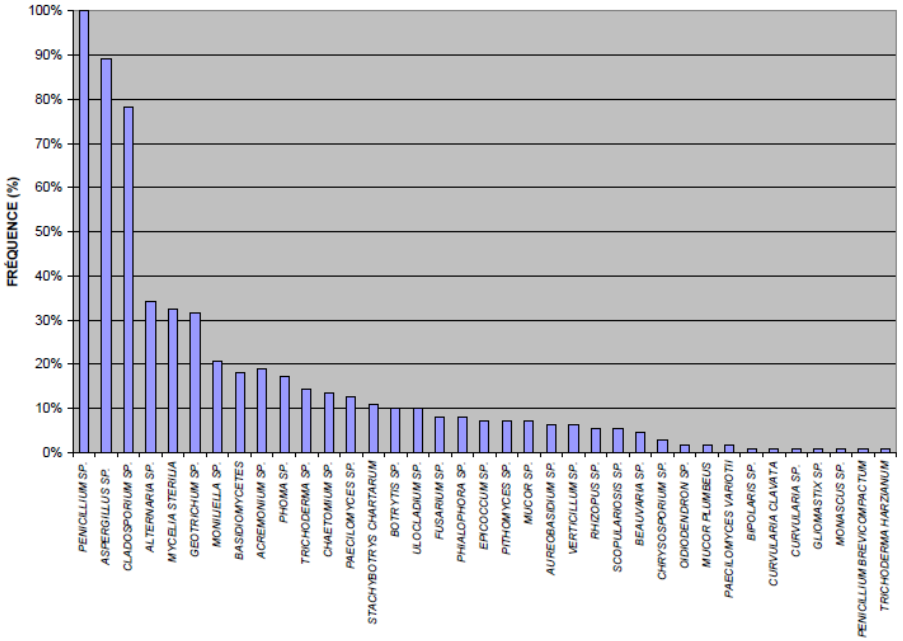


BIBLIOGRAPHY: BIO AEROSOL DIVERSITY IN WORKING PLACES



Frequency of Occurrence. Microbial genus identified by the IRSST's microbiology laboratory (Canadian organization) in 63 work environments, including 36 office buildings, 12 schools and 15 hospitals (Góyer, 2001).

Penicillium sp.
Photo-IRSST (500 x)



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BIBLIOGRAPHY : IN INDOOR AIR

- Airborne *Cladosporium* and *Penicillium* were detected (150 houses in Brittany) in more than 90% of the dwellings, *Aspergillus* in 46% and *Alternaria* in only 6% of the housings. Total molds (Sampl'air bioimpactor) Living room minimum 40 CFU/m^3, median 510 CFU/m^3, mean 729 CFU/m^3 maximum >2000 CFU/m^3 (Dallongeville et al, 2015)

- Filters from two shopping centers in Singapore using an AHU were sampled. The airborne metagenome was determined. The air microbiota is primarily bacteria, including potential opportunistic pathogens. Comparison of air samples with each other and nearby environments suggested that the indoor air microbes are not random transients from surrounding outdoor environments, but rather originate from indoor niches (Tringe et al, 2008)

- 64 prefilters and final filters from HVAC systems from 2 large public buildings in Minneapolis and Seattle were sampled to determine the presence of human respiratory viruses and viruses with bioterrorism potential. Nine filters were positive for influenza A virus, 2 filters were positive for influenza B virus, and 1 filter was positive for parainfluenza virus 1 (DNA or RNA detected but no infectious virus) (Goyal et al, 2011).

- Review of bioaerosols in indoor environment with special reference to sampling, analysis and control mechanisms (Ghosh, et al, 2015)

CASE STUDY

Filtration Performances of Fibrous Filters Clogged with PM10 and Microbial Aerosols: Influence of Ventilation Stops in Lab-Scale-HVAC-Unit

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VEOLIA
ENVIRONNEMENT
Recherche & Innovation

OBJECTIVES

☞Identify factors influencing MA capture and survival / growth

(*Kemp 1995; Kuehn 1991; Bonnevie-Perrier 2008; Forthomme 2014*)

✓Filter composition & geometry:

fibre type, water retention, porosity

✓Captured particles: organic to mineral ratio, nutrient content,

water retention capacity

✓AHU operating conditions: flow rate, ventilation stop/restart

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Filtration performances of HVAC filters for PM10 and microbial aerosols—Influence of management in a lab-scale air handling unit

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CONCLUSION

☞ $E_{CFU} \approx E_{PM}$: Microorganism capture efficiency depends on it size

➔ E_{CFU} is a good parameter to evaluate MA efficiency

➢ Same collection mechanism for microbial aerosol than PM of same size

☞ PM release: few PM detected for ventilation restart

➔ no MA release

☞ Microrganisms behavior: able to survive in filter cake

➔ able to grow when PM substrate is adapted

➢ Microbial development is influenced by fibrous material nature, collected dust and RH

➢ Heating and dry air limit the fungal survival and growth

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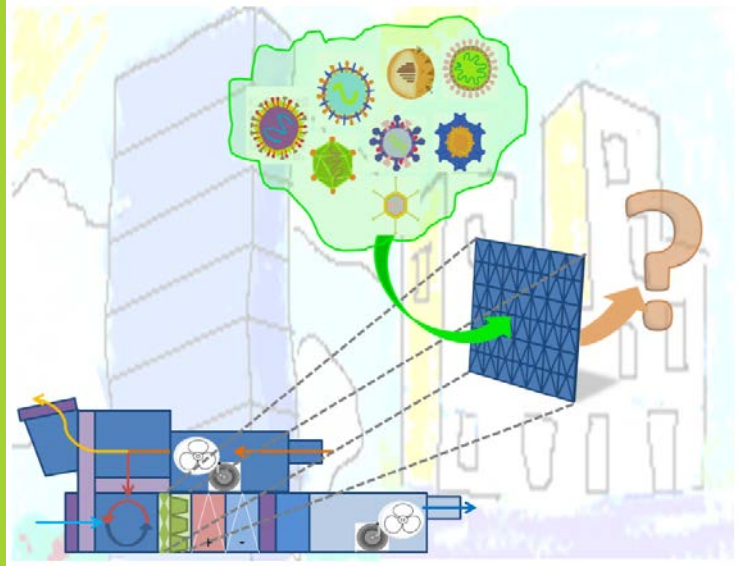

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