ENGINEERED SYSTEMS

Pathogens 101

Learn how these tiny threats thrive and spread to the next person, and why your relative humidity and temperature decisions matter.

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In a sense, HVAC engineers are the microbiologists of the built environment because indoor air quality (IAQ) and water management determine the growth and transmission of many micro-organisms. Therefore, it is essential for engineers to understand the basic characteristics of these minuscule beings.

Many people think of "germs" as one big group of tiny (how tiny?) organisms that cause infections. There are, however, several different categories of micro-organisms, and within these categories only some are pathogens, or can cause human disease. The main groups of pathogens in buildings are viruses, bacteria, fungi (mold) and parasites such as mites.

Indoor pathogens

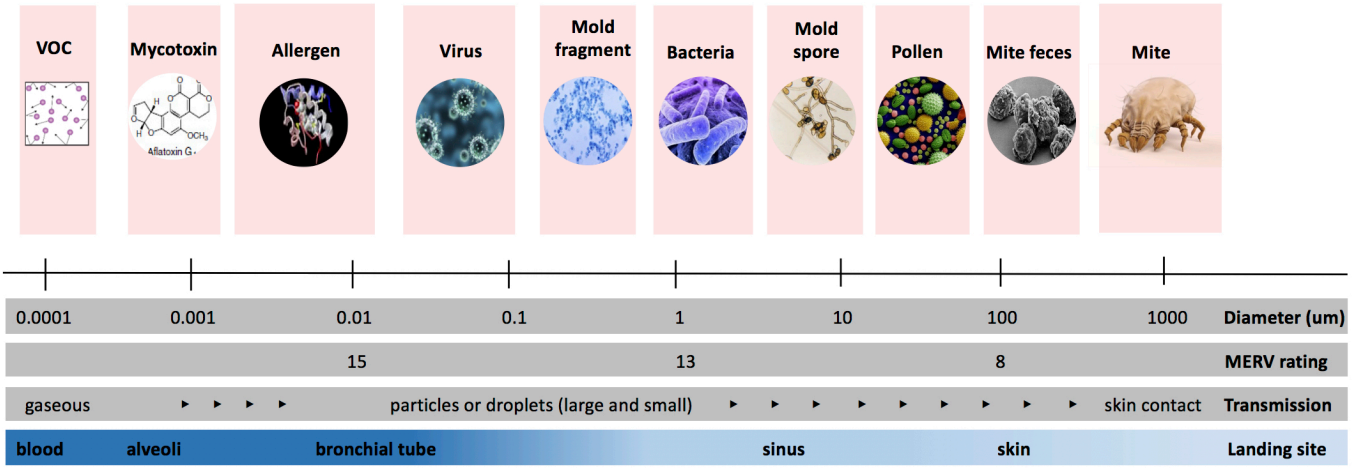

figure with assistance from Walter Hugentobler, MD

The major transmission routes of most pathogens in buildings are:

Direct contact: A person with contaminated hands touches another person or a common surface, thus passing the pathogen along. This route can spread viruses, bacteria, allergens and parasites.

Indirect Contact: Large mucus droplets containing pathogens are expelled by a person sneezing, then settle onto a surface within several feet to be picked up by second person's hand.

Airborne transmission: Pathogens that only infect people via aerosols, such as those that cause Tuberculosis and Measles, are **obligate** airborne pathogens. Until recently, many microbiologists only considered these pathogens as airborne. We now know that there are two other important subcategories of airborne transmission: **preferential** and **opportunistic** modalities. Preferential airborne pathogens transmit diseases primarily through aerosols that land in deep lung regions, however, they can use other entry points such as the gastrointestinal tract. Pathogens spreading via opportunistic airborne transmission usually infect people through non-air routes, but are able to survive to infect secondary hosts when the indoor environment promotes the formation of tiny aerosols.

Clearly, pathogens do not curb their mode of transmission as neatly as many microbiologists have outlined. Indirect contact and airborne routes have significant overlap when dry indoor air (less than 40% RH) fosters shrinkage of large mucus droplets into tiny “droplet nuclei” which can then travel on air currents over extended lengths of time and distance, ultimately causing illness in patients far from the initial sick person. Restricting the concept of airborne transmission to obligate pathogens alone, while ignoring the air travel of preferential and opportunistic pathogens, is much too narrow a categorization!

Building disinfection protocols attempt to decrease the spread of infections by interrupting the transmission route of pathogens, making it critical to have a good understanding these processes. Most infection prevention strategies assume that direct contact is the dominant route of indoor pathogen transmission so, understandably, efforts focus on hand and surface hygiene. While this cleaning is very important, it will not interrupt the spread of illness from pathogens capable of preferential and opportunistic airborne transmission in tiny droplet-nuclei.

Because of the important role of the indoor environment in controlling the spread of infectious diseases, it is essential for facility managers to understand how HVAC management influences the transmission modalities of many pathogens. For example, studies show that indoor RH below 40% enhances the survival of infectious airborne droplet nuclei. If building managers want to maintain clean indoor environments, their thinking needs to be as broad minded and agile as the travel capabilities of the pathogens they are trying to contain. **ES**