

Health Effects – Microbiological and Environmental

I. Microbiological

Mold or Fungi

Mold or fungi have the potential to cause health problems. They are not usually a problem indoors, unless mold spores land on a wet or damp spot and begin growing. Molds produce allergens (substances that can cause allergic reactions), irritants, and in some cases, potentially toxic substances (mycotoxins).

Inhaling or touching mold or its spores may cause allergic reactions in sensitive individuals. Allergic responses include hay fever-type symptoms, such as sneezing, runny nose, red eyes, and skin rash (dermatitis). Allergic reactions to mold are common. They can be immediate or delayed. Molds can also cause asthma attacks in people with asthma who are allergic to mold. In addition, mold exposure can irritate the eyes, skin, nose, throat, and lungs of mold-allergic and non-allergic people. Repeated or single exposure to mold or mold spores may cause previously non-sensitive individuals to become sensitive. Symptoms other than the allergic and irritant types are not commonly reported as a result of inhaling mold.

Other health effects that are attributed to mold and/or mold spore exposure include: memory loss, fatigue, digestive problems, chronic aches and pains, sinus infections and sinusitis, headaches, and upper / lower respiratory infections. The effects are not significant when mold invades the tissues of a healthy lung or respiratory tract, but they can be dangerous for individuals such as the elderly, infants, and those with weakened, compromised, or suppressed immune systems (such as cancer patients taking chemotherapy, HIV positive individuals, people who have received an organ transplant, or those with chronic lung diseases such as obstructive lung disease). These individuals are more vulnerable to opportunistic infections from airborne mold exposure. *Aspergillus fumigatus*, for example, have been known to infect the lungs of immune-compromised children. Hypersensitivity pneumonitis, which resembles bacterial pneumonia, may develop following either short-term (acute) or long-term (chronic) exposure to molds. Molds can also cause common skin diseases, such as athlete's foot, as well as other infections (including yeast infections).

Mold spores are microscopic (2-10 um) and are naturally present in both indoor and outdoor air. Molds reproduce by means of spores. Some mold have spores that are easily disturbed and waft into the air and settle repeatedly with each disturbance. Other molds have sticky spores that will cling to surfaces and are dislodged by brushing against them or by other direct contact. Spores may remain able to grow for years after they are produced and the allergens, whether or not the spores are alive, can remain allergenic for years.

Molds can also produce toxic substances called mycotoxins, which cling to the surface of mold spores or can be found within the spores. More than 200 mycotoxins have been identified from common mold, with many more remaining to be identified. Exposure pathways are similar to that of the parent mold; either through inhalation, ingestion, or skin contact. Aflatoxin B, produced by the molds *Aspergillus flavus* and *Aspergillus parasiticus*, is one of the most potent carcinogens known. Ingestion can cause liver cancer while inhalation can cause lung cancer. Aflatoxin B has been found on contaminated grains, peanuts, and other human and animal foodstuffs, however, *Aspergillus flavus* and *Aspergillus parasiticus* are not commonly found on building materials or indoor environments.

Some molds, such as *Aspergillus versicolor* and *Stachybotrys chartarum* (also known as “black mold” or “toxic mold”), are known to produce potent toxins under certain circumstances. Many symptoms and human health effects attributed to the inhalation of mycotoxins have been reported including: mucous membrane irritation, skin rash, nausea, immune system suppression, acute or chronic liver damage, acute or chronic central nervous system damage, endocrine effects, and cancer. The presence mold in a building, however, does not necessarily mean that mycotoxins are present as they are produced only under certain environmental conditions.

Some compounds produced by molds are volatile and released directly into the air. They are known as microbial volatile organic compounds (mVOCs). Because they often have strong and/or unpleasant odors, they are often associated with molds. Although research is still in the early phase, exposure to mVOCs from molds has been linked to symptoms such as headaches, nasal irritation, dizziness, fatigue, and nausea.

Glucans are small pieces of mold cell walls which can when inhaled cause inflammatory lung and airway reactions as well as affect the immune system. Exposure mainly in agricultural and manufacturing settings to high levels of glucans in dust mixtures has been shown to cause a flu-like illness known as Organic Dust Toxic Syndrome (ODTS).

Research on mold and health effects is ongoing. This website provides a very brief overview; it does not describe all potential health effects related to mold exposure. For more detailed information consult a health professional. You may also wish to consult your state or local health department.

Bacteria

Bacteria are single-celled organisms that have cell membranes but no organized nuclei. They seldom form distinct, visible colonies, but may form slime, bio-film, or foam. Most naturally occurring bacteria do not cause human illness. Bacteria survive by metabolizing carbon compounds in the presence (aerobic) or absence (anaerobic) of oxygen. Some bacteria, such as Bacillus and Clostridium, are capable of forming endospores, which is a dormant form of the bacteria that can reestablish its vegetative form under appropriate circumstances and persist for years in a harsh environment. Bacteria are divided into two groups based cell wall morphology and ability to retain crystal violet stain (Gram-negative and Gram-positive). Found on the outer walls of Gram-negative bacteria (E. Coli, Salmonella, Psuedomonus, Legionella) are endotoxins that cause irritation and flu-like illness in those who are exposed, usually when water containing the endotoxin is aerosolized.

Personal exposure to bacteria typically can either be from a human source (skin contact, talking, coughing, sneezing) or from an environmental source (water reservoirs – humidifiers, drain pans, cooling towers). Commonly known human source bacteria include Streptococcus (pneumonia, meningitis, strep throat) and Staphylococcus (skin “staph” infection and MRSA – Methicillin Resistant Staphylococcus aureus). Commonly known environmental source bacteria include Mycobacterium (Tuberculosis and Leprosy), Legionella (Legionnaire’s Disease and Pontiac Fever), and Bacillus (Anthrax).

Viruses

Viruses are considered non-cellular and therefore ‘non-living’. They consist of DNA or RNA in a protein coat (capsid). They attach and inject their genetic code into a cell, take over the host cell and direct it to reproduce viruses. Multiplication can take from 6 to 48 hours. Diseases caused by viruses include the common cold, influenza, chicken pox, HIV, measles, mumps, SARS, polio, rabies, Hepatitis A, B, C, Herpes, Ebola, West Nile, and certain types of cancer.

Relative humidity (RH), temperature, and ventilation are important factors controlling the infectivity of airborne viruses, with no one condition favorable for all viruses. The increased survival of influenza virus

in aerosols at low relative humidity has been suggested as a factor that accounts for the seasonality of influenza. In contrast, exactly the opposite relationship (high RH) has been shown for poliovirus.

II. Environmental

Allergens

Allergens are usually environmentally stable foreign substances that induce allergy immune reactions in predisposed individuals. The allergic reaction to the allergen results in allergy symptoms – runny nose, itchy eyes, coughing, and sneezing. These symptoms are your body's attempt to expel the allergen it wrongly assumes is dangerous. Common allergens include pollen (from trees, grasses, and weeds), dust mites (microscopic arachnid excrement found in dust), cockroaches, animal allergens (from cats, dogs, birds), latex (gloves, rubber bands, balloons), and mold (refer above). Studies show over 50% of the population in the U.S. would have a positive test response to one or more allergens.

VOC's

Volatile organic compounds (VOC's) include a broad classification of thousands of organic gases emitted or "off-gassed" from common household products including but not limited to carpets, paints, fuels, solvents, cleaning chemicals, cosmetics, and pressed wood. Symptoms attributable to VOC's include respiratory distress, sore throat, eye irritation, nausea, drowsiness, fatigue, headaches, and general malaise. Due to the large numbers of chemicals found indoors and their synergistic effect, it is very difficult to establish the causal relationship between health and specific VOC's. Industrial exposure studies have, however, documented respiratory ailments, heart disease, allergic reactions, mutagenicity and cancer to certain VOC's like benzene and formaldehyde.

Pesticides

Pesticides used in and around the home include products to control insects (insecticides), fungi (fungicides), and microbes (disinfectants). The American Association of Poison Control Centers reported in 1990 that some 79,000 children were involved in common household pesticide poisonings or exposures. Pesticides, which are considered semi-volatiles, are designed to kill or control pests, including termites, cockroaches, ants, fungi, and bacteria, to name a few.

The specific symptoms that will result from a given exposure situation depend on the pesticide and its site of action, the dose received, and the sensitivity of the exposed individual. Irritation of the eyes, skin, and respiratory tract are common effects. Skin exposure can lead to itching, redness, swelling, blistering, or acne-like condition.

Combustion By-products

Combustion by-products that can create indoor air quality (IAQ) issues include carbon monoxide (CO), nitrogen oxides (NO_x), sulphuric oxides (SO_x), and polycyclic aromatic hydrocarbons (PAHs). They become an indoor air quality problem when they are introduced into buildings through outdoor air intakes or loading docks.

Carbon monoxide (CO), the by-product of incomplete combustion, is colorless, odorless, and has about 250 times more affinity for hemoglobin than oxygen has. In the body it acts as an asphyxiating agent by reducing the hemoglobin available to carry oxygen to body tissues. Common symptoms are dizziness, headache, nausea, ringing in the ears, and pounding of the heart. Acute exposure can be fatal. Potential sources of CO include unvented kerosene and gas space heaters, furnaces, gas stoves, fireplaces, water heaters, auto exhaust, tobacco smoke, and generators.

Nitrogen Oxides, or NO_x, is the generic term for a group of highly reactive gases which contain nitrogen and oxygen in varying amounts. Nitrogen oxides are formed fuel is burned at high temperatures, with the primary sources being motor vehicles, electric utilities, and other industrial, commercial, and residential fuel burning sources. Smog is formed when NO_x and VOC's react in the presence of heat and sunlight. Exposure to NO₂ may increase rates of respiratory infections, adversely affect lung function, and exacerbate the status of persons with preexisting lung conditions such as asthma.

Sulphuric Oxides, of SO_x, are also combustion by-products with common sources including power generation, industrial plants, and motor vehicles. Sulfur dioxide exerts its irritant effects primarily on the upper respiratory tract. There is considerable variability in the response of SO₂ among normal, healthy adults and asthmatics, which makes it difficult to define a no-adverse-health-effect level.

Polycyclic Aromatic Hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. Animal studies have shown that PAHs can cause harmful effects on the skin, body fluid, detoxifying systems and ability to fight disease after both short and long-term exposure. PAH compounds have been shown to be carcinogenic in animal tests and mutagenic in short-term laboratory tests.

Ozone, also called activated or pure air, is comprised of three oxygen atoms (O₃) whereas atmospheric oxygen is comprised of two oxygen atoms (O₂). Ozone is created in nature when oxygen comes in contact with the electrical charge from lightening or ultraviolet radiation. Ozone will usually break down within 20 minutes and revert back to the more stable O₂ and a single oxygen atom that is highly reactive. The singlet oxygen atom will oxidize many indoor gases, odors, and VOCs; hence the reason it is generated by many of today's "air cleaners". The single atom, however, will also react with the human body causing irritation to the eyes, mucous membranes, and airways. The American Lung Association has declared ozone a concern for human exposure and the EPA considers it to be a contaminant of concern for humans at short term exposure concentrations in excess of .08 ppm. Documented symptoms include decreases in lung function, aggravation of asthma, throat irritation and cough, chest pain and shortness of breath, inflammation of lung tissue, and a higher susceptibility to respiratory infection possibly resulting in bronchitis or pneumonia.

"Asbestos" is a generic name given to a group of minerals that due to their high tensile strength, flexibility, and chemical/thermal/electrical resistance, have been incorporated into many products, including: insulation, ceiling tiles, automotive brakes, floor tiles, cement, drywall, and roofing materials. The asbestos minerals have a tendency to separate into microscopic-size particles that can remain in the air and be easily inhaled. Persons occupationally exposed to asbestos have developed several types of life-threatening diseases, including lung cancer (asbestosis and mesothelioma). Although the use of asbestos and asbestos products has dramatically decreased, they are still found in many residential and commercial settings continuing to pose a health risk to workers and others.

Sewer gas is a complex mixture of toxic and non-toxic gases formed during the decay of household and industrial waste that can be present at varying concentrations depending on the source. In addition to methane, carbon dioxide, sulfur dioxide, and nitrous oxides, sewer gas can also include the more toxic components hydrogen sulfide and ammonia. Sewer gas can enter a home through a floor drain, from a leaking or blocked plumbing roof vent, or (if the gases are in soil adjacent to the house) through cracks in the foundations.