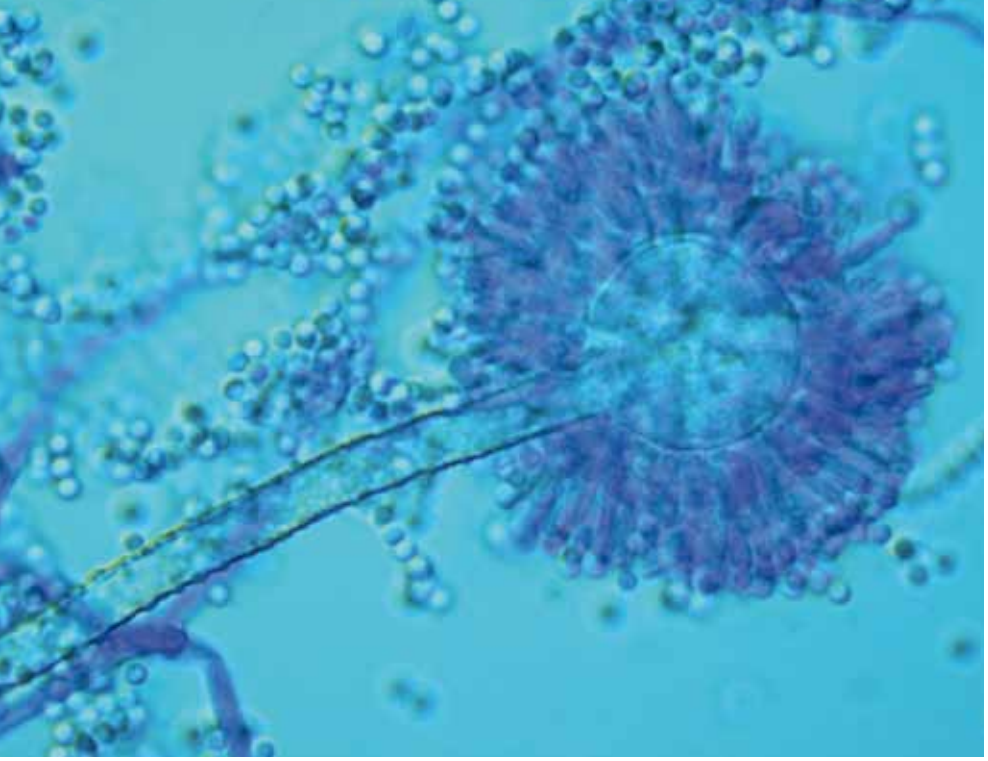
MOULD FUNGI INDOORS

CAUSES – ASSESSMENT – SANITATION



Mould fungus – what's that?

Mould fungus – a natural element of our environment

Mould fungi can be found everywhere. They are an important ecological element in our natural environment, because they break down organic substances thus making them accessible to plants as food source. Strictly speaking, "mould fungi" is the collective term for a multitude of different types of fungi of varying manifestations and life-forms. There are an estimated 250,000 types of fungi of which to date approximately 100,000 have been registered. Mould fungi are able to thrive world-wide in all climatic zones. Since they colonize a substrate first, they only have few competitors. Their characteristics are the ability to form typical fungal threads and spores.

During their development stage the spores germinate and form cell threads, so-called hyphae, which are called mycelia. Normally these threads are colourless and, therefore, invisible to the eye during this stage. They usually multiply asexual by releasing spores into the air. The spores of the mould fungi become visible e.g. as mould fungi spots because of their colour and great number, and quickly occupy new nutrient media. The combination of heat and humidity has an extremely positive influence on their growth, large numbers of mycelia develop and multiply like an explosion. The size of the spores is usually between 3 to 20 µm and thus so small that they can be inhaled by humans or transported with the air across wide distances.

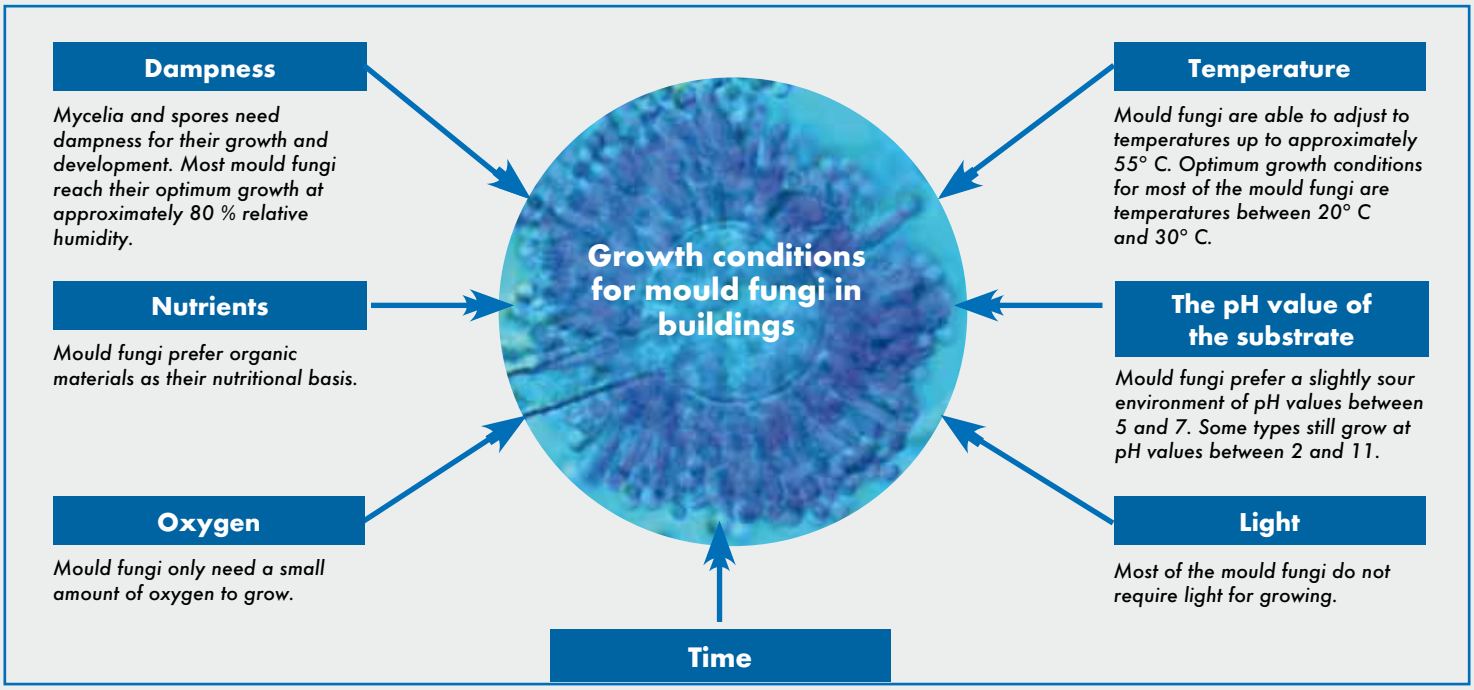
Health risks

Mycotoxins are able to cause severe illnesses

Micro-organisms such as fungi and germs are a natural part of our natural environment and usually tolerated by humans without major reactions. However, if the concentration of mould fungi reaches a certain amount severe health problems may arise for humans. In the meantime it seems to be proven that higher levels of fungi indoors can cause a series of severe illnesses. Respiratory diseases, asthma, allergies, susceptibility to infections, but also fatigue, headaches, skin and eye irritations are only a few of the health disorders that can be caused by mould fungi. These illnesses develop through the spores and mycotoxins (metabolic products of mould fungi) in the air that are being inhaled.

The health risks depend on various factors

To evaluate the health risks resulting from microbial infection various factors have to be considered. It is not enough to include just the size of the infested area or the type and usage of the contaminated rooms for an assessment of the risk. For making a statement about the actual health risk the type of mould fungi, the complete situation of the building and the constitution of the affected person are also decisive. Certain mould fungi, for instance, release mycotoxins whose toxic effects are higher than the ones of others. There are certain high-risk groups among the affected persons, e.g. older people, but mainly children that react more sensitive to microbial exposure and its side effects than others.



Prerequisites for growth

Humidity, availability of nutrients, temperature and the pH value of the substrate are the most important factors determining the growth of mould fungi. However, light, the oxygen content in the air as well as chemical substances may also have a positive or negative effect.

Optimal growth conditions for all types of fungi relevant indoors are a relative surface dampness of 80 % or the formation of dew on or in the material.

Humidity

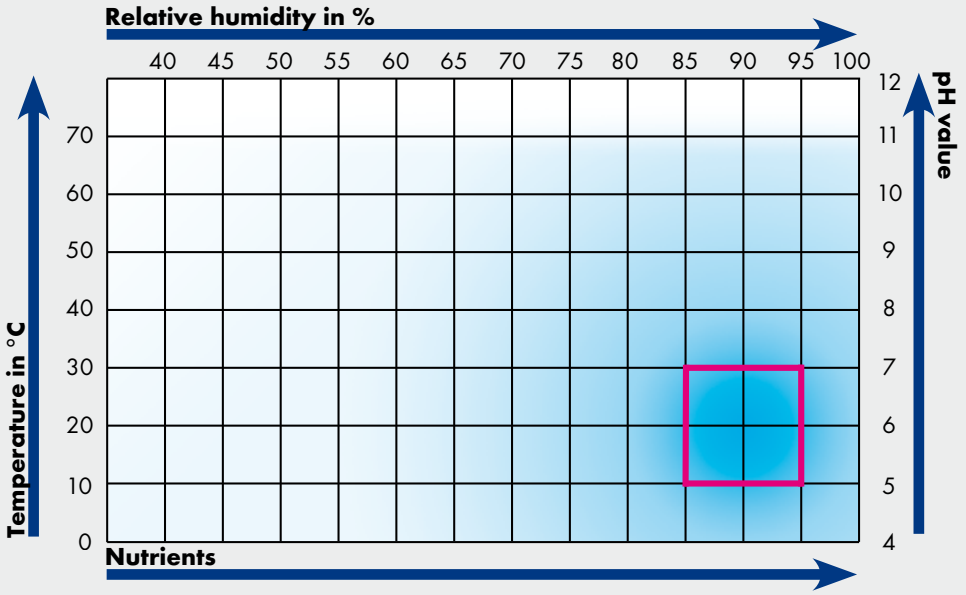
The process of infestation and the growth of micro-organisms is mainly dependent on the amount of available humidity. Contrary to other micro-organisms, e.g. algae, mould fungi also grow by slightly elevated and changing humidity.

Mould fungi are already able to grow at a relative humidity of 70 %. Thus fungi also grow on materials and/or surfaces which are not visibly wet. It is sufficient that the surface has the respective dampness.

Temperature

Although humidity is the most important factor for mould fungi to grow, prerequisites such as temperature and nutrients over a certain time period must also be fulfilled. Mould fungi can only grow within a certain temperature range, which, however, covers a relatively wide range of approximately 0 to 55 °C and varies according to the type of fungi. However, germination by low humidity is also possible if the temperature conditions are optimal, while the growth of mycelia requires a higher humidity when the temperatures are unfavourable.

Risk areas for the growth of mould fungi



The growth of mould fungi is most distinctive in these areas.

Nutrients

Also important for the growth of mould fungi is, next to the dampness and temperature, the nutrient content of the substrate. In general, mould fungi are able to use a multitude of materials as a basis for nutrients. This includes all kinds of organic materials, e.g. cellulose, wood, chip boards, wallpaper, wallpaper paste, plastics, lacquer, dispersions, paper and textiles. Glass and metals do not release nutrients, however, particles from the air or sediments of dust, grease, etc. can offer a suitable breeding ground.

pH value

The pH value also plays an important role in the risk of a mould fungi infection. The pH range in which a substrate offers the mould fungi perfect conditions for growth is relatively wide. The range for optimal growth lies between 5 and 7. Most of the mould fungi grow in the range between 3 and 9, some also tolerate values between 2 and 11. True is that mould fungi prefer a sour environment and that alkaline areas offer poor growth conditions. Therefore, special attention must be paid to building materials: wallpaper, dispersion paint and organic plaster lie in the pH value range of 5 to 8 thus offering the perfect base for mould fungi, while mineral building materials, e.g. silicate paint or lime plaster, have a negative influence on its growth.

By the way: do not wash off damages caused by mould fungi with vinegar. The acid of the vinegar creates the perfect breeding ground for mould fungi!

Structural and usage influences

The main factor for the growth of fungi is dampness. The dampness may be for climatic reasons, result from the structure or the user of the facility. Expert construction measures and sensible behaviour of the facility user must work together to keep a home free of fungi.

Structural influences

Mould fungi may be caused by various construction deficiencies: permeable building components, connections or sealing, insufficient roof constructions to protect against heavy rain, defect or poor insulated installations, missing waterproofing layer in the ground against rising soil moisture or poor drying of the new construction promote damages caused by dampness and, from a construction-physical viewpoint, the growth of mould fungi. Poor thermal insulation as well as a thermal bridge effect a drop in the surface temperature on the interior side of the wall and, therefore, a higher risk for the formation of condensation water and mould fungi growth. Damages through floods can also trigger the growth of mould fungi based on the high exposure to dampness.

There are also influences on the growth of mould fungi for which the residents are responsible. Highly relevant for the dampness exposure of a room is the connection between the surface temperature and the surface dampness which are dependent on the climatic conditions in the room. By rule of thumb warm air can absorb more moisture in the form of water vapour than cold air. If warm, damp air cools off it can no longer hold the water vapour and water drops are forming. In nature this process is called fog and dew. The same thing happens when warm and damp air meets colder walls in the rooms of homes. The air cools off and the water condensates on the wall surface. This creates the perfect conditions for mould fungi growth.

Structural connections

1 Condensation in not insulated window niche

2 Leaking water pipes

3 Exposure to dampness after flood damages or rising dampness

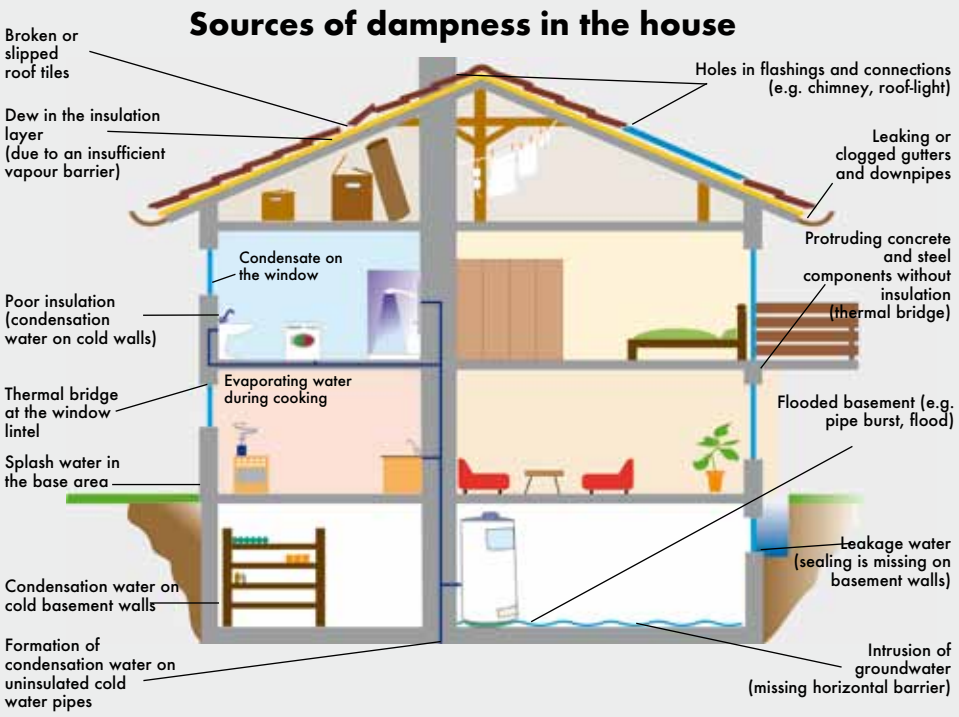
4 Low surface temperature due to insufficient thermal insulation

5 Leaking rainwater drainage

6 Permeable window connections

Images: Dipl.-Ing. K.-D. Schmalfuß

Sources of dampness	Release of dampness per day (l/d)
Drying dripping	*5 - 10*
Laundry (4.5-kg drum) spin-dried	*1 - 2*
Human (light activity)	*ca. 1,5*
Human (resting, sleep)	*ca. 1*
Taking a shower	*ca. 1,25*
Taking a bath	*ca. 0,75*
Cooking	*ca. 0,75*
Open aquarium	*ca. 1*
Covered aquarium	*ca. 0,1*
Indoor plants	*0,75 - 1,5*



Usage influences

The user of the dwelling is able to influence this through his behaviour. The dampness in the building can be limited by ventilating and heating it properly. Increasing the room temperature by heating causes a decrease of the relative humidity and increases the surface temperatures of the interior walls. At the same time, the dampness created by humans and their activities can be educted through proper ventilation. If the value of the room dampness is higher than 60 % it should be educted. The production of the dampness is then mainly dependent on the user of the room. In an average household with three people, pets, shower, cooking, doing laundry, indoor plants, etc. approximately six to twelve litres of water vapour are released into the air per day.

Especially in rooms with a high humidity and low temperatures, such as bedrooms, mould fungi find extremely good conditions for growth. In this case one needs to ensure that additional sources of dampness, e.g. indoor plants, aquariums, etc. are avoided. The building components used also play a special role. Based on the composition of the mineral materials, e.g. silicate paint and lime/lime cement plasters, they are able to absorb dampness thus improving the room climate. When the relative humidity rises they absorb part of the dampness into the layers of the material close to the surface. If the room dampness decreases they release it into the air again. This way the surplus dampness can be absorbed form the air or buffered respectively.

Images of damages and their assessment

Sanitation of mould fungi – an interdisciplinary task

Damages caused by mould fungi require the detailed assessment of the overall situation, the removal of the sources and taking measures accordingly. A uniform procedure for the sanitation of the mould fungi in homes is not possible, because there are many different types of fungi, influential factors and damages to be considered. The sanitation of mould fungi indoors is an interdisciplinary task and should always be performed by qualified companies in cooperation with different handicraft businesses.

Decisive for further measures is the extent of the risk potential of the affected area.

Criteria for the assessment are:

- the size of the affected area
- the strength and depth of the infestation
- the usage of the room
- the possibility of spores being released during the sanitation
- the health condition of the user

The encountered types of mould fungi as well as the kind of materials affected can also be included in the risk assessment.

The final risk assessment is divided into three categories, from low to high. As a result of this assessment the respective sanitation as well as necessary safety measures must be taken.

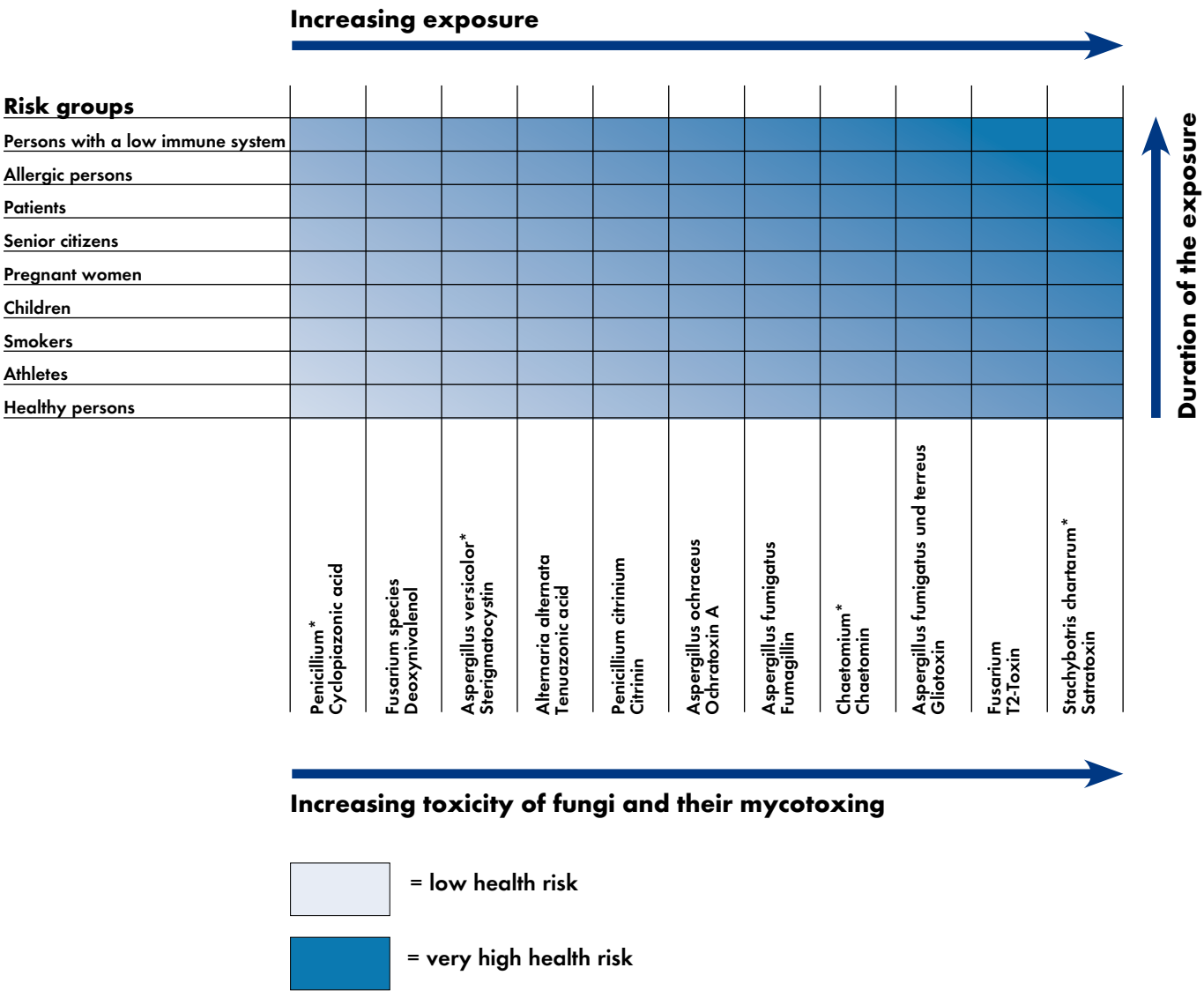
Mould fungi often grow hidden. Although the typical scungy fungi smell as well as the first dark spots on the walls, the ceilings and furniture show that there is such a hidden fungi infestation (Image 1 - 3). The situation is clearer when the fungi infestation can be visually recognized (Image 4 - 6).

Images 1, 2, 3, 6: Dipl.- Ing. K.-D. Schmalfuß

Image 5, Images of the cover page, Image above Page 11:Jörg Brandhorst

Risk potential

Assessment criteria	Low risk	Medium risk	High risk
Size of the visually infected area	*0.5 m²*	*0.5 – 3 m²*	*> 3 m²*
Depth of the infection	*superficial*	*< 0.5 cm*	*> 0.5 cm*
Room usage	*hardly occupied room*	*living and working quarters*	*hospital, kindergarten, senior citizen's home, school, food storage areas*
Risk of release of spores during the sanitation	*easy demounting of installations with no expected development of dust*	*avoidance of flying spores possible*	*mechanical stripping of larger areas is necessary*
Health condition of the user	*good to very good*	*average*	*patients, allergic person, persons with a low immune system*



*Construction-related fungi are quite often encountered indoors.

Protective measures according to risk potential

Assessment criteria	Low risk	Medium risk	High risk
Level	**1**	**2**	**3**
The following directives must be observed:	*None*	*Directives for dangerous materials, directives for organic materials, technical directives for biological work materials, directives of the BGI, UBA and LGA*	*Directives for dangerous materials, directives for organic materials, technical directives for biological working materials, directives of the BGI, UBA and LGA*
Personal protective clothing, according to exposure level	*Required are, e.g gloves*	*Required are, e.g. gloves, protective glasses, respiratory equipment*	*Required are, e.g. gloves, dust-tight protective suit. Respirator equipment with face mask, eye shield, black-and-white separation*

Sanitation of damages caused by mould fungi

Removal of source and repair of damages

The sustained sanitation of damages caused by mould fungi requires the elimination of the source of infection. This is the only way to prevent another infestation. Abating only the symptoms is just a temporary measure.

To fight the source requires primarily

- avoiding dampness and damp building components,
- ensuring proper ventilation and heating and,
- the repair of construction defects and moisture damages.

Over and above that the areas infected by the mould fungus must be properly repaired. It is better not to use toxins indoors, because biocidal products may be a health hazard, which is often higher than the exposure to the microbial infection itself.

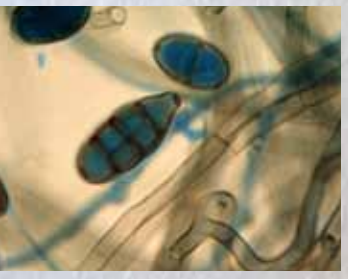
Generally the following applies to the sanitation of damages caused by mould fungi: infected areas or building components must be replaced and not treated. This proves to be especially true for level 2 and 3 damages.

REMEMBER:

The sustained sanitation of mould fungi always includes the elimination of the source as well as the repair of damages.

The repair of damages often involves several handicraft branches.

When in doubt, contact a specialist for fungi.



Avoidance of flying spores

One of the most important points is to avoid spores in the air – this is one of the biggest risk factors during the repair of damages. Because: flying spores are a hazard to the technician and the person living there. It is often the reason for secondary damages due to secondary contamination.

Also important is that the building materials contaminated by mould fungi are safely disposed after removal. According to the directives for hazardous materials is the building material contaminated with mould fungi considered hazardous.

Additional information

Further recommended actions pertaining to the sanitation of mould fungi are available in „The guide to prevention, examination, assessment and sanitation of mould fungi growth indoors" of the Federal Office for the Environment and the „Recommended actions for the sanitation of indoor rooms affected by mould fungi" of the Regional Department of Health for Baden Württemberg.

Suitable systems solutions

A sustained sanitation always includes the fight against the causes and the repair of damages. Suitable measurements for the repair must be determined for each case individually according to the extent of the damages.

The KEIM **Mycal** Sanitation System for Mould Fungi consists of different single products in varying combinations to suit the repair options according to the extent of damages.

KEIM Mycal Sanitation System for Mould Fungi

Mycal-Fix

Silicate pre-treatment to bind fungi spores:

- to protect against the contamination through flying spores
- in addition, the high pH value inhibits the growth of mould fungi.

Mycal-Ex

Aqueous base for the pre-treatment of microbial or residual contaminated interior walls:

- a combination of active ingredients of alcohol and chlorine-free, diluted oxidizing agent
- an ecologically safe alternative to chlorous or biocidal products

Mycal-Top

Highly specialized silicate indoor paint:

- enormeously open to diffusion and moisture-regulating for dry wall surfaces
- alkaline against new infections
- offers no nutrients for fungi because it is mineral
- inhibits the growth of fungi – contains a natural antimicrobial mineral
- photocatalytic active pigments ensure additional protection.
- hydroactive

Mycal-Por

Mineral Special Lime Plaster for indoors:

- absorbent and moisture-regulating
- minimized condensation risk
- alkaline depot for additional fungi protection
- hydroactive

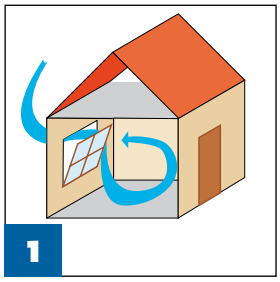
Mycal-CS-Platte (Panel)

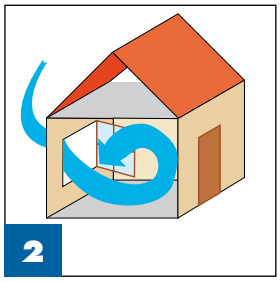
Light hydroactive calcium-silicate plate to raise the surface temperature of the wall.

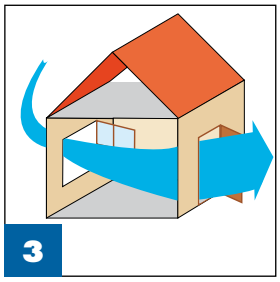
Depending on the structural situation it may be necessary to increase the temperatures of the surface of the interior walls as a prerequisite for the sanitation of the mould fungi.

Systems solutions depending on the threat potential

	Nutrient supply	Dampness exposure	pH value	Temperature
Level 1: low risk				
KEIM Mycal- **Fix** Spore Binder **Ex** Fungi Remover **Top** Paint	Minimized through: mineral paint coat, anti-microbial mineral, photo catalysis	Minimized through: vapour permeable, moisture regulating paint coat	Alkalinity is a fungi inhibitor	
Level 2: medium risk				
KEIM Mycal- **Fix** Spore Binder **Ex** Fungi Remover **Por** Special Lime Plaster **Top** Paint	Minimized through: mineral paint coat, anti-microbial mineral, photocatalysis	Minimized through: absorbent, mineral plaster and paint coat, dampness buffer and alkali depot	Alkalinity is a fungi inhibitor	
Level 3: high risk				
KEIM Mycal- **Fix** Spore Binder **Ex** Fungi Remover **Por** Special Lime Plaster **CS-Platte** Insulation Panel **Top** Paint	Minimized through: mineral paint coat, anti-microbial mineral, photocatalysis	Minimized through: absorbent, mineral plaster dampness buffer and alkali depot	Alkalinity is a fungi inhibitor	Increasing the wall surface temperature reduces the risk of infection







Type of ventilation through window setting	Number of air exchanges per hour	Approximate duration of ventilation to exchange air
1 *Gap ventilation*	*1 – 2*	*30 – 60 minutes*
2 *Shock ventilation*	*9 – 15*	*4 – 8 minutes*
3 *Cross-ventilation*	*approx. 40*	*1 – 2 minutes*

Advice to prevent mould fungi

Proper ventilation – proper heating

Keeping the rooms healthy and dry needs some learning. In general one should make sure that the rooms are correctly ventilated and heated and that there is enough air circulation provided and that water permeable materials are being used.

The air should be exchanged completely several times a day to reduce the dampness in the room. The most effective and economic way is the so-called shock-ventilation. Open the window wide for 5 –10 minutes. Along with the air of the room some heat is also escaping, however, the heat stored in the walls and furniture, which is much larger, remains in the room.

During the heating period rooms have to be heated sufficiently and equally so that they cannot cool off and enough moisture is absorbed by the air in the room. The perfect room temperature is between 19 and 21 °C.

Closets, furniture or heavy curtains should never be placed/hung directly at the walls, especially at „cold" outer walls. A minimum distance of approximately 10 cm should be kept for sufficient air circulation.

Dispersion and latex paints can hardly absorb moisture. Thus all of the moisture stays in the room air. Wallpaper is also not advantageous. It prevents the absorption of moisture and its paper contents and wallpaper paste are an ideal breeding ground for fungi. Permeable silicate paints and mineral plaster, however, are able to absorb water vapour and slowly release it into the room air. This way you create an additional buffer against moisture.

BATHROOM

Shower and take a bath only when window is open or briefly shock-ventilate the area afterwards. Remove excess water from walls and floors.

Remove damp towels from the bathroom or dry while window is open or place them on radiators.

Floor and wall tiling only for splash water areas. Mineral plasters and silicate paints regulate the moisture.

Avoid damp laundry in the bathroom.

BEDROOM

Heat steadily to a comfortable temperature of 18 – 19°C while sleeping and do not cross-ventilate or tilt windows.

Thoroughly shock-ventilate after getting up and before going to bed.

Avoid furniture or curtains which prevent air circulation and/or set or hang them at a distance of 10 cm to the wall.

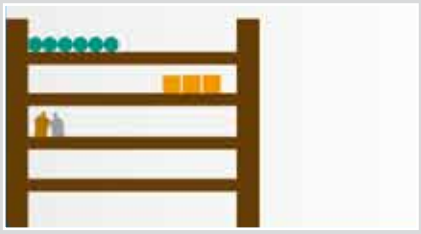
Create an additional buffer against moisture with materials open for diffusion and moisture absorbing e.g. lime plaster and silicate paint.

NOTE:

Built-in kitchens mounted at the exterior wall should have air circulation and access to air for the walling, e.g. by opening the back of the cupboards or installing a ventilation grid in the kitchen worktop plate.

Use exhauster hoods for transporting the moist air to the outside. Open the windows during and immediately after cooking.

KITCHEN



During the summer only open windows early in the morning or at night, because the hot air transports humidity that settles on the cold basement walls.

Place furniture at inner walls and leave enough space between walls and furniture.

Cross-ventilate rooms at the same temperature to allow a minimum of air circulation.

BASEMENT

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