

## **Cleaning a domestic property that has become mouldy**

Moulds only need two things to grow; a source of food and a source of moisture. They are present in all of the air we breathe as tiny spores so will soon start to grow if a spore lands on a suitable surface. They will then push their tiny threads outwards and downwards into the food supply so as to find all the food there is available. The threads (hyphae) are so small they can grow into the tiny spaces of many porous materials – even many rigid building materials such as plasterboard.

Once established they will continue to grow until either the moisture or the food supply is exhausted, but before they expire they reach out into the air and produce billions of new spores, waiting for someone or something to brush past and release the spores or perhaps a draught of air that blows the spores into the air, ready to seek out new food and complete the cycle.

Homes are built out of many materials, some porous and some solid, some wettable and some not. They consist of many cavities, some exposed to casual observation, others concealed behind plasterboard walls & ceilings or under floors for example.

There are also several sources of moisture (also see [Reference](#)):

- People & pets breathe out moisture and sweat constantly
- Activities such as cooking, showering and washing & drying clothes inside a home release vast amounts of moisture (estimated at over 30 litres a day)
- Defects in the building structure that allow damp ingress
- Pipe bursts, floods

All this water has to be removed every day otherwise it will eventually start to wet colder indoor surfaces such as interior walls directly connecting to outside walls and if it wets something that can act as a food source for a mould then mould will start to grow. This can also happen in cavities in the structure of a building as no sunlight is needed for moulds to grow.

Growing, sporulating mould and damp in our homes is thought to be bad for our health and is strongly associated with initiating asthma in children and making it worse ([Reference](#)), so we need to get rid of it. This is particularly important for people who have become sensitised to moulds and other microorganisms and it is suggested that those people do not attempt cleaning of moulds themselves to avoid exposure.

### ***Kitchen, bathroom***

In areas of the house that routinely get wet (bathroom, kitchen) we usually have non-porous materials in place to prevent water getting everywhere. We don't generally have absorbent materials in those rooms e.g. wallpaper, bare plasterwork and generally use a particular standard of paint that does not allow water penetration. Despite these precautions we still get a few microorganisms growing in the corners where ceramic wall tiles meet the bath for example or on the shower screen as these surfaces tend to get wet every day.

There are a variety of commercial products now designed to kill bacteria and fungi that are readily available and many of these are based on sodium hypochlorite - commonly referred to as bleach (*EU approved products are listed here ([Reference](#)) – different rules for approval are in use outside the EU so you are advised to check with your national authority. In the US this is the EPA ([Reference](#)) and the CDC have responsibility to advise on avoidance of infection ([Reference](#))*). Note that the spray applicators can generate a mist that is unpleasant to inhale, particularly if you are asthmatic.

Sodium hypochlorite – based products are very effective and for non-porous surfaces it is tested as effective against most moulds and other spore forming microorganisms.

‘Neat’ bleach (rated at 5% sodium hypochlorite) is also sold to the domestic consumer for use as a disinfectant and can be very effective and safe provided a few guidelines are followed:

1. Do NOT mix with any other solution containing ammonia (e.g. many other domestic cleaning fluids contain ammonia) as dangerous chlorine gas can be released
2. Wear protective clothing as directed by the manufacturer (usually listed on the bottle of bleach but should include effective waterproof gloves and eye protection)
3. Ensure you can dispose of bleach responsibly to avoid environmental damage (instructions are usually to be found on the bottle of bleach)
4. Check the use by date on the bottle – it will become less active over time
5. You will need a solution of 1 cup of bleach for every 9 cups of water
6. The bleach solution must be made up fresh for each use as it can go off quite quickly once diluted and used
7. It is not as effective if a lot of organic material is present so make sure the area is clean prior to using bleach i.e. remove dust, debris, soil, faeces if present and use a clean cloth to apply
8. It is less effective when used on organic material (i.e. plant-derived materials such as wood, paper). A common scenario is wallpaper at the top or bottom of a wall becomes mouldy as the mould is living on the wallpaper and the paste used to stick the wallpaper to the wall. In this case the paper and paste have to be removed prior to cleaning. Even then bleach will not be effective if the wall consists of unpainted plasterboard or other porous material.
9. The area must remain wetted for bleach to work, as soon as it dries it rapidly becomes useless. Gel-type (or ‘thick’) bleaches might help achieve longer wetted time. Treatment times should be at least 5-10min.
10. To assist removal of spores from a variety of materials detergent can be added to bleach (1/4 cup per 10 cups of bleach solution)

### **Limitations of bleach**

1. It is likely to only be active at the surface of a porous material, leaving fungal growth that has grown into a material untouched, so treating porous materials is unlikely to work other than as a short term clean. Painting with fungicidal chemicals may help (there are some paints available) but if the area remains damp the problem is likely to return. If you cannot quickly dry the area out or contamination is heavy you will have to replace the porous material after preventing further moisture accumulation.
2. Bleach releases fumes that may be irritating to the breathing of some people while working
3. Treating with bleach has no long lasting coating effect (once it is dry it rapidly becomes inactive), so further treatment may be necessary if the area isn't dried thoroughly. Other chemical fungicides may be more persisting but may be expensive and toxic for the home environment
4. Bleach can cause damage to vulnerable surfaces as it is highly caustic – ask the manufacturer for details

NOTE some preparations of bleach intended for the commercial market are far stronger – ensure you are using a product intended for the domestic consumer.

**Conclusion** Working with bleach or other fungicidal chemical we can keep the microbial growth in the 'wet' areas of our homes under strict control.

### ***Living areas, bedroom***

If mould occurs in other parts of a home e.g. bedroom, living room then it is far more likely to be growing on porous surfaces e.g. bare plaster walls, wallpaper, non-varnished wooden furniture. Moulds can grow into these materials so to achieve complete removal of fungal contamination we must remove the source of moisture. Any form of treatment that does not include that is likely to fail, but once that is achieved we are still left with sporulated moulds in our homes that need to be removed.

If the area remains damp and/or a large area (>1 square metre) becomes mouldy then professional help should be sought to arrange repair to prevent further water ingress and/or improve ventilation and remove the affected materials (reliable contractors can be found in the UK via [the Institute of Specialist Surveyors and Engineers](#)).

For smaller areas and assuming the person cleaning is not asthmatic or allergic for fungi or [immunocompromised](#) we need to remove the spores and that can be achieved by extensive wiping using a cloth and water and detergent. However the use of bleach is still of benefit as it will kill most of the spores and a lot of the fungal material near the surface of porous material, but possibly just as important the fungal material removed will be killed once it is rinsed from the cloth into the bleach solution, so when it is discarded it will not be active. Likewise as the cloth is re-used in other parts of the house the bleach should help prevent spreading viable spores via the cloth.

Non-porous surfaces that have mould growing on them would benefit from wiping down with a bleach solution to reduce the amount of fungal material and bleach is recommended as again it will kill the fungal material once it has been removed.

If a material has to be cleaned that is sensitive to bleach it would generally be sensible to clean with a solution of detergent (or perhaps a less caustic alternative antifungal product if available—[Reference](#)) and dispose of used cloths into the bleach solution afterwards.

If it is possible to completely dry out the affected area (i.e. improve ventilation, repair leak) and it is a small area AND the person doing the cleaning is not asthmatic, allergic or [immunocompromised](#) then bleach or a detergent solution could be used to clean the mouldy area prior to quickly drying out. However if the area isn't dried rapidly the mould will reappear quickly.

If the mouldy area is non-porous e.g. painted plasterwork, varnished woodwork then washing off with bleach and/or detergent should be sufficient to clean but again the source of the moisture MUST be stopped to achieve a long lasting solution.

Other soft & porous material in a home will have to be treated differently;

1. Carpets & mats often hide mould underneath after being wetted regularly. Discard & replace.
2. Soft furnishing: if mould is growing on the material it should be discarded. If it is present in a room where mould has appeared on the walls then washing or extensive wiping (preferably with bleach or other suitable fungicide) may be sufficient to reduce the number of spores present.
3. HEPA grade vacuum cleaning is also mentioned as an effective way to reduce the number of mould spores and other dust from domestic houses ([Reference](#)) but as the efficiency of domestic vacuum cleaners may well be variable and depend on age and effective maintenance and the user would be left with the job of safely disposing the captured material we would suggest that this is carried out by a professional if the user or anyone else in the house is allergic, asthmatic or immunocompromised.

### **What is an unhealthy amount of spores & other fungal material present in a home?**

This question is very difficult to answer simply as different individuals are likely to respond to exposure to mould in different ways. Some people can live in a damp house with few observable effects on their health, while others seem sensitive to lower amounts. Consider that moulds in the outside air can exceed several tens of thousands of spores per cubic metre of air at some times of the year (as I write this in July 2012 there are up to 5 - 20 000 spores per cubic metre of air in the UK) and the breathing difficulties of some asthmatics and people with other breathing disorders tend to increase at these times, perhaps that gives us a rough guideline to the numbers of spores needed to cause problems amongst those already sensitive. For most people however even those levels of spores in the air do not seem to cause severe problems.

We don't know much that is reliable about long term exposure to moulds in the indoor environment but until we do we know that long term exposure to damp is bad for our health and moulds may

well play a part in that. There may also be many other factors such as bacterial growth on damp materials, chemical odours, bacterial & fungal toxins and much more that is not in the scope of this article – but we do know that once damp is eliminated and the building is effectively remediated the health problems tend to reduce.

NOTE These recommendations are based on information published in the scientific peer reviewed media where tests have been carried out to ascertain the effectiveness of bleach in removing microbial spores from several different types of material. None of these papers claim to test the use of these chemicals or techniques in the domestic environment so we cannot claim that our suggestions are more than that. If more information comes to light as more papers are published we will progressively update our suggestions.

**References – these are all research papers that have been reviewed by other scientists before being accepted for publication. It is the job of the reviewing scientists to identify any weaknesses in the work which must be successfully addressed before the paper can be published. Peer-reviewed papers are the highest quality publications we have and represent a reasonable minimum standard of work – we can therefore trust the conclusions with some degree of certainty.**

[http://www.euro.who.int/\\_data/assets/pdf\\_file/0005/97007/3.5.-homes-with-problems-with-damp-EDITING\\_layouted\\_V2.pdf](http://www.euro.who.int/_data/assets/pdf_file/0005/97007/3.5.-homes-with-problems-with-damp-EDITING_layouted_V2.pdf) In recent years, annual surveys providing representative data on the total population of European Union (EU) Member States have shown that exposure to dampness is a frequent health risk, with 18% of the EU population exposed in 2007 (vs 19% and 18% in 2005 and 2006, respectively). Exposure varies greatly among countries, however, ranging between 5% and 37%. High exposure levels are especially reported by the new EU Member States in Eastern Europe, but within such countries reporting a high prevalence there is also an indication that exposure has fallen in recent years. Differences may be due to a combination of factors, including climate, socioeconomic status, housing characteristics, culture and lifestyle, and the existence and effectiveness of related policies (e.g. on ventilation or thermal insulation). Children are particularly susceptible to the health effects of damp, which include respiratory disorders such as irritation of the respiratory tract, allergies and exacerbation of asthma.

[http://webcommunities.hse.gov.uk/connect.ti/pesticides/viewdatastore?spiderFormState=S&DSID=2308&ADV=S&search\\_0=9&searchop\\_6=%3D&search\\_6=&between\\_6=&search\\_10=&search\\_2=&search\\_3=&search\\_8=-Any-](http://webcommunities.hse.gov.uk/connect.ti/pesticides/viewdatastore?spiderFormState=S&DSID=2308&ADV=S&search_0=9&searchop_6=%3D&search_6=&between_6=&search_10=&search_2=&search_3=&search_8=-Any-) HSE COPR registered commercial products – Surface Biocides. Helpfully each product is listed as either recommended for the amateur or professional user. NOTE approval and appearance on this list is not mandatory for products that existed prior to 2000 until sometime in 2013.

<http://www.epa.gov/mold/index.html> Molds and Moisture, United States Environmental Protection Agency

<http://www.isse.org.uk/> The Institute of Specialist Surveyors and Engineers - The ISSE originated in the 1970's to promote professional standards within the fields of specialist surveyor, engineers and related professions. Members activities range from the investigation of all types of dampness

including condensation through to structural defects, conservation and restoration of listed buildings.

[http://www.hpa.org.uk/webc/HPAwebFile/HPAweb\\_C/1194947350070](http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1194947350070) General information on hazards associated with the use of bleach from the UK Health Protection Agency.

<http://www.cdc.gov/mold/cleanup.htm/> US Centre for Disease Control and Prevention – advice on cleanup of moulds, removal and remediation after a flood (advises on safe use of bleach).

<http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2672.2012.05259.x/abstract> pH adjusted bleach (10% solution) plus alternative sporicide sprayed onto wood & concrete coated with *Bacillus* spores. Concludes pH-adjusted bleach isn't wholly effective in killing *Bacillus* spores i.e. didn't achieve sterile conditions BUT did reduce the number of spores by 6 logs (one million fold reduction) after 30mins 22°C on both surfaces. The alternative tested was less effective than bleach.

<http://onlinelibrary.wiley.com/doi/10.1111/j.1472-765X.2011.03162.x/abstract> used acidified bleach to clean several test materials (wood, ceramic and galvanized steel) coated with *Bacillus subtilis* spores. Treated with varying pH of bleach for 10 mins 20°C. A pH of 4.5 was highly effective on metal and ceramic but not on wood.

<http://www.tandfonline.com/doi/full/10.1080/15459620490462823> looks at various inoculated materials and bleach at various pH's and concludes that pH optimised bleach (2% solution with 2% detergent at 39°C for 10 mins) works well against *Aspergillus* spores on all materials tested (wood, cloth, paper, carpet) during simulated washing. Activity against *Penicillium chrysogenum* and *Stachybotrys chartarum* was also excellent but there was poorer activity against the larger, better protected *Chaetomium globosum* spores.

Attempts to measure reduction in active mycotoxins in the same assay showed poor activity unless an extra washing step was used.

<http://www.ncbi.nlm.nih.gov/pubmed/21882971> Advice for professional to clean up after a release of anthrax spores, which are bacterial structures designed to withstand difficult environmental conditions and are thus resistant to killing. Most mould spores are not so adapted to be resistant to harsh environmental conditions as their primary purpose is to disseminate the fungus rather than resist attack. We might interpret this to suggest anthrax spores will be more resistant to bleach when compared to many mould spores. It can also be noted that efficient cleanup of anthrax is vital to prevent harm to human health as anthrax causes lethal infection if not completely eliminated.

Advice given in this paper includes recommending the use of pH adjusted bleach as well as alternative sporicide and HEPA vacuum cleaning to remove spores and debris .

<http://www.ncbi.nlm.nih.gov/pubmed/19031383> An extensive review of different techniques used to eradicate anthrax spores over the last 60 years. Specifically states that bleach was effectively used as one strategy to remove anthrax spores, along with HEPA vacuum cleaning.

<http://www.ncbi.nlm.nih.gov/pubmed/21034981> Spore-forming bacteria (similar to anthrax spores in that they are designed to be highly resistant to destruction) are cleaned from a metal surface using bleach (1% & 10%) with contact times between bleach and spores of 1, 5 and 10 mins at 20°C. At 1% bleach did not work but at 10% bleach was effective after 10 mins (but not after 5 mins). A gel-based

4.5% hydrogen peroxide product performed as well as 10% bleach and was much less caustic. The authors noted that the bleach dried after 4 mins of application whereas the gel didn't and suggest that might be one reason why it performed well.

<http://www.ncbi.nlm.nih.gov/pubmed/16683620> Less caustic alternative to sodium hypochlorite effectively reduces Bacillus & Aspergillus spore viability 1 million fold in 1 min at 22°C, and up to 100 million fold in 10mins.

[http://www.jacionline.org/article/S0091-6749\(05\)01303-5/abstract](http://www.jacionline.org/article/S0091-6749(05)01303-5/abstract) Spray application of sodium hypochlorite-containing disinfectants onto mould-contaminated building material kills *A. fumigatus*, modifies the surface characteristics of *A. fumigatus* conidia, reduces recognition of *A. fumigatus* mould by ELISA, and results in loss of skin test reactivity to the treated mould in individuals allergic to *A. fumigatus*.

<http://informahealthcare.com/doi/abs/10.1080/13693780600654414> Sodium hypochlorite and cupric sulphate were equivalent for the killing of *Aspergillus fumigatus* with an MIC of 2.5 – 5% using standard CLSI M38-A protocol to determine MIC. Authors conclude both are effective treatments for food & water for the prevention of infection of susceptible patients.

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