

# HUMIDIFICATION REQUIRED OR NECESSARY ON THE WORKPLACE?

**New Royal Resolution 23/03/2016 about art.3/36 en 4 ARAB/RGPT**  
13 October 2016

*Msc. Dirk Vanhove*

*Sales Manager CONDAIR*



# RR 23/03/2016 about art.3/36 and 4 ARAB/RGPT

- In a airconditioning installation the average relative humidification must be between 40 and 60% on a working day, unless it's not possible for technical reasons.
- *Exception* :The relative humidity are allowed between 35% and 70% when the employer shows that there are no pollution ( chemical or biological agents )in the air and no risks for safety and health for the people on the workfloor/shop.

# Humidity level

- **Relative humidity RH in %**
- $\frac{\text{Quantity water vapor in the air}}{\text{Maximum quantity water vapor in the air (dewpoint)}} (\%)$
- **Absolute humidity**
- The quantity water vapor present in some quantity air by a certain temperature and pressure g/m<sup>3</sup> or g/kg
- 20°C/40% = 5,79 g/kg and Pressure 101.325 kPa (Density 1,2 kg/m<sup>3</sup> )
- 40% / 20°C is the same as 55% / 15°C and 30%/ 25°C
- Always in relation to the temperature !

# Humidity and health standards

## THE PHYSIOLOGICAL BASIS OF HEALTH STANDARDS FOR DWELLINGS

The modern home should not only provide protection from unfavourable atmospheric conditions, but also prevent the spread of contagious disease and ensure physical and mental comfort, rest or activity and the maintenance of human health in the wider sense.



WORLD HEALTH ORGANIZATION

GENEVA

1968

# Humidity and health standards

## THE PHYSIOLOGICAL BASIS OF HEALTH STANDARDS FOR DWELLINGS

M. S. GOROMOSOV

PHYSIOLOGICAL BASIS OF HEALTH STANDARDS FOR DWELLINGS 27

It would thus appear that the permissible limits of humidity at moderate temperatures may be set somewhat more widely than was previously supposed. However, from the standpoint of health, the humidity should not exceed 60 % or be lower than 30 %.

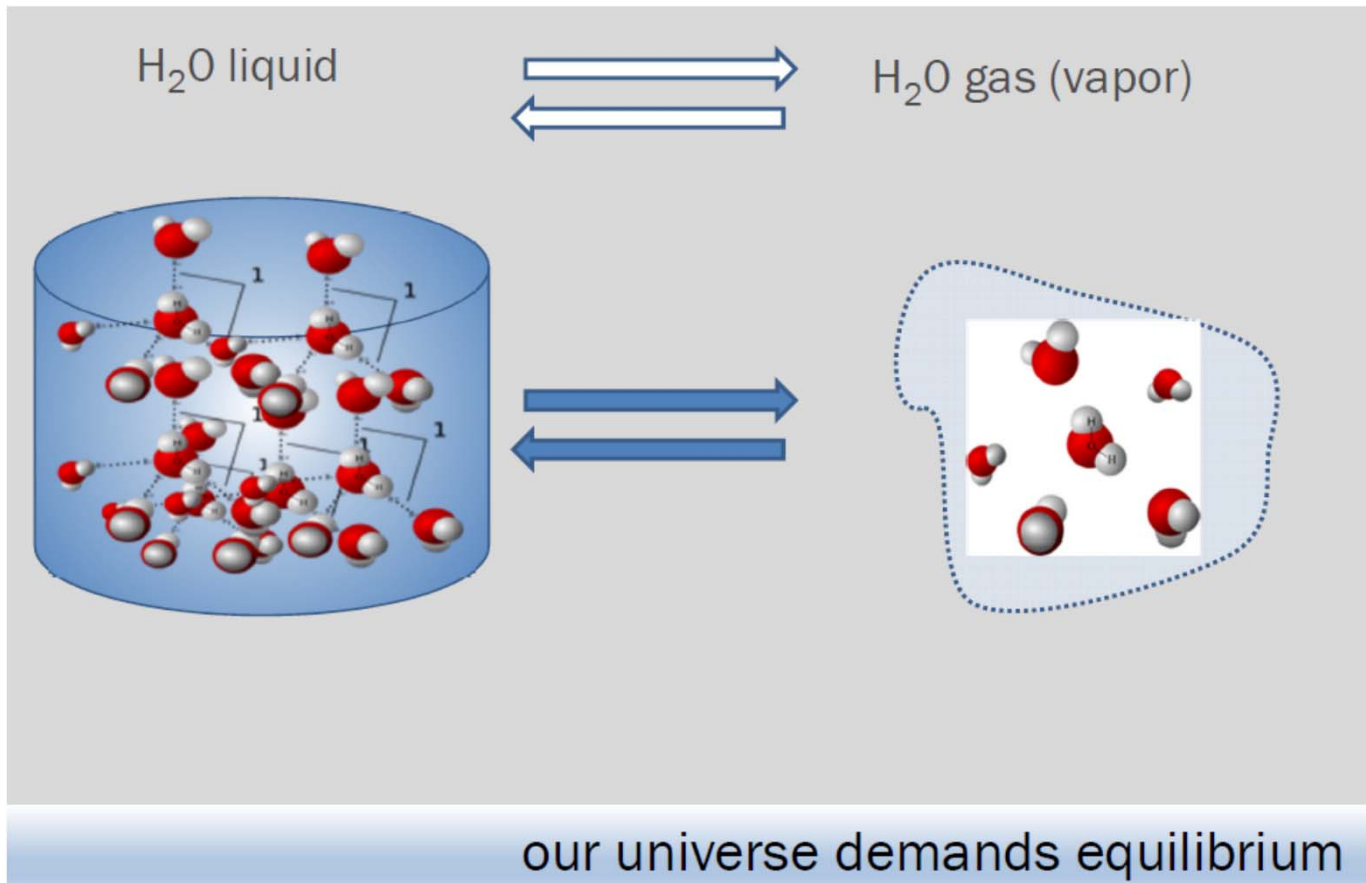


WORLD HEALTH ORGANIZATION

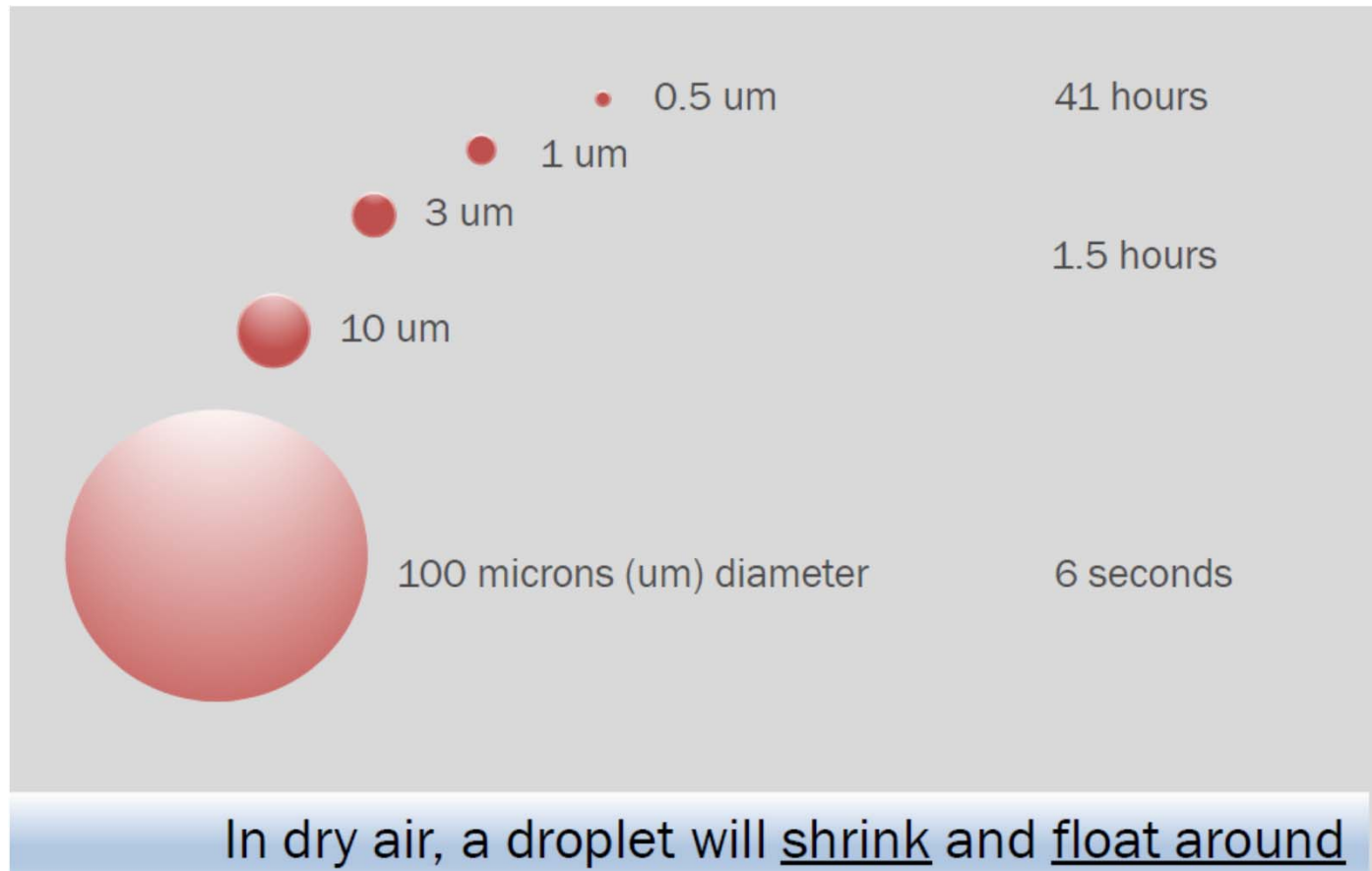
GENEVA

1968

# Water and vapor



# Water droplets



# Dehydration

this makes us vulnerable to dehydration

- an average sized human at rest inhales and exhales approx. 14,000 L of air per day
- in air with RH 20%, about 800 ml of water is lost through respiration and through the skin in 8 hrs
- **a 50 kg person loses 1 - 2% body weight while DOING NOTHING**
- by the time our body volume sensors activate thirst centers, we are already clinically dehydrated



# What dry air do with our body

Dry air is a dangerous indoor pollutant for humans!

## dehydration



- respiratory infections
- asthma and allergies
- fatigue, weight gain
- constipation and digestive disorders
- increased cholesterol
- joint pain and stiffness
- increased blood viscosity



# What dry air do with us

low indoor humidity causes



decreased  
brain function



eye irritation



skin  
thinning



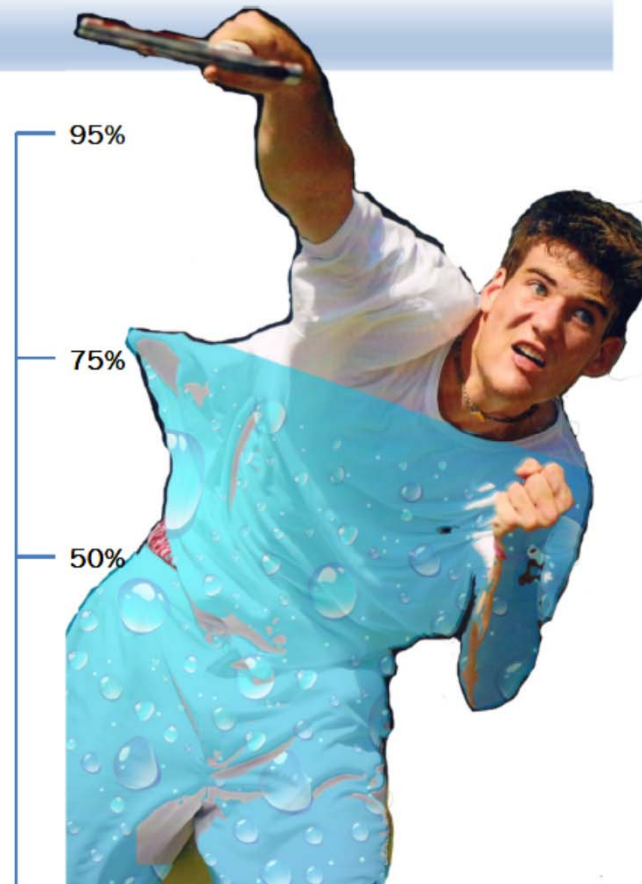
increased  
infections

# Hydration

proper hydration is essential

the average person requires 75% H<sub>2</sub>O

- to facilitate food digestion to produce energy and build tissues
- to transport dissolved O<sub>2</sub> and CO<sub>2</sub> (breathing)
- to keep our structure and epithelial layers intact
- to allow immune system training for allergy and infection prevention



# Dehydration

even mild dehydration impairs our performance

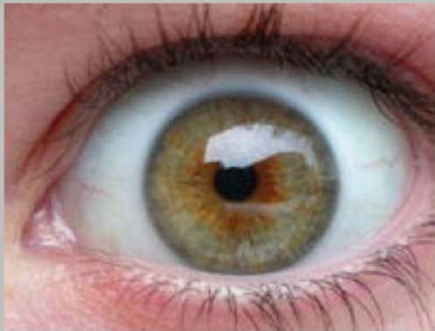


1% decrease of our body weight from water losses diminishes our:

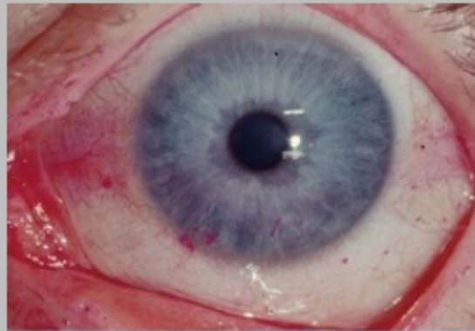
- ability to think
- short-term memory
- concentration
- reaction times
- visual-motor tracking

# Dry air and Eyes

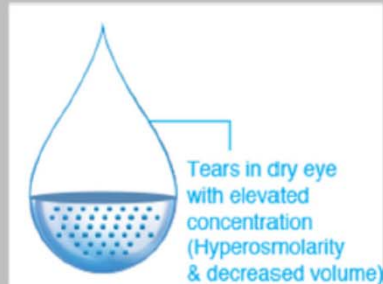
## Dry Eye Syndrome



Well hydrated



Dry

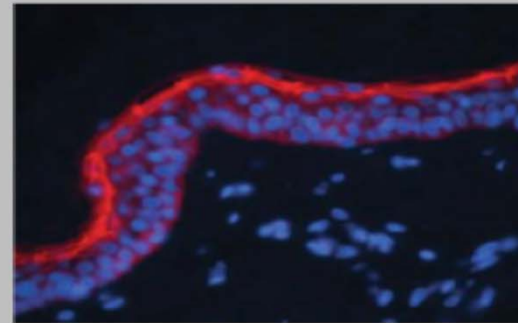
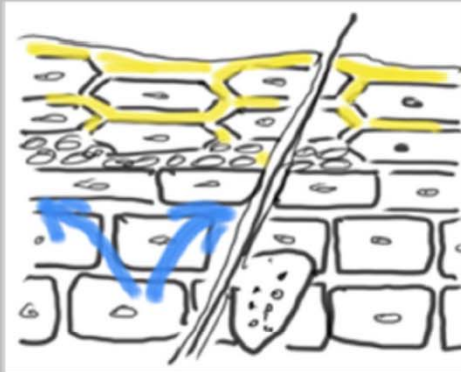


- redness
- scratchiness
- burning sensation

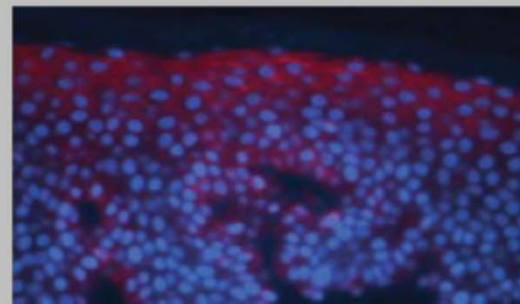
# Dehydration

Skin - the first physical barrier of the body

well hydrated



dehydrated



Dry air harms skin

# Our skin loves humidity

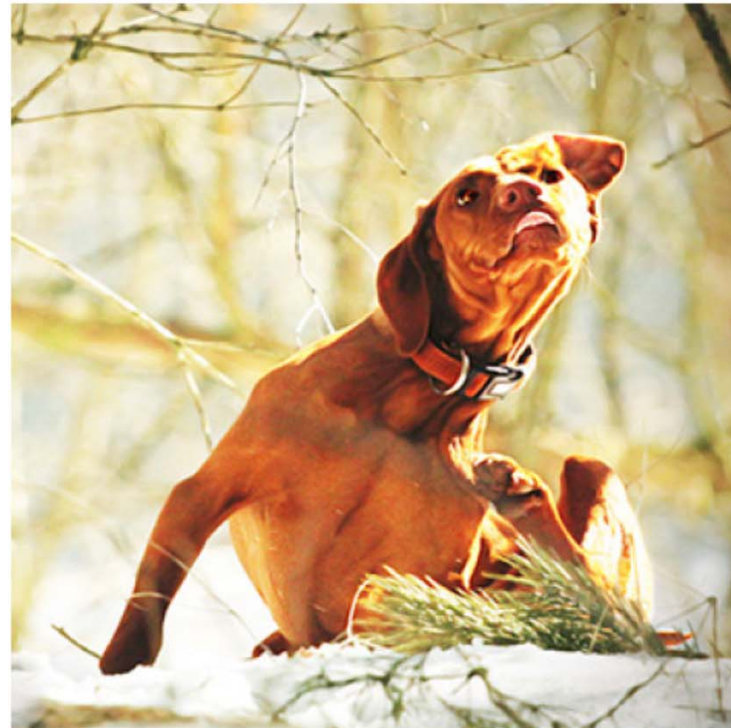
The importance of healthy skin: beyond comfort & cosmetics

## Our defense against

- environmental
- physical
- chemical
- microbial insults

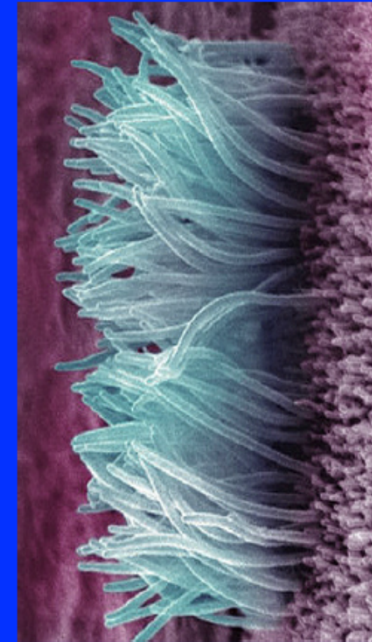
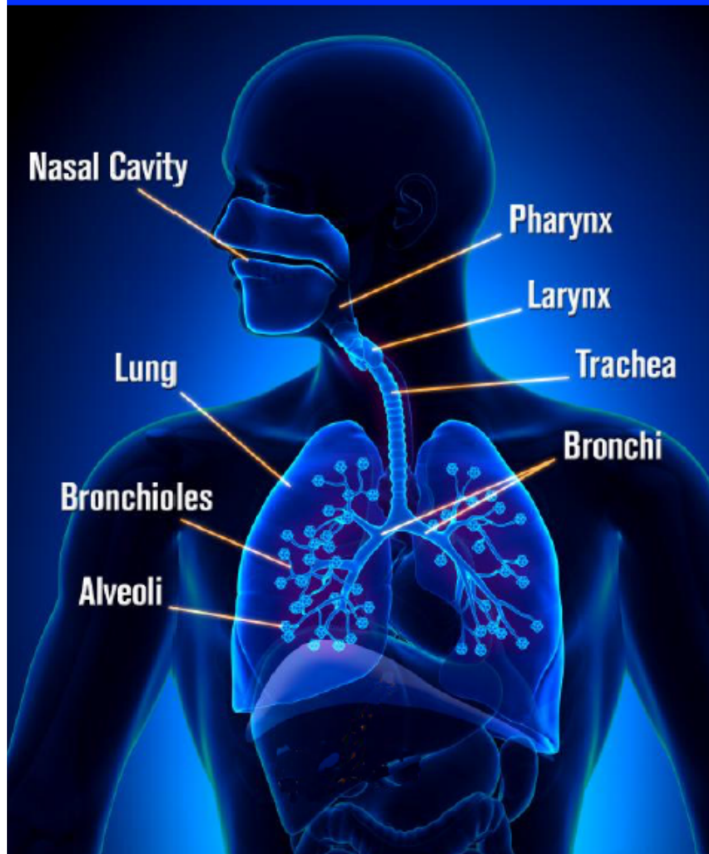
## Essential for

- wound healing
- immune system development



# Respiratory system and dry air

our respiratory epithelium demands hydration



hydrated epithelia with active cilia



# Viruses and bacteria

Conversely, pathogens love dry indoor air!



wider spread



longer life  
for many

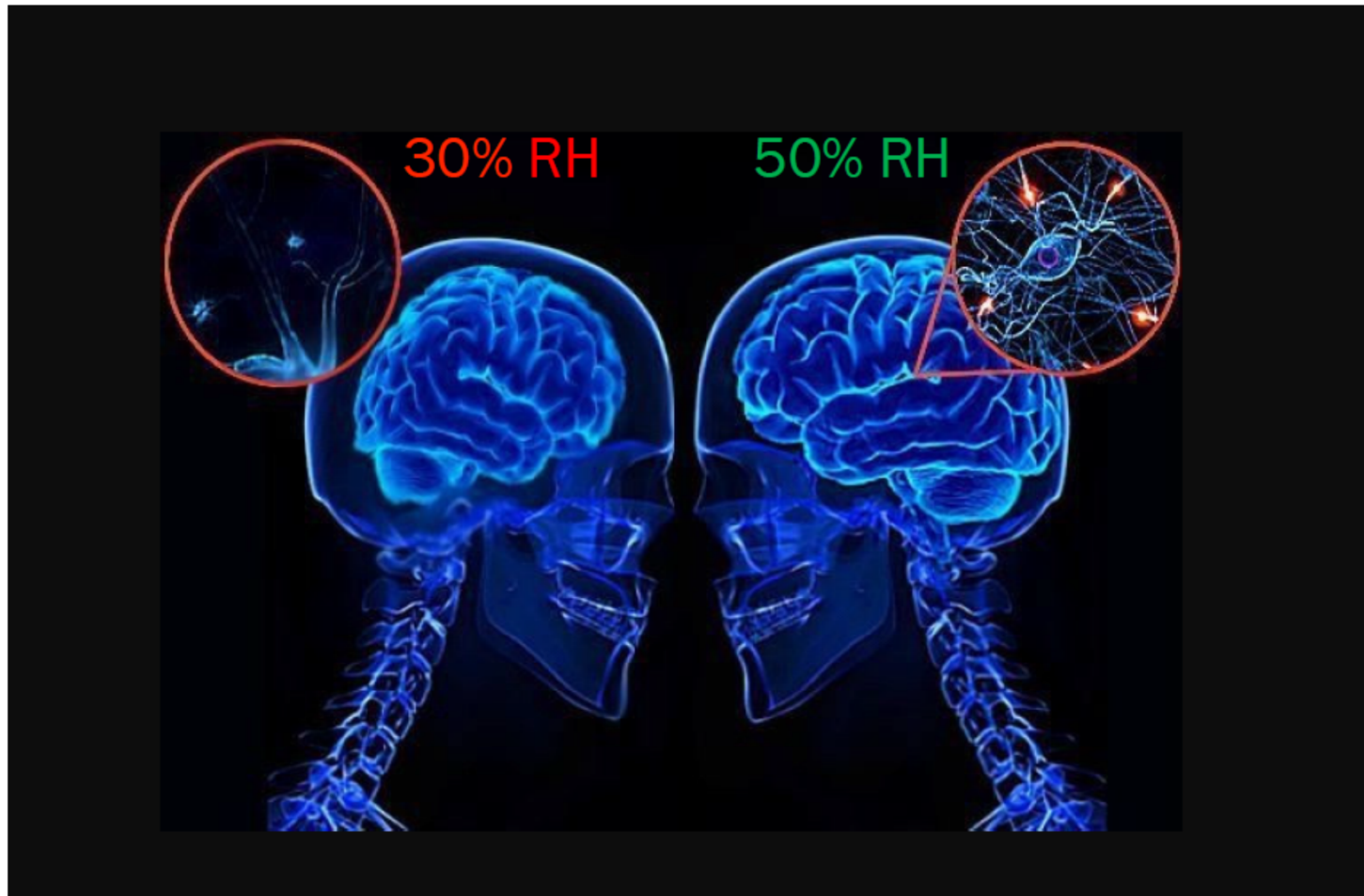


re-suspension



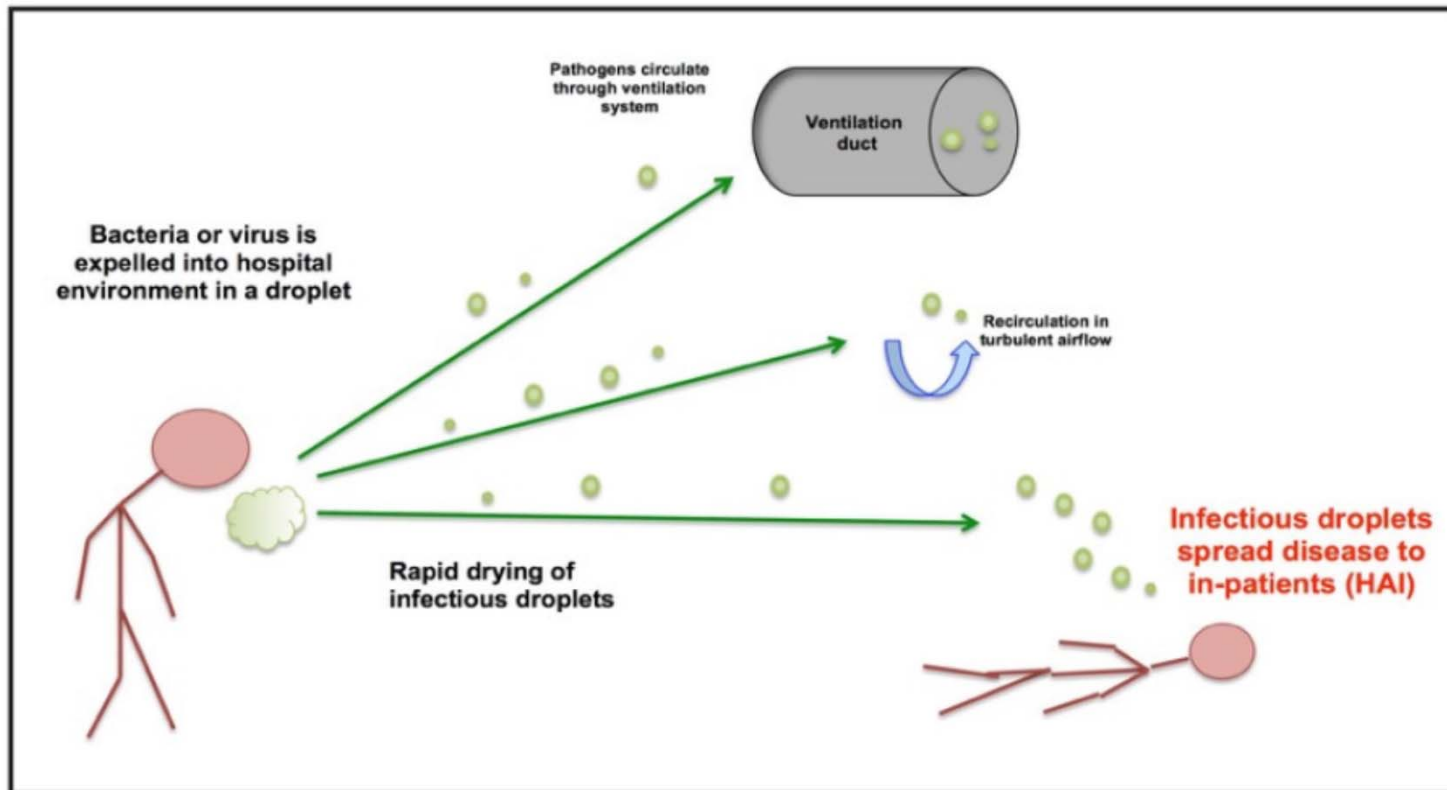
reproduction  
through more  
infected hosts

# Brain activity



# Dry air and health

Indoor RH < 20 %



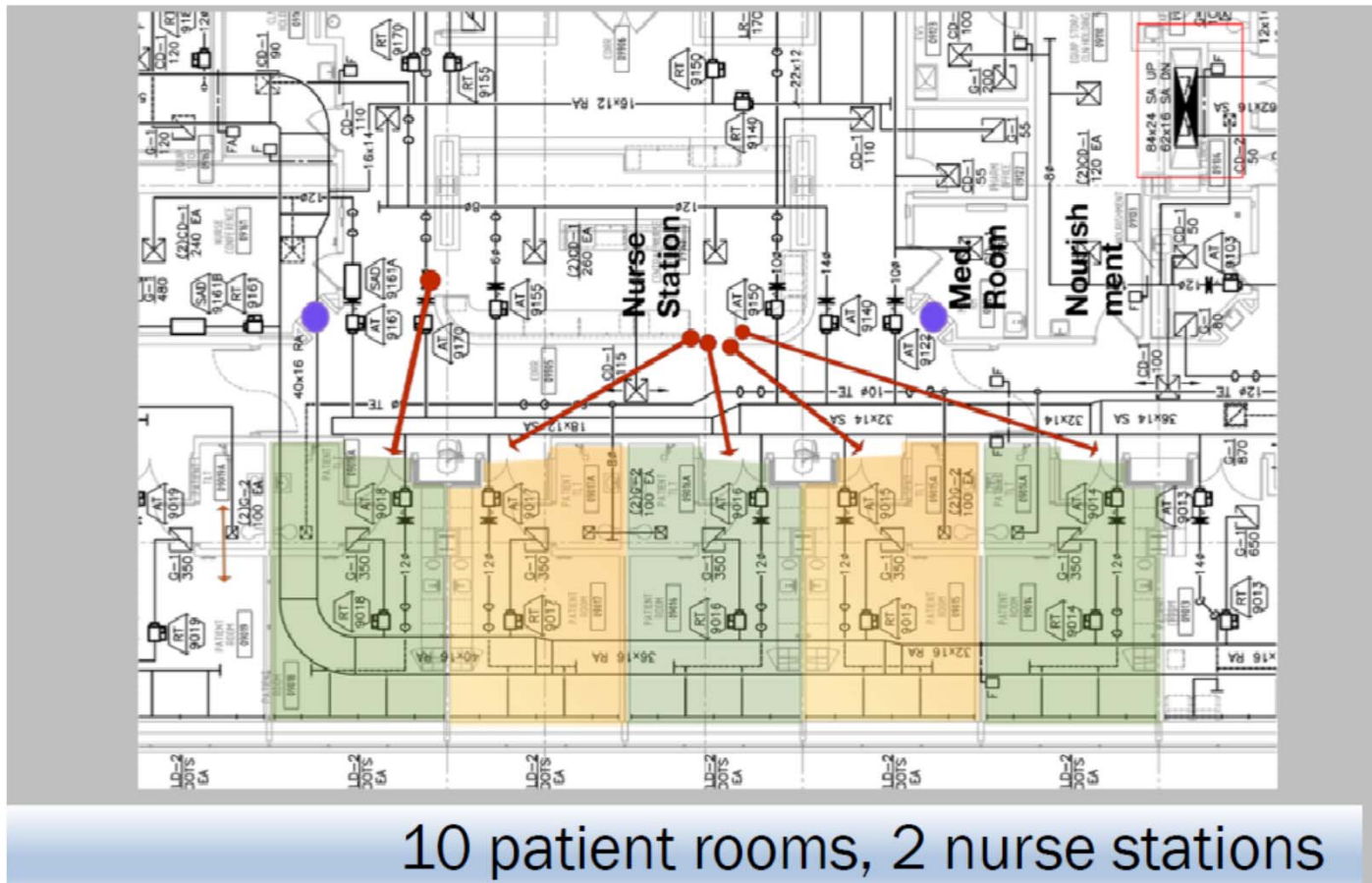
# Scientific study about RH influence

- Built 2013, LEED Silver
- 1.2 million square feet
- 240 single-occupancy inpatient rooms
- 52 ICU beds. 28 operating suites
- green roof
- levels 8, 9, 10 - surgical, oncology and transplant patient rooms
- humid, continental climate (cold winter & hot, humid summer)



Microbiome Project in a New Hospital

# Scientific study about RH influence

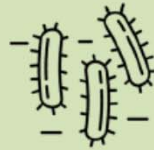


# Scientific study about RH influence

Does the room environment influence microbe spread  
&/or patient infection rates?



monitored patient  
rooms & nurse  
stations



measured the  
microbial fingerprint -  
PCR

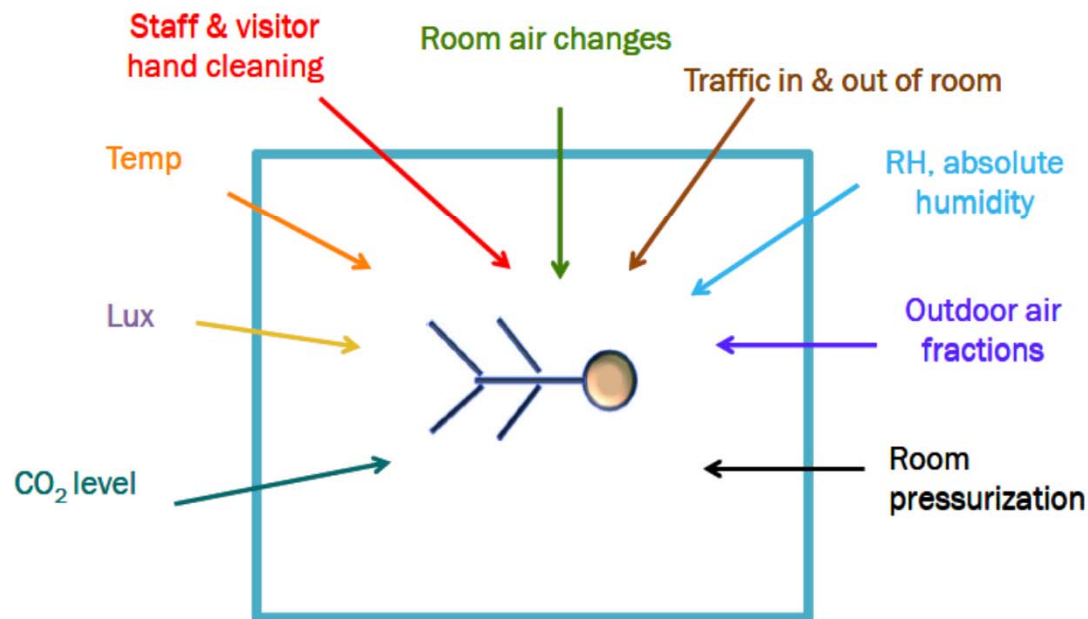


determined % patient  
healthcare-associated  
infections (HAIs)

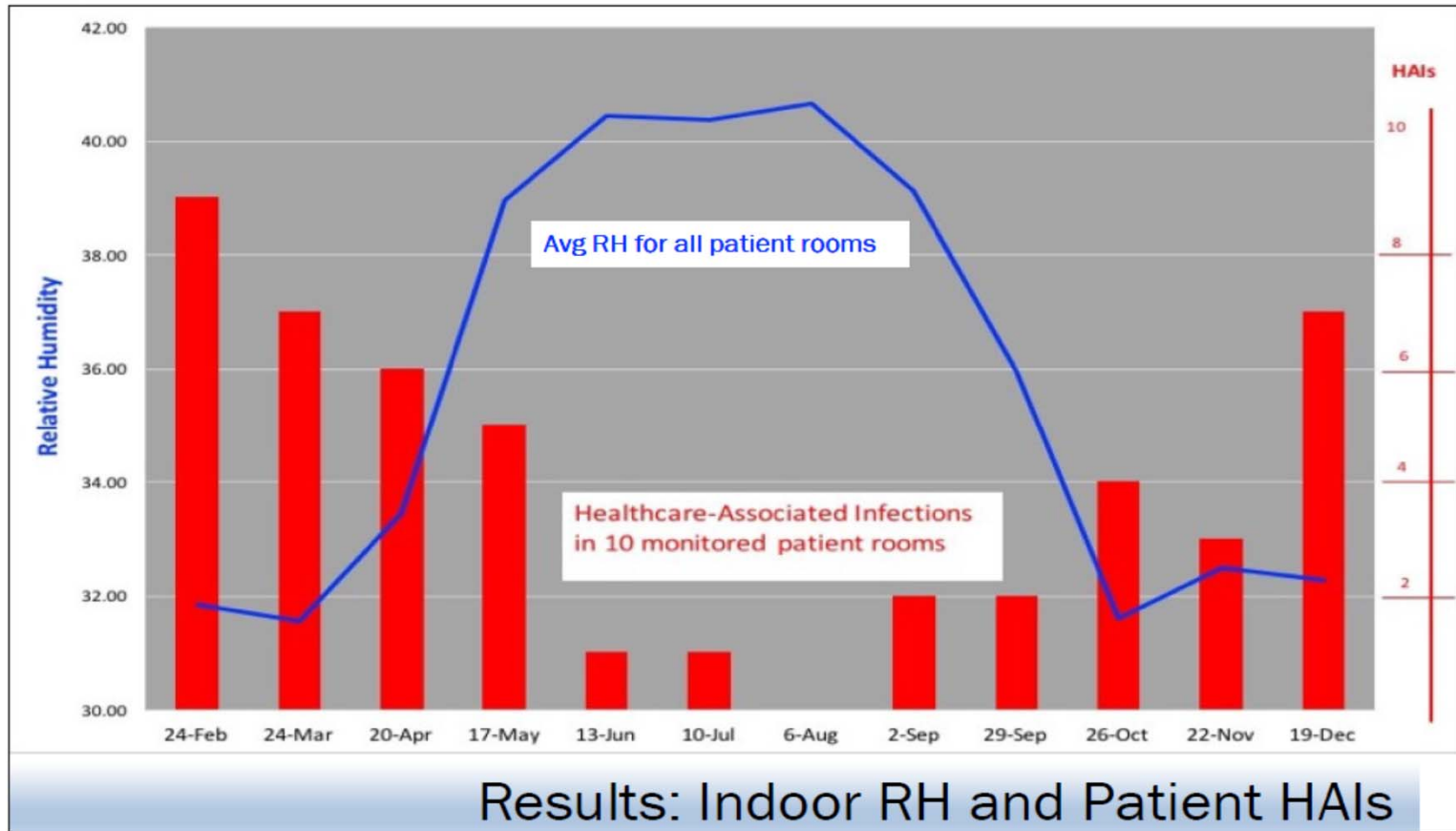
a three layer study over 13 months

# Scientific study about RH influence

Collect information on the patient room environment



# Scientific study about RH influence

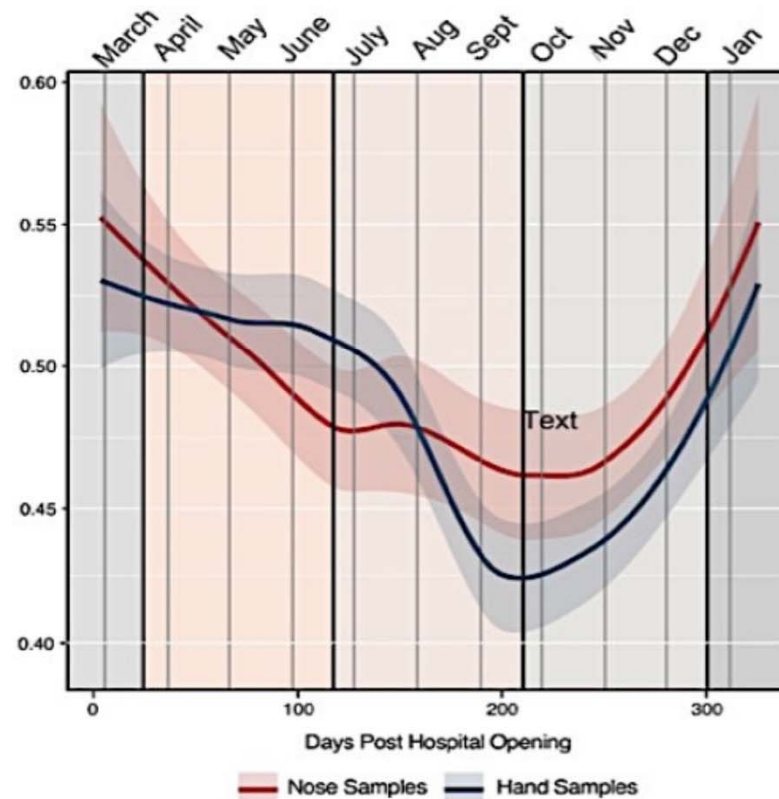




# Scientific study about RH influence

## Results: Indoor RH and bacterial spread

Spread of skin bacteria  
from clinical staff



# Conclusions

Conclusion

As RH goes ↓ ... infections go ↑

$t < 0.02$

Conclusion

As RH goes ↓ ... bacterial spread ↑

$t < 0.01$

# Dry air and health

We cannot just give up!  
Dry indoor air has created a  
public health crisis.

# Study in working or school areas

## Summarized results of studies on health consequences of low humidity (before 1985)

By increasing air humidity in dominant working or school areas of a study population, respiratory infections and sick days can be substantially reduced

The reduction of respiratory infections was

**for adults 25 percent**

**for children 50 percent**


The **absolute reduction of sick days** in winter-trimester was **20 percent**

The effect of air humidification on productivity (work day loss and reduced job performance) corresponds to **0.9 percent of the annual payroll** (extrapolations of the speaker)

# Air indoor



# Air in modern buildings



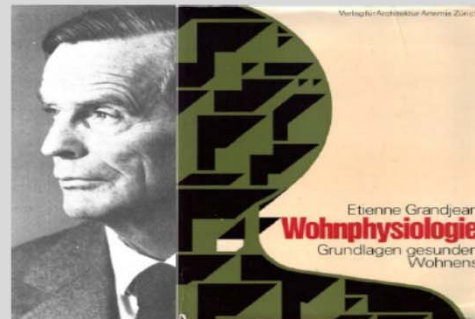
**in modern, energy-efficient,  
airtight, mechanically ventilated  
buildings of light-construction  
indoor dryness has reached  
dimensions never seen before !**

# Indoor humidity

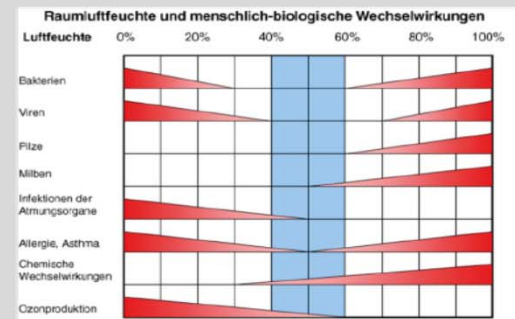
Assessment of Indoor humidity between then and now .....

**Back then: standards for indoor climate and humidity were based on human needs, physiology and health concerns .....**

**Prof. Dr. W. Diebschlag** Technical University Munich, engineer **and** occupational physician



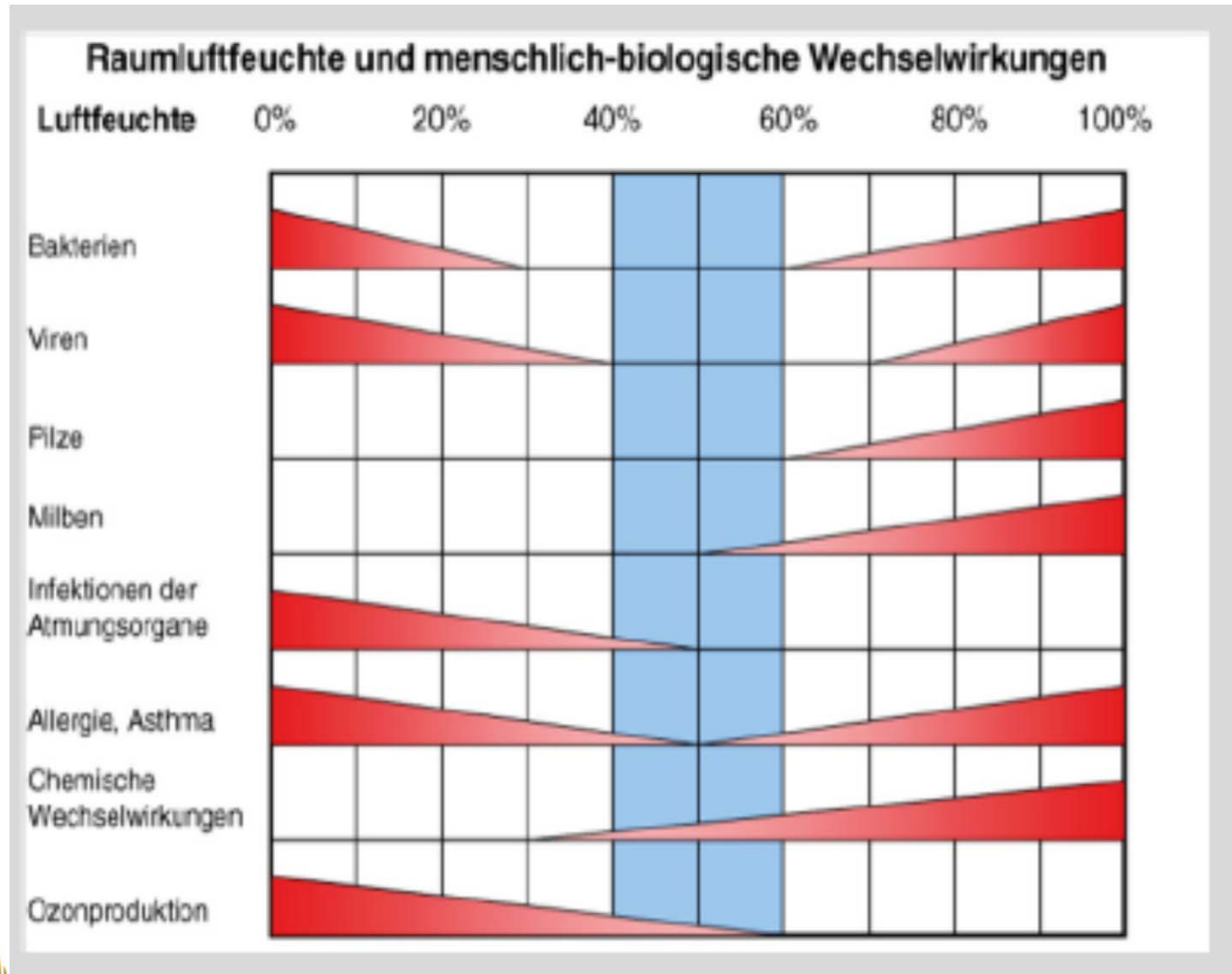
**Prof. Etienne Grandjean** ETH Zurich, chair of Institute for Hygiene and Occupational Physiology, Physician and engineer, 1950-1983



**Scofield, Sterling, Arundel, Ing. ASRAE**

Scofield Sterling Diagramm, 1985

# Optimal Humidity %RH ?






# Indoor humidity

Assessment of Indoor humidity between then and now ....

Standards for climate and humidity were based on human needs and physiology ....

Prof. Dr. W. Diebschlag, Technical University Munich, engineer and occupational physician



40 - 60% rel. Humidity  
Optimal Indoor Climate

Etienne Grandjean, Institute for Environmental and Occupational Physiology, Physician, 1950 - 1983

Scottfield, Starling, Architect, Eng. ASRAE  
Scottfield Starling Diagramm, 1985

Diagram: Raumlufffeuchte (Raumluftfeuchte) vs. Luftfeuchte (Luftfeuchte) showing biological effects (Bakterien, Pilze, Motten, etc.) across humidity levels (20%, 40%, 60%, 100%).

Relative Humidity	Bakterien	Pilze	Motten	Chemische Wechselwirkungen	Ozonproduktion
20%	Low	Low	Low	Low	High
40%	Medium	Medium	Medium	Medium	Medium
60%	High	High	High	High	Low
100%	Very High	Very High	Very High	Very High	Very Low

# Temperature and humidity

How humid is ambient air at room temperature of 20 to 24 °C ?

city	type	No*	MV*	StDe*	10%	20%	30%	40%	50%	60%	70%	80%	90%
Palermo	coastal cities	1765	70.5	12.0	indoor climate «reality»	indoor climate «required»							
San Diego (USA)		1829	66.7	12.2									
Malaga		1702	61.9	14.3									
Hamburg		498	61.9	15.4									
Vienna	inland cities	914	61.4	15.5									
Munich		736	60.3	15.5									
Berlin		735	58.8	16.3									
St. Moritz (CH)	mountain cities	233	40.4	11.2									
Denver (USA)		791	39.1	14.7									
Tucson (USA)	desert cities	1225	31.0	16.6									
Riyadh (KSA)		1035	30.6	10.1									
Medina (KSA)		1146	29.3	8.5									
Tamanrasset (ALG)		1544	22.1	9.2									

No = number of countable hourly averages at location, MV = median value RH at 20-24 °C

StDe = standard deviation (≈ 68% of values are within ± standard deviation)

Climatic data from World Meteorological Organisation: [www.wmo.int](http://www.wmo.int)

# Temperature and humidity

How humid is ambient air at room temperature of 20 to 24 °C ?

city	type	No*	MV*	StDe*	10%	20%	30%	40%	50%	60%	70%	80%	90%
Palermo	coastal cities	1765	<b>70.5</b>	12.0									
San Diego (USA)		1829	<b>66.7</b>	12.2									
Malaga		1702	<b>61.9</b>	14.3									
Hamburg		498	<b>61.9</b>	15.4									
Vienna	inland cities	914	<b>61.4</b>	15.5									
Munich		736	<b>60.3</b>	15.5									
Berlin		735	<b>58.8</b>	16.3									
St. Moritz (CH)	mountain cities	233	<b>40.4</b>	11.2									
Denver (USA)		791	<b>39.1</b>	14.7									
Tucson (USA)	desert cities	1225	<b>31.0</b>	16.6									
Riyadh (KSA)		1035	<b>30.6</b>	10.1									
Medina (KSA)		1146	<b>29.3</b>	8.5									
Tamanrasset (ALG)		1544	<b>22.1</b>	9.2									

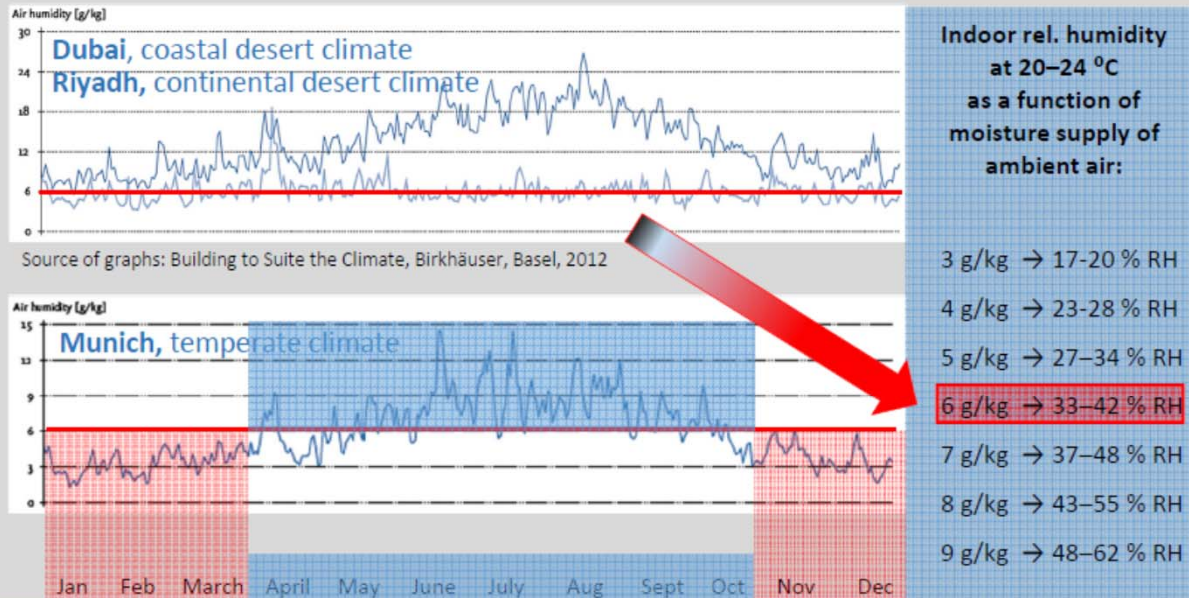
No = number of countable hourly averages at location, MV = median value RH at 20-24 °C

StDe = standard deviation ( $\approx$  68% of values are within  $\pm$  standard deviation)

Climatic data from World Meteorological Organisation: [www.wmo.int](http://www.wmo.int)

# Temperature and humidity

## Absolute humidity in ambient air and achievable RH in heated interiors



Source of graphs: Building to Suite the Climate, Birkhäuser, Basel, 2012

A minimal moisture content of 6 g/kg is needed in ambient air to achieve an indoor relative humidity of 40 to 60 % in heated interiors, if there's no extra moisture input !  
Precondition: ventilation is regulated by CO2 level

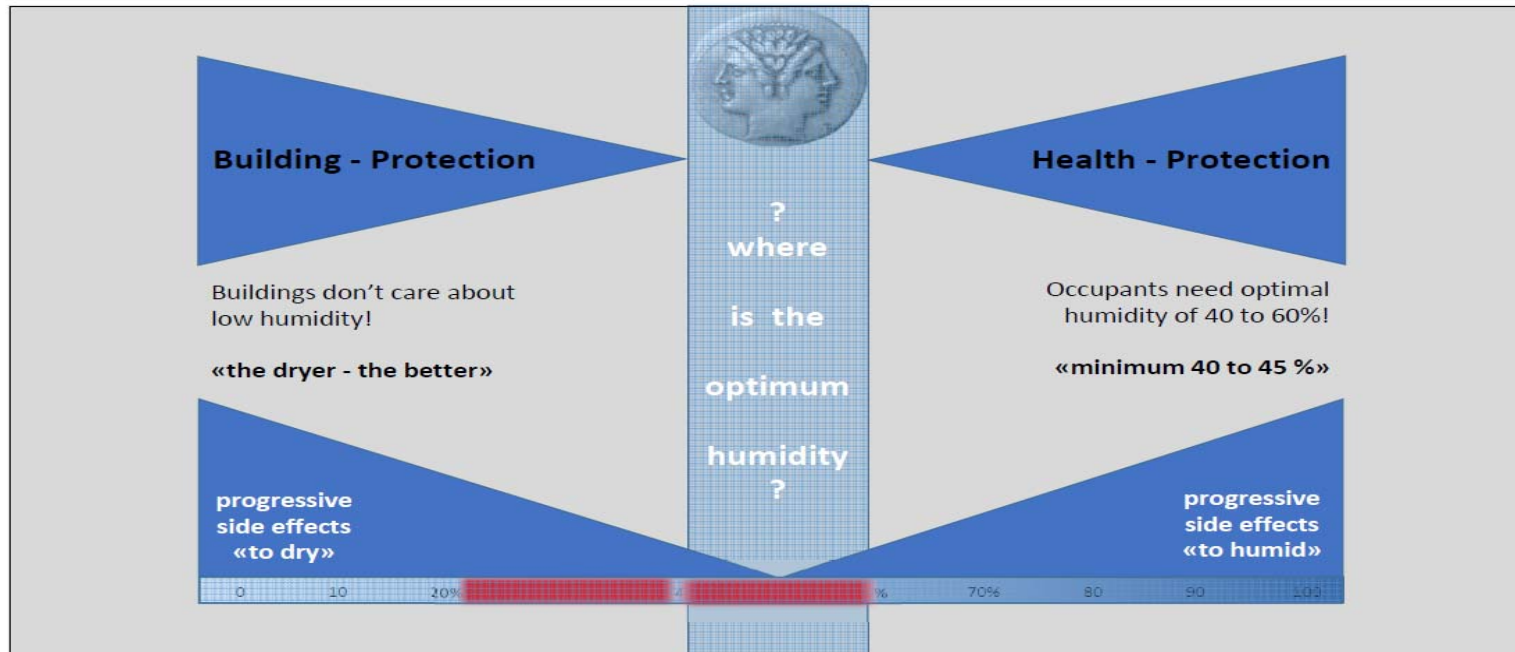
6 g/kg moisture in ambient air, supplied by nature, is a rare event in our moderate climate !

# Temperature and humidity

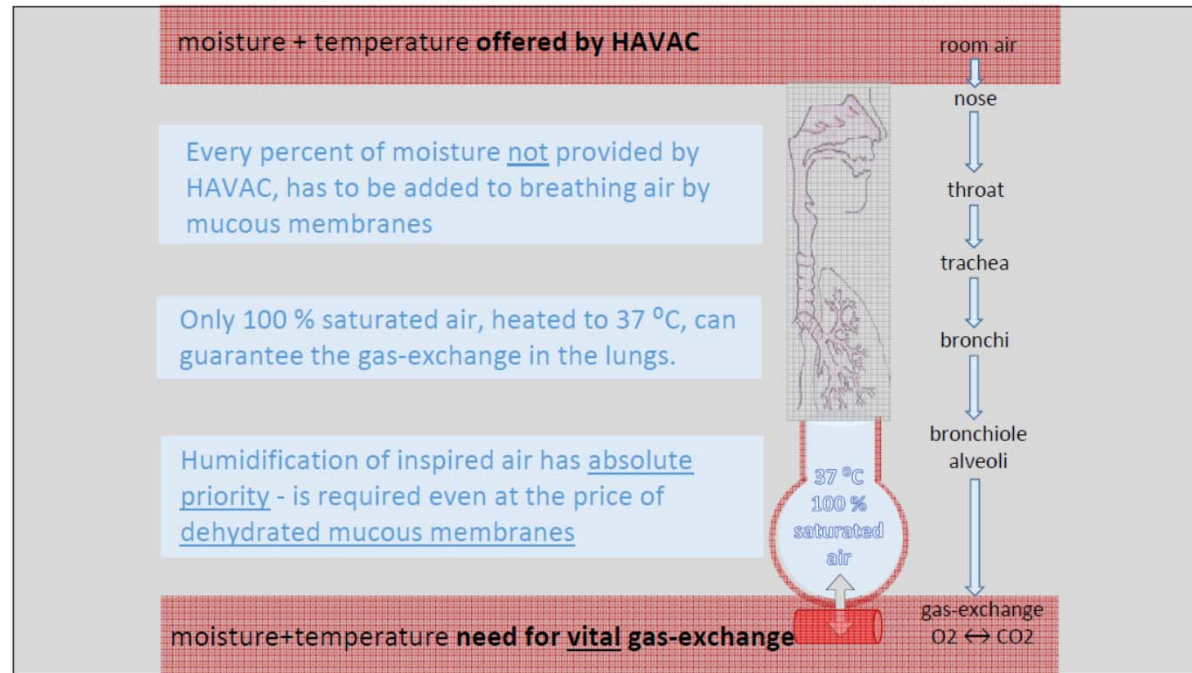
Can we compare it to a continental  
desert climate ?



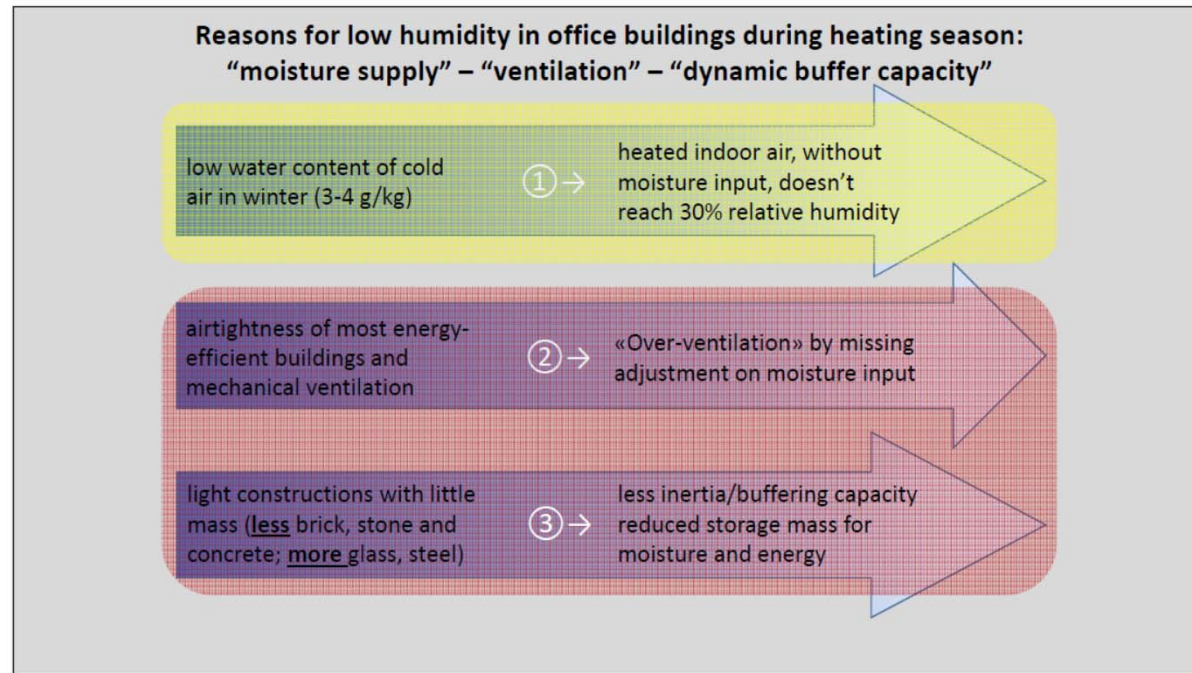
# Optimal humidity ?



# HVAC and humidity



# Humidity





# Water and humidity

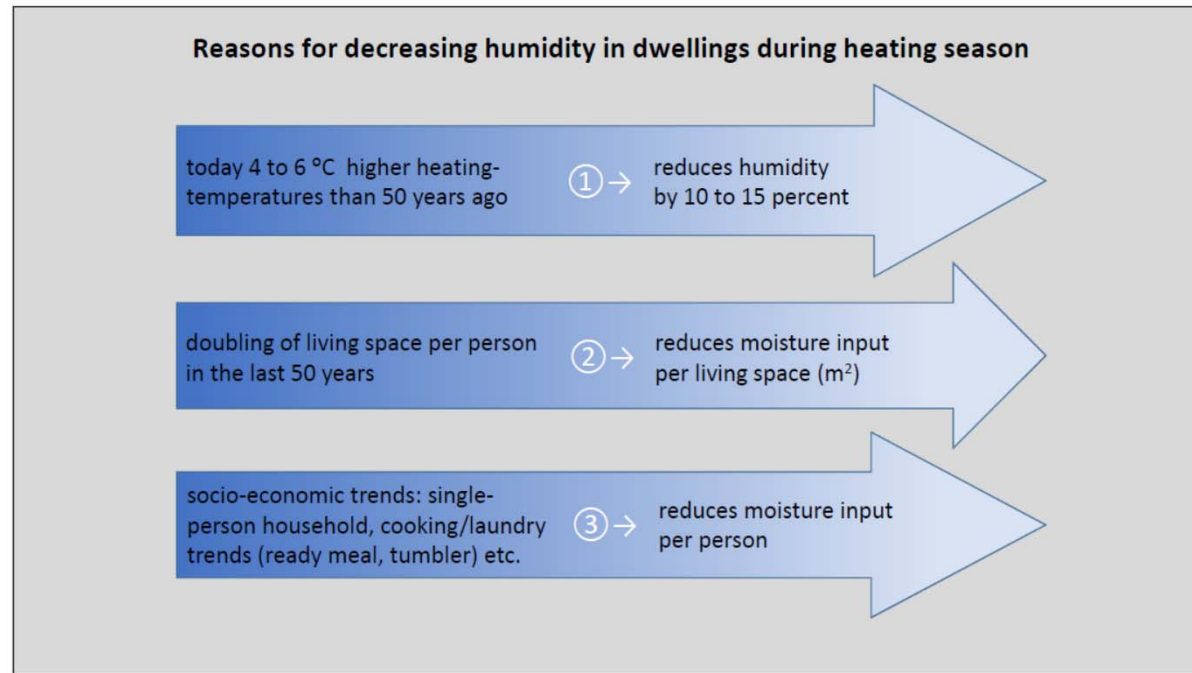
Air is constantly striving for maximal water vapour saturation ...

Relative humidity is the ideal measuring for this eternal competition ...

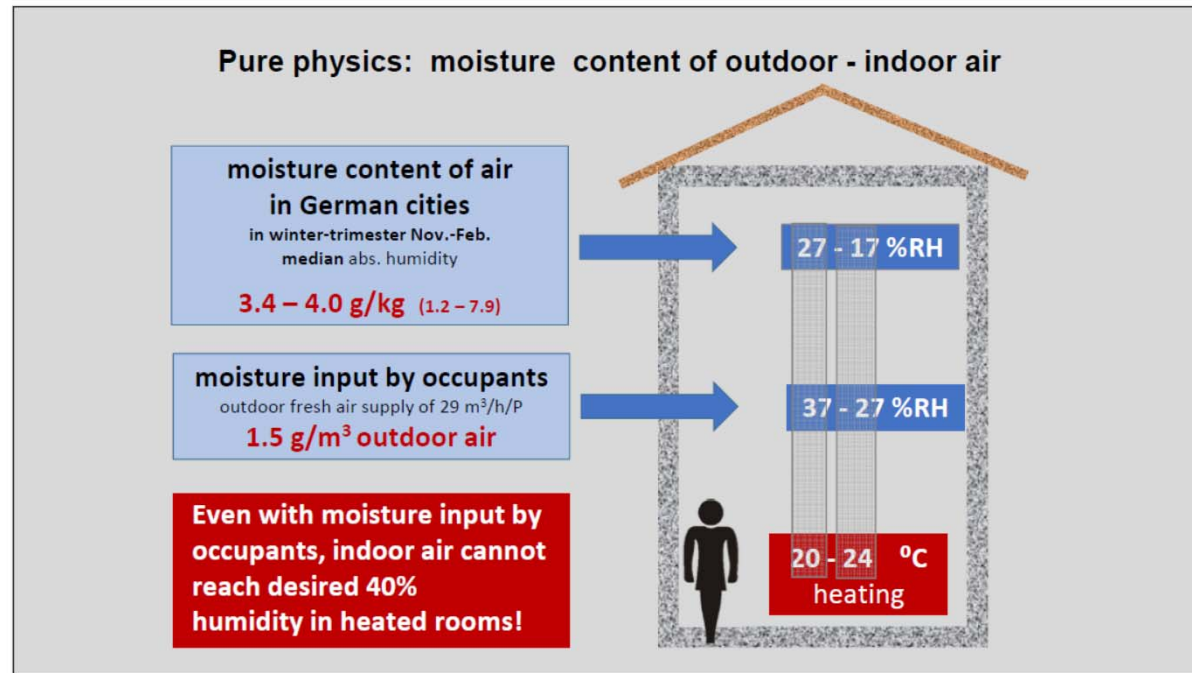
creating an eternal competition for water between thirsty air on one side ...

humans and materials on the other side ...

# Humidity



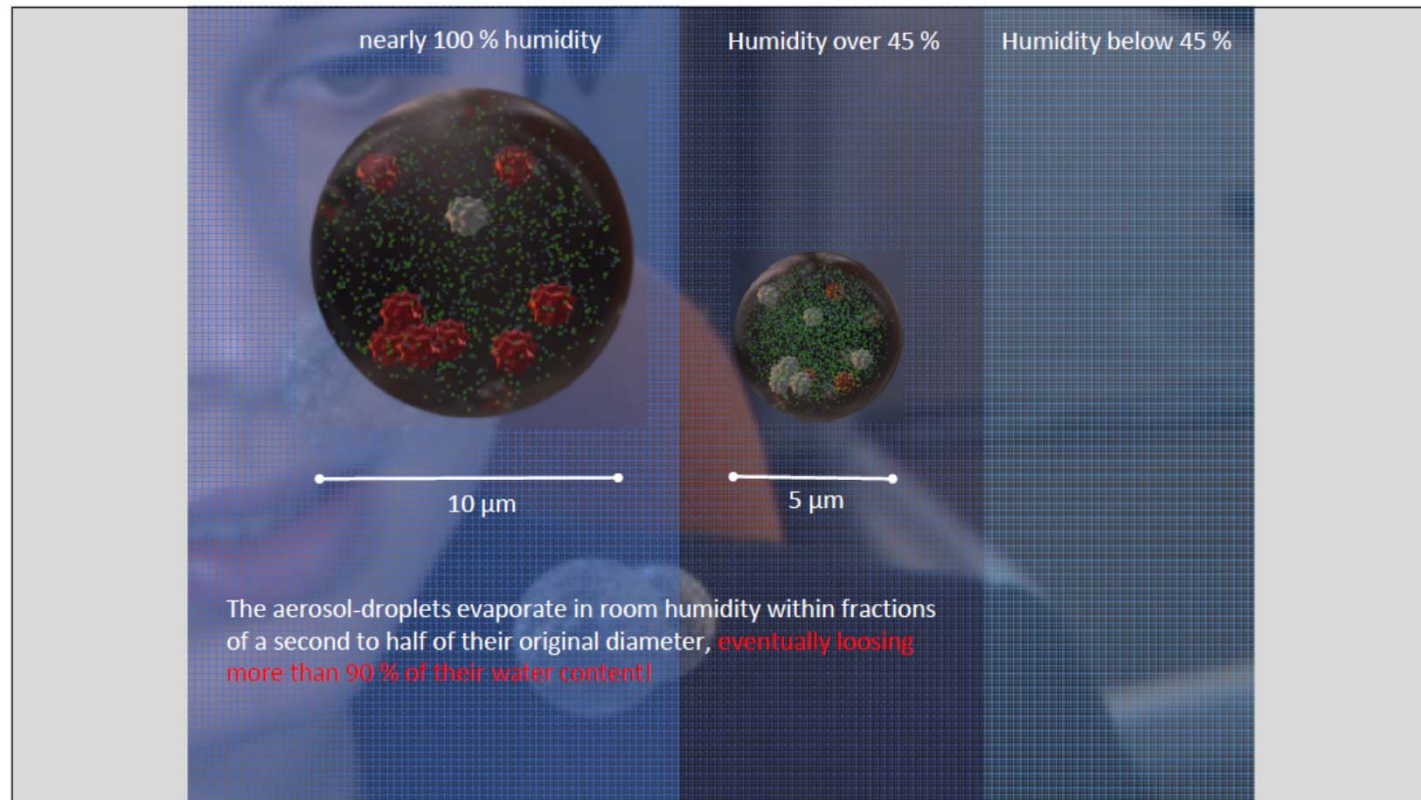
# Moisture



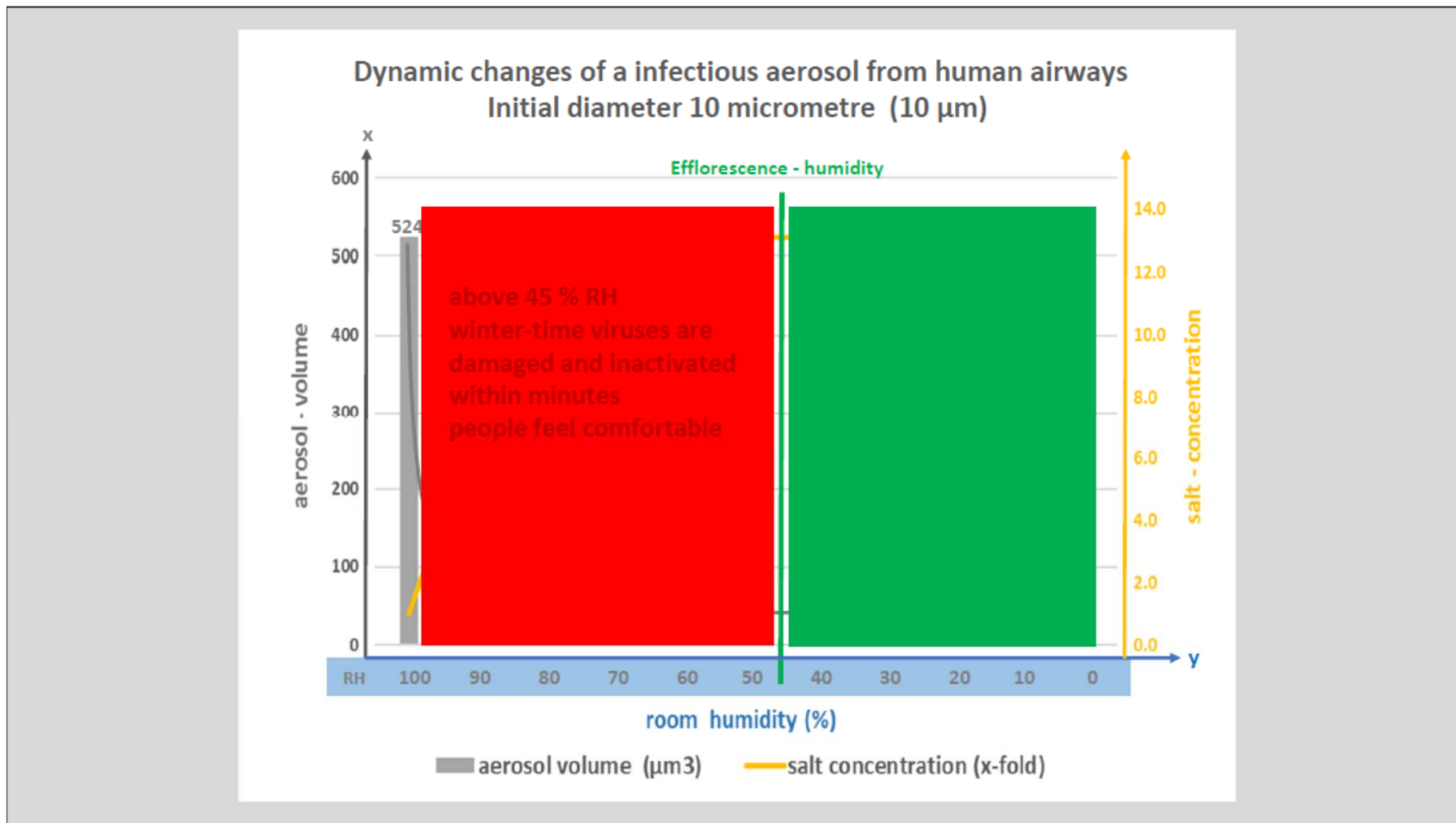
# Humidification

Why humidify for people?	
Dry Air	① Turns off natural, humidity-based protection against winter-time viruses which cause flu and colds
below	② Dries out mucous membranes, preventing clearance of pathogens and increasing our risk of disease from infections and air pollution
40 % rh	③ Increases resuspension and spread of any kind of air pollutants

# Aerosol droplets

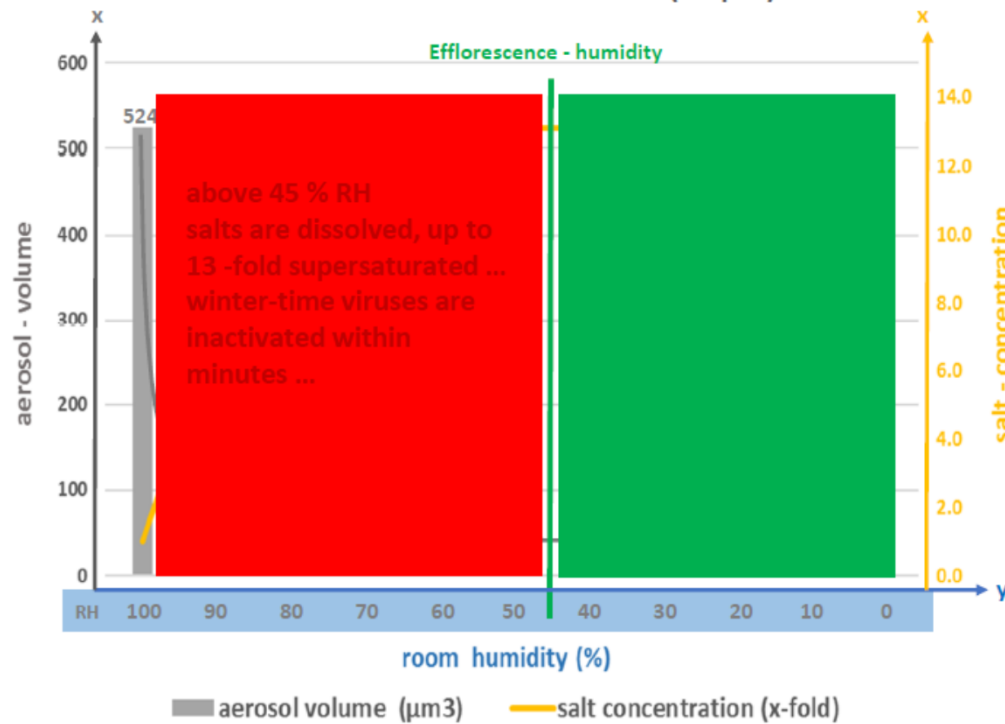


# Aerosols in human airways

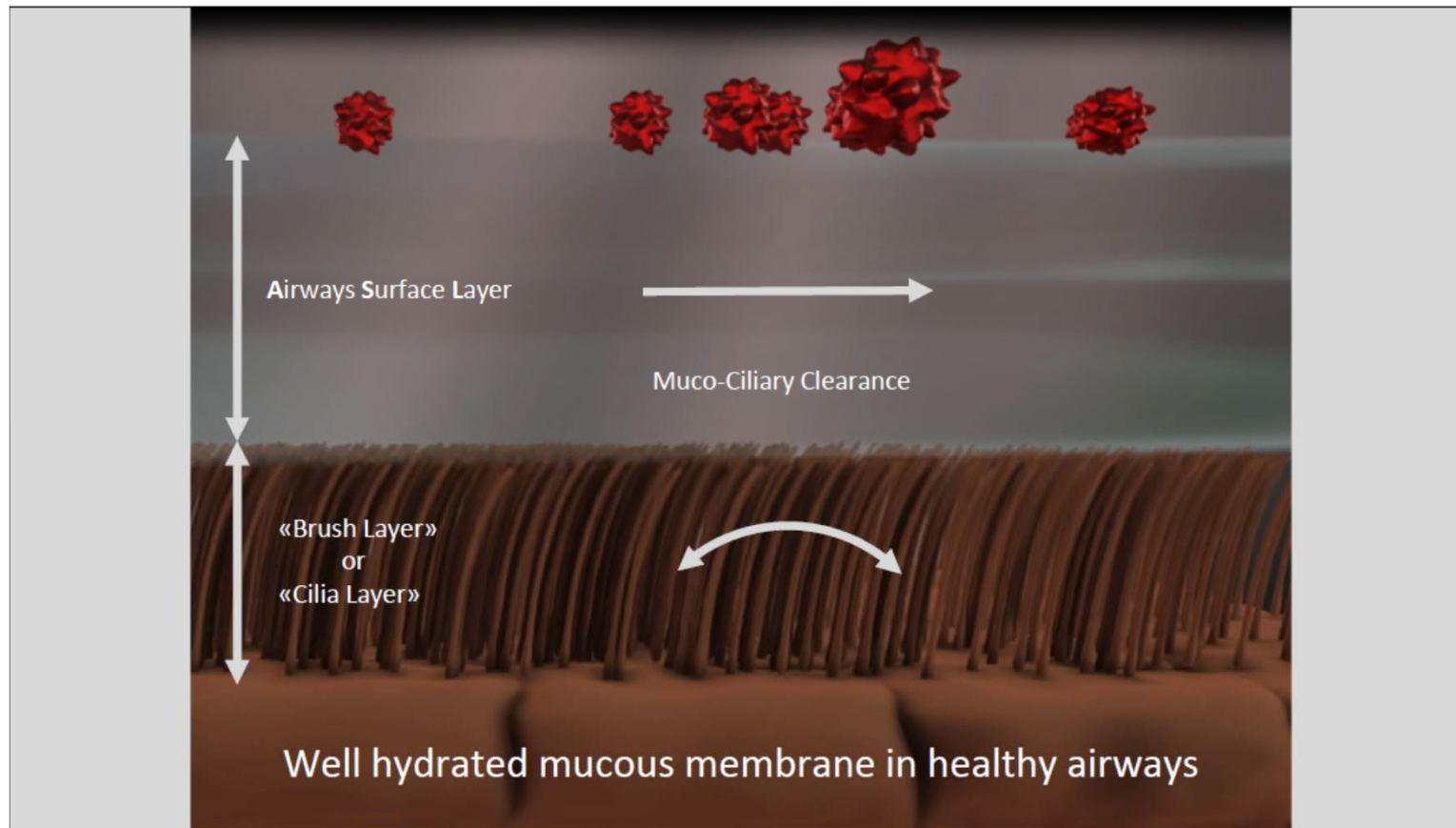


# Aerosols in human airways

Dynamic changes of an infectious aerosol expelled from human airways  
Initial diameter 10 micrometre (10  $\mu\text{m}$ )

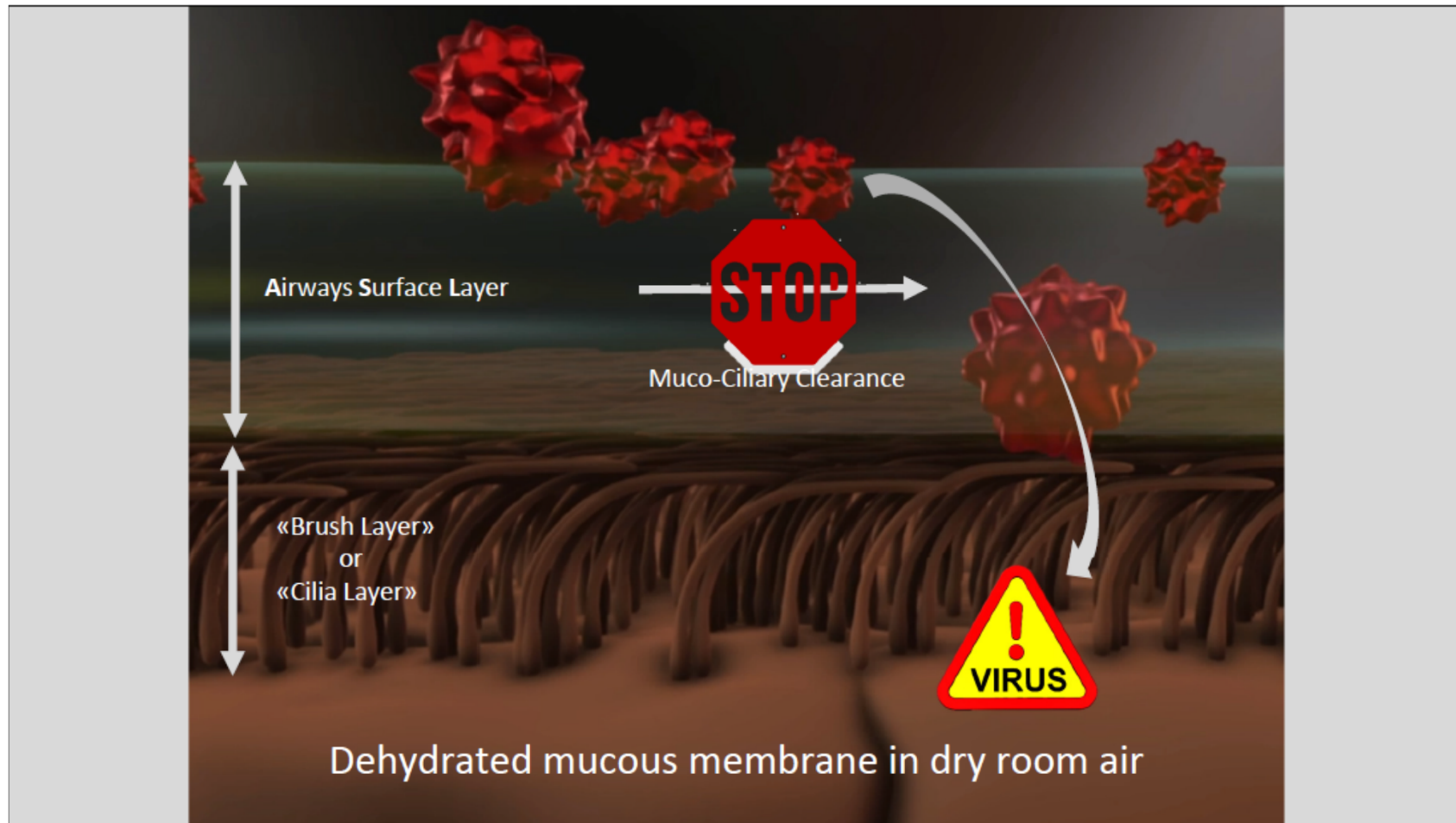


# Mucous membrane

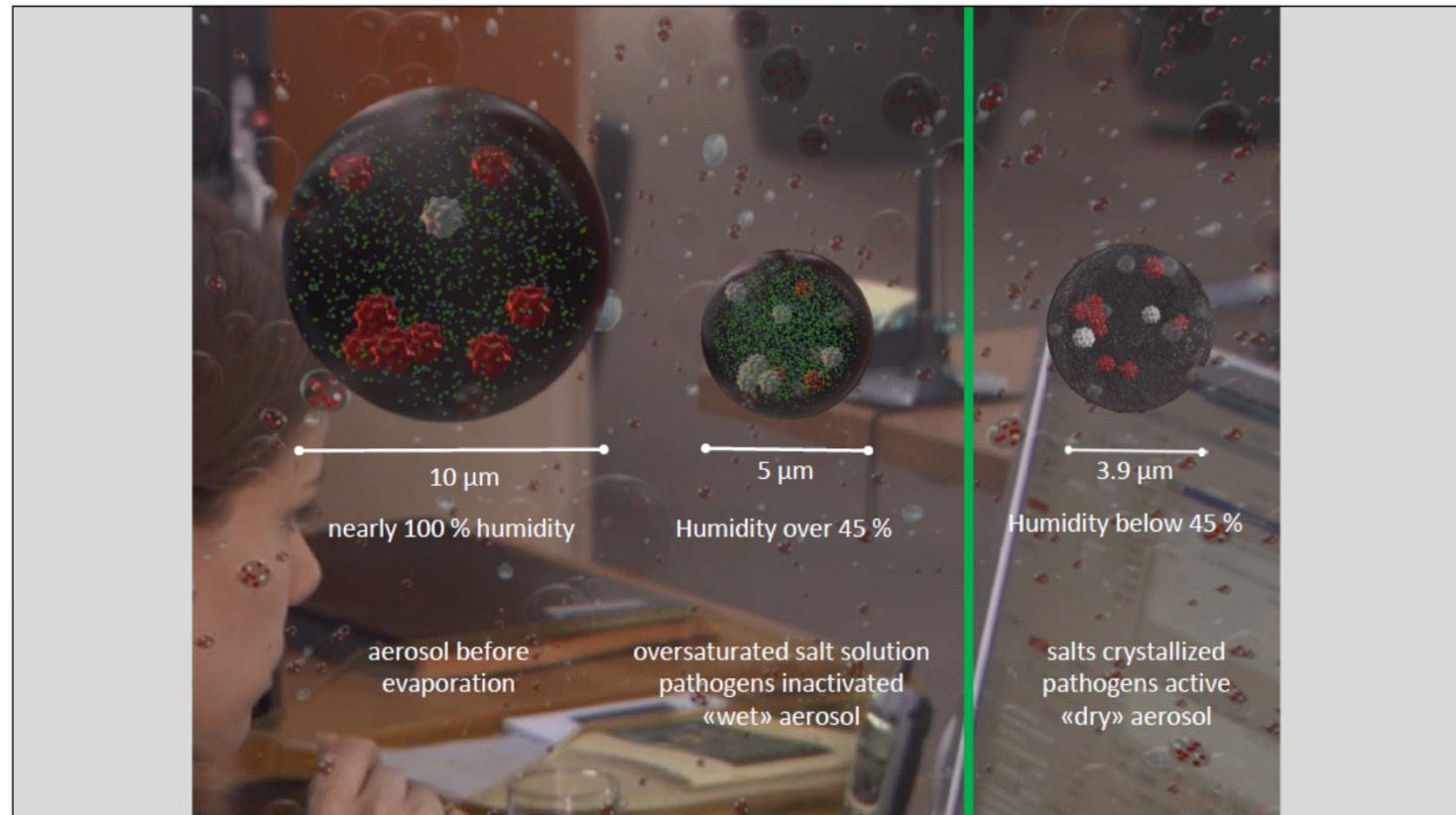




# Mucous mebrame and humidity

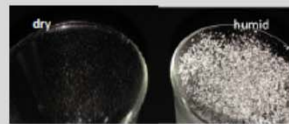


# Aerosols and humidity



# Moisture

Moisture has a «sticking effect», that corresponds to our everyday perception of the adhesivity of water



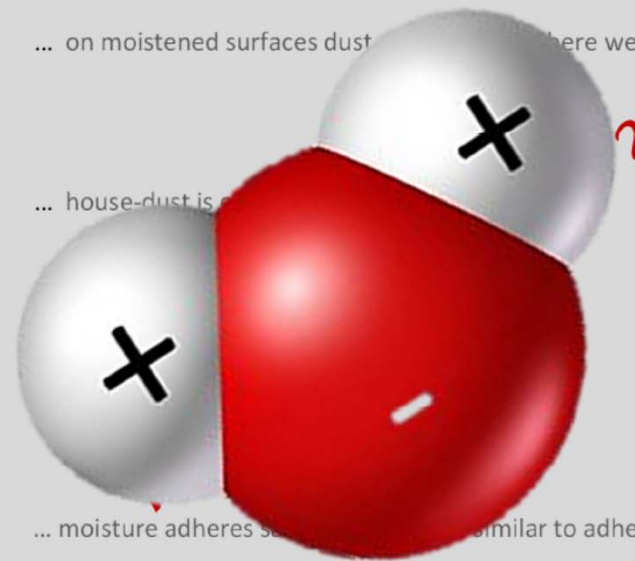
... on moistened surfaces dust particles adhere well ...



... house-dust is ...

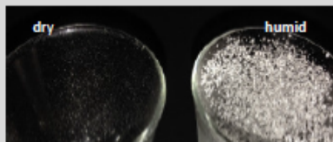


... moisture adheres to particles similar to adhesive ...



# Humidity and moisture

Moisture has a «sticking effect», that corresponds with our everyday perception of the adhesivity of water



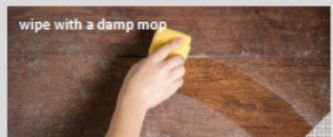
... on moistened surfaces dust and powder adhere well ...

Humidity dependent adhesive forces are the strongest forces between particles and surfaces



... house-dust is easily raised when air is dry ...

«resuspension» an important cause of increased particle numbers caused by showers and human activities



... dust is easily wiped with a damp mop ....

Water covered, moist particles adhere to each other, clumping together aggregates ....



... moisture adheres sand/powder, acts similar to adhesive ...

«wet particles» adhere better to each other and to surfaces than «dry particles» ....

*Humidity is the Adhesive of particles*

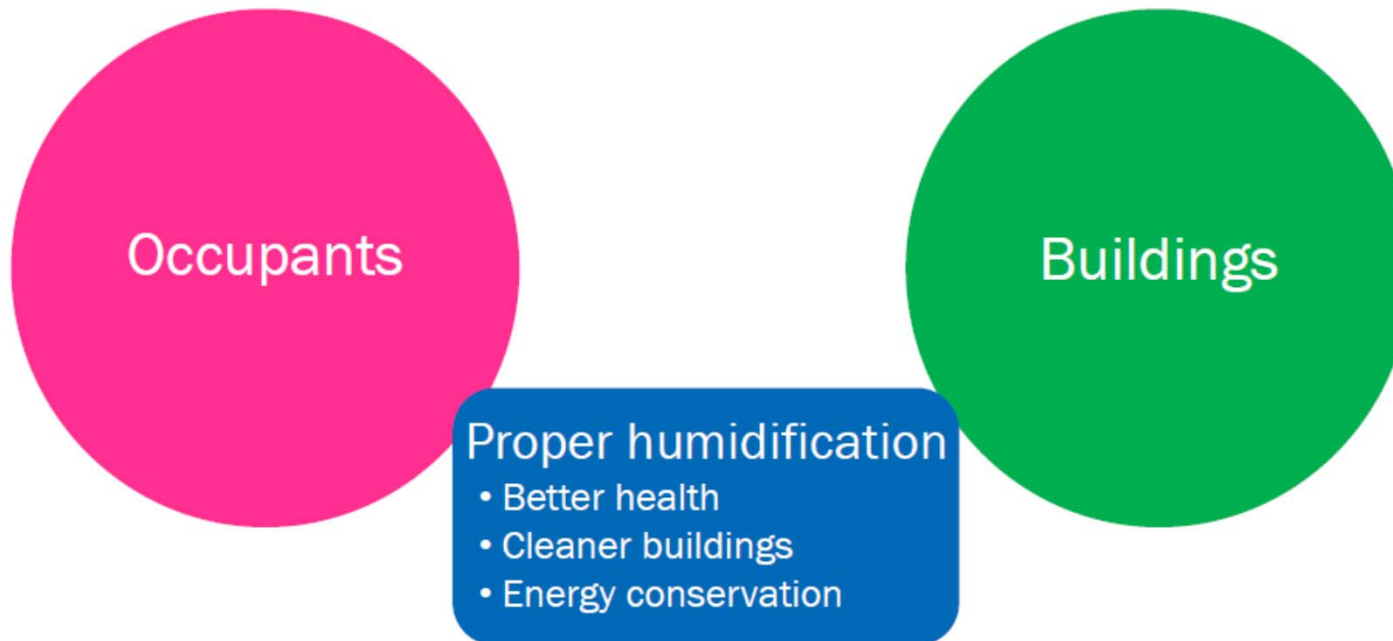
# Humidity on the work floor

When humidity is between 40 -60% :

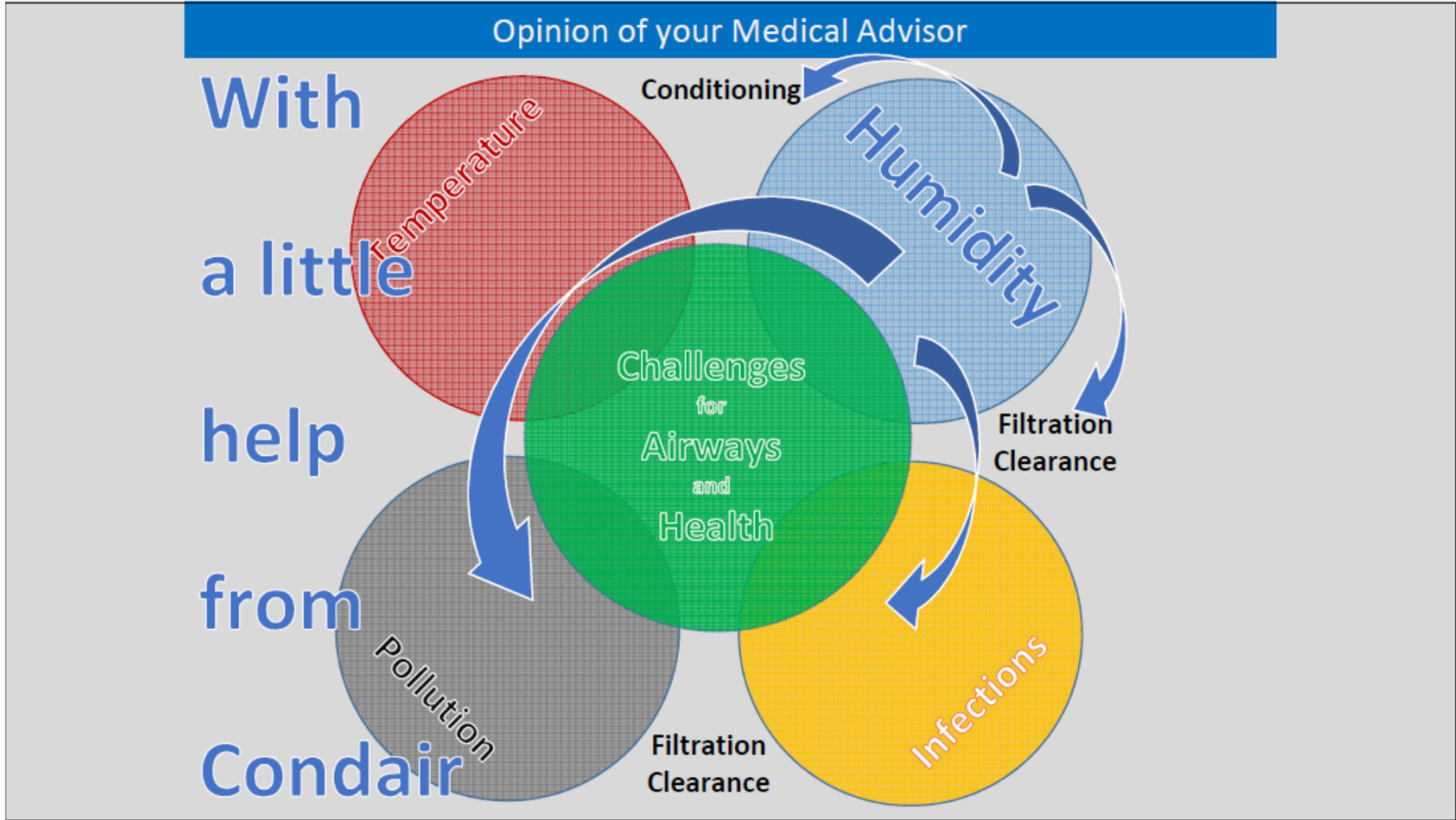
- People feels good, wellbeing , motivated
- People works more attentive, more safety
- People achieve better
- People are less sensitive for viruses ( flu )
- People has less absenteeism
- People has less influence for dust and static electricity
- Conclusion : A good humidity is NECCESARY on the workplace
- We advise MINIMUM 45% RH is needed !

# How you can help us ?

YOU hold the key



# Conclusions: Need for humidification



# Thanks to our scientists

Special thanks for using the slides for this presentation

Stephanie Taylor MD, M Arch, FRSPH(UK), CABE  
Harvard Medical School Primary Care Incite Fellow  
Medical and Scientific Advisor of Condair Group AG

Walter Hugentobler, MD  
General and Internal Medicine, Institute for Primary Care  
University and University Hospital Zurich  
Medical and Scientific Advisor of Condair Group AG



# The end.....



Hygienic Humidity

help for health  
and comfort

Thanks for your attention