# THE AIRBORNE SPREAD OF INFECTIOUS AGENTS: SURVIVAL AND DECONTAMINATION OF HUMAN PATHOGENS IN INDOOR AIR


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**May 18, 2017**

# ACKNOWLEDGEMENTS


- MR. PAUL WEBBER (WEBBER TRAINING)
- DR. KATHIE WRIGHT (BMI, UNIV. OF OTTAWA)
- DR. BAHRAM ZARGAR, (CREMCO)
- MR. RICHARD KIBBEE (CARLETON UNIV., OTTAWA, ON)
- MR. JOSEPH RUBINO, DR. M. KHALID IJAZ & MISS ILZE BRUNING (RB, MONTVALE, NJ)
- DR. M. SOLTANI (JOHNS HOPKINS UNIV., BALTIMORE, MD)
- MR. F.M. KASHKOOLI & MR. F. MORADI (K.N. TOOSI UNIV., TEHRAN)

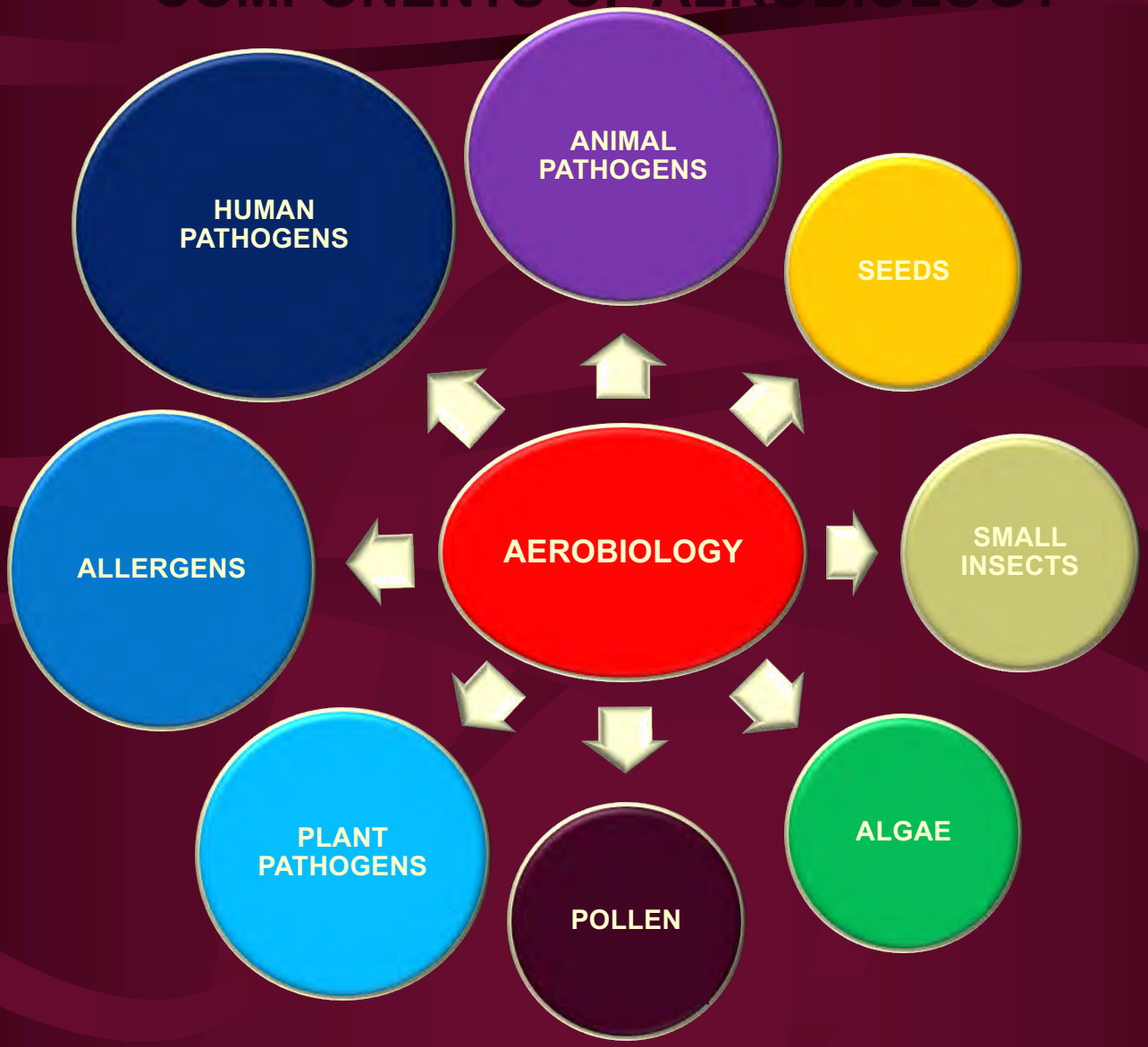
# OBJECTIVES

- 'AEROBIOLOGY' & POTENTIAL OF PATHOGEN SPREAD BY AIR
- CHALLENGES OF STUDYING PATHOGENS IN AIR
- OBSTACLES IN LINKING AIR TO ACQUISITION OF INFECTIONS
- SET-UP TO STUDY AIRBORNE SURVIVAL & REMOVAL/INACTIVATION
- TESTING OF AIR DECONTAMINATION DEVICES
- FUTURE DIRECTIONS

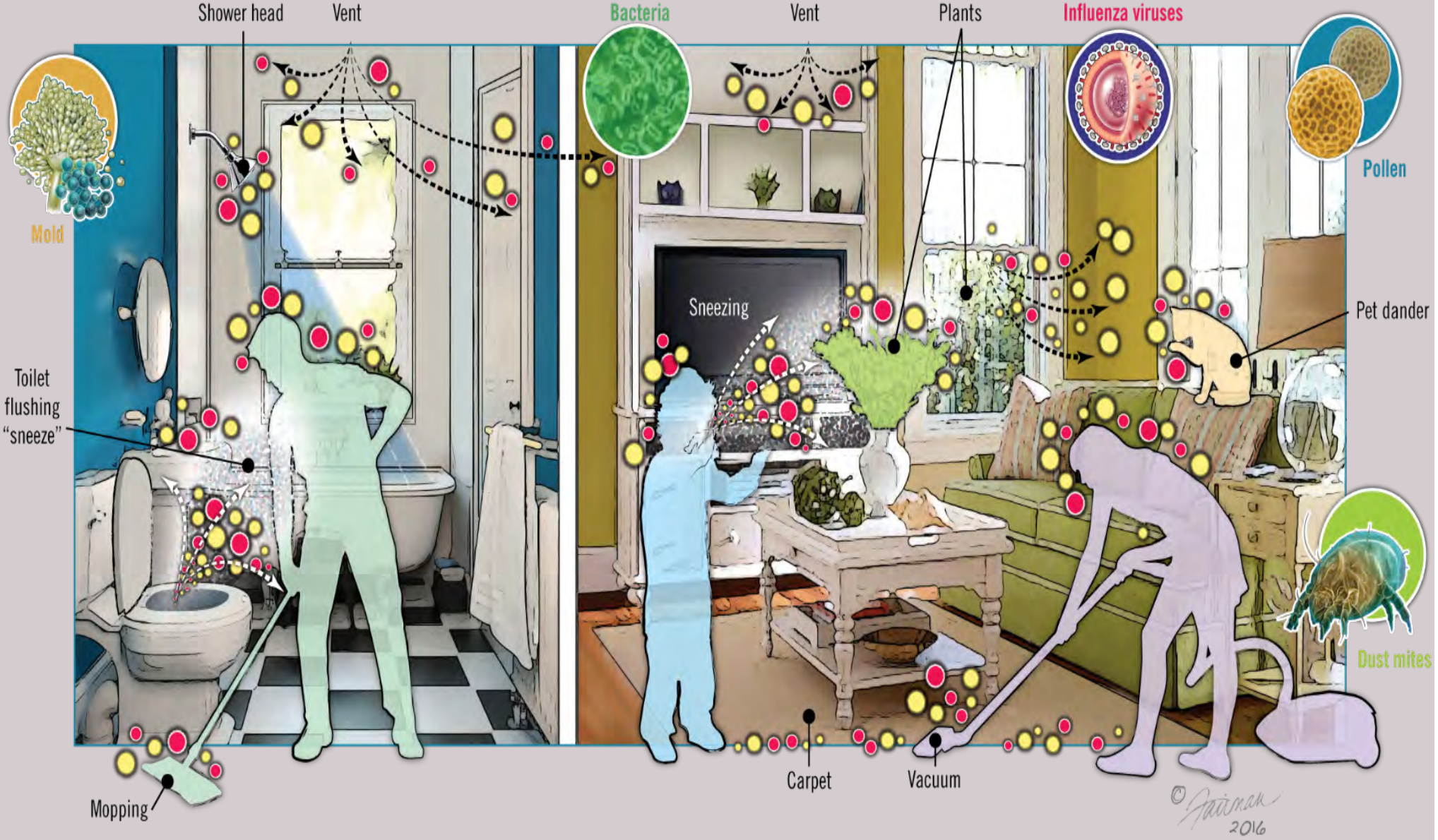
# AEROBIOLOGY & INDOOR AIR QUALITY

- 'AEROBIOLOGY' – STUDY OF LIVING ORGANISMS & THEIR PARTS IN AIR
  - INCLUDES MICROBIAL QUALITY OF INDOOR AIR
- INDOOR AIR IS AN ENVIRONMENTAL EQUALIZER!
- EXPOSURE TO 'INDOOR AIR' WITH CAVE-DWELLING ~200,000 YEARS AGO
- DOMESTICATED ANIMALS (CATTLE, DOGS & PIGS) FACILITATED RISE OF ZOONOSES INCLUDING AIRBORNE ONES (E.G., MEASLES)
- WE SPEND MORE TIME INDOORS & BREATHE ~11,000 L OF AIR/DAY
- WE ALL LEAVE OUR OWN PERSONAL MICROBIAL 'FOOT-PRINT' INDOORS
- BUT, LACK OF STANDARDIZED WAYS TO STUDY MICROBIAL AIR QUALITY
- ALSO, DEARTH OF MEANS TO ASSESS INDOOR AIR DECONTAMINATION

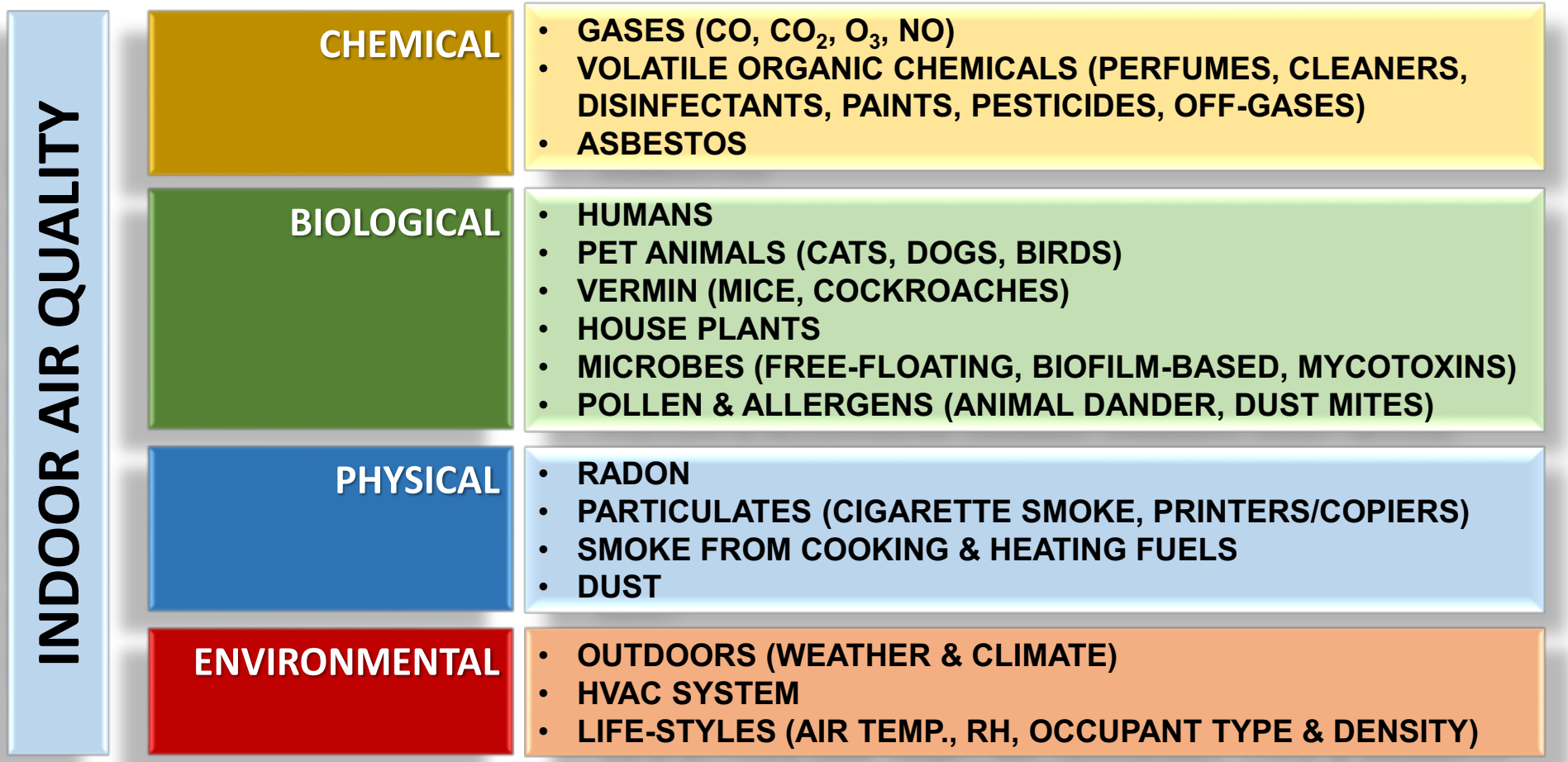
# COMPONENTS OF AEROBIOLOGY



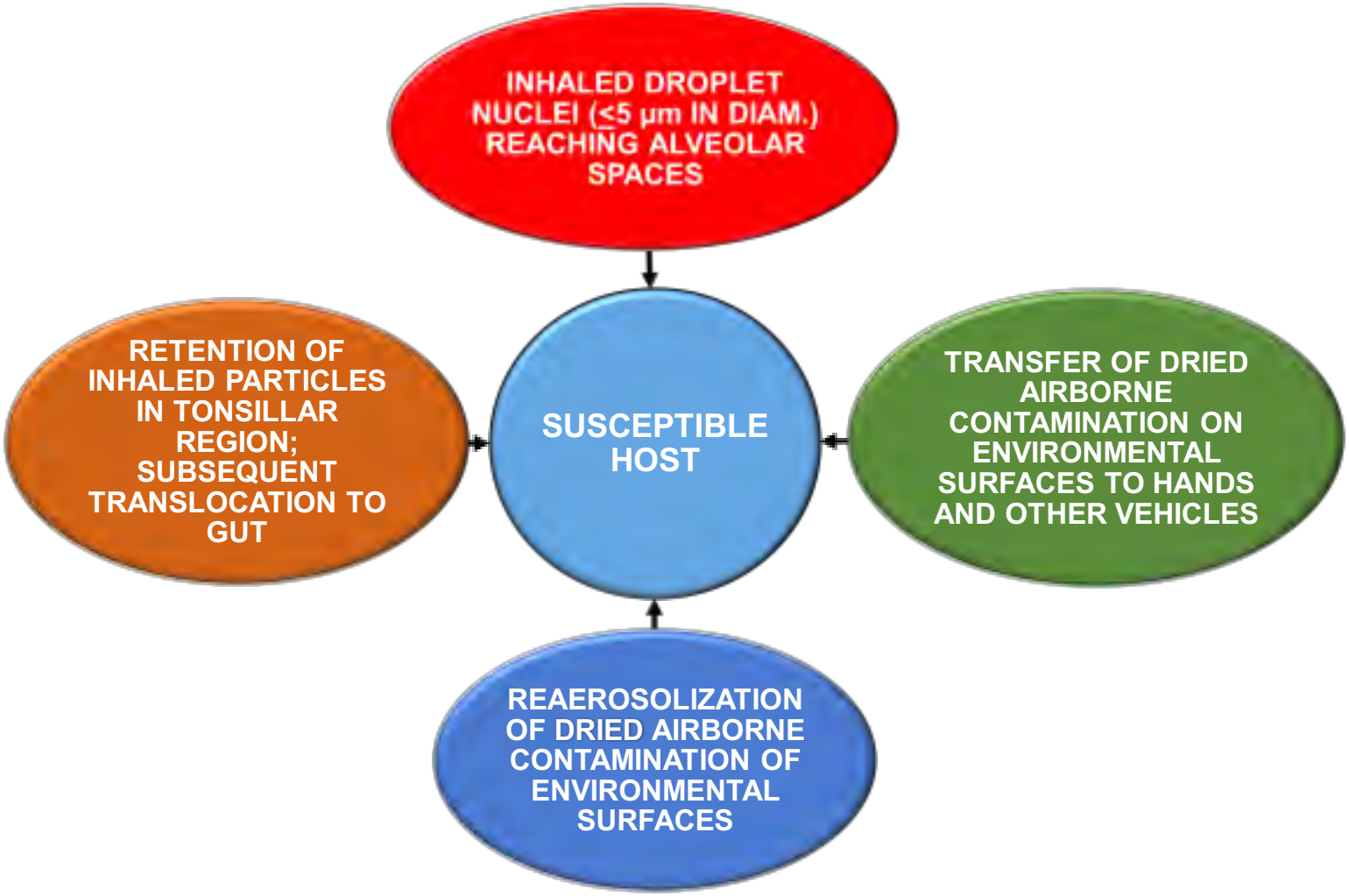
# SOURCES OF AIRBORNE PATHOGENS & ALLERGENS INDOORS (IJAZ ET AL., 2016)



# FACTORS AFFECTING INDOOR AIR QUALITY (SATTAR ET AL., 2016)



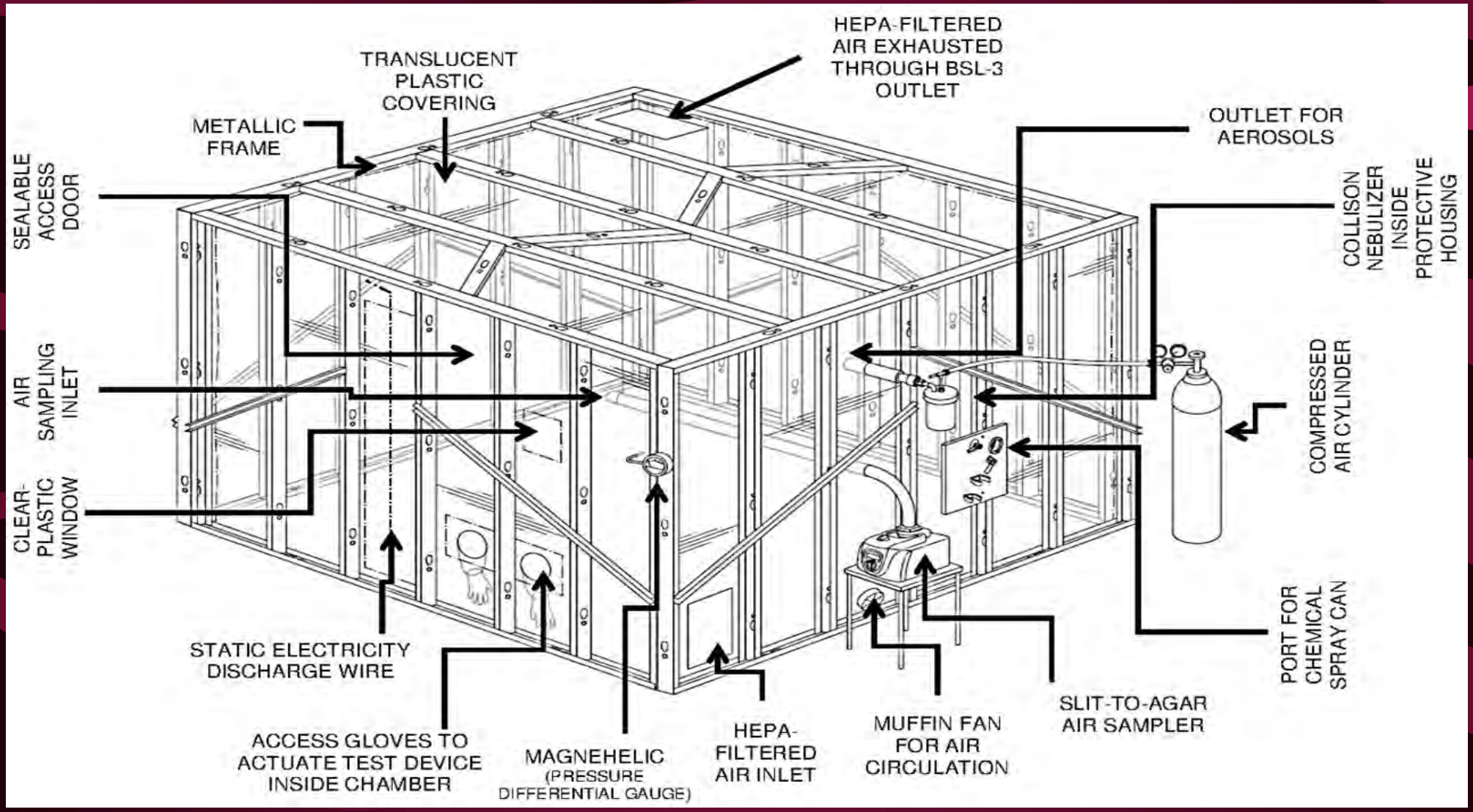
# AIRBORNE SPREAD OF HUMAN PATHOGENS (SATTAR ET AL., 2015)



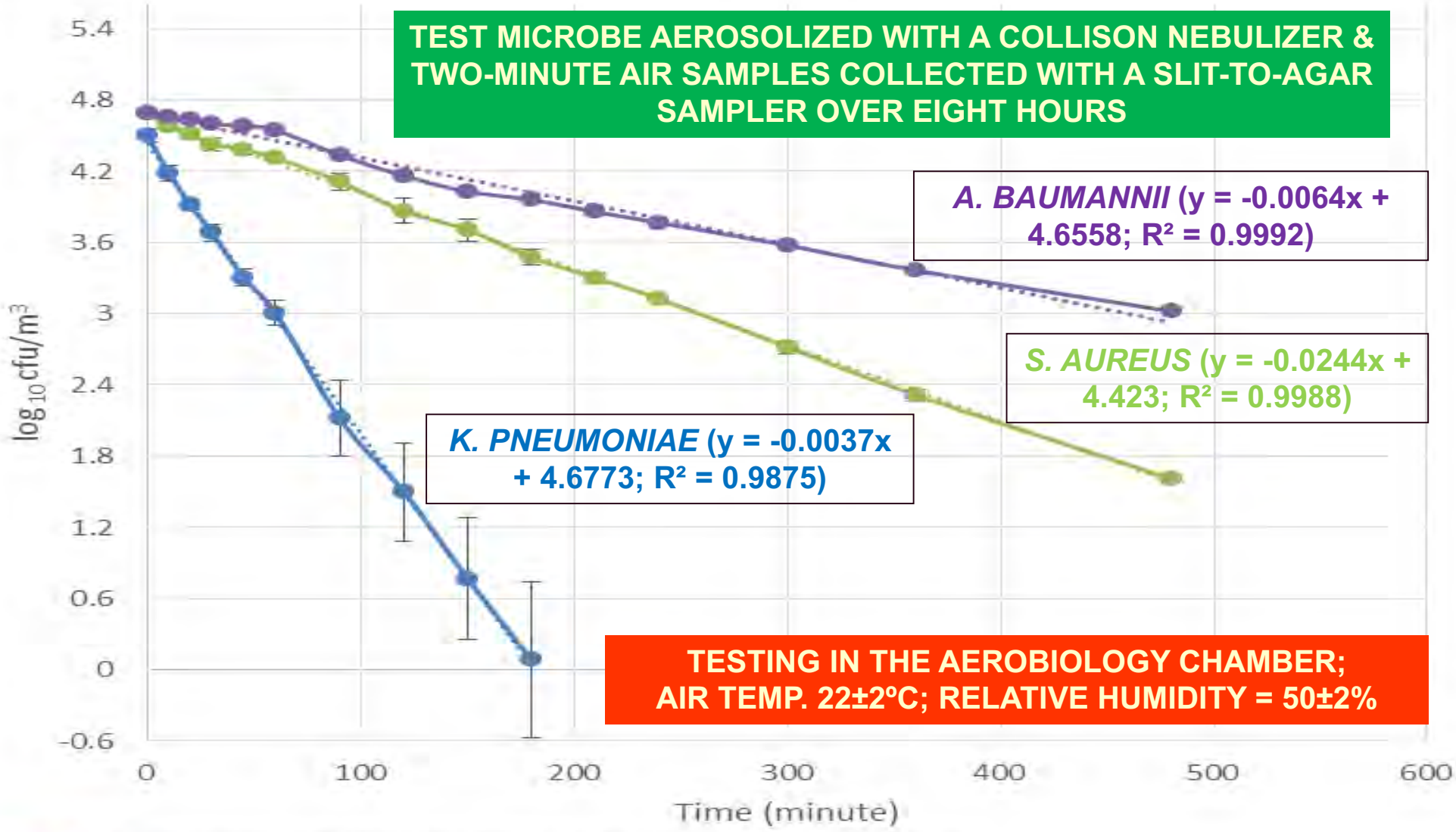
# CHALLENGES IN STUDYING AEROBIOLOGY OF PATHOGENS (SATTAR ET AL., 2016)

| FACTOR(S) | REFINEMENTS REQUIRED |
|---|---|
| EXPERIMENTAL SET-UP | SPACE, BIOSAFETY, FIELD-RELEVANCE, EASE OF CONTROL & MONITORING OF TEST PARAMETERS |
| CHALLENGE-MICROBE SELECTION | REPRESENTATIVE OF AIRBORNE PATHOGENS, EASE OF CULTURE & RECOVERY, STABILITY DURING AEROSOLIZATION & IN AIR, PREP, CONC., PROTECTION |
| SUSPENSION TO BE NEBULIZED | SAFE & STANDARDIZED SOIL LOAD REPRESENTING BODY FLUIDS, ANTI-FOAM, PHYSICAL TRACER (IF NEEDED) |
| NEBULIZATION & PARTICLE SIZE DISTRIBUTION | SAFETY FOR MICROBE, GENERATION OF AEROSOLS/DROPLET NUCLEI, GRANULOMETRICS, UNIFORM DISTRIBUTION |
| AGING & EXPOSURE CONDITIONS | BETTER CONTROL OF AIR TEMP. & RH; TESTING AT RH BELOW 20%; HARMONIZED FOR MAJOR MICROBIAL TYPES |
| AEROSOL COLLECTION & SIZING | PROTECTION OF VIABILITY, OPTIMAL GROWTH CONDITIONS, NEUTRALIZATION OF ACTIVES, |
| ASSESSING DECONTAMINATION | PROPER CONTROLS, REALISTIC EFFICACY CRITERIA FOR METHOD/DEVICE AIR-DECONTAMINATION TECHNOLOGIES, NUMBER OF REPEATS |
| INTERPRETATION OF DATA | STATISTICAL ANALYSES, FIELD RELEVANCE & REGULATORY REQUIREMENTS |

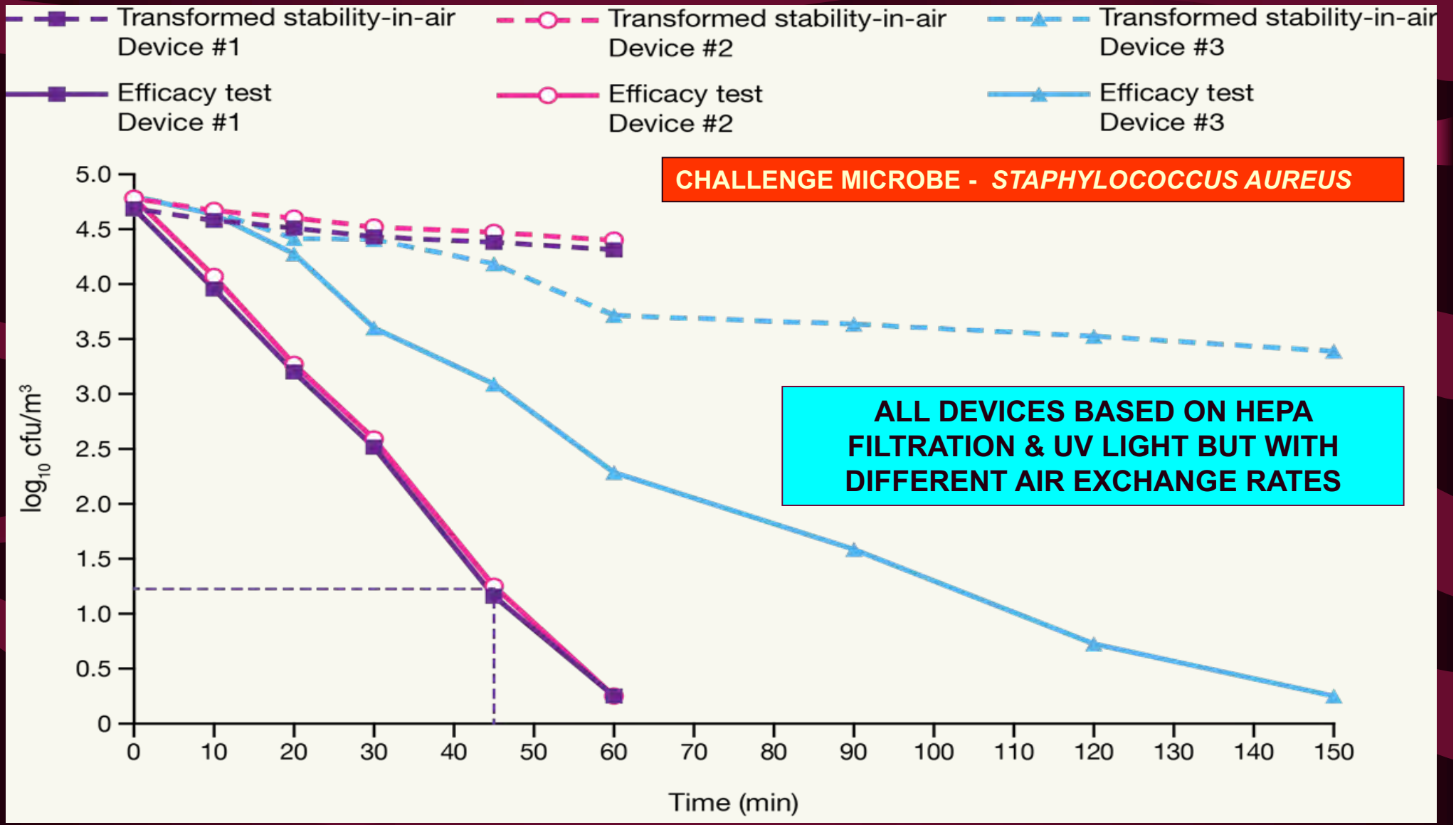
# AEROBIOLOGY CHAMBER TO STUDY MICROBIAL SURVIVAL & DECONTAMINATION IN INDOOR AIR (IJAZ ET AL., 2016)



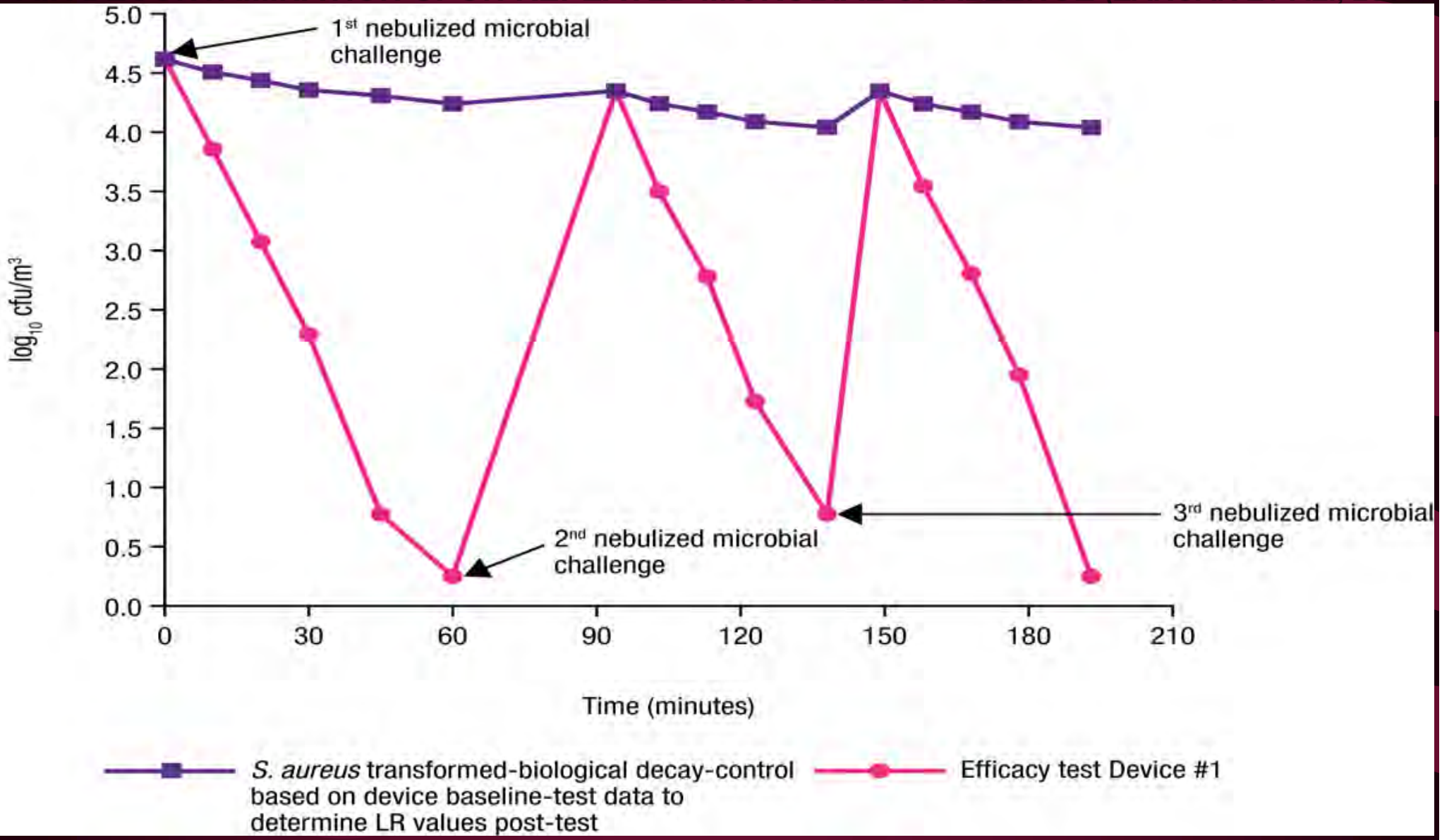
# SURVIVAL OF BACTERIAL PATHOGENS IN INDOOR AIR (IJAZ ET AL., 2016)



# TESTING PATHOGEN SURVIVAL & DECONTAMINATION (ZARGAR ET AL., 2016)



# AIR DECONTAMINATION UPON REPEATED MICROBIAL CHALLENGE (ZARGAR ET AL., 2016)



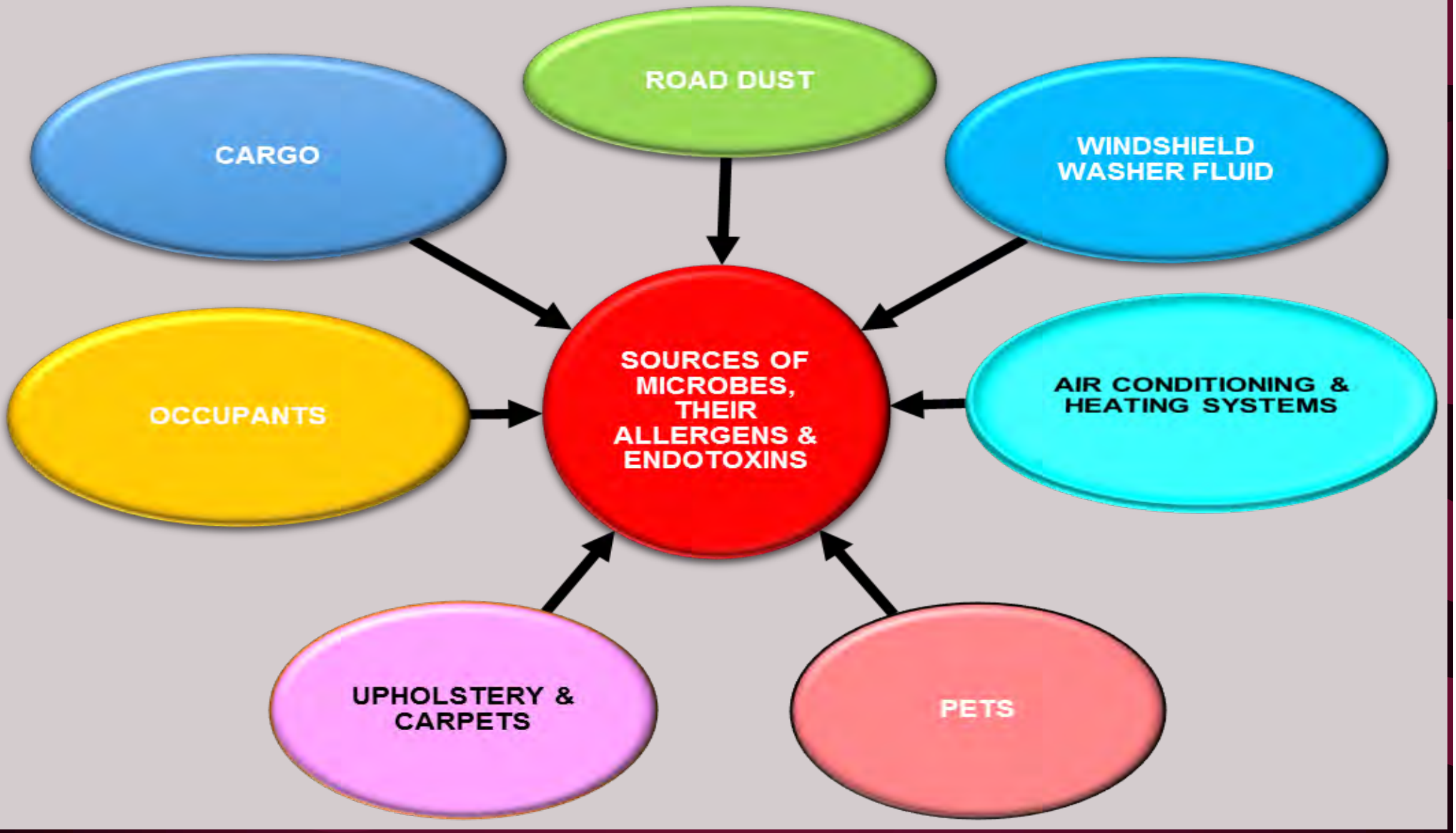
## DOES IN-CAR AIR POSE A RISK TO HUMAN HEALTH? (SATTAR ET AL., 2016)

- WORLD TOTAL OF PASSENGER CARS TO INCREASE FROM CURRENT ONE BILLION TO >2.5 BILLION BY 2050; FAMILY CARS REPRESENT ~74% OF WORLD'S YEARLY OUTPUT OF MOTORIZED VEHICLES
- ~80% OF N. AMERICAN COMMUTERS USE THEIR OWN CAR WITH ANOTHER 5.6% TRAVELLING AS PASSENGERS
- WITH A LIFE-EXPECTANCY OF ~79 YEARS, THE AVERAGE N. AMERICAN SPENDS 4.3 YEARS DRIVING A CAR!
- THIS EQUATES TO DRIVING ~100 MINUTES/DAY WITH A LIFE-TIME DRIVING DISTANCE OF NEARLY 1.3 MILLION KM INSIDE THE CONFINED & OFTEN SHARED SPACE OF THE CAR
- EXPOSURE TO A MIX OF POTENTIALLY HARMFUL POLLUTANTS

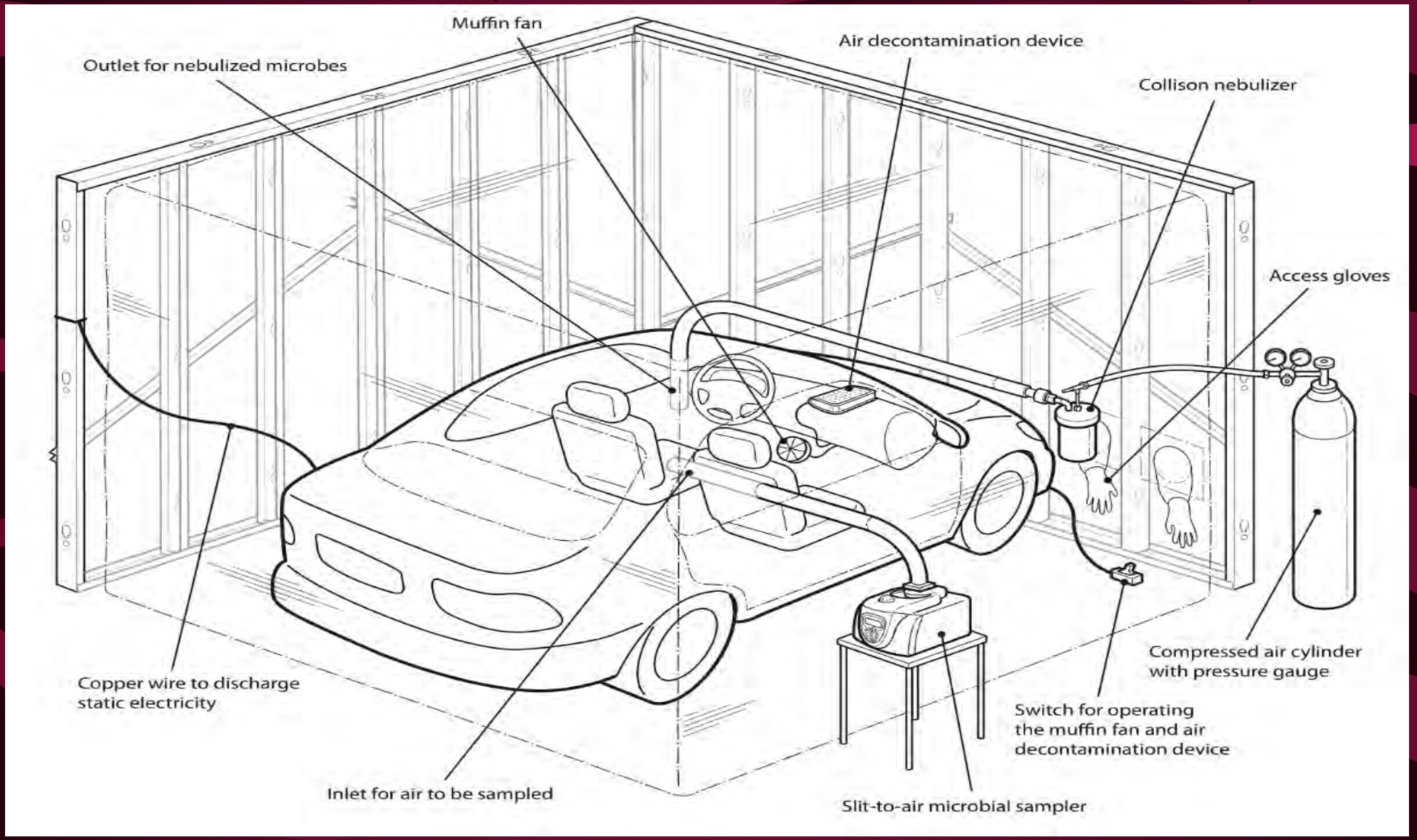
# RISK FACTORS FOR IN-CAR SPREAD OF PATHOGENS (SATTAR ET AL., 2016)

| FACTORS | IMPACT |
|---|---|
| LENGTH OF COMMUTE | RISK OF EXPOSURE TO HARMFUL AIRBORNE CONTAMINANTS INCREASES IN DIRECT PROPORTION TO LENGTH & FREQUENCY OF COMMUTE |
| CAR-POOLING | RISK OF EXPOSURE TO HARMFUL AIRBORNE CONTAMINANTS INCREASES IN DIRECT PROPORTION TO THE NUMBER OF OCCUPANTS |
| IMMUNOSUPPRESSION | INCREASING PROPORTION OF THE IMMUNOSUPPRESSED IN SOCIETY |
| POTENTIAL HOSTS | WIDE VARIATION IN THE AGE & GENERAL HEALTH STATUS OF OCCUPANTS |
| STRESS OF DRIVING | STRESS OF DRIVING MAY LOWER BODY'S GENERAL RESISTANCE MECHANISMS |
| RESPIRABLE PARTICLES (E.G., PM 2.5) | INHALATION OF SUCH PARTICULATES MAY ENHANCE EXPOSURE & SUSCEPTIBILITY TO INFECTIOUS AGENTS |
| VOLATILE ORGANIC CHEMICALS (VOCs) | EXPOSURE TO VOCs MAY OCCUR SIMULTANEOUSLY WITH INHALATION OF RESPIRABLE PARTICULATES & MICROBES WITH POTENTIAL NEGATIVE ADDITIVE EFFECTS ON HEALTH |

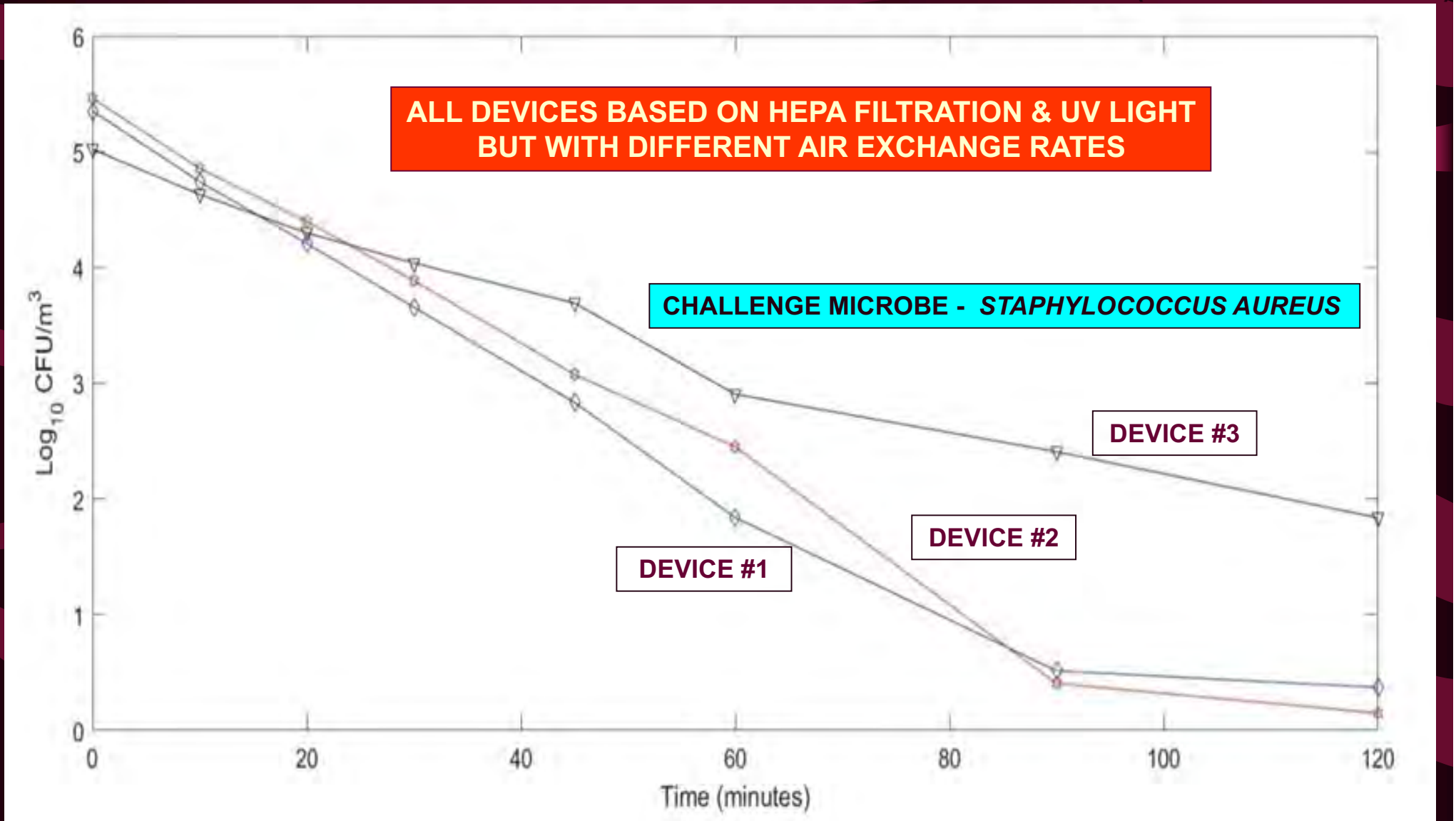
# SOURCES OF MICROBES, ALLERGENS & ENDOTOXINS IN IN-CAR AIR (SATTAR ET AL, 2016)



# CAR CHAMBER (SATTAR ET AL., APPL. ENVIRON. MICROBIOL., 2017)



# TESTING OF THREE IN-CAR AIR DECONTAMINATION DEVICES (SATTAR ET AL., 2017)



# SUMMARY OF THE MAIN FINDINGS

- PATHOGENS INDOORS COME FROM HUMANS, PETS, PLANTS, PLUMBING, TOILETS, SHOWERHEAD, HEATING/COOLING/VENTILATION SYSTEMS
- VACUUMING/MOPPING/DUSTING RESUSPEND SETTLED DUST
- *A. BAUMANNII* MORE STABLE THAN *K. PNEUMONIAE* IN AIR; POTENTIALLY A BETTER SURROGATE FOR GRAM-NEGATIVES
- DEVICES #1 & #2 REDUCED TEST MICROBES BY $\geq$3-LOG$_{10}$ IN ~45 MINUTES
- DEVICE #1 REMAINED EFFECTIVE AFTER 3 MICROBIAL CHALLENGES
- TESTING OF PATHOGEN SURVIVAL & DECONTAMINATION IN IN-CAR AIR
- AEROBIOLOGY PROTOCOL APPROVED BY U.S. EPA!
- TREATING INDOOR AIR TO PREVENT ENVIRON. SURFACE CONTAMINATION

## FUTURE DIRECTIONS FOR R&D

- STUDY OF AEROBIOLOGY OF HUMAN PATHOGENS IS IN ITS INFANCY!
- STANDARDIZED TEST FACILITIES, PROTOCOLS & GUIDELINES NEEDED
- EFFICIENT WAYS TO DETECT LOW LEVELS OF AIRBORNE PATHOGENS
- BETTER FIELD INVESTIGATIONS WITH UNEQUIVOCAL RESULTS
- MORE INFORMATION ON HEALTH IMPACT OF VARIOUS LEVELS OF RH/TEMP. ON HUMANS & THEIR SUSCEPTIBILITY TO AIRBORNE PATHOGENS
- COMBINED HEALTH IMPACT OF AIRBORNE POLLUTANTS
- RELEVANCE OF DATA FROM MOLECULAR STUDIES TO ASSESS RISKS?
- BETTER & LONGER-TERM RESEARCH FUNDING

# FURTHER READING


- Ijaz MK, Zargar B, Wright KE, Rubino JR, Sattar SA (2016). Generic Aspects of the Airborne Spread of Human Pathogens Indoors and Emerging Air Decontamination Technologies. Am J Infect Control. 44(9 Suppl):S109-120.
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"CLEAN AIR IS A BASIC REQUIREMENT OF LIFE. THE QUALITY OF AIR INSIDE HOMES, OFFICES, SCHOOLS, DAY CARE CENTRES, PUBLIC BUILDINGS, HEALTH CARE FACILITIES OR OTHER PRIVATE AND PUBLIC BUILDINGS WHERE PEOPLE SPEND A LARGE PART OF THEIR LIFE IS AN ESSENTIAL DETERMINANT OF HEALTHY LIFE AND PEOPLE'S WELL-BEING. ……..." - WHO, 2010

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| | |
|---|---|
| May 30, 2017 | *(European Teleclass)*<br>**THE GOOD THE BAD AND THE UGLY METHODS FOR BEDPAN MANAGEMENT**<br>Speaker: **Gertie van Knippenberg-Gordebeke**, International Consultant Infection Prevention, The Netherlands<br><br>*Sponsored by CleanIs (www.cleanis.com)* |
| June 1, 2017 | **USING UNOFFICIAL SOURCES TO MONITOR OUTBREAKS OF EMERGING INFECTIOUS DISEASES: LESSONS FROM PROMED**<br>Speaker: **Prof. Lawrence Madoff**, Harvard University Medical School, Editor of ProMED Mail |
| June 7, 2017 | *(South Pacific Teleclass)*<br>**THE IMPACT OF CATHETER ASSOCIATED URINARY TRACT INFECTION**<br>Speaker: **Prof. Brett Mitchell**, Avondale College of Higher Education, Australia |
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