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ENVIRONMENTAL FATE, TRANSMISSION AND CONTROL OF HUMAN PATHOGENS INDOORS: RELEVANCE TO BIOSAFETY AND BIOSECURITY

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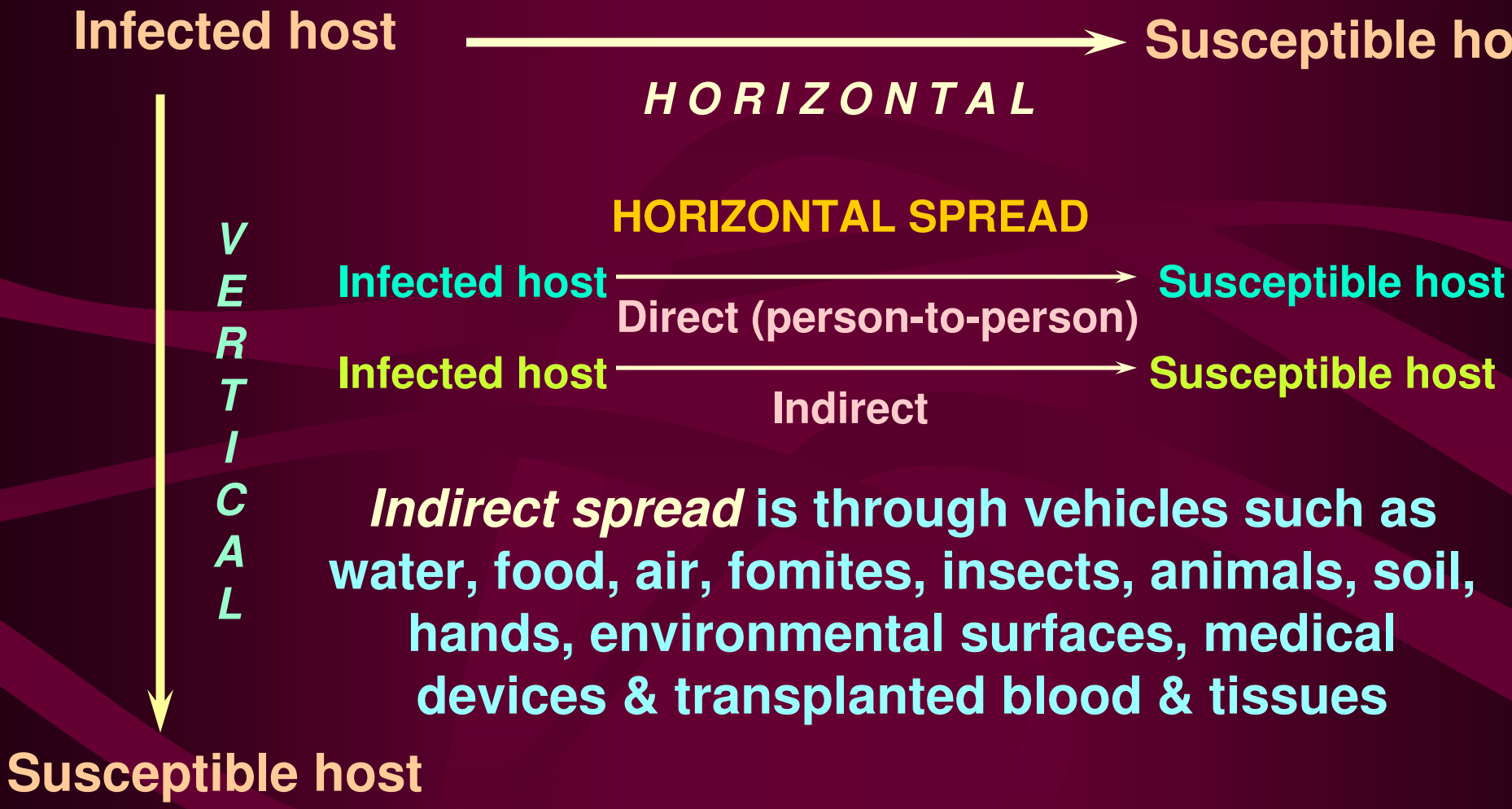
KNOWN SPECIES OF HUMAN PATHOGENS

(TAYLOR *ET AL.*, PHIL. TRANS. R. SOC. LOND. B. 2001; 356:983-989)

- A COMPREHENSIVE LITERATURE-BASED INVENTORY OF HUMAN PATHOGENS
- 61% (868/1415) ARE ZOONOTIC
- 175 SPECIES ARE CONSIDERED EMERGING; 75% (132/175) OF THESE ARE ZOONOTIC
- THE ROUTE(S) OF SPREAD OF >200 HUMAN PATHOGENS REMAINS UNKNOWN!!

BACTERIA	538
VIRUSES & PRIONS	217
FUNGI	307
PROTOZOA	66
HELMINTHS	287
TOTAL	1,415

MODES & MEANS OF PATHOGEN SPREAD IN NATURE

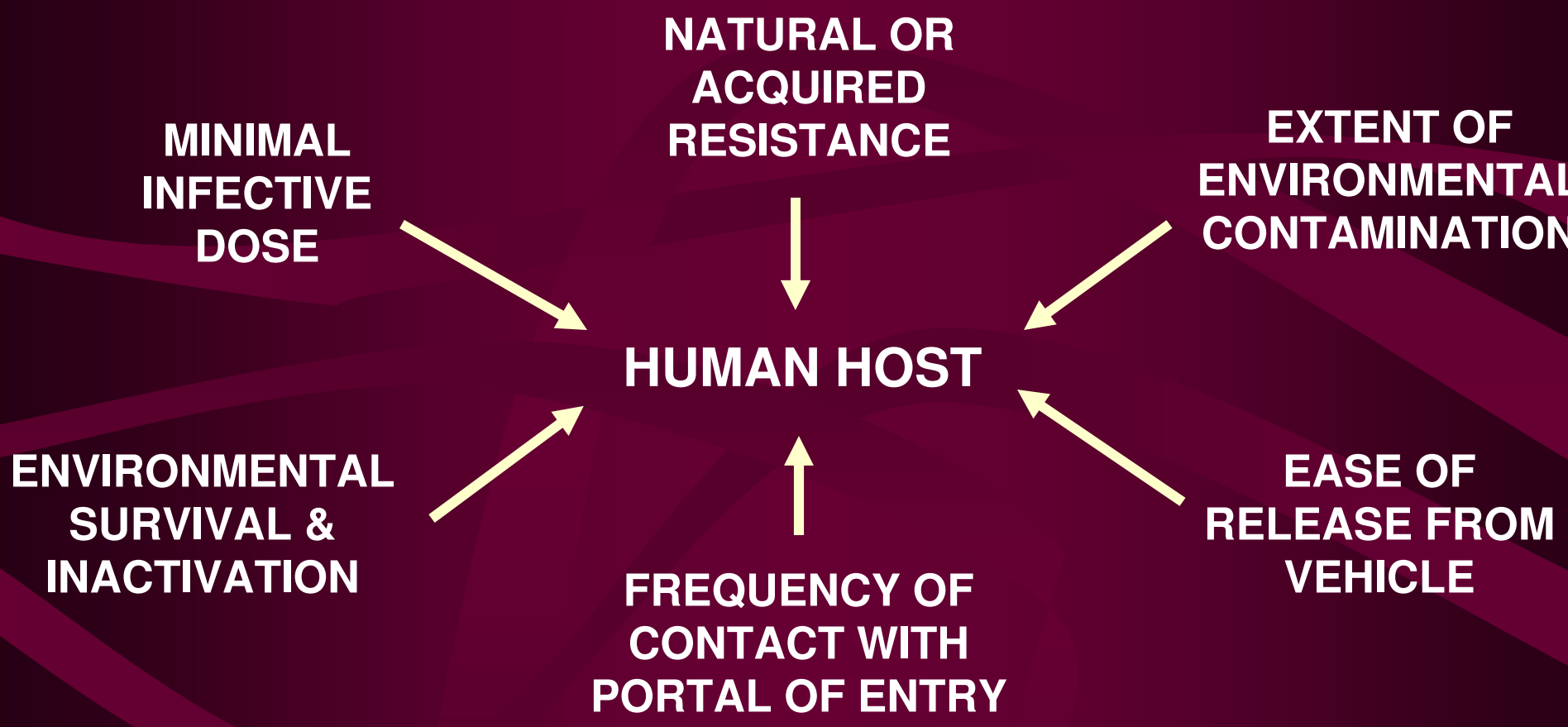


Indirect spread **is through vehicles such as water, food, air, fomites, insects, animals, soil, hands, environmental surfaces, medical devices & transplanted blood & tissues**

PATHOGENS IN THE ENVIRONMENT

- 'FRANK PATHOGENS' GET INTO THE ENVIRONMENT FROM SYMPTOMATIC & NON-SYMPTOMATIC HOSTS OR BY ACCIDENTAL/DELIBERATE RELEASE
- 'ENVIRONMENTAL PATHOGENS' *LIVE* IN THE ENVIRONMENT BUT CAN INFECT HUMANS; MOSTLY OPPORTUNISTIC PATHOGENS (PERIKAIROTS)
- PERIKAIROTS OFTEN CAUSE NO SECONDARY CASES

FACTORS GOVERNING ENVIRONMENTAL SPREAD OF PATHOGENS



HIERARCHY OF DISINFECTANT RESISTANCE OF SOME RELEVANT PATHOGENS

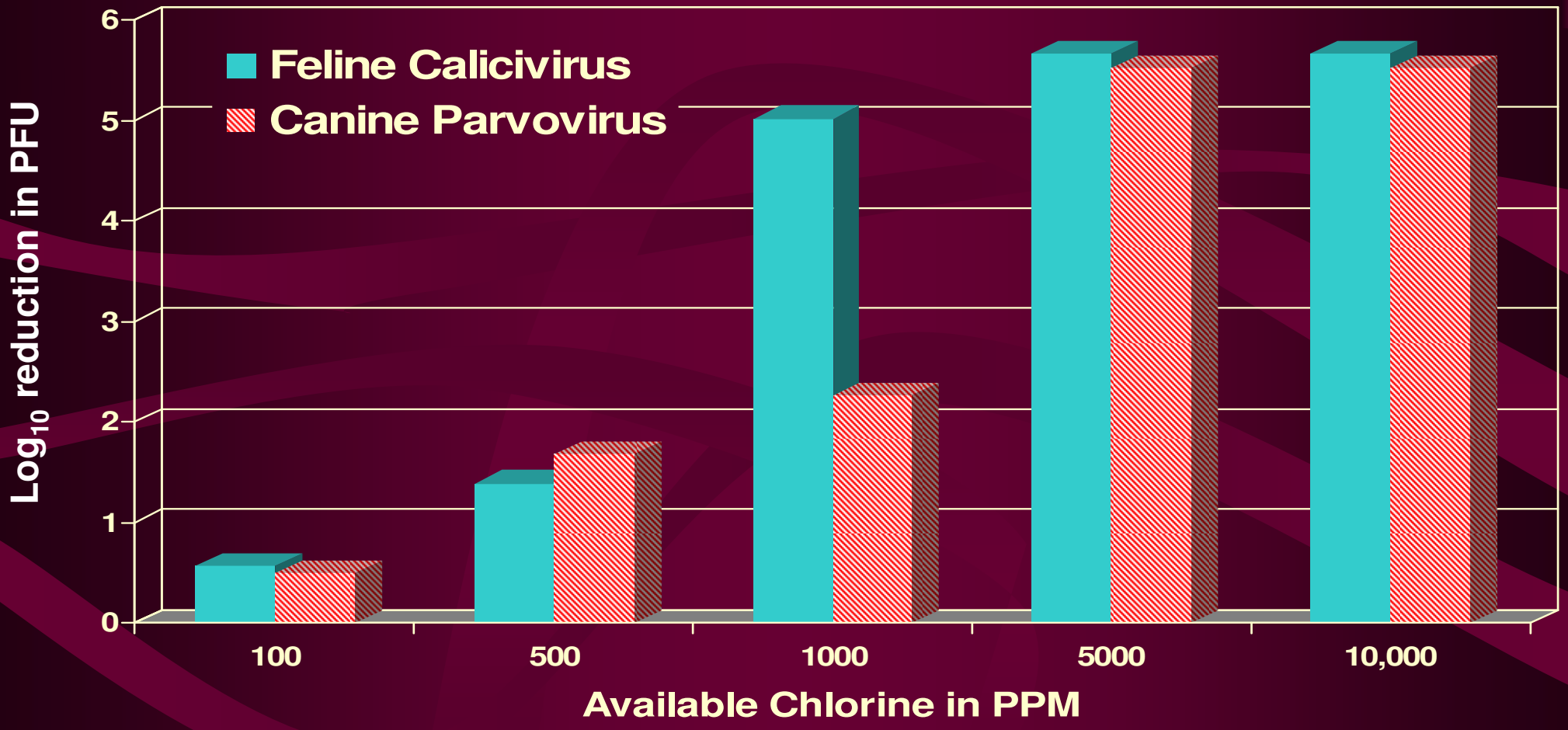
DECREASING LEVEL OF RESISTANCE	EXAMPLES OF KNOWN OR POTENTIAL BIOAGENTS	LEVEL OF DISINFECTANT & CONTACT TIME REQUIRED
BACTERIAL SPORES	*BACILLUS ANTHRACIS*	SPORICIDAL WITH CONTACT OF MINUTES TO HOURS
NON-ENVELOPED VIRUSES	NORO, HEPATITIS A, POLIO	HIGH TO INTERMEDIATE WITH CONTACT OF 1-10 MINUTES
MYCOBACTERIA	*MYCOBACTERIUM TUBERCULOSIS*	HIGH TO INTERMEDIATE WITH CONTACT OF 1-10 MINUTES
VEGETATIVE BACTERIA	*YERSINIA PESTIS, FRANCISELLA TULARENSIS*	LOW WITH CONTACT OF 1-10 MINUTES
ENVELOPED VIRUSES	INFLUENZA, HEMORRHAGIC FEVERS	LOW WITH CONTACT OF 1-10 MINUTES

QUANTITATIVE CARRIER TEST (QCT) WITH METAL DISKS AND TEFLON VIALS AS CARRIER HOLDERS

- BASIC METHOD
  - DISK OF MAGNETIZED & BRUSHED STAINLESS STEEL WITH 10 µL OF INOCULUM
  - TEFLON VIAL HOLDING DISK WITH DRIED INOCULUM
  - 50 µL OF TEST FORMULATION COVERING THE DISK SURFACE
- SUITABLE FOR TESTING LIQUID, SPRAY & GASEOUS CHEMICALS AGAINST ALL MAJOR CLASSES OF HUMAN & ANIMAL PATHOGENS
- STANDARDS OF ASTM INTERNATIONAL
- HEALTH CANADA ACCEPTS DATA BASED ON QCT
- POTENTIAL STANDARD OF OECD

VIRUCIDAL ACTIVITY OF DOMESTIC BLEACH
(SATTAR ET AL., UNPUBLISHED DATA)

(QCT-2 WITH SOIL LOAD, 400 PPM HARD WATER & CONTACT TIME OF 5 MINUTES AT 23°C)



DISINFECTANTS TESTED AS SPORICIDES

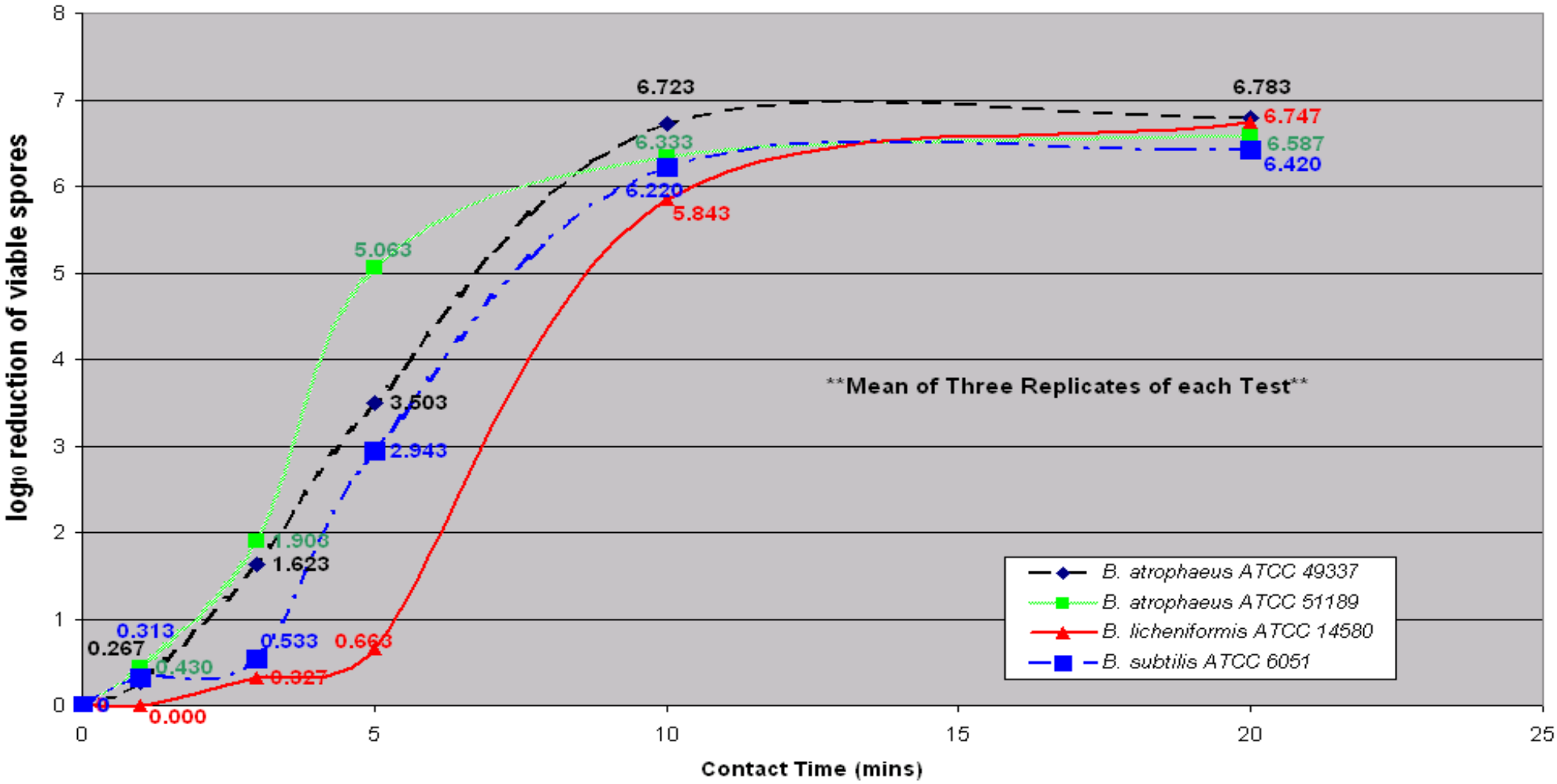
(MAJCHER, M.Sc. THESIS, UNIV. OF MANITOBA, 2007)

- TEN-FOLD DILUTION OF DOMESTIC CHLORINE BLEACH (~5,000 PPM AS FREE AVAILABLE CHLORINE)
- 7% ACCELERATED HYDROGEN PEROXIDE (70,000 PPM)
- 2.6% ACTIVATED GLUTARALDEHYDE (26,000 PPM)
- 0.1% LIQUID CHLORINE DIOXIDE (1000 PPM)
- 0.3% PERACETIC ACID (3,000 PPM)
- WATER WITH 400 PPM $CaCO_3$ USED TO DILUTE FORMULATIONS REQUIRING DILUTION FOR TESTING
- ALL SPORE SUSPENSIONS CONTAINED A SOIL LOAD

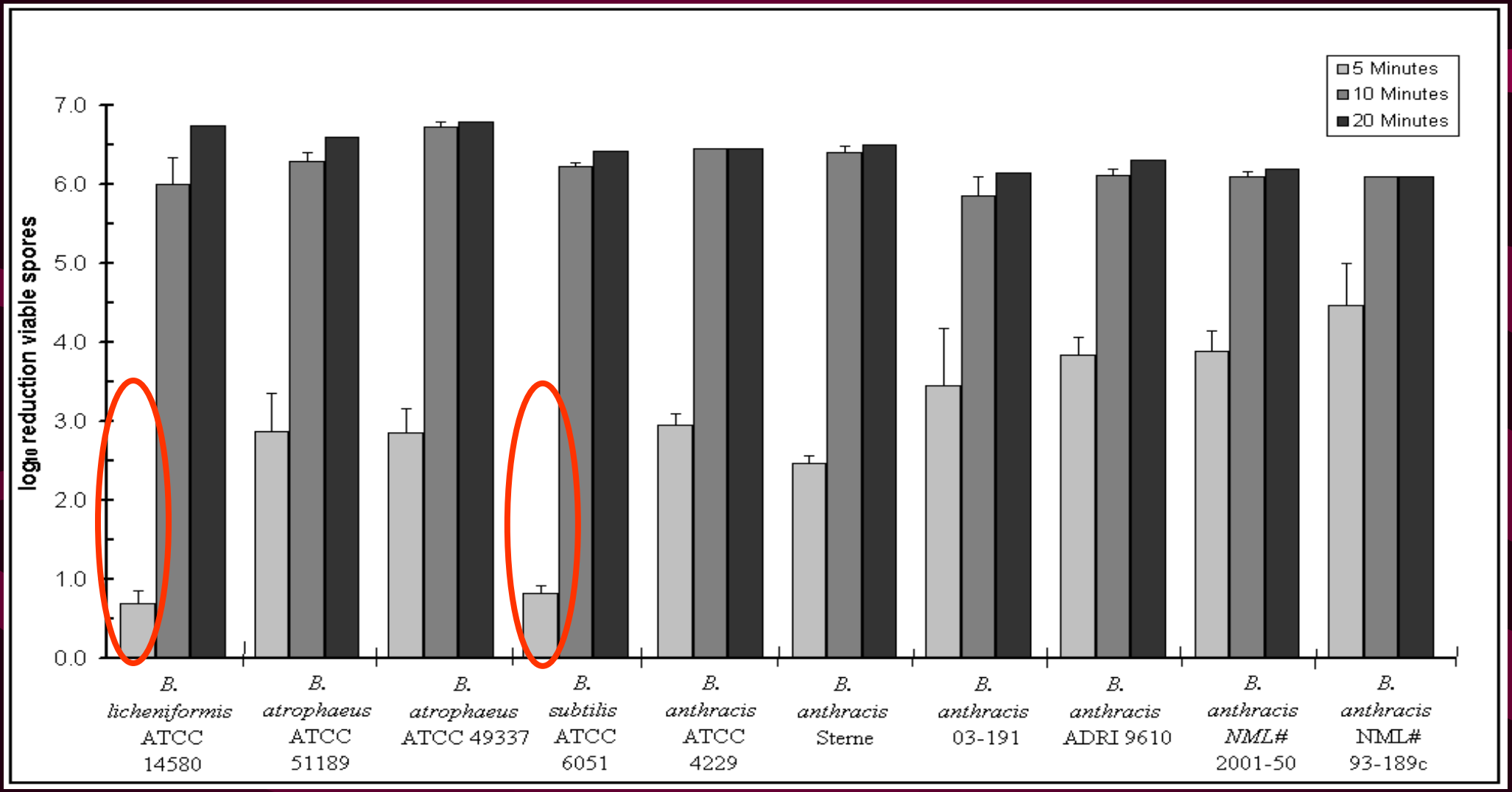
SPORE-FORMERS TESTED IN A STUDY ON POTENTIAL SURROGATES FOR *B. ANTHRACIS* (MAJCHER, M.Sc. THESIS, UNIV. OF MANITOBA, 2007)

SPORE FORMERS TESTED	NUMBER OF SPECIES/ISOLATES
BACILLUS (NON-ANTHRAX)	13
BACILLUS ANTHRACIS	6
BREVIBACILLUS	1
PAENIBACILLUS	2
VIRGIBACILLUS	1

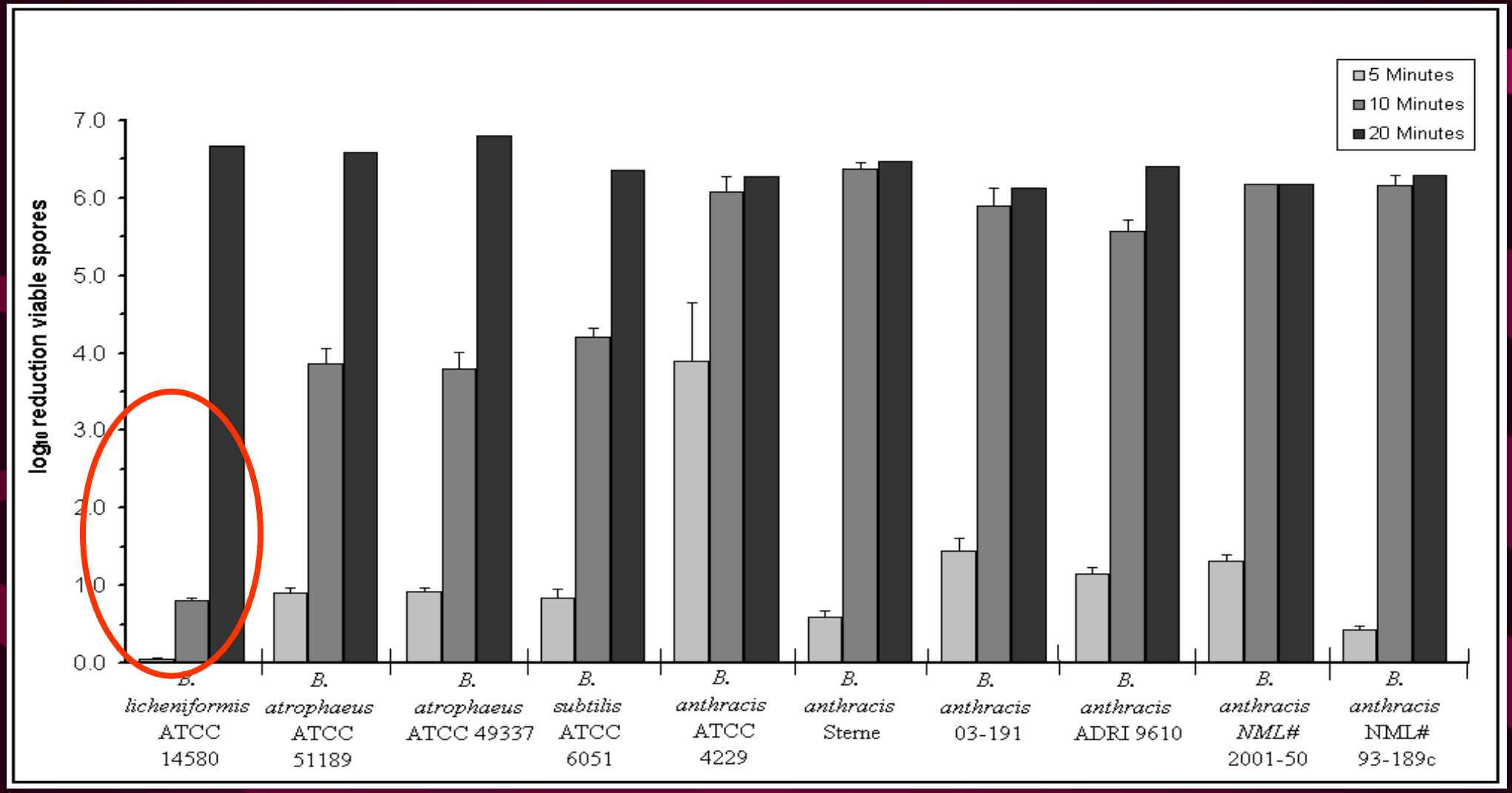
QCT-2 TO TEST THE EFFECT OF CONTACT TIME ON THE ACTIVITY OF DILUTED BLEACH (5,000 PPM FAC) AGAINST THE SPORES OF FOUR SPECIES OF *BACILLUS* (MAJCHER, M.Sc. THESIS, UNIV. OF MANITOBA, 2007)



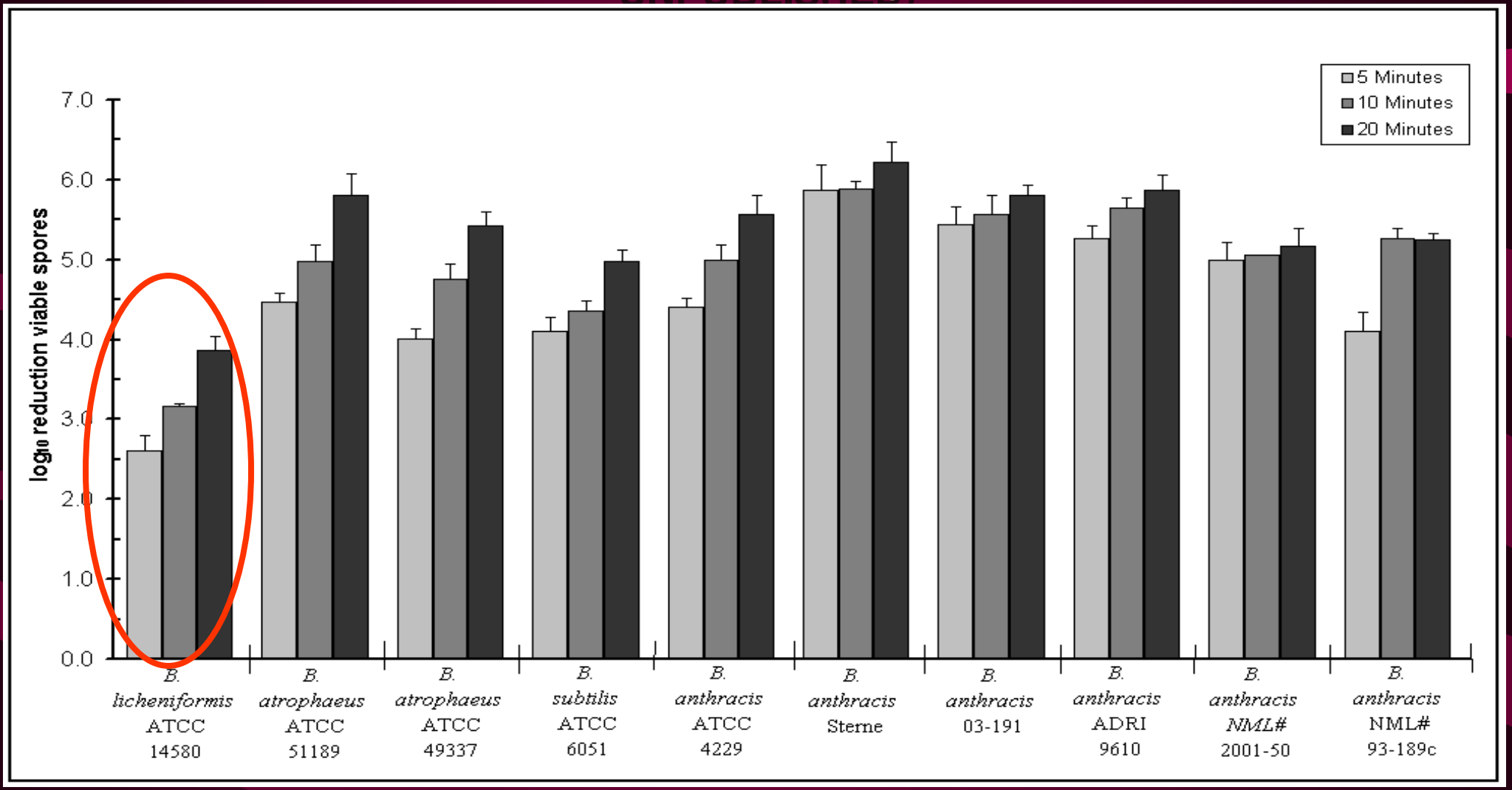
ACTIVITY OF DILUTED BLEACH (5,000 PPM FAC) AGAINST THE SPORES OF *BACILLUS* SPECIES (MAJCHER ET AL., UNPUBLISHED)



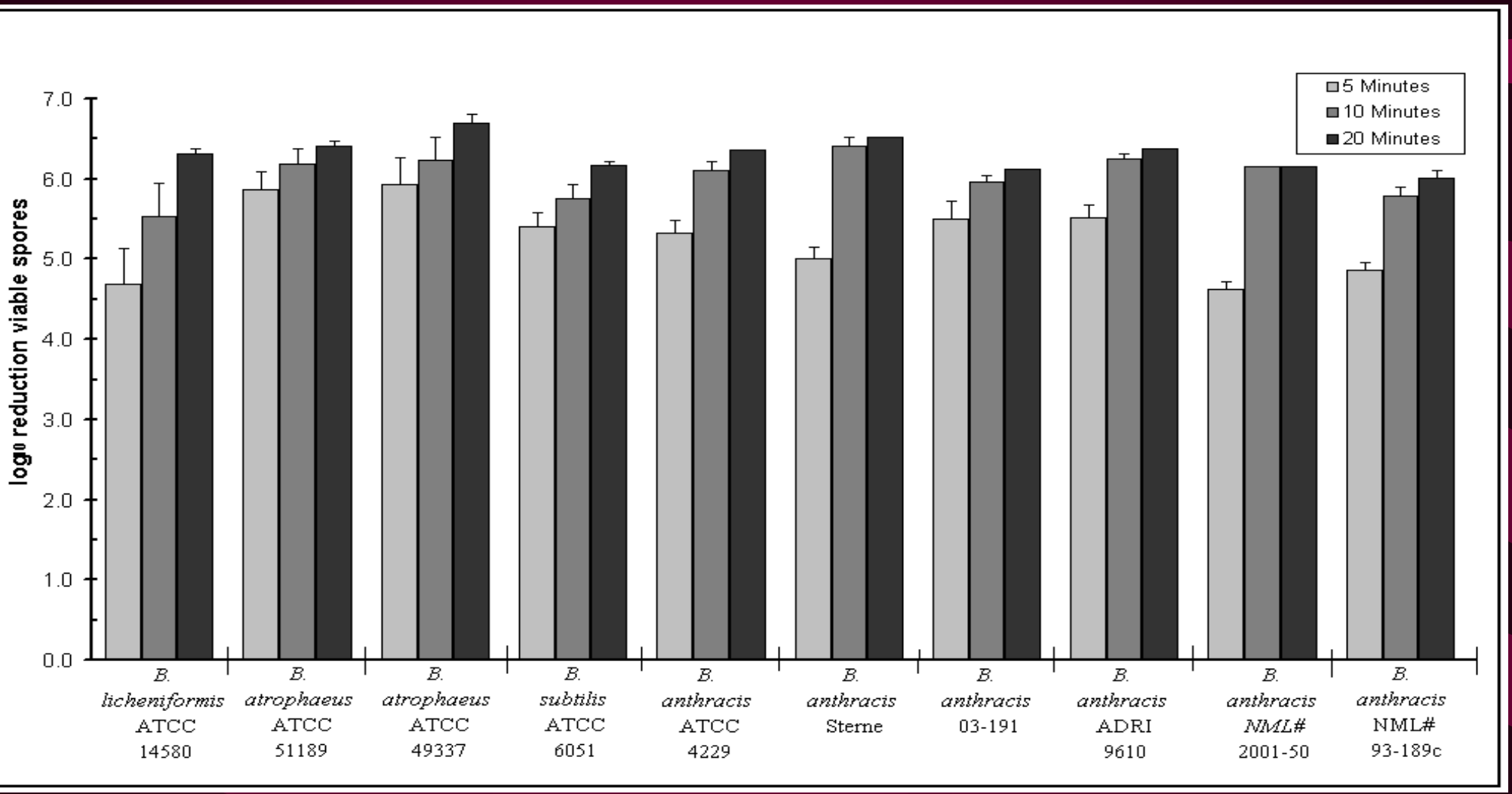
ACTIVITY OF ACCELERATED H_2O_2 (70,000 PPM) AGAINST THE SPORES OF *BACILLUS* SPECIES (MAJCHER ET AL., UNPUBLISHED)



ACTIVITY OF LIQUID CHLORINE DIOXIDE (1,000 PPM) AGAINST THE SPORES OF *BACILLUS* SPECIES (MAJCHER ET AL., UNPUBLISHED)



ACTIVITY OF PERACETIC ACID (3,000 PPM) AGAINST THE SPORES OF *BACILLUS* SPECIES (MAJCHER ET AL., UNPUBLISHED)



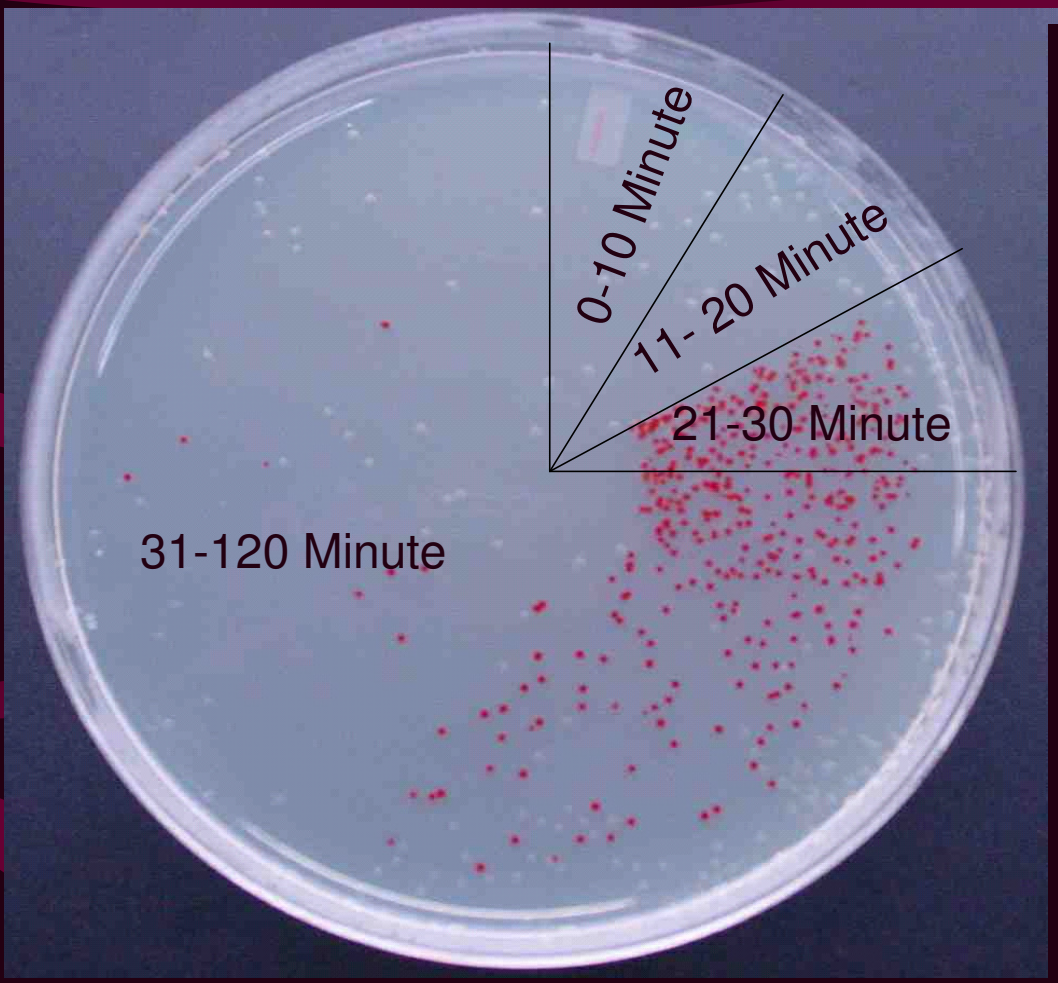
SUMMARY STATEMENTS ON SURROGATES

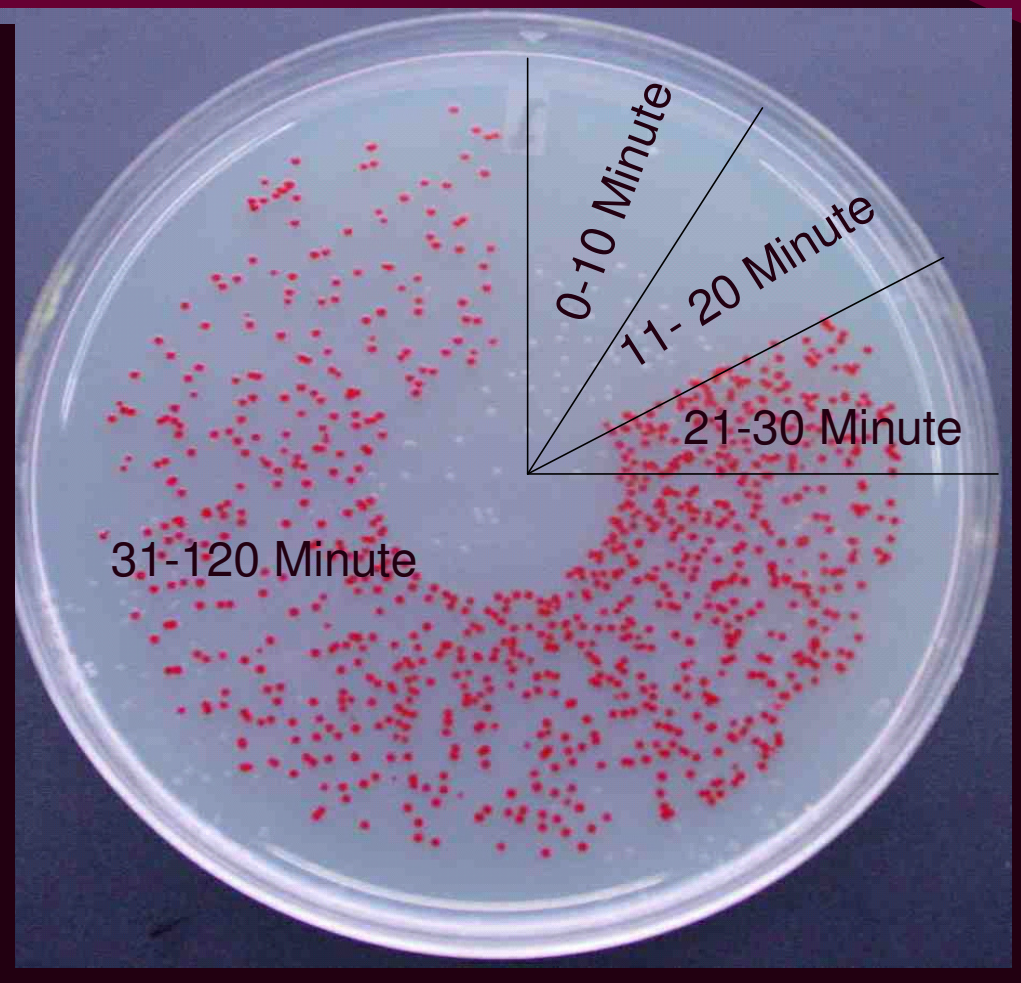
- *B. LICHENIFORMIS* (ATCC 14580) AND *B. SUBTILIS* (ATCC 6051) WERE GENERALLY MORE RESISTANT TO THE FOUR CHEMICALS TESTED
- RECOMMENDED THAT THE SPORES OF ONE OR BOTH OF THEM BE CONSIDERED AS SUITABLE SURROGATES TO EVALUATE LIQUID CHEMICAL SPORICIDES FOR THEIR ACTIVITY AGAINST THE SPORES OF *B. ANTHRACIS*
- BOTH ORGANISMS ARE SAFE AND EASY TO WORK WITH

UV LIGHT & HEPA TO DECONTAMINATE AIR

- EVALUATED A COMMERCIALLY-AVAILABLE, FREE-STANDING UV LIGHT GENERATOR TO DECONTAMINATE AIR
- ENCLOSURE WITH PLASTIC SHEETING (33 CUBIC METERS)
- SPORES OF *GEOBACILLUS STEAROTHERMOPHILUS* AND BACTERIOPHAGE MS-2 SPRAYED USING A COLLISON NEBULIZER
- AIR WITHOUT & WITH UV EXPOSURE WAS SAMPLED USING A SLIT SAMPLER
- PLATES INCUBATED; CFU AND PFU OBSERVED

UV LIGHT FOR INACTIVATION OF *GEOBACILLUS STEAROTHERMOPHILUS* SPORES IN AIR: LOW-LEVEL CHALLENGE (SATTAR ET AL, UNPUBLISHED)

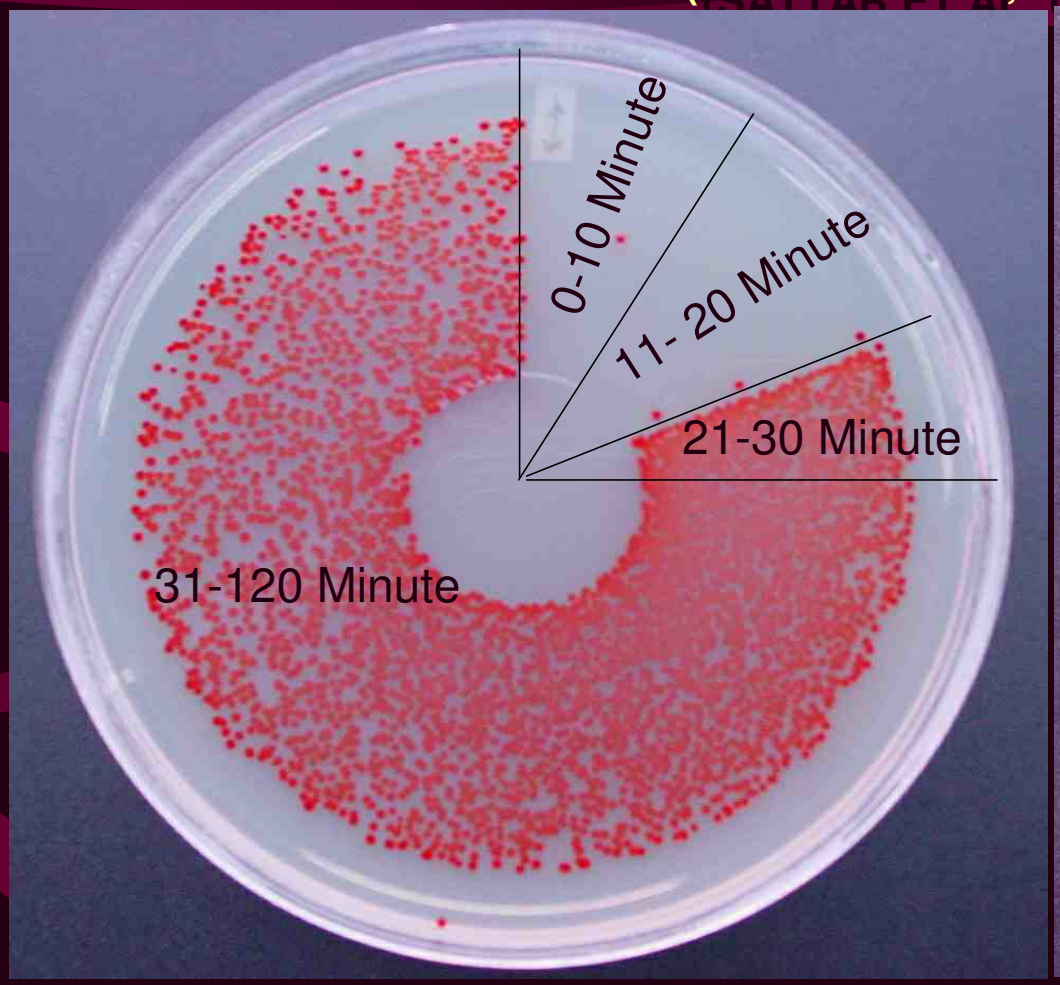


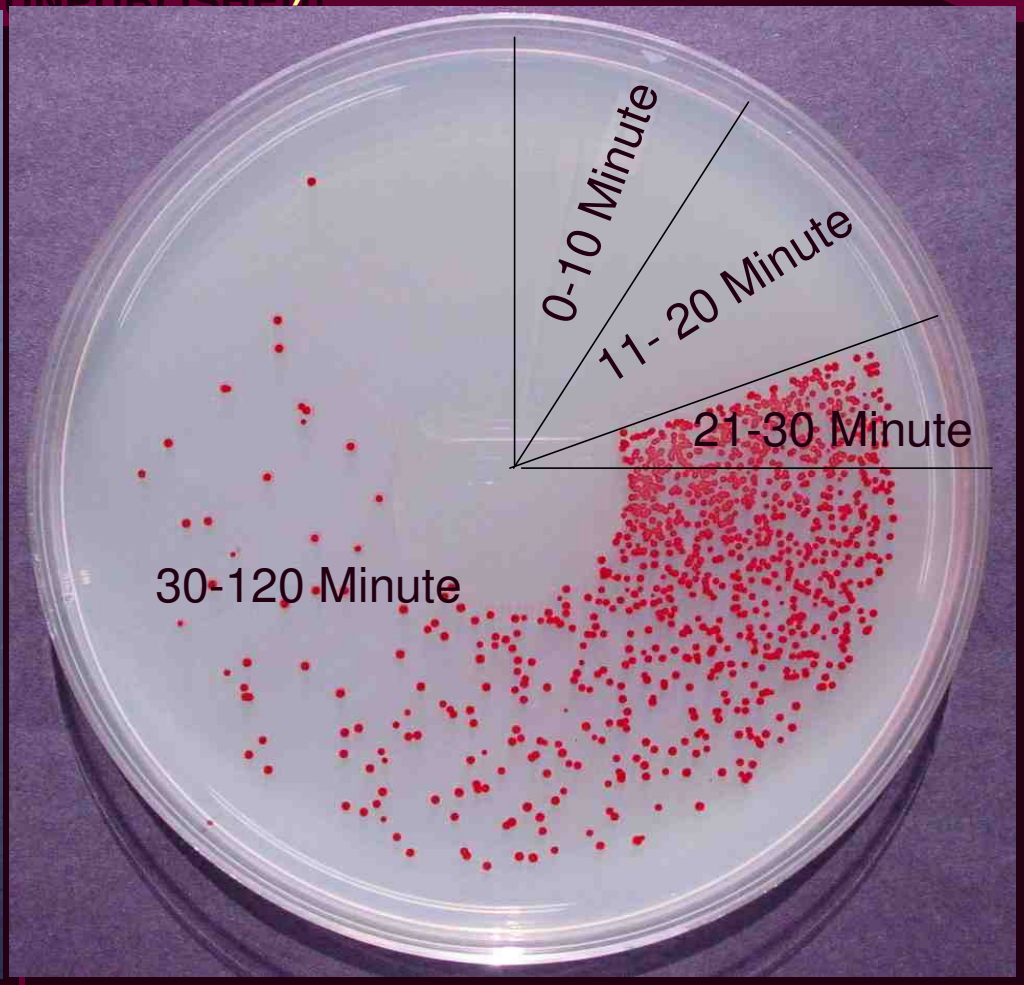


WITH UV EXPOSURE

WITHOUT UV EXPOSURE

UV LIGHT FOR INACTIVATION OF *GEOBACILLUS STEAROTHERMOPHILUS* SPORES IN AIR: HIGH-LEVEL CHALLENGE (SATTAR ET AL, UNPUBLISHED)

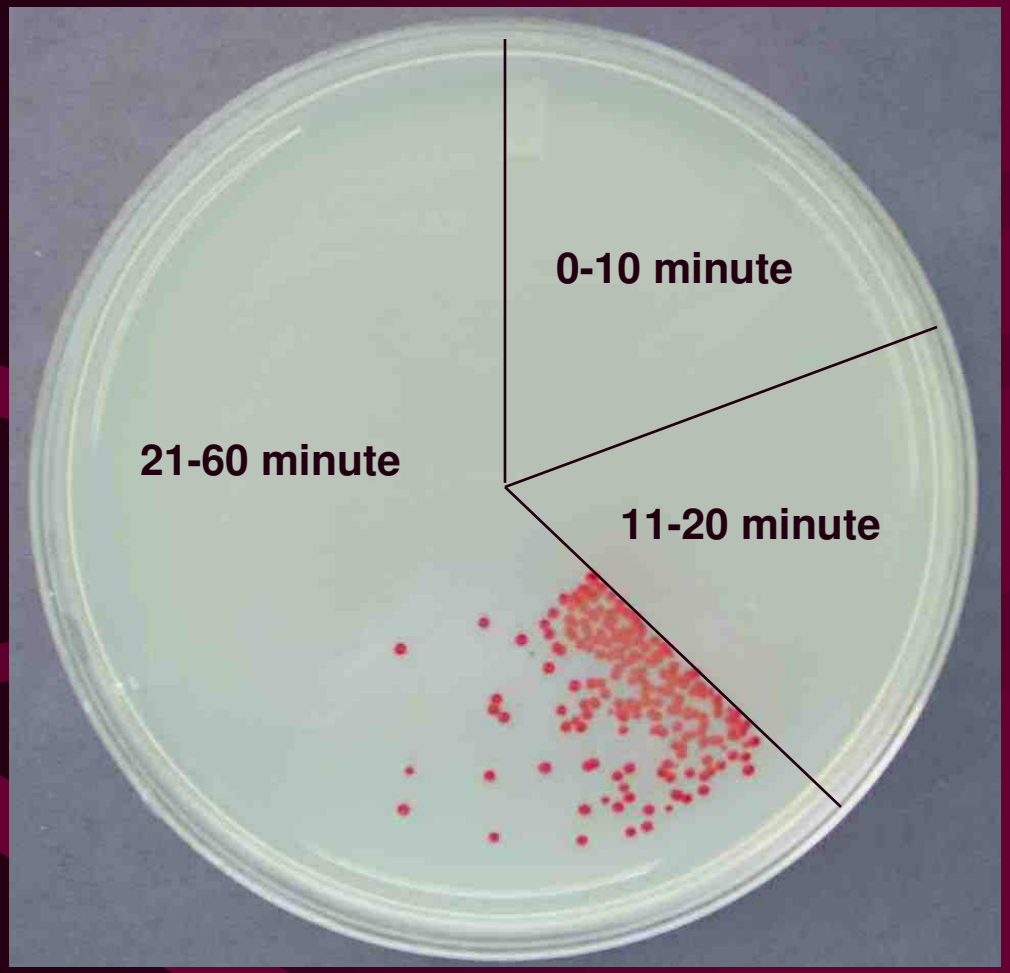




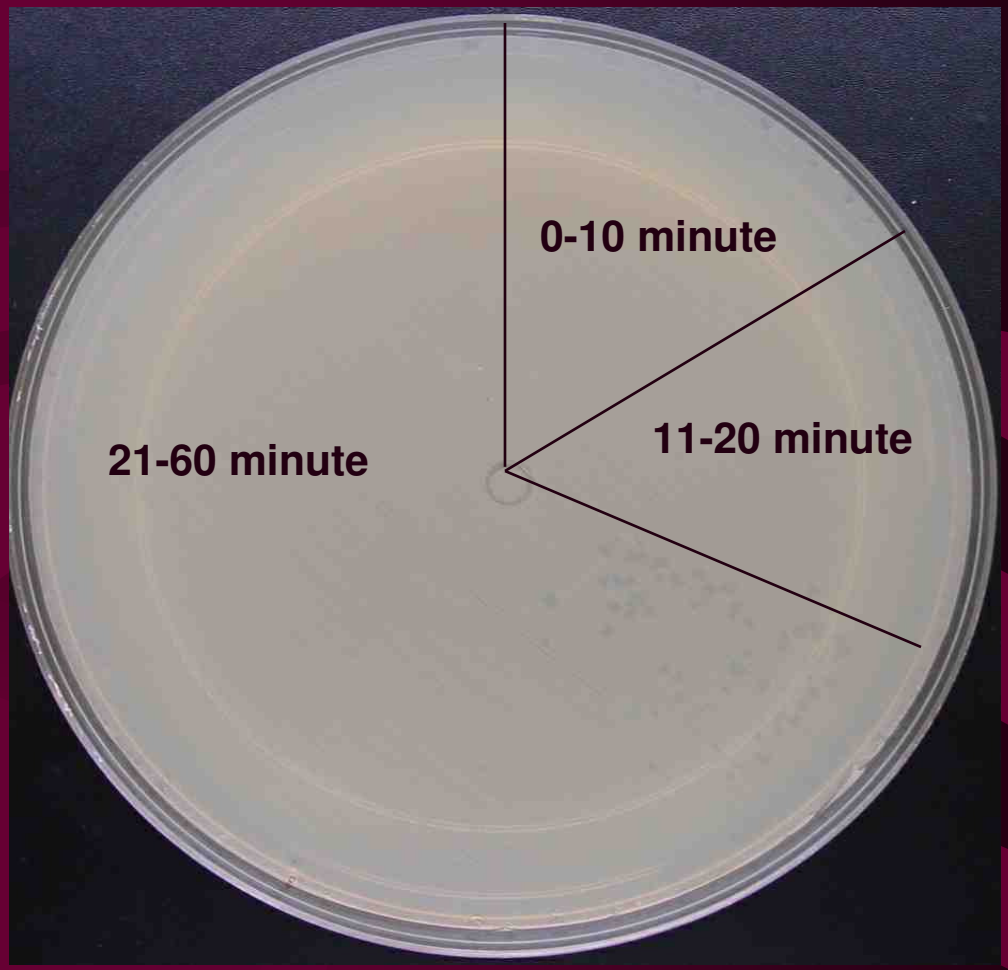
WITHOUT UV EXPOSURE

WITH UV EXPOSURE

DECONTAMINATION OF AIR WITH A FREE-STANDING UNIT BASED ON HEPA FILTERS & UV LAMPS (SATTAR, UNPUBLISHED)



REMOVAL/KILLING OF SPORES



REMOVAL/KILLING OF PHAGE

CONCLUDING REMARKS

- SURVIVAL OUTSIDE HOST PRE-REQUISITE FOR *ENVIRONMENTAL* SPREAD OF INFECTIOUS AGENTS
- SUCH SURVIVAL ALSO DETERMINES FOCUS & NEED FOR ENVIRONMENTAL CONTROL
- MANY OTHERWISE SERIOUS PATHOGENS SURVIVE POORLY
- ENVIRONMENTAL CONTROL STAGING A MAJOR COMEBACK!
- NEED FOR BETTER, SAFER & FASTER-ACTING MICROBICIDES
- MORE RESEARCH ON MODES & VEHICLES FOR PATHOGEN SPREAD