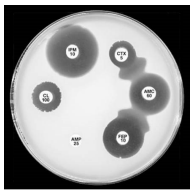
Basic Microbiology





Your Presenter

Jim Gauthier, MLT, CIC
Senior Clinical Advisor, Infection Prevention
james.gauthier@diversey.com

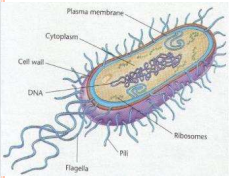
Disclosure

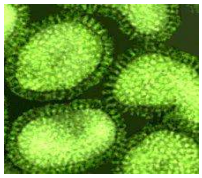
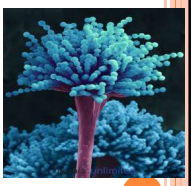
- Jim is employed by Diversey. His expenses to present this webinar (salary) is paid by this company. Diversey has had no input into this presentation from a commercial interest.

Objectives

- Define: Microbiology
- List the major groups or 'buckets' of microorganisms
- Explain the importance of the organism characteristics in our world

Microorganisms



Microbiology

- The study of microorganisms (microbes, pathogens, bugs, germs)
  - They are living organisms, mostly invisible
  - The majority can only be seen with a microscope
  - Make up more than 60% of the Earth's living matter
  - About 2-3 billion species share the planet with us!

Microbiology

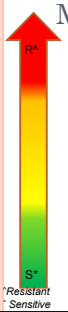
- We all have 1.4-2.3kg (3–5 POUNDS) of bacteria in and on us!
  - Human Microbiome
  - 10x more bacterial cells than tissue or structural cells

7

The Main Buckets of Microorganisms

Bacteria	Gram Positive Gram Negative	*Staphylococcus,* *E. coli,* *Pseudomonas*
Spores	Resistant form of bacteria	*Clostridioides difficile,* *Bacillus anthracis*
Viruses	Envelope or Non-Envelope	Influenza, Rhinovirus, HIV, HBV
Fungi	Multicellular	*Trichophyton,* *Aspergillus*

Effect of Disinfectants on Microorganisms



*Resistant
* Sensitive

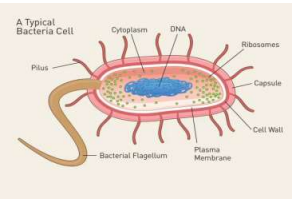
Organism	Type	Examples
Bacterial Spores	Spore	*Bacillus anthracis, Clostridioides difficile*
Mycobacteria	Bacteria	*M. tuberculosis*
Small non-enveloped virus	Virus	Poliovirus, Norovirus, Rhinovirus, Hep A
Fungal spores	Fungus	Aspergillus, Penicillium, Trichophyton
Gram negative bacteria	Bacteria	*E. coli*, Klebsiella including CRE, Pseudomonas, Acinetobacter
Fungi (Vegetative)	Fungus	Candida
Large Virus (non-enveloped)	Virus	Adenovirus, Rotavirus
Gram positive bacteria	Bacteria	Staphylococcus including MRSA Enterococcus including VRE
Virus (enveloped)	Virus	HIV, HBV, HCV, Influenza, Coronavirus

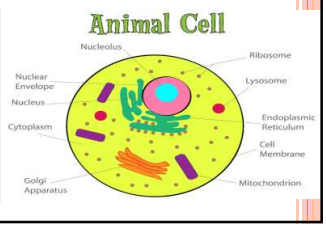
Adapted from Rutala et al. ICHE 2014;35(7):862

THE MAIN BUCKETS OF MICROORGANISMS

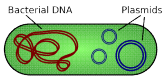
Bacteria	Gram Positive Gram Negative	*Staphylococcus,* *E. coli,* *Pseudomonas*

BACTERIA





BACTERIA



- Single cell
- Genetic information is contained in a single loop of DNA
- Some have an extra circle of mobile genetic material called a "plasmid"
  - Plasmids may contain a gene that makes it resistant to certain antibiotics
  - Plasmids can move from one bacterium to another!

Identification of Microorganisms

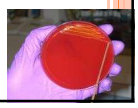
Staining: To microscopically visualize the microbial structures (bacteria, fungi)



Identification of Microorganisms

Culture: Grow microorganisms on agar plates or in test tubes (bacteria and fungi)

- Culture media encourage growth of microorganisms by providing nutrients
- Swabs can be used, or excretions (urine, feces)
- Environmental testing uses swab or agar to press on surface
- Culture can take 24 – 48 hours



Identification

- PCR (polymerase chain reaction):
  - 1 – 3 hours. Technology now has 'panels' of organisms
- https://www.youtube.com/watch?v=2KoLnIwoZKU

Microbiology Flowsheet
Microbiology Miscl.
RVP Adenovirus
RVP Bordetella Pertussis
RVP Chlamydia Pneumonia
RVP Coronavirus 229E
RVP Coronavirus HKU1
RVP Coronarvirus NL63
RVP Coronavirus OC43
RVP Human Metapneumovirus
RVP Human Rhinovirus/Enterovirus
RVP Influenza A
RVP Influenza B
RVP Mycoplasma Pneumoniae
RVP Parainfluenza Virus 1
RVP Parainfluenza Virus 2
RVP Parainfluenza Virus 3
RVP Parainfluenza Virus 4
RVP Respiratory Syncytial Virus

← Respiratory

Enteric →

Microbiology Miscl.
GIP Campylobacter
GIP Plesiomonas shigelloides
GIP Salmonella
GIP Vibrio
GIP Vibrio cholerae
GIP Yersinia enterocolitica
GIP Enteroaggregative E. coli (EAEC)
GIP Enteropathogenic E. coli (EPEC)
GIP Enterotoxigenic E. coli (ETEC)
GIP Shiga-like toxin-producing E. coli
GIP E. coli O157
GIP Shigella/Enteroinvasive E. coli
GIP Cryptosporidium
GIP Cyclospora cayetanensis
GIP Entamoeba histolytica
GIP Giardia lamblia
GIP Adenovirus F 40/41
GIP Astrovirus
GIP Norovirus GI/GII
GIP Rotavirus A
GIP Sapovirus

Cycle Time (Ct)

- Number of times the machine has to reproduce the DNA/RNA to detectable levels
- Higher Ct – lower numbers of organism
- Low Ct – higher number of organisms
- SARS-CoV-2
  - Discussion concerning infectivity of high Ct individuals

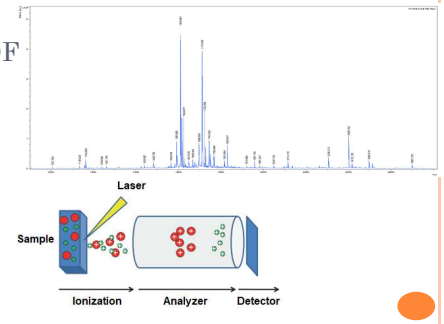
17

MALDI-TOF

www.biomerieux-diagnostics.com

Matrix
Associated
Laser
Desorption
Ionization
Time-**o**f-**F**light

MALDI-TOF

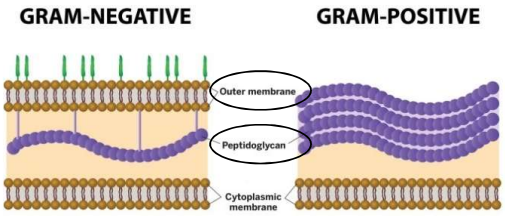


Carson Szot, et al. - https://commons.wikimedia.org/wiki/File%3AMALDI-TOF_MS.png

Gram Stain

- Developed by Dr. Gram
- The majority of bacteria fall under one of two categories
  - **Gram Positive Bacteria**
  - **Gram Negative Bacteria**
- Based on cell wall composition of bacteria

Cell Wall

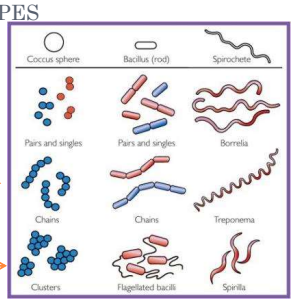


cen.acs.org

Gram Stain

- Gives a quick look at the specimen
- Can interpret quality of specimen
  - Number of "pus" (polymorphonuclear) cells present
    - Infection
  - Number of epithelial cells present
    - Surface, not good
  - Number of bacteria present (and likely Genus)
    - Normal vs. abnormal

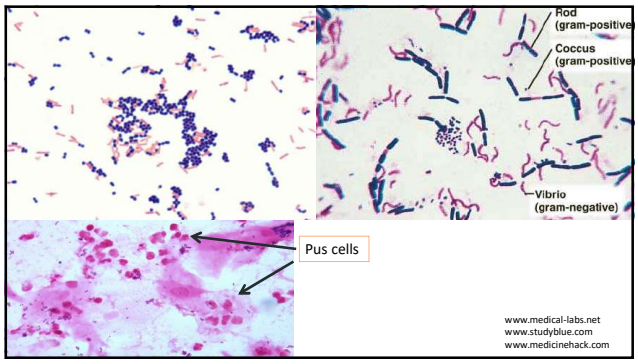
Bacterial Shapes



Strepto

Staphylo

www.i-fink.com



Gram Stain

- Can help direct antibiotic therapy
  - Based on cell wall composition
  - Based on mode of action of antibiotic
- Not so helpful if lots of normal flora present
  - throats, stool, pressure injuries
- Quite significant on sterile body sites
  - CSF and other fluids

Effect of Disinfectants on Microorganisms

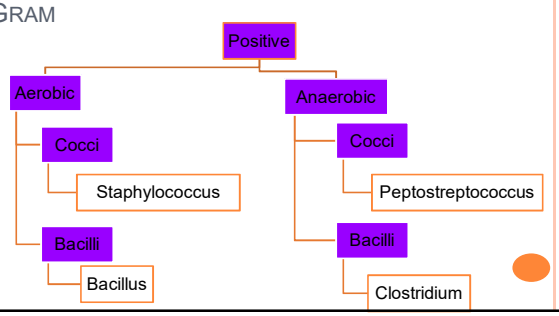
R* S*

*Resistant
* Sensitive

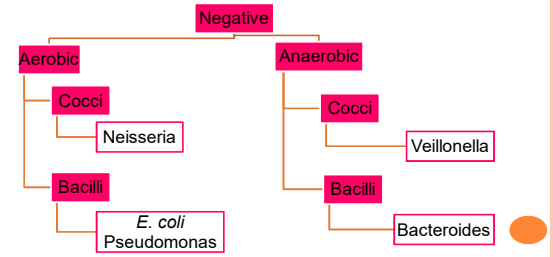
Organism	Type	Examples
Bacterial Spores	Spore	*Bacillus anthracis, Clostridioides difficile*
Mycobacteria	Bacteria	*M. tuberculosis*
Small non-enveloped virus	Virus	Poliovirus, Norovirus, Rhinovirus, Hep A
Fungal spores	Fungus	Aspergillus, Penicillium, Trichophyton
Gram negative bacteria	Bacteria	*E. coli*, Klebsiella including CRE, Pseudomonas, Acinetobacter
Fungi (Vegetative)	Fungus	Candida
Large Virus (non-enveloped)	Virus	Adenovirus, Rotavirus
Gram positive bacteria	Bacteria	Staphylococcus including MRSA Enterococcus including VRE
Virus (enveloped)	Virus	HIV, HBV, HCV, Influenza, Coronavirus

Adapted from Rutala et al. ICHE 2014;35(7):862

GRAM



GRAM



GROWTH CHARACTERISTICS

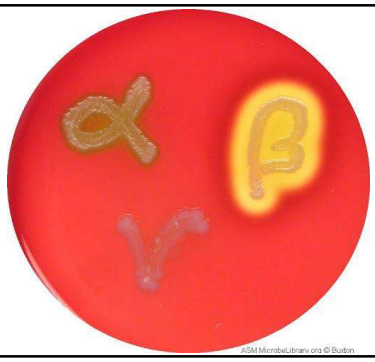
- Oxygen requirements
- Able to ferment or oxidize sugars to produce acid end products
- Temperature ranges
- Salt tolerance
- Chemical tolerance
- Enzymes
- Motile

Oxygen Requirements

- Bacteria can either grow in the presence of oxygen or not
  - **Aerobic**: Require Oxygen
    - Pseudomonas, Bacillus
  - **Anaerobic**: Can't grow with Oxygen
    - Clostridium, Clostridioides, Bacteriodes
  - **Facultative Anaerobe**: Can grow either with, or without Oxygen
    - *E. coli, K. pneumoniae*

Appearance

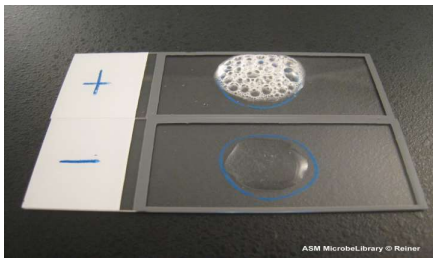
- Hemolysis – ability to break down red blood cells in agar
  - **Beta**: complete destruction
  - **Alpha**: partial destruction of the cells, leaving a greenish hue to the blood
  - No hemolysis



Enzymes

- Catalase
  - Tests the organism's ability to liberate oxygen from hydrogen peroxide
  - Main distinguishing feature between Staphylococci and Streptococci/Enterococci
  - Pure organism placed into H_2O_2 – observe!

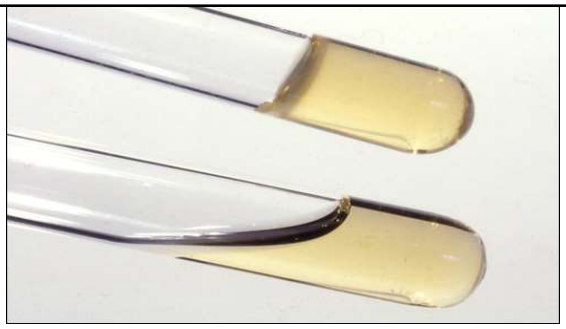
Catalase



35

Enzymes

- Coagulase
  - The ability of the organism under study to clump, clot, or coagulate rabbit plasma, turning a solution from liquid to semi-solid
    - Can use plasma or latex particles
  - Used as main identification of *Staphylococcus aureus*, distinguishing it from other Staph. species (coagulase negative Staph or CNS)

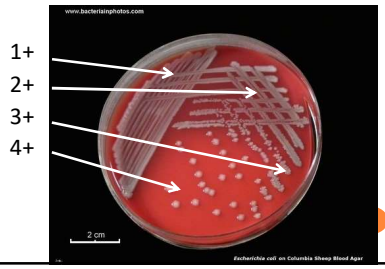


Temperature Ranges

- 37°C (98.6°F)
  - Most human pathogens
- 4°C (39°F)
  - Yersinia, Listeria (food borne organisms)
- 42°C (107.6°F)
  - Campylobacter (enteric organism)
- 56°C (132.8°F)
  - Fecal *E. coli* – water testing

38

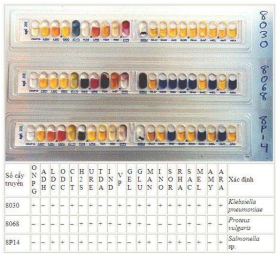
Growth Quantitation



Biochemical Identification

- Use various sugars and substrates to detect ability to ferment, oxidize or use an enzyme (e.g. gelatinase)
- Most of this is now automated

Identification Strip



Số cây trên đĩa	ONPG	ADH	LDC	ODC	CIT	H2S	URE	TDA	IND	VP	GEL	GLU	MAN	INO	SOR	RHA	SAC	MEL	AMY	ARA	Xác định
E030	+	-	+	+	-	-	-	-	-	-	-	+	+	-	-	+	+	+	+	+	*Klebsiella pneumoniae*
E068	-	-	-	-	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	*Proteus vulgaris*
KP14	-	-	+	+	+	+	-	-	-	-	+	+	+	+	+	+	+	+	+	+	*Salmonella* sp.

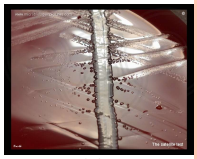
nihe.org.vn

Agar Plates

www.coleparmer.com

Agar Plates

- Nutritive
  - Blood agar, chocolate agar
- Selective/Differential
  - MacConkey, Mannitol Salt



Microbiologyinpictures.com
Microbeonline.com

Resistance to Antibiotics

- Naturally occurring (genetic)
- Acquired
  - Genetic mutation
  - Transfer of resistance from another bacterium (plasmid)
- Antibiotics are only effective on bacteria

www.keralaayurveda.biz

Sensitivity Testing

- Basically expose organism to antibiotic and see if it kills the bug!
  - Antibiotic impregnated discs
  - Micro-wells to which an organism suspension is added
- 4 - 24 hours
  - E-test (determines minimum inhibitory concentration)

KIRBY-BAUER

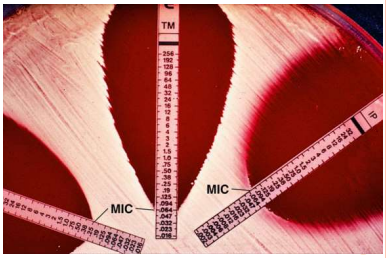
(Qualitative)

www.sciencebuddies.org

E-TEST

MIC -
Minimum
Inhibitory
Concentration

(Quantitative)



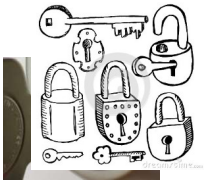
classes.midlandstech.edu

RESISTANT ORGANISMS

- Antibiotic resistance does NOT confer disinfectant resistance!
  - *E. coli* is *E. coli* whether it can produce a beta lactamase or a carbapenemase
- Antibiotics are an elegant "Lock and Key"
- Disinfectants are more "Dynamite" or "Sledgehammer"

Weber 2006, Rutala 1997

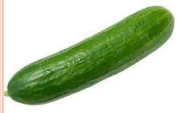
Antibiotics

Antibiotic Resistance


50

Analogy for Disinfectants

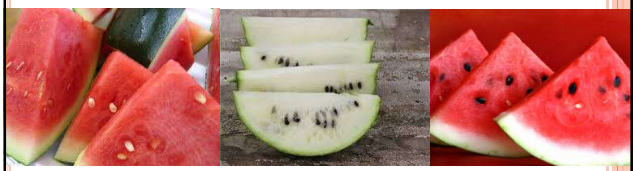




The Family Tree

- Family • *Cucurbitaceae*
- Genus • Last Name
- Species • First Name

Genetic Mutations



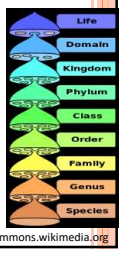
Watermelon coli *Watermelon ESBL* *Watermelon CRE*

The Family Tree

Family **Enterobacteriaceae**

Genus • Last Name

Species • First Name



commons.wikimedia.org

Representative Organisms

Gram Negative

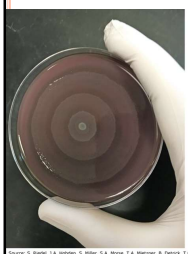
Family Enterobacteriaceae

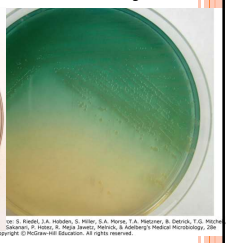
- *Escherichia coli*
- *Klebsiella pneumonia*
- *Enterobacter cloacae*
- *Proteus mirabilis*
- *Serratia marcescens*
- *Salmonella enteritidis*
- *Shigella flexneri*

Other Gram Negative

- *Pseudomonas aeruginosa*
- *Stenotrophomonas maltophilia*
- *Burkholderia cepacia*
- *Acinetobacter baumannii*
- *Yersinia enterocolitica*
  - (*Y. pestis* – plague)

Proteus mirabilis | *Serratia marcescens* | *Pseudomonas aeruginosa*





58

Jawetz et al, Chapter 15 https://www.wikiwand.com/en/Serratia_marcescens Jawetz et al, Chapter 16

Representative Organisms

Gram Positive

- *Staphylococcus aureus (MRSA) (MDRO)*
- Coagulase Negative Staph
- *Streptococcus pyogenes* (Group A Strep)
- *Enterococcus* species (VRE)

TABLE 3. Most Prevalent Pathogens Causing Healthcare-Associated Infections (HAIs)

Recommended organism (% of HAIs caused)	Why organisms are relevant
Staphylococcus aureus (15.6%) *Escherichia coli* (11.5%) Coagulase-negative *Staphylococcus* (11.4%) *Klebsiella* (8.0%) *Pseudomonas aeruginosa* (7.5%) *Enterococcus faecalis* (6.8%) *Candida albicans* (5.3%) *Enterobacter* species (4.7%) Other *Candida* species (4.2%) *Enterococcus faecium* (4.1%) *Enterococcus* species (3.0%) *Proteus* species (2.5%) *Serratia* species (2.1%) *Acinetobacter baumanni* (1.8%)	Most prevalent overall contributors to HAIs (NHSN/CDC)[11]

Rutala 2014

Table 3. Reported Causative Pathogens, According to Type of Infection.*

Magill 2014

Pathogen	All Health Care–Associated Infections (N = 504)†	rank	Pneumonia (N = 110)	Surgical-Site Infections (N = 110)	GI Infections (N = 86)	UTIs (N = 65)	Bloodstream Infections (N = 50)
	no. (%)				*number (percent)*		
Clostridium difficile	61 (12.1)	1	0	0	61 (70.9)	0	0
Staphylococcus aureus	54 (10.7)	2	18 (16.4)	17 (15.5)	1 (1.2)	2 (3.1)	7 (14.0)
Klebsiella pneumoniae or K. oxytoca	50 (9.9)	3	13 (11.8)	15 (13.6)	1 (1.2)	15 (23.1)	4 (8.0)
Escherichia coli	47 (9.3)	4	3 (2.7)	14 (12.7)	1 (1.2)	18 (27.7)	5 (10.0)
Enterococcus species‡	44 (8.7)	5	2 (1.8)	16 (14.5)	5 (5.8)	11 (16.9)	6 (12.0)
Pseudomonas aeruginosa	36 (7.1)	6	14 (12.7)	7 (6.4)	1 (1.2)	7 (10.8)	2 (4.0)
Candida species§	32 (6.3)	7	4 (3.6)	3 (2.7)	3 (3.5)	3 (4.6)	11 (22.0)
Streptococcus species¶	25 (5.0)	8	7 (6.4)	8 (7.3)	2 (2.3)	2 (3.1)	2 (4.0)
Coagulase-negative staphylococcus species	24 (4.8)	9	0	7 (6.4)	0	1 (1.5)	9 (18.0)
Enterobacter species	16 (3.2)	10	3 (2.7)	5 (4.5)	0	2 (3.1)	2 (4.0)
Acinetobacter baumannii	8 (1.6)	11, tie	4 (3.6)	2 (1.8)	0	0	0
Proteus mirabilis	8 (1.6)	11, tie	1 (0.9)	5 (4.5)	0	1 (1.5)	0
Yeast, unspecified	8 (1.6)	11, tie	3 (2.7)	0	1 (1.2)	4 (6.2)	0
Stenotrophomonas maltophilia	8 (1.6)	11, tie	6 (5.5)	0	0	2 (3.1)	0
Citrobacter species	6 (1.2)	15, tie	2 (1.8)	1 (0.9)	0	1 (1.5)	0
Serratia species	6 (1.2)	15, tie	2 (1.8)	0	0	2 (3.1)	0
Bacteroides species	6 (1.2)	15, tie	0	5 (4.5)	1 (1.2)	0	0
Haemophilus species	6 (1.2)	15, tie	2 (1.8)	2 (1.8)	0	0	0
Viruses‖	3 (0.6)	19, tie	1 (0.9)	0	0	0	0
Peptostreptococcus species	3 (0.6)	19, tie	0	2 (1.8)	0	0	1 (2.0)

Pathogen	All Health Care–Associated Infections (N = 504)†	rank	Pneumonia (N = 110)	Surgical-Site Infections (N = 110)	GI Infections (N = 86)	UTIs (N = 65)	Bloodstream Infections (N = 50)
	no. (%)				*number (percent)*		
Clostridium difficile	61 (12.1)	1	0	0	61 (70.9)	0	0
Staphylococcus aureus	54 (10.7)	2	18 (16.4)	17 (15.5)	1 (1.2)	2 (3.1)	7 (14.0)
Klebsiella pneumoniae or K. oxytoca	50 (9.9)	3	13 (11.8)	15 (13.6)	1 (1.2)	15 (23.1)	4 (8.0)
Escherichia coli	47 (9.3)	4	3 (2.7)	14 (12.7)	1 (1.2)	18 (27.7)	5 (10.0)
Enterococcus species‡	44 (8.7)	5	2 (1.8)	16 (14.5)	5 (5.8)	11 (16.9)	6 (12.0)
Pseudomonas aeruginosa	36 (7.1)	65%	14 (12.7)	7 (6.4)	1 (1.2)	7 (10.8)	2 (4.0)
Candida species§	32 (6.3)		4 (3.6)	3 (2.7)	3 (3.5)	3 (4.6)	11 (22.0)
Streptococcus species¶	25 (5.0)	8	7 (6.4)	8 (7.3)	2 (2.3)	2 (3.1)	2 (4.0)
Coagulase-negative staphylococcus species	24 (4.8)	9	0	7 (6.4)	0	1 (1.5)	9 (18.0)
Enterobacter species	16 (3.2)	10	3 (2.7)	5 (4.5)	0	2 (3.1)	2 (4.0)

Magill 2014

Pathogen	All Infections (N = 427)	Pneumonia (N = 110)††	Gastrointestinal Infection (N = 91)‡‡	Surgical-Site Infection (N = 69)§§	Bloodstream Infection (N = 52)¶¶	Urinary Tract Infection (N = 39)‖‖	Other Infection (N = 66)***
				number of infections (percent)			
C. difficile	66 (15)	0	66 (73)	0	0	0	0
Staphylococcus aureus	48 (11)	13 (12)	2 (2)	12 (17)	12 (23)	0	9 (14)
Escherichia coli	44 (10)	2 (2)	1 (1)	13 (19)	4 (8)	18 (46)	6 (9)
Candida species	26 (6)	7 (6)	3 (3)	1 (1)	7 (13)	3 (8)	5 (8)
Enterococcus species	23 (5)	1 (1)	2 (2)	8 (12)	6 (12)	4 (10)	2 (3)
Enterobacter species†††	22 (5)	56%	1 (1)	10 (14)	0	3 (8)	5 (8)
Pseudomonas aeruginosa	22 (5)	8 (7)	2 (2)	3 (4)	0	5 (13)	4 (6)
Klebsiella pneumoniae or K. oxytoca	21 (5)	6 (5)	1 (1)	3 (4)	3 (6)	7 (18)	1 (2)
Streptococcus species§§§	21 (5)	4 (4)	1 (1)	9 (13)	6 (12)	0	1 (2)
Coagulase-negative staphylococcus	16 (4)	1 (1)	2 (2)	6 (9)	6 (12)	0	1 (2)

63

Magill 2018

Top 10 NHSN 2015–2017

Distribution and Rank Order of the 15 Most Frequently Reported Pathogens Across All Types of Adult Healthcare-Associated Infections (HAIs), 2015–2017

Pathogen[a]	No. (%) Pathogens	Rank
Escherichia coli	62,571 (17.5)	1
Staphylococcus aureus	42,132 (11.8)	2
Selected *Klebsiella* spp	31,530 (8.8)	3
Pseudomonas aeruginosa	28,513 (8.0)	4
Enterococcus faecalis[b]	28,236 (7.9)	5
Coagulase-negative staphylococci	24,199 (6.8)	6
Enterobacter spp	16,568 (4.6)	7
Enterococcus faecium[b]	13,687 (3.8)	8
Proteus spp	11,463 (3.2)	9
Candida albicans[b]	11,043 (3.1)	10

Weiner-Lastinger LM et al 2020

This just in! Global Top 10 Microorganisms Causing Death

Rank	Pathogen	All-cause age-standardised mortality rate
1	*Staphylococcus aureus*	14.6
2	*E. coli*	12.6
3	*Streptococcus pneumoniae*	11.4
4	*Klebsiella pneumoniae*	11.4
5	*Pseudomonas aeruginosa*	7.4
6	*Acinetobacter baumannii*	5.8
7	*Enterobacter species*	4.2
8	Group B *Streptococcus*	4.4
9	*Enterococcus faecalis*	2.8
10	*Enterococcus faecium*	2.8
27	*Clostridioides difficile*	0.4

Ikuta 2022

Outbreaks by Pathogen

THEN

- ***Clostridioides difficile***
- **Norovirus**
- **Aspergillus**
- **Rotavirus**
- **Adenovirus**

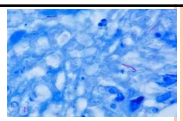
Rutala 2014

NOW?

While not all are causing "outbreaks," since 2018:

- **Hepatitis A**
- **SARS CoV-2**
- **Monkeypox**
- ***Candida auris***
- **Polio**

Mycobacteria / TB



en.wikipedia.org

- *M. tuberculosis*
- Cell wall very different from other bacteria
- "Waxy" in nature, difficult to stain, difficult to penetrate
- Acid Fast Bacilli or AFB
- 24 hours to reproduce
- "Tuberculocidal"

Effect of Disinfectants on Microorganisms

Organism	Type	Examples
Bacterial Spores	Spore	*Bacillus anthracis, Clostridioides difficile*
Mycobacteria	Bacteria	*M. tuberculosis*
Small non-enveloped virus	Virus	Poliovirus, Norovirus, Rhinovirus, Hep A
Fungal spores	Fungus	Aspergillus, Penicillium, Trichophyton
Gram negative bacteria	Bacteria	*E. coli*, Klebsiella including CRE, Pseudomonas, Acinetobacter
Fungi (Vegetative)	Fungus	Candida
Large Virus (non-enveloped)	Virus	Adenovirus, Rotavirus
Gram positive bacteria	Bacteria	Staphylococcus including MRSA Enterococcus including VRE

Mycobacteria / TB

- "Tuberculocidal germicides …will not interrupt and prevent the transmission of *M. tuberculosis* in health-care settings."
- "The same cleaning procedures used in other rooms in the health-care setting should be used to clean AII rooms."
  - Follow Airborne precautions while cleaning if air exchanges have not been adequate.

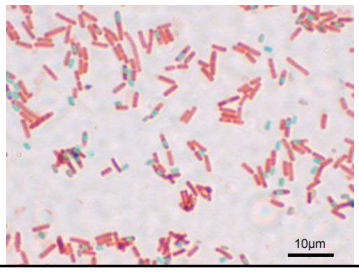
Centers for Disease Control and Prevention. Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-Care Settings. MMWR 2005;54(No. RR-17): 79

TB and Tuberculocide - Silent

- Health Canada
- Public Health Agency of Canada
- Canadian Standards Association Z317-12-20
- Canadian Tuberculosis Standards 2022
  - Canadian Journal of Respiratory, Critical Care, and Sleep Medicine 2022;6(sup 1):1-255 (https://www.tandfonline.com/toc/ucts20/6/sup1?nav=tocList)

THE MAIN BUCKETS OF MICROORGANISMS

Spores	Resistant form of bacteria	*Clostridioides difficile, Bacillus anthracis*



71

Wikipedia - Endospore

EFFECT OF DISINFECTANTS ON MICROORGANISMS

R* S*

*Resistant
* Sensitive

Organism	Type	Examples
Bacterial Spores	Spore	*Bacillus anthracis, Clostridioides difficile*
Mycobacteria	Bacteria	*M. tuberculosis*
Small non-enveloped virus	Virus	Poliovirus, Norovirus, Rhinovirus, Hep A
Fungal spores	Fungus	Aspergillus, Penicillium, Trichophyton
Gram negative bacteria	Bacteria	*E. coli*, Klebsiella including CRE, Pseudomonas, Acinetobacter
Fungi (Vegetative)	Fungus	Candida
Large Virus (non-enveloped)	Virus	Adenovirus, Rotavirus
Gram positive bacteria	Bacteria	Staphylococcus including MRSA Enterococcus including VRE
Virus (enveloped)	Virus	HIV, HBV, HCV, Influenza, Coronavirus

Adapted from Rutala et al. ICHE 2014;35(7):862

Spores

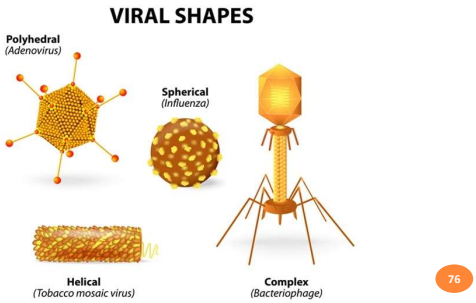
- Some bacteria can form endospores
- Formed in vegetative bacteria in times of stress
- These are dormant structures, which are extremely resistant to hostile physical and chemical conditions such as heat, natural UV radiation and most disinfectants
  - This makes destroying them very difficult

Spore-Forming Bacteria

- Many endospore-producing bacteria are nasty pathogens
  - *Clostridioides difficile* (*C. difficile* Infection – CDI)
    - Name change for *C. difficile* – 2016
    - Only two members of Genus
  - *Clostridium perfringens* (gas gangrene), *C. botulinum* (botulism) *C. tetani* (tetanus)
  - *Bacillus anthracis* (anthrax – bioterrorism)
  - *B. cereus* (food poisoning)

The Main Buckets of Microorganisms

Viruses	Enveloped or Non-Enveloped	Influenza, Rhinovirus, HIV, HBV



VIRUSES

- "Obligate Intracellular Parasites"
  - Need host cell machinery to reproduce
- Small: diameter 20 – 400 nanometers
- Shapes: usually geometric
- Identification
  - PCR
  - Electron microscopy
  - Tissue culture

VIRUSES

- Enveloped Viruses
  E = Easy to kill
- Non-Enveloped Viruses
  NE = Not Easy to kill

VIRUSES

- Large non-enveloped viruses are easier to kill than small non-enveloped viruses
  - Large
    - Adenovirus, Rotavirus
  - Small
    - Norovirus (FCV), Poliovirus, Rhinovirus, Enterovirus, Hepatitis A

HEALTH CANADA: EMERGING VIRAL PATHOGENS

Emerging Viral Pathogens

- https://www.canada.ca/en/health-canada/services/drugs-health-products/disinfectants/emerging-viral-pathogens.html

On this page

- What are emerging viral pathogens
- How a disinfectant works against EVPs
- List of surface disinfectants for EVPs
- For more information

VIRAL TYPES

- **Broad-spectrum virucide**: '..efficacy against a representative hard to kill non-enveloped virus, and which is expected to inactivate other non-enveloped and enveloped viruses (i.e., the product has demonstrated 'broad-spectrum virucidal efficacy'
  - Poliovirus type 1, Chat strain (ATCC VR-1562) OR
  - Human adenovirus type 5 (ATCC VR-5) OR
  - Bovine parvovirus (ATCC VR-767) OR
  - Canine parvovirus (ATCC VR-2017)

LOOK UP YOUR DISINFECTANT

- Locate the DIN on the disinfectant product label
- Search the DIN on the List of surface disinfectants for emerging viral pathogens

Filter items: Diversey — Showing 1 to 10 of 31 entries (filtered from 589 total entries) | Show 10 entries

List of surface disinfectants for emerging viral pathogens

Drug identification number (DIN)	Product name	Company name	Active ingredient(s)	Product form	Approved use
02239775	Virox 5 RTU	Diversey Inc	Hydrogen peroxide	Liquid	Food Premises, Hospital/HC Facilities, Institutional/Industrial
02239828	Virox 5	Diversey Inc	Hydrogen peroxide	Liquid	Food Premises, Hospital/HC Facilities, Institutional/Industrial

ENVELOPED EMERGING VIRAL PATHOGEN (TIER 1)

- Inactivate at least **one large or one small non-enveloped virus**
  - Adenovirus or Rhinovirus/Norovirus
- Example: A New Coronavirus

LARGE NON-ENVELOPED EMERGING VIRUS (TIER 2)

- Inactivate at least **one small, non-enveloped virus**
  - Rhinovirus/Norovirus
- Example: A new mutant Rotavirus

Small Non-enveloped Emerging Virus (Tier 3)

- Inactivate at least **two small, non-enveloped viruses**
  - Rhinovirus, Norovirus, or Poliovirus
- Example: A new Rhinovirus mutant

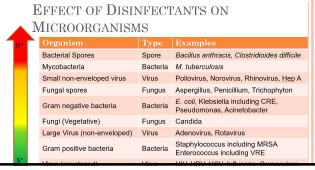
Bloodborne Pathogens

- Bloodborne pathogens are infectious microorganisms present in blood that can cause disease in humans
- Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Human Immunodeficiency Virus (HIV)
- All of these pathogens are quite easy to kill (Enveloped)
- No designation in Canada like this!

Mycobacteria Species

- Bloodborne Pathogen Standard – OSHA
  - 1991 – product must be tuberculocidal
  - 1997 – product must be effective against HIV, HBV and HCV

Effect of Disinfectants on Microorganisms



Organism	Type	Examples
Bacterial Spores	Spore	*Bacillus anthracis, Clostridioides difficile*
Mycobacteria	Bacteria	*M. tuberculosis*
Small non-enveloped virus	Virus	Poliovirus, Norovirus, Rhinovirus, Hep A
Fungal spores	Fungus	Aspergillus, Penicillium, Trichophyton
Gram negative bacteria	Bacteria	*E. coli*, Klebsiella including CRE, Pseudomonas, Acinetobacter
Fungi (Vegetative)	Fungus	Candida
Large Virus (non-enveloped)	Virus	Adenovirus, Rotavirus
Gram positive bacteria	Bacteria	Staphylococcus including MRSA Enterococcus including VRE

Effect of Disinfectants on Microorganisms

*Resistant
* Sensitive

Organism	Type	Examples
Bacterial Spores	Spore	*Bacillus anthracis, Clostridioides difficile*
Mycobacteria	Bacteria	*M. tuberculosis*
Small non-enveloped virus	Virus	Poliovirus, Norovirus, Rhinovirus, Hep A
Fungal spores	Fungus	Aspergillus, Penicillium, Trichophyton
Gram negative bacteria	Bacteria	*E. coli*, Klebsiella including CRE, Pseudomonas, Acinetobacter
Fungi (Vegetative)	Fungus	Candida
Large Virus (non-enveloped)	Virus	Adenovirus, Rotavirus
Gram positive bacteria	Bacteria	Staphylococcus including MRSA Enterococcus including VRE
Virus (enveloped)	Virus	HIV, HBV, HCV, Influenza, Coronavirus

Adapted from Rutala et al. ICHE 2014;35(7):862

COVID and Disinfectants

- US - Recommendations to use List N disinfectants
- CDN – Recommend use products on EVP chart
  - Very effective on enveloped viruses
  - Seeing outbreaks of Rhinovirus, Norovirus, Enterovirus

Monkeypox and Disinfectants

- PHAC recommends standard housekeeping and use of DIN registered disinfectant
- CDC recommends to use Emerging Viral Pathogen products
  - Very effective on enveloped viruses

https://www.canada.ca/en/public-health/services/diseases/monkeypox/health-professionals/interim-guidance-infection-prevention-control-healthcare-settings.html#a6

Hepatitis A and Disinfectants

- Fecal-oral spread
- Vaccination of food workers?
- If not on label, CDC suggests bleach
- PHAC silent!

Parechovirus and Disinfectants

- Small, non-enveloped virus
- Waiting for 'emerging pathogen' statement from CDC!
  - No response to my queries!

The Main Buckets of Microorganisms

Fungi	Multicellular	*Penicillium, Aspergillus*

Fungi

Effect of Disinfectants on Microorganisms

Organism	Type	Examples
Bacterial Spores	Spore	*Bacillus anthracis, Clostridioides difficile*
Mycobacteria	Bacteria	*M. tuberculosis*
Small non-enveloped virus	Virus	Poliovirus, Norovirus, Rhinovirus, Hep A
Fungal spores	Fungus	Aspergillus, Penicillium, Trichophyton
Gram negative bacteria	Bacteria	*E. coli*, Klebsiella including CRE, Pseudomonas, Acinetobacter
Fungi (Vegetative)	Fungus	Candida
Large Virus (non-enveloped)	Virus	Adenovirus, Rotavirus
Gram positive bacteria	Bacteria	Staphylococcus including MRSA Enterococcus including VRE
Virus (enveloped)	Virus	HIV, HBV, HCV, Influenza, Coronavirus

R* S*

*Resistant
*Sensitive

Adapted from Rutala et al. ICHE 2014;35(7):862

Fungi

- Approximately 100,000 species of fungi are divided into two groups
  - Macroscopic (visible) fungi such as mushrooms and puffballs
  - Microscopic fungi such as molds and yeasts

Clinical Fungi

- A small number cause disease in humans
  - Athletes' foot, ringworm, oral or vaginal thrush
- Invasive disease is severe (sterile body site such as blood, lung or CSF)
- *Candida auris* in the news – resistant to common antifungal agents – See List P (EPA)
- Health Canada…?Sporicidal? (Schwartz 2018)

https://www.epa.gov/pesticide-registration/list-p-antimicrobial-products-registered-epa-claims-against-candida-auris

Fungi

- Common fungal pathogens include:
- *Trichophyton mentagrophytes* (athlete's foot)

www.healthline.com

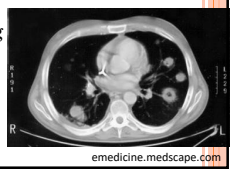
Fungi

- Common fungal pathogens include:
- *Trichophyton mentagrophytes* (athlete's foot)
- *Trichophyton mentagrophytes*
  - (ringworm)

www.thefitindian.com

Fungi

- Common fungal pathogens include:
  - *Trichophyton mentagrophytes* (athlete's foot)
  - *Trichophyton mentagrophytes*
    - (ringworm)
  - *Aspergillus fumigatus* (issue during construction/renovation)



emedicine.medscape.com

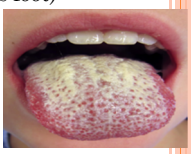
Fungi

- Common fungal pathogens include:
  - *Trichophyton mentagrophytes* (athl
  - *Trichophyton mentagrophytes*
    - (ringworm)
  - *Aspergillus fumigatus* (issue during construction/renovation)
  - *Aspergillus niger* (black mold)

moldyfacts.com

Fungi

- Common fungal pathogens include:
  - *Trichophyton mentagrophytes* (athlete's foot)
  - *Trichophyton mentagrophytes*
    - (ringworm)
  - *Aspergillus fumigatus* (issue during construction/renovation)
  - *Aspergillus niger* (black mold)
  - *Candida albicans* (mucous membrane thrush)



en.wikipedia.org

Fungicidal Test Organisms

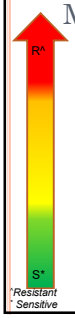
- *Trichophyton interdigitale (Trichophyton mentagrophytes)*
- *Aspergillus brasiliensis*
- *Microsporum canis*
- *Candida albicans*

Summary

THE MAIN BUCKETS OF MICROORGANISMS

Bacteria	Gram Positive Gram Negative	*Staphylococcus* *E. coli*
Spores	Resistant form of bacteria	*Clostridium difficile, Bacillus anthracis*
Viruses	Envelope or Non-Envelope	Influenza, Rhinovirus, HIV, HBV
Fungi	Multicellular	*Trichophyton, Aspergillus*

Effect of Disinfectants on Microorganisms



*Resistant
* Sensitive

Organism	Type	Examples
Bacterial Spores	Spore	*Bacillus anthracis, Clostridioides difficile*
Mycobacteria	Bacteria	*M. tuberculosis*
Small non-enveloped virus	Virus	Poliovirus, Norovirus, Rhinovirus, Hep A
Fungal spores	Fungus	Aspergillus, Penicillium, Trichophyton
Gram negative bacteria	Bacteria	*E. coli*, Klebsiella including CRE, Pseudomonas, Acinetobacter
Fungi (Vegetative)	Fungus	Candida
Large Virus (non-enveloped)	Virus	Adenovirus, Rotavirus
Gram positive bacteria	Bacteria	Staphylococcus including MRSA Enterococcus including VRE
Virus (enveloped)	Virus	HIV, HBV, HCV, Influenza, Coronavirus

Adapted from Rutala et al. ICHE 2014;35(7):862

References

- APIC Text Chapter 24, Microbiology Basics. Online at http://text.apic.org/
- Jarvis WD. *Bennett and Brachman's Hospital Infections,* 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2013. Chapter 11
- Jawetz, Melnick, & Adelberg's Medical Microbiology, 28e Eds. Stefan Riedel, et al. McGraw-Hill, 2019
- Hooten TM, et al. Diagnosis, prevention, and treatment of catheter associated urinary tract infection in adults: 2009 International clinical practice guidelines from the Infectious Diseases Society of America. Clin Infect Dis 2010;50(1 March):625-663

References

- Magill SS, et al. Multistate point-prevalence survey of health care–associated infections. N Engl J Med 2014;370:1198-208. DOI: 10.1056/NEJMoa1306801
- Magill SS, et al. Changes in prevalence of health care–associated infections in U.S. hospitals. N Engl J Med 2018;379:1732-44. DOI: 10.1056/NEJMoa1801550
- Dr. Prameet Sheth, Medical Microbiologist, Kingston General Hospital
- Rutala WA, Stiegel MM, Sarubbi FA and Weber DJ. Susceptibility of antibiotic-susceptible and antibiotic-resistant hospital bacteria to disinfectants. ICHE 1997;18(6):417-21

References

- Rutala WA, Weber DJ, HICPAC. Guideline for disinfection and sterilization in healthcare facilities 2008. Center for Disease Control, Atlanta GA http://www.cdc.gov/hicpac/pdf/guidelines/Disinfection_Nov_2008.pdf (accessed Dec 18, 2015)
- Rutala WA, Weber DJ. Selection of the ideal disinfectant. ICHE 2014;35(7):855-865
- Schwartz IS, et al. Something wicked this way comes: What health care providers need to know about Candida auris. Can Commun Dis Rep 2018;44(11):271–6. https://doi.org/10.14745/ccdr.v44i11a01

References

- Weber, DJ, Rutala WA. Use of germicides in the home and the healthcare setting: is there a relationship between germicide use and antibiotic resistance? ICHE 2006;27(10):1107-19

Contact Information

Rebecca Battjes, MPH, CIC, FAPIC
Senior Clinical Advisor, Infection Prevention
803 280 1742
@boxfulloletters
linkedin.com/in/rebecca-battjes-mph-cic-fapic-2a4361171
rebecca.battjes@diversey.com

Jim Gauthier, MLT, CIC
Senior Clinical Advisor, Infection Prevention
613 328 2288
@diverseybugman
linkedin.com/in/jim-gauthier-a7043542
james.gauthier@diversey.com

Gord Platt
Healthcare Representative
gord.platt@diversey.com