03 – Core Concepts: Microbiology
04 – Microbiology: What You Need to Know for The Exam
Speaker: Robin Patel, MD

IDBR INFECTIOUS DISEASE BOARD REVIEW AUGUST 20-24 2022

Core Concepts:
Microbiology: What You Need to Know for the Exam
and (some) Microbiology Questions That Could be on the Exam

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4/20/2022

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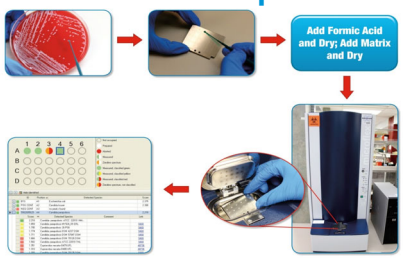
Disclosures of Financial Relationships with Relevant Commercial Interests

- Contracted Research: ContraFect, TenNor Therapeutics Limited, and BioFire
- Consultant: Curetis, Specific Technologies, Next Gen Diagnostics, PathoQuest, Selux Diagnostics, 1928 Diagnostics, PhAST, Torus Biosystems, Day Zero Diagnostics, Mammoth Biosciences, CARB-X, Qvella, Netflix
- Mayo Clinic and Dr. Patel have a relationship with Adaptive Phage Therapeutics and Pathogenomix
- Patents: Bordetella pertussis/parapertussis PCR; device/method for sonication; anti-biofilm substance

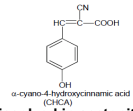
MALDI ToF Mass Spectrometry



MAYO CLINIC

MALDI ToF Mass Spectrometry

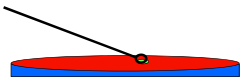
1. Add colony
2. Add matrix (1-2 µl)



α-cyano-4-hydroxycinnamic acid (CHCA)

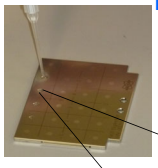
Dissolved in acetonitrile (50%) & 2.5% trifluoroacetic acid

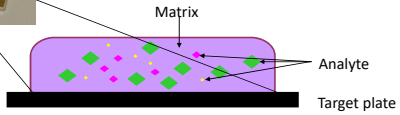
3. Dry – room air 5 min



MAYO CLINIC

Matrix Assisted Laser Desorption Ionization





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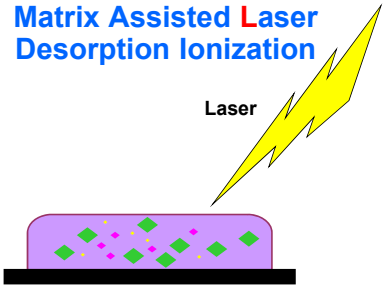
Matrix Assisted Laser Desorption Ionization



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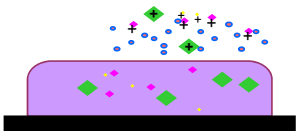
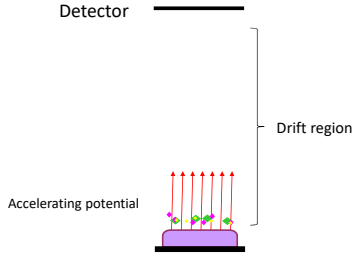
Matrix Assisted Laser Desorption Ionization



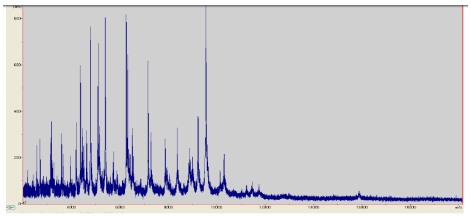
MAYO CLINIC

Time of Flight



MAYO CLINIC

Mass Spectrum Generated Compared with Library (Database)



QUESTION #1

PREVIEW QUESTION

Which of the following will not grow on sheep blood, chocolate and/or MacConkey agar?

A. *Granulicatella adiacens*
B. *Bordetella pertussis*
C. *Brucella melitensis*
D. *Vibrio cholerae*
E. *Abiotrophia defectiva*

BACTERIA REQUIRING SPECIALIZED MEDIA

- *Bordetella pertussis*
- *Brucella* species (+/-)
- *Burkholdheria pseudomallei* (+/-)
- *Campylobacter* species
- *Francisella tularensis* (+/-)
- *Helicobacter pylori*
- *Legionella* species
- *Mycoplasma* species (+/-)
- *Ureaplasma* species

QUESTION #2

PREVIEW QUESTION

Which of the following bacteria may stain acid-fast positive?

A. ***Rhodococcus* species**
B. ***Cutibacterium* species**
C. ***Finegoldia* species**
D. ***Microbacterium* species**
E. ***Wolbachia* species**

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ACID-FAST BACTERIA (MYCOLIC ACIDS)

- *Mycobacterium* species
- "Modified" acid fast stain positive
  - Weaker decolorizing agent (0.5-1% sulfuric acid in place of 3% acid-alcohol); do not stain well with Ziehl-Neelsen or Kinyoun stain
    - *Nocardia* species
    - *Rhodococcus* species
    - *Gordonia* species
    - *Tsukamurella* species
    - *Dietzia* species
- *Legionella micdadei* and some *Corynebacterium* species
  - [But not *Cutibacterium* species]

QUESTION #3

A laboratory technologist who has a longstanding history of diabetes mellitus inadvertently opens the lid of an agar plate growing an organism which is subsequently determined to be *Burkholdheria pseudomallei*.

You are asked to make a recommendation regarding postexposure prophylaxis.

QUESTION #3

Which of the following would you recommend?

A. Trimethoprim-sulfamethoxazole
B. Amoxicillin
C. Streptomycin
D. Cephalexin
E. None

Burkholderia pseudomallei

- Postexposure antimicrobial prophylaxis
  - Trimethoprim-sulfamethoxazole
  - Doxycycline
  - Amoxicillin–clavulanic acid

Peacock SJ et al. Emerg Infect Dis. 2008 Jul http://wwwnc.cdc.gov/eid/article/14/7/07-1501

QUESTION #4

Which of the following, if present in a clinical specimen, poses a hazard for laboratory personnel?

a. *Entamoeba histolytica*
b. *Trichuris trichiura*
c. *Enterobius vermicularis*
d. *Strongyloides stercoralis*
e. *Babesia microti*

Strongyloides stercoralis

- Larvae - two forms
  1. Rhabditiform (in stool)
  2. Filariform

  Infectious stage that develops in soil and occasionally in patient (leads to autoinfection and is hazardous to laboratory personnel)
- Larvae detected
  - Microscopically (top) or
  - By placing feces on plate and detecting migrating larvae where they leave a trail of bacterial colonies (bottom)

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LABORATORY- ACQUIRED BACTERIAL, FUNGAL AND PARASITIC INFECTIONS (SELECTED)

- *Bacillus anthracis*
- *Brucella* species
- *Burkholdheria pseudomallei*
  - (*Burkholdheria mallei*)
- *Coxiella burnetii*
- *Coccidioides immitis/posadasii* (*Blastomyces dermatitidis, Histoplasma capsulatum*)
- Dermatophytes
- Enteric pathogens
- *Francisella tularensis*
- *Mycobacterium tuberculosis*
- *Neisseria meningitidis*
- *Salmonella enterica* subsp. *enterica* serovar Typhi
- *Staphylococcus aureus*
- *Strongyloides stercoralis*
- *Yersinia pestis*

ORGANISMS ABOUT WHICH THE LABORATORY SHOULD BE NOTIFIED IF SUSPECTED

- **Avian influenza**
- ***Bacillus anthracis***
- ***Brucella* species**
- ***Burkholdheria pseudomallei***
- ***Burkholdheria mallei***
- ***Clostridium botulinum***
- ***Coxiella burnetii***
- ***Coccidioides immitis/posadasii***
- **Hemorrhagic fever viruses**
  (e.g., Ebola, Marburg, Chapare, Crimean-Congo, Guanarito, Hanta, Junin, Kayasnur Forest Disease, Lassa fever, Lujo, Machupo, Omsk Hemorrhagic Fever, Sabia)
- ***Francisella tularensis***
- **Measles**
- **MERS, SARS-CoV**
- **Nipah virus, Hendra virus**
- **Smallpox**
- ***Yersinia pestis***

FDA-APPROVED/CLEARED MULTIPLEX PANELS FOR GASTROINTESTINAL PATHOGENS IN STOOL (for reference)

	Verigene EP	Luminex GPP	BioFire GIP
Number of targets	8	14	22
Campylobacter species	✓	✓	✓
Salmonella species	✓	✓	✓
Shigella species/Enteroinvasive *E. coli*	✓	✓	✓
Vibrio species	✓	✓	✓
Yersinia enterocolitica	✓	✓	✓
Escherichia coli 0157		✓	✓
Enterotoxigenic *E. coli*		✓	✓
Enteropathogenic *E. coli*			✓
Enteroaggregative *E. coli*			✓
Plesiomonas shigelloides			✓
Shiga toxin-producing *E. coli*	✓	✓	✓
Clostridioides difficile		✓	✓
Norovirus	✓	✓	✓
Rotavirus A	✓	✓	✓
Astrovirus			✓
Adenovirus 40/41		✓	✓
Sapovirus			✓
Cryptosporidium species		✓	✓
Entamoeba histolytica		✓	✓
Giardia lamblia		✓	✓
Cyclospora cayetanensis			✓

GASTROENTERITIS PANEL TESTING KEY POINTS

- If available, culture independent methods of diagnosis recommended
- Indications: Dysentery, moderate-to-severe disease, and symptoms lasting >7 days (define etiology, inform potential treatment)
- Not recommended for chronic diarrhea
- If *C. difficile* main consideration, test for *C. difficile* alone
- *Aerococcus* species not included

Riddle et al. Am J Gastroenterol 2016;111:602–622

BIOFIRE FILMARRAY MENINGITIS/ENCEPHALITIS PANEL (for reference)

Viruses	Bacteria	Fungi
Cytomegalovirus	*Escherichia coli* K1	*Cryptococcus neoformans/gattii*
Enterovirus	*Haemophilus influenzae*	
Herpes simplex virus 1	*Listeria monocytogenes*	
Herpes simplex virus 2	*Neisseria meningitidis*	
Human herpes virus 6	*Streptococcus agalactiae*	
Human parechovirus	*Streptococcus pneumoniae*	
Varicella zoster virus		

MENINGITIS/ENCEPHALITIS PANEL KEY POINTS

- Doesn't nullify need for cell count, differential, protein, glucose, Gram stain, culture
- Cryptococcal antigen more sensitive than PCR
- *Streptococcus pneumoniae* antigen plus HSV, enterovirus and possibly VZV PCR an alternative
- May be helpful with current/recent antibiotic treatment
- HHV6 & CMV may not be clinically significant

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Lower Respiratory Tract Panels (for reference)

	Curetis Unyvero	BioFire
Bacteria		
Acinetobacter spp.	✓	
Acinetobacter calcoaceticus-baumannii complex		✓
Chlamydia pneumoniae	✓	✓
Citrobacter freundii	✓	
Enterobacter aerogenes		✓
Enterobacter cloacae complex	✓	✓
Escherichia coli	✓	✓
Haemophilus influenzae	✓	✓
Klebsiella oxytoca	✓	✓
Klebsiella pneumoniae	✓	
Klebsiella pneumoniae group		✓
Klebsiella variicola	✓	
Legionella pneumophila	✓	✓
Moraxella catarrhalis	✓	✓
Morganella morganii	✓	
Mycoplasma pneumoniae	✓	✓
Proteus spp.	✓	✓
Pseudomonas aeruginosa	✓	✓
Serratia marcescens	✓	✓
Staphylococcus aureus	✓	✓
Stenotrophomonas maltophilia	✓	
Streptococcus agalactiae		✓
Streptococcus pneumoniae	✓	✓
Streptococcus pyogenes		✓

	Curetis Unyvero	BioFire
Viruses		
Influenza A		✓
Influenza B		✓
Respiratory Syncytial Virus		✓
Human Rhinovirus/Enterovirus		✓
Human Metapneumovirus		✓
Parainfluenza virus		✓
Adenovirus		✓
Coronavirus (non-SARS-CoV)		✓
Fungi		
Pneumocystis jirovecii		
Resistance genes		
bla_{KPC}	✓	✓
bla_{NDM}	✓	✓
bla_{IMP}		✓
bla_{OXA-23}	✓	
bla_{OXA-24}	✓	
bla_{OXA-48}	✓	
$bla_{OXA-48-like}$		✓
bla_{VIM}	✓	✓
bla_{CTX-M}	✓	✓
bla_{TEM}	✓	
mecA	✓	
mecA/C and *MREJ*		✓

QUESTION #5

INFECTIOUS DISEASE BOARD REVIEW AUGUST 20-24 2022 PREVIEW QUESTION

- You are asked to see a 62 year old man with a positive blood culture to advise on management.
- Gram stain of the positive blood culture bottle shows Gram positive cocci in clusters.
- A rapid PCR panel performed on the positive blood culture bottle contents detects *Staphylococcus aureus*, *Staphylococcus epidermidis* as well as *mecA/C* but not *mecA/C* and MREJ.

QUESTION #5

INFECTIOUS DISEASE BOARD REVIEW AUGUST 20-24 2022 PREVIEW QUESTION

Which of the following is the interpretation of this finding?

A. Methicillin-susceptible *S. aureus* and methicillin-resistant *S. epidermidis*
B. Methicillin-susceptible *S. aureus* and methicillin-susceptible *S. epidermidis*
C. Methicillin-resistant *S. aureus* and methicillin-resistant *S. epidermidis*
D. Methicillin-resistant *S. aureus* and methicillin-susceptible *S. epidermidis*

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FDA-Approved Multiplex Panels for Detection of Gram-Positive Bacteria in Positive Blood Cultures (for reference)

	FilmArray BCID2	VERIGENE®	GenMark$_{dx}$	
		Gram-Positive Blood Culture Test	ePlex BCID-GP Panel	ePlex BCID-GN Panel
Staphylococcus species	✓	✓	✓	
Staphylococcus aureus	✓	✓	✓	
Staphylococcus epidermidis	✓	✓	✓	
Staphylococcus lugdunensis	✓	✓	✓	
Streptococcus species	✓	✓	✓	
Streptococcus agalactiae	✓	✓	✓	
Streptococcus pyogenes	✓	✓	✓	
Streptococcus pneumoniae	✓	✓	✓	
Streptococcus anginosus group		✓	✓	
Enterococcus species			✓	
Enterococcus faecalis	✓	✓	✓	
Enterococcus faecium	✓	✓	✓	
Listeria species		✓	✓	
Listeria monocytogenes	✓		✓	
Bacillus cereus group			✓	
Bacillus subtilis group			✓	
Corynebacterium species			✓	
Cutibacterium acnes			✓	
Lactobacillus species			✓	
Micrococcus species		✓	✓	
Pan Gram-Positive				✓

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FDA-Approved Multiplex Panels for Detection of Gram-Negative Bacteria in Positive Blood Cultures (for reference), continued

	FilmArray BCID2	VERIGENE®	GenMark$_{dx}$	
		Gram-Negative Blood Culture Test	ePlex BCID-GP Panel	ePlex BCID-GN Panel
Klebsiella oxytoca	✓	✓		✓
Klebsiella pneumoniae		✓		
Klebsiella pneumoniae group	✓			✓
Klebsiella aerogenes	✓	*		*
Salmonella species	✓			✓
Morganella morganii				✓
Stenotrophomonas maltophilia	✓			✓
Serratia species				✓
Serratia marcescens	✓	✓		✓
Proteus species	✓	✓		✓
Proteus mirabilis				✓
Acinetobacter species		✓		
Acinetobacter baumannii				✓
Acinetobacter calcoaceticus-baumannii complex	✓			
Hemophilus influenzae	✓			✓
Cronobacter sakazakii				✓
Neisseria meningitidis	✓			✓
Pseudomonas aeruginosa	✓	✓		✓
Enterobacterales	✓			
Escherichia coli	✓	✓		✓
Enterobacter species		✓		✓
Enterobacter cloacae complex	✓			✓
Citrobacter species		✓		✓
Bacteroides fragilis	✓			✓
Fusobacterium necrophorum				✓
Fusobacterium nucleatum				✓
Pan Gram-Negative			✓	

*Detected as *Enterobacter* species

MAYO CLINIC

FDA-Approved Multiplex Panels for Detection of Select Resistance Genes in Positive Blood Cultures (for reference), continued

	FilmArray BCID2	VERIGENE®		GenMark$_{dx}$	
		Gram-Positive Blood Culture Test	Gram-Negative Blood Culture Test	ePlex BCID-GP Panel	ePlex BCID-GN Panel
mecA		✓		✓	
mecC				✓	
mecA/C	✓				
mecA/C and MREJ	✓				
vanA		✓		✓	
vanB		✓		✓	
vanA/B	✓				
bla_{KPC}	✓		✓		✓
bla_{NDM}	✓		✓		✓
bla_{OXA}	✓		✓		✓
bla_{VIM}	✓		✓		✓
bla_{IMP}	✓		✓		✓
bla_{CTX-M}	✓		✓		✓
mcr-1	✓				

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FDA-Approved Multiplex Panels for Detection of Fungi in Positive Blood Cultures (for reference), continued

	FilmArray BCID2	GenMark$_{Dx}$ ePlex BCID-GP Panel	GenMark$_{Dx}$ ePlex BCID-FP Panel	GenMark$_{Dx}$ ePlex BCID-GN Panel
Candida albicans	✓		✓	
Candida auris	✓		✓	
Candida dubliniensis			✓	
Candida famata			✓	
Nakaseomyces glabrata	✓		✓	
Candida guilliermondii			✓	
Candida kefyr			✓	
Pichia kudriavzevii	✓		✓	
Candida lusitaniae			✓	
Candida parapsilosis	✓		✓	
Candida tropicalis	✓		✓	
Cryptococcus gattii			✓	
Cryptococcus neoformans			✓	
C. neoformans/gattii	✓			
Fusarium species			✓	
Rhodotorula species			✓	
Pan *Candida*		✓		✓

STAPHYLOCOCCI
METHICILLIN RESISTANCE

- Methicilllin resistance mediated by *mecA* (or rarely *mecC*) gene products
  - Penicillin binding protein (PBP) target altered (PBP2a)
    - Confers resistance to all available β-lactams (except ceftaroline)
    - Even if staphylococci that are methicillin-resistant *appear* susceptible to these other β-lactams, they are not effective
- Oxacillin or cefoxitin tested
- *mecA/C* and MREJ specific for *Staphylococcus aureus*
- For serious infections, susceptibility to oxacillin confirmed using PBP2a testing or nucleic acid amplification test (NAAT) to detect *mecA* (and *mecC*)

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T2Direct Diagnostics
Direct from Blood

- Multiplex PCR and T2 magnetic resonance, average turnaround time 4.3 hours
- T2Candida Panel
  - *Candida albicans*
  - *Candida tropicalis*
  - *Candida krusei*
  - *Candida glabrata*
  - *Candida parapsilosis*
- T2Bacteria Panel
  - *Enterococcus faecium*
  - *Staphylococcus aureus*
  - *Klebsiella pneumoniae*
  - *Pseudomonas aeruginosa*
  - *Escherichia coli*

QUESTION #6

- **A 52 year old woman receives a liver transplant (CMV D^+/R^-) at your medical center.**
- **Seven months later (after she has completed a course of valganciclovir), she develops fever and diarrhea and is found to have a CMV viral load of 20,000 IU/ml.**
- **In addition to treating the patient with intravenous ganciclovir and performing a colonoscopy to assess for CMV colitis, you recommend follow-up CMV viral load testing.**

QUESTION #6

How often should this test be performed?

A. Daily
B. Twice a week
C. Weekly
D. Every two weeks
E. Monthly

OPTIMAL FREQUENCY CMV VIRAL LOAD TESTING

- **Weekly viral load testing sufficient to document antiviral response, antiviral resistance emergence**
  - **$T_{1/2}$ virus ~5-8 days**
  - **May rise 1st few days on therapy**
  - **Obtain baseline viral load day therapy started**
- **Treatment**
  - **Until viral clearance, symptom resolution and 2 week minimum**
- **Changes >3-fold (>0.5 log)**
  - **Biologically important changes in viral replication**
- **Preemptive treatment → weekly viral load testing**

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QUESTION #7

You are consulted to advise on the course of action for a 57 year old female liver transplant recipient (transplant for alcoholic steatohepatitis; CMV D^+/R^+) who has a whole blood HHV-6 viral load of $3.6x10^6$ copies/ml at three months post-transplant. The test was performed because of a report of subjective fever of four days' duration. She has no other new symptoms. The patient received one month of acyclovir prophylaxis post-transplant and is currently receiving mycophenolate mofetil, prednisone and trimethoprim-sulfamethoxazole. Her post-transplant course was complicated by one episode of treated rejection on day 30 post transplant. Physical examination is unremarkable and she is afebrile.

QUESTION #7

Which of the following would you recommend?

A. Intravenous ganciclovir
B. Oral valganciclovir
C. Oral acyclovir
D. Intravenous foscarnet
E. No antiviral therapy is indicated

CHROMOSOMALLY INTEGRATED HUMAN HERPESVIRUS-6

- High HHV-6 levels in whole blood
  - (>5.5 $\log_{10}$ copies/ml)
  - Suggest chromosomally integrated HHV-6
- 1:1 ratio of viral to human genomes

Pellett et al. Rev Med Virol 2012;22:144-55

QUESTION #8

A 65 year old man has multiple blood cultures positive for *Pseudomonas aeruginosa* resistant to amikacin, gentamicin, tobramycin, aztreonam, cefepime, ceftazidime, meropenem, piperacillin-tazobactam, ciprofloxacin, and levofloxacin. You call the clinical microbiology laboratory to request susceptibility testing of an additional antimicrobial.

Which of the following is most appropriate?

A. Dalbavancin
B. Tedizolid
C. Ceftolozane/tazobactam
D. Oritavancin

QUESTION #9

You are asked to see a 43 year old woman to advise on management of a positive blood culture.

- Gram stain of her blood culture bottle shows Gram-negative bacilli.
- A rapid PCR panel performed on the positive blood culture bottle contents detects *Enterobacteriaceae* and bla_{KPC}.

QUESTION #9

The bla_{KPC} gene product would be expected to confer resistance to which of the following?

A. Cefepime
B. Plazomicin
C. Colistin
D. Ceftazidime/avibactam

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TYPICAL SUSCEPTIBILITY OF A *bla*$_{KPC}$-PRODUCER

Klebsiella pneumoniae

Ampicillin	>16 R	Ampicillin/Sulbactam	>16/8 R	Piperacillin/Tazobactam	64/4 R
Cefazolin	>16 R	Oral cephalosporins	R	Cefepime	>16 R
Ceftazidime	>16 R	Ceftriaxone	>32 R	Ertapenem	>1 R
Meropenem	>8 R	Aztreonam	>16 R	Ciprofloxacin	>2 R
Levofloxacin	4 I	Amikacin	>32 R	Gentamicin	>8 R
Tobramycin	4 S	Tigecycline	2 S	TMP/SMX	>2/38 R

TYPICAL SUSCEPTIBILITY OF AN ESBL-PRODUCER

Escherichia coli

Ampicillin	>16 R	Ampicillin/Sulbactam	>16/8 R	Piperacillin/Tazobactam	S/R*
Cefazolin	>16 R	Oral cephalosporins	R	Cefepime	S/SDD/R
Ceftazidime	>16 R	Ceftriaxone	>32 R	Ertapenem	≤0.5 S
Meropenem	≤1 S	Aztreonam	>16 R	Ciprofloxacin	≤1 S
Levofloxacin	≤2 S	Amikacin	≤8 S	Gentamicin	≤1 S
Tobramycin	4 S	Tigecycline	2 S	TMP/SMX	>2/38 R

*Not currently recommended for infection outside of urinary tract

TYPICAL SUSCEPTIBILITY OF INDUCIBLE, CHROMOSOMALLY-ENCODED AmpC β-LACTAMASE PRODUCER

Enterobacter species*

Ampicillin	>16 R	Ampicillin/Sulbactam	>16/8 R	Piperacillin/Tazobactam	S/R*
Cefazolin	>16 R	Oral cephalosporins	R	Cefepime	S/SDD
Ceftazidime	>16 R	Ceftriaxone	>32 R	Ertapenem	≤0.5 S
Meropenem	≤1 S	Aztreonam	S/R	Ciprofloxacin	≤1 S
Levofloxacin	≤2 S	Amikacin	≤8 S	Gentamicin	≤1 S
Tobramycin	4 S	Tigecycline	2 S	TMP/SMX	>2/38 R

*Cefoxitin S; avoid expanded-spectrum cephalosporins even if test susceptible; cefepime an acceptable choice

QUESTION #10

Which of the following susceptibility patterns would be typical for an *Escherichia coli* isolate carrying a New Delhi metallo-β-lactamase (NDM)?

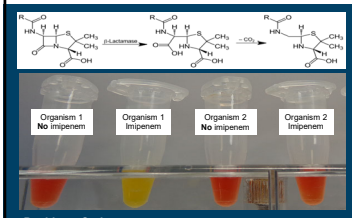
	Cefazolin	Cefotaxime	Ceftazidime	Piperacillin/ tazobactam	Imipenem	Aztreonam
a)	R	S	S	S	S	S
b)	R	R	R	S	S	R
c)	R	R	R	R	S	R
d)	R	R	R	R	R	R

QUESTION #11

Which of the following tests for carbapenemase production?

A. PBP2a test
B. D-test
C. Carba NP test
D. Polymerase chain reaction assay

CARBAPENEMASE PRODUCTION TEST
Carba NP TEST



Positive = Carbapenemase Producer

Negative = Carbapenemase Non-Producer

- β-lactam ring hydrolyzed by carbapenemase
- ↓pH (detected by indicator dye color change red → yellow)
- Rapid (2 hours)

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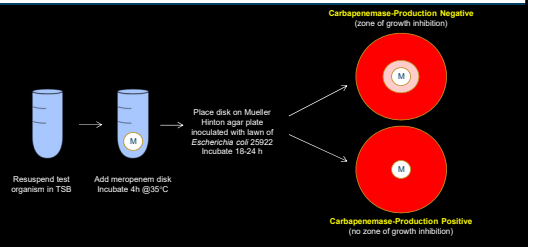
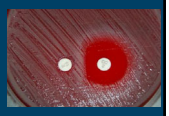
CARBAPENEMASE PRODUCTION TEST MODIFIED CARBAPENEM INACTIVATION



QUESTION #12

The image shows *Staphylococcus aureus* grown with an erythromycin disc (left) and a clindamycin disc (right).

Which of the following is the correct interpretation of these results?



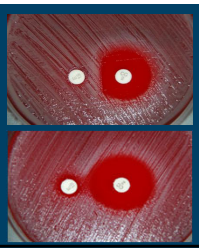
A. **Erythromycin susceptibility, inducible clindamycin resistance**
B. **Erythromycin resistance, constitutive clindamycin resistance**
C. **Erythromycin resistance, inducible clindamycin resistance**
D. **Erythromycin susceptibility, constitutive clindamycin resistance**

INDUCIBLE CLINDAMYCIN RESISTANCE (D-TEST)

- Macrolide resistance from alteration in ribosomal target → co-resistance to clindamycin; constitutive or inducible
  - Constitutive, erythromycin & clindamycin test resistant
  - Inducible, erythromycin tests resistant but clindamycin tests falsely susceptible
- (Macrolide resistance due to efflux → no effect on clindamycin)

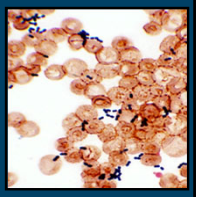
INDUCIBLE CLINDAMYCIN RESISTANCE (D-TEST)

- Erythromycin & clindamycin disks incubated on plate
  - Flattening of zone of inhibited growth between disks = inducible clindamycin resistance (top)
  - If erythromycin does not influence zone around clindamycin disk, clindamycin susceptible (bottom)



QUESTION #13

- **You are asked to see a 95 year old woman who is a resident of a long-term care facility to advise on therapy for bacteremia associated with a urinary tract infection.**
- **She has had two sets of blood cultures collected, both of which signaled positive after 17 hours of incubation.**
- **Gram stain of the bottles is shown.**
- **A rapid PCR panel performed on the positive blood culture bottle detects *Enterococcus* species as well as *vanA/vanB*.**



QUESTION #13

Which of the following is the most likely identity of the blood culture isolate?

A. ***Enterococcus gallinarum***
B. ***Enterococcus faecium***
C. ***Enterococcus faecalis***
D. ***Enterococcus casseliflavus***
E. ***Enterococcus avium***

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ENTEROCOCCI
VANCOMYCIN SUSCEPTIBILITY TESTING

- **Vancomycin MICs ≥32 µg/ml**
  - Typically VanA or VanB mediated resistance
  - Typically *E. faecium*
  - Epidemiologically significant
- **Vancomycin MICs, 8-16 µg/ml (intermediate)**
  - VanC
  - *E. gallinarum* or *E. casseliflavus/flavescens*
  - Not epidemiologically significant

QUESTION #14

A 44 year old man who underwent bilateral lung transplantation for pulmonary hypertension develops a sternal wound infection with sternal dehiscence 15 days post-transplant.

Blood cultures are negative. He undergoes sternal debridement with the finding of purulence and negative Gram and KOH stains.

After three days of incubation, pinpoint, clear colonies are visualized on cultures on sheep blood agar, however Gram stain of these colonies is negative.

QUESTION #14

Which of the following is the most appropriate empiric antibiotic to treat this patient?

a) Cefepime
b) Ceftriaxone
c) Trimethoprim-sulfamethoxazole
d) Azithromycin
e) Doxycycline

Mycoplasma hominis

- Post-cardiothoracic transplant
  - Pleuritis, surgical site infection and/or mediastinitis
- Treatment
  - Inactive
    - Cell wall active antibiotics
    - Trimethoprim/sulfamethoxazole
    - Aminoglycosides
    - Erythromycin and azithromycin
  - Active
    - Tetracyclines (doxycycline preferred)
    - Fluoroquinolones
    - Clindamycin

Sampath, R., et al. EBioMedicine (2017), http://dx.doi.org/10.1016/j.ebiom.2017.04.026

QUESTION #15

A transplant hepatologist calls to inquire about ganciclovir resistance testing on a liver transplant patient with CMV colitis and the following CMV viral loads:

7/01/16: 26,000 IU/ml (day of diagnosis)
7/11/16: 25,000 IU/ml
7/20/16: 22,000 IU/ml
7/31/16: 27,000 IU/ml

- **The patient is CMV D^+/R^-, received 3 months of valganciclovir prophylaxis, and now has CMV disease after discontinuing valganciclovir.**
- **He has been receiving full dose intravenous ganciclovir since July 1st and his diarrhea is unchanged.**

QUESTION #15

A plasma test for mutations in which of the following genes is most appropriate?

A. UL51
B. UL54
C. UL89
D. UL97
E. Testing is unlikely to be helpful given the patient's viral load

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QUESTION #16

Results of testing show a M460V UL97 mutation. This mutation would be expected to confer resistance to:

A. Cidofovir
B. Foscarnet
C. Ganciclovir
D. Ganciclovir and foscarnet
E. Ganciclovir and cidofovir

CYTOMEGALOVIRUS ANTIVIRAL RESISTANCE

- **Risk factors**
  - Prolonged drug exposure
  - D+R-, lung transplant recipient
- **Amplify and sequence directly from plasma**
  - (viral load ~1,000 IU/ml required)
- **≥6 weeks antiviral drug exposure**
  - Should include ≥2 weeks full-dose therapy before testing
  - Accelerated schedule: Poor host factors, extreme viral loads

Gene	Drug(s) affected
UL97	Ganciclovir, marabavir
UL54	Ganciclovir and cidofovir (if selected for by these agents); foscarnet (if selected for by foscarnet)
UL56	Letermovir

Kotton CN et al. Transplantation 2013;96:333 and Chou S. Curr Opin Infect Dis 2015;28:293

COVID-19 DIAGNOSTICS

- Healthcare provider or patient collected specimens acceptable
- Nasopharyngeal swab, mid-turbinate swab, anterior nasal swab, saliva or combined anterior nasal/oropharyngeal swab acceptable
- Suspected lower respiratory infection → upper respiratory sample; if negative, lower respiratory sample
- Interpret Ct values with caution
- NAAT generally preferred over antigen testing
  - Symptomatic individuals suspected of having COVID-19
  - Asymptomatic individuals exposed to SARS-CoV-2 infection
- Avoid serologic testing for diagnosis in the 2 weeks post symptom onset
  - IgG or total antibody tested 3-4 weeks post symptom onset provide evidence of past SARS-CoV-2 infection (clinical or epidemiological purposes)
  - Avoid IgA tests

IDSA Guidelines on the Diagnosis of COVID-19