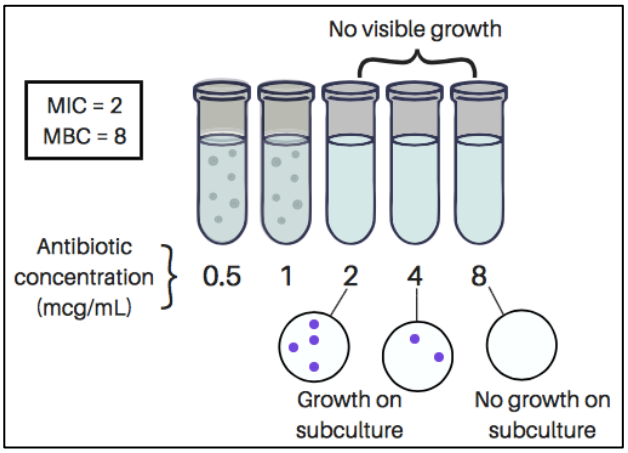
Bacterial Resistance Cheat Sheet

IDSTEWARDSHIP TRAINING
at www.LearnAntibiotics.com

Antimicrobial resistance is incredibly complex. This cheat sheet is meant to be a quick study reference and is not a comprehensive resource for clinical decision making.

Definitions (Generalization)	
Pan drug-sensitive (aka pan-sensitive)	An organism sensitive to all drugs typically tested for potential treatment
Multidrug-resistant (MDR)	An organism resistant to a few drug classes typically used for treatment
Extensively drug-resistant (XDR)	An organism resistant to most drug classes typically used for treatment
Pan drug-resistant (PDR)	An organism resistant to all drug classes typically used for treatment
Minimum inhibitory concentration (MIC)	The lowest antibiotic concentration to inhibit bacterial growth
Minimum bactericidal concentration (MBC)	The lowest antibiotic concentration to kill a bacteria
Breakpoint	MIC cut points for differentiating an organism as S, I, or R
Sensitive (S)	An organism with an MIC at or below the assigned breakpoint for sensitive
Intermediate (I)	An organism with an MIC that falls between the breakpoint for S and R
Resistant (R)	An organism with an MIC that is above the breakpoint for S or I

- The lowest MIC does not necessarily indicate the best drug to select for an infection and thus MICs are not always reported
- MIC testing can be done in several ways, the method pictured here on the right is called broth dilution
- Molecular-based tests for antimicrobial resistance such as PCR, PNA-FISH, MALDI-TOFF, and microplex multiarrays provide more rapid results than traditional sensitivity testing and are revolutionizing the field of clinical microbiology by enabling faster decision making
- Breakpoints are defined by organizations such as CLSI and EUCAST
- Breakpoints can change as guidelines are updated
- Breakpoints may vary by site of infection (*e.g.,* urine versus blood)
- Breakpoints are specific to each bacteria-antibiotic combination
- When the lab reports a list of antibiotics for which a bacteria is S, I, or R, that is called an antibiogram



Antimicrobial resistance can be intrinsic (*i.e.*, chromosomal) or acquired (*e.g.*, via plasmids)
The 4 main mechanisms of microbial resistance that can be present are…

1. **Change in the binding site**: changes at the site of action confer bacterial resistance (*i.e.*, "the lock changes")
2. **Enzymatic degradation**: enzymes that hydrolyze antibiotics, disrupting their structure and rendering them inactive
3. **Porin channels**: loss of porin channels confers reduced ability for antibiotics to penetrate into the microbe
4. **Efflux pumps**: increased efflux pump activity reduces the concentration of antibiotic inside the bacterial cell

Bonus: *Staphylococcus aureus* can have increasing MICs to glycopeptides like vancomycin via thickening of the cell wall

Some Important Resistance Genes		
Gene / Protein/ Enzyme	Resistance Type	Notes
MecA	Binding site change	PBP2 changes to PBP2a → MSSA into MRSA
VanA, VanB, VanC	Binding site change	Leads to vancomycin resistance in Enterococci
gyrA, gyrB, parC	Binding site change	Can cause fluoroquinolone resistance
Erm	Binding site change	Can cause plasmid-mediated resistance in clindamycin & macrloides
TetA, TetB, TetC	Efflux pump	Can make *E. coli* resistant to tetracyclines
OprD	Porin channel	Can make *Pseudomonas aeruginosa* resistant to carbapenems
KPC, CTX-M, TEM, SHV	Enzymatic	Ambler class A
NDM, VIM, IMP	Enzymatic	Ambler class B, zinc-dependant metallo-beta-lactamases
AmpC	Enzymatic	Ambler class C, inducible-type resistance
Oxa	Enzymatic	Ambler class D

- The Ambler classification is used to differentiate β-lactamases that hydrolyze β-lactam antibiotics

OTHER NOTES

- The "SPACE-M" organisms can harbor an inducible AmpC gene. These organisms are: *Serratia*, *Pseudomonas*, *Acinetobacter*, *Citrobacter*, *Enterobacter*, and *Morganella*
  - The potential to induce AmpC-mediated resistance varies by bacterial species
- A D-test can be utilized to detect the *Erm* gene and determine if inducible clindamycin resistance is present in MRSA
  - In this test erythromycin and clindamycin are used, the presence of *erm* causes a D shape in bacterial growth