Class	Example(s)	Mechanism of action	Spectrum	Side effects / Notes
BETA-LACTAMS				
PENICILLINS				
Natural Penicillins	PCN G PCN VK (oral)	all beta lactam antibiotics bind penicillin-binding-proteins (PBP's) to inhibit bacterial cell wall synthesis NOTE: antimicrobial effect depends on *time over MIC*	GPC (streptococci, enterococci, PCN-S staph) *N. meningitidis* *T. pallidum* (syphilis) Actinomycosis	Allergy / rash GI intolerance including *C diff* Neurologic (encephalopathy / seizure) immune-mediated cytopenias JH reaction (when treating syphilis) (NOTE: these apply to all beta-lactams - additional / idiosyncratic SE's listed for each class below)
Penicillinase-resistant (anti-staphylococcal) Penicillins	Nafcillin Oxacillin		MSSA	interstitial nephritis (nafcillin) hepatitis (oxacillin)
Aminopenicillins	Amoxicillin (oral) Ampicillin (IV)		similar to natural penicillins but better gram neg coverage (e.g. *H. flu* , *E. coli*)	rash (idiosyncratic with EBV)
Anti-Pseudomonal Penicillins	Ticarcillin Piperacillin		improved gram negative coverage including *Pseudomonas* and anaerobes (e.g. *Bacteriodes fragilis*)	leukopenia and thrombocytopenia including bleeding diathesis (rare) interstitial nephritis hepatitis
CEPHALOSPORINS				
General information	see below for each generation	all beta lactam antibiotics bind penicillin-binding-proteins (PBP's) to inhibit bacterial cell wall synthesis NOTE: antimicrobial effect depends on *time over MIC*	rule of thumb: successive generations have increasing gram neg and decreasing gram pos coverage; enterococci are instrinsically resistant to cephalosporins	usually well-tolerated even in persons with reported PCN allergy SE profile similar to PCN's: allergic reactions (often with eosinophilia), hepatitis, cytopenias, and CNS effects (confusion, seizures)
1st gen	Cephalexin (oral) Cefazolin (IV)		Primarily gram positives e.g. MSSA, streptococci Some aerobic gram neg e.g. *E. coli* , *Klebsiella* Poor anaerobic coverage	
2nd gen	Cefuroxime (oral) Cefotetan Cefoxitin		still some activity vs. gram positives but used more commonly for gram neg aerobes (*H. flu* ; *Moraxella; E. Coli*) Cefotetan and Cefoxitin are active against *Bacterioides fragilis* but resistance is increasing	Disulfiram-like reaction with ETOH (cefotetan)
3rd gen	Cefdinir (oral) Cefpoxodime (oral) Cefotaxime Ceftazidime Ceftriaxone		enhanced gram neg coverage due to beta-lactamase stability less activity against gram positives BUT cefotaxime and ceftriaxone remain active vs. *S. pneumo* good CSF penetration Ceftazidime active vs. *Pseudomonas* Common uses: *N. meningitidis; N. gonorrhea; S. pneumo; Enterobacteriaceae*	biliary sludge (ceftriaxone)
4th gen	Cefepime		excellent gram neg including *Pseudomonas;* poor activity vs. gram pos cocci; good CSF penetration	injection site reaction; GI intolerance; cytopenias; hypophosphatemia
5th gen	Ceftaroline		Staph aureus (including MRSA, VRSA, VISA); streptococci; *E. faecalis* ; Enterobacteriaceae (but NOT *Pseudomonas)*	GI intolerance; cytopenias; hypokalemia; pruritis

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MONOBACTAMS	Aztreonam	all beta lactam antibiotics bind penicillin-binding-proteins (PBP's) to inhibit bacterial cell wall synthesis NOTE: antimicrobial effect depends on *time over MIC*	gram neg *only* , including *Pseduomonas* (if not resistant); particularly for PCN-allergic patients	safe in patients with PCN allergy
CARBAPENEMS	Imipenem-cilastatin Meropenem Ertapenem Doripenem	all beta lactam antibiotics bind penicillin-binding-proteins (PBP's) to inhibit bacterial cell wall synthesis NOTE: antimicrobial effect depends on *time over MIC*	gram pos, neg and anaerobes; particularly useful for enterobacteriaceae with extended spectrum beta-lactamase (ESBL); note: ertapenem does NOT have activity vs. Pseudomonas	usually well-tolerated even in persons with reported PCN allergy SE profile similar to PCN's: allergic reactions (often with eosinophilia), hepatitis, cytopenias, and seizures (especially with imipenem-cilastatin in setting of renal insufficiency)
BETA-LACTAM / BETA-LACTAMASE INHIBITOR COMBINATIONS	see below for each generation	bacteria produce beta-lactamases to break up the beta-lactam ring, thus rendering beta-lactam antibiotics ineffective; by adding a beta-lactamase inhibitor, these drugs restore the beta-lactam activity and extend the antimicrobial spectrum		SE profile similar to other beta-lactams: allergic reactions (often with eosinophilia), hepatitis, interstitial nephritis; cytopenias, and CNS toxicity (seizures) especially in setting of renal failure
	Amoxicillin-clavulanate		MSSA and beta-lactamase producing *H. flu*	rash (idiosyncratic with EBV)
	Ampicillin-sulbactam		MSSA and beta-lactamase producing *H. flu* , anaerobes; *Acinetobacter*	
	Ticarcillin-clavulanate Piperacillin-tazobactam		aerobic gran neg including *Pseudomonas*	high sodium content platelet dysfunction
	Ceftolazone-tazobactam Ceftazidime-avibactam		aerobic gram neg including *Pseudomonas* and most ESBL Enterobacteriaceae (complicated UTI / intra-abdominal infection)	lower cure rates in patients with reduced GFR
	Meropenem-Vaborbactam		aerobic and anaerobic gram positives and negatives, including *Pseudomonas,* ESBL Enterobacteriaceae and some carbapenemase-producing gram negatives (such as KPC); approved for complicated UTI	injection site reaction; GI intolerance; elevation of liver function tests; hypokalemia; lowered seizure threshold

Class	Example(s)	Mechanism of action	Spectrum	Side effects / Notes
NON-BETA-LACTAM ANTIBIOTICS				
QUINOLONES	Ciprofloxacin Levofloxacin Moxifloxacin	block DNA snythesis (via gyrase inhibition); note 100% bioavailability	spectrum varies by drug: cipro - gram neg, including *Pseudomonas* levofloxacin - gram neg but also streptococci, atypical respiratory pathogens *(Legionella; mycoplasma)* moxifloxacin - gram neg including anaerobes, also streptococci, atypical respiratory pathogens, non-tuberculous mycobacteria	QT interval prolongation tendinopathy / rupture
AMINOGLYCOSIDES	Gentamicin Tobramycin Amikacin	inhibit protein synthesis (bind 30S ribosomal subunit); NOTE: *concentration-dependent* killing with post-antibiotic effect	aerobic gram neg bacilli, including *Pseudomonas;* atypical mycobacteria; part of combination therapy for some forms of endocarditis (e.g. enterococcus, certain streptococci, prosthetic valve endocarditis)	nephrotoxicity ototoxicity (can be irreversible)
TETRACYCLINES	Tetracycline Doxycycline	inhibit protein synthesis (bind 30S ribosomal subunit)	atypical respiratory pathogens (*Chlamydia* , *Mycoplasma*) STI's (1st line for *Chlamydia;* also gonorrhea and syphilis in PCN-allergic patients multiple vector-born diseases e.g. RMSF and other rickettsial infections, Lyme disease	GI upset esophageal ulcerations (pill esophagitis) photosensitivity stains / deforms teeth in children
GLYCYLCYCLINE	Tigecycline	inhibit protein synthesis (bind 30S ribosomal subunit)	broad spectrum - MRSA, VRE, ESBL gram negatives, *C diff* however, side effects and poor blood levels limit utility (cannot use in bacteremia)	nausea / vomiting renal and liver toxicity some reports of increased mortality with use
LINCOSAMIDES	Clindamycin	inhibit protein synthesis (bind 50S ribosomal subunit)	gram positive aerobes (strep, staph including MRSA); anaerobes "above the belt" (*Fusobacterium* ; *Prevotella* ; *Peptostreptococcus*)	most likely to cause *C diff*
MACROLIDES	Erythromycin (rarely used) Azithromycin Clarithromycin	inhibit protein synthesis (bind 50S ribosomal subunit)	most upper respiratory pathogens (*S. pneumo* , *moraxella* , *H. flu*) and atypical PNA pathogens (*Legionella* , *Chlamydia* , *Mycoplasma*); some gram negative rods such as causes of traveler's diarrhea (*E. coli* , *Shigella*); STI's (*N. gonorrhea* ; *Chlamydia*); part of treatment for atypical mycobacteria (e.g. MAC)	GI intolerance QT prolongation (one study with increased risk of CV death)
NITROIMIDAZOLES	Metronidazole	disrupts host cell DNA	anaerobes "below the belt" (bacterial vaginosis; *Bacteroides* ; *Clostridium* including *C diff*); *Trichomonas*	GI intolerance (common) Disulfiram-like reaction with ETOH CNS effects (neuropathy, encephalopathy, tremors)
OXAZOLIDINONES	Linezolid Tedizolid	inhibit protein synthesis (bind 50S ribosomal subunit)	gram positives, including MRSA, MSSA, strep, enterococcus including VRE	bone marrow suppression (especially anemia and thrombocytopenia) serotonin syndrome (if given with SSRI) lactic acidosis optic neuritis or peripheral neuropathy

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GLYCOPEPTIDE	Vancomycin	inhibits bacterial cell wall synthesis by binding D-ala-D-ala	gram positives, including MRSA, vanc-S enterococcus; *C diff* (with oral administration) NOTE - inferior to anti-staph PCN for treatment of MSSA	Red man syndrome (note - NOT an allergy; improves with prolonged infusion) phlebitis renal dysfunction allergic reaction with rash neutropenia, thrombocytopenia
CYCLIC LIPOPEPTIDES	Daptomycin	binds bacterial membrane causing depolarization of membrane potential and cell death	gram positives, including MSSA, MRSA, VRE	elevated CPK and/or myopathy (d/c statins during therapy) elevated LFT's eosinophilic pneumonia
POLYMYXINS	Colistin (Polymyxin E) Polymyxin B	disupts cell membrane	reserved for treatment of resistant gram negatives due to toxicities NOTE: dosing is complex and depends on formulation	nephrotoxicity neurotoxicity (paresthesia, vertigo, visual problems)
RIFAMYCINS	Rifampin Rifabutin	inhibit bacterial DNA-dependent RNA polymerase	tuberculosis and non-tuberculous mycobacteria adjunctive therapy for some forms of staphylococcal endocarditis or infections involving a biofilm (e.g. prosthetic joint infections) should not be used as monotherapy due to rapid emergency of resistance	many drug interactions as revs up P450 system causes red-orange discoloration of body fluids hepatitis
SULFONAMIDES	Trimethoprim-Sulfamethoxazole	inhibits enzymes along bacterial folic acid pathway	broad spectrum including Staph (MRSA and MSSA); gram negatives especially in treatment of UTI; PCP and Toxoplasmosis; *Nocardia* ; *Listeria;* non-tuberculous mycobacteria	rash (including severe reactions e.g. SJS) GI intolerance elevated Cr (due to decreased secretion of Cr) hyperkalemia, possible Type IV RTA bone marrow suppression hemolysis and/or methemoglobinemia in patients with G6PD deficiency hepatitis (often cholestatic)
SULFONES	Dapsone	inhibits enzymes along bacterial folic acid pathway	Leprosy; PCP and Toxoplasmosis	rash (including severe reactions e.g. SJS) hepatitis blood dyscrasias including methemoglobinemia (with or without G6PD deficiency)
NITROFURANTOIN	Nitrofurantoin	bacterial flavoproteins metabolize the drug to reactive intermediates that disrupt ribosomal proteins	UTI pathogens (*E. coli* , *Staph saprophyticus* , *E. faecalis* , some *Enterobacter sp.*) NOTE: drug is inactivated by most body tissues, so only effective in urinary tract	acute hypersensitivity with pulmonary symptoms / infiltrates Pulmonary fibrosis with long-term use hemolysis and methemoglobinemia with G6PD deficiency Neuropathy Lupus-like reaction

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ANTI-FUNGALS				
POLYENES	Amphotericin B (deoxycholate B; lipid formulations) Nystatin	bind sterols of fungal cell wall leading to leakage of cellular contents and cell death	**Amphotericin:** very broad antifungal spectrum **Nystatin:** limited to oral / topical use for *Candida* infections	**Amphotericin:** "shake and bake" infusion reaction with chills, rigors (seen with older formulation - amphotericin B deoxycholate) nephrotoxicity and electrolyte disurbances (less common with lipid formulations) **Nystatin:** GI / skin irritation
ECHINOCANDINS	Caspofungin Micafungin Anindulafungin	block fungal cell wall synthesis by inhibiting beta-D-glucan synthesis	*Candidas spp.* (including most azole-resistant strains) *Aspergillus* NOTE: not effective against *Cryptococcus sp.* or Mucorales	generally very well tolerated hepatotoxicity but typically asymptomatic elevation of LFT's
AZOLES	Triazoles: Fluconazole Itraconoazole Voriconazole Posaconazole Isavuconazole Imidazoles: Ketoconazole	block fungal cell wall synthesis by inhibiting ergosterol synthesis	Vary by drug **Fluconazole:** active against yeasts including *Candida* ; *Cryptococcus* ; NOT effective against molds **Itraconazole:** fairly broad spectrum including treatment of endemic fungi, but use limited by inconsistent bioavailability **Voriconazole:** *Aspergillus* and other resistant molds (*Scedosporium* ; *Fusarium*); fluconazole-resistant *Candida (C. glabrata* ; *C. krusei*) **Posaconazole and Isavuconazole**: similar to voriconazole but with addition of activity against Mucorales **Ketoconazole:** rarely used due to SE profile / drug interactions	All: hepatotoxicity Drug specific: **Fluconazole:** dry skin, alopecia; renal toxicity **Itraconazole:** requires food and acidic gastric pH for absroption (tell patients to drink a Coke); cardiac dysfunction **Voriconazole:** vision changes / hallucinations; photosensitivity; QT prolongation; periostitis (with elevation in serum fluoride levels) **Posaconazole:** QT prolongation **Isavuconazole:** GI intolerance; peripheral edema; *shortens* QT interval **Ketoconazole:** adrenal insufficiency