

Antibiotic Target Atlas

Every major antibiotic class sorted by the part of the bacterial cell it attacks.

Find the target on the cell, then read the class cards below for the exact mechanism, spectrum and key examples.

① Cell wall synthesis

β -lactams · vancomycin · fosfomycin

④ 50S ribosome

macrolides · chloramphenicol · linezolid

② Cell membrane

polymyxin B · colistin · daptomycin

③ 30S ribosome

aminoglycosides · tetracyclines

⑦ Mycobacterial wall

isoniazid · ethambutol · pyrazinamide

⑤ RNA synthesis

rifampicin → RNA polymerase

⑤ DNA replication

fluoroquinolones → gyrase · metronidazole

⑥ Folate synthesis

sulfonamides · trimethoprim

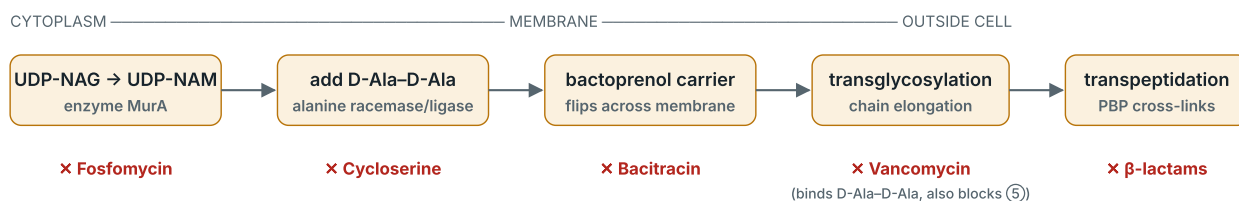
Schematic Gram-positive-style rod. Gram-negatives add an outer membrane outside the wall (target of polymyxins).

CIDAL kills bacteria **STATIC** stops growth; immune system clears

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Cell wall synthesis inhibitors

Peptidoglycan is built in the cytoplasm (NAM–NAG units), carried across the membrane on bactoprenol, then cross-linked outside by penicillin-binding proteins (PBPs). Humans have no peptidoglycan, so these drugs are highly selective.



Each step of peptidoglycan assembly has its own inhibitor. Reading left to right is the order of synthesis.

Penicillins

CIDAL

Penicillin G/V, ampicillin, amoxicillin, methicillin, oxacillin, piperacillin

β -lactam ring mimics D-Ala–D-Ala and acylates PBPs (transpeptidases), blocking cross-linking. Autolysins then lyse the weakened cell.

SPECTRUM Gram +; extended forms reach some Gram –

RESISTANCE β -lactamases (counter with clavulanate, tazobactam); altered PBP2a in MRSA

Cephalosporins

CIDAL

Cefazolin (1st), cefuroxime (2nd), ceftriaxone (3rd), cefepime (4th), ceftaroline (5th)

Same PBP target as penicillins, with a 7-aminocephalosporanic acid nucleus more stable to β -lactamases. Later generations gain Gram – cover.

SPECTRUM Broadens by generation; ceftaroline covers MRSA

NOTE No activity against enterococci

Carbapenems

CIDAL

Imipenem (+ cilastatin), meropenem, ertapenem

Bind multiple PBPs; resist most β -lactamases. Broadest-spectrum β -lactams.

SPECTRUM Gram +, Gram –, anaerobes

RESISTANCE Carbapenemases (KPC, NDM-1)

Monobactams

CIDAL

Aztreonam

Single β -lactam ring that binds PBP3 of Gram – rods.

SPECTRUM Gram – aerobes only

NOTE Safe in penicillin allergy

Glycopeptides

CIDAL

Vancomycin, teicoplanin

Bind the D-Ala–D-Ala terminus of the precursor, sterically blocking transglycosylation and transpeptidation.

SPECTRUM Gram + only (too big to cross Gram – outer membrane); MRSA, C. difficile

RESISTANCE VRE swap to D-Ala–D-Lac

Other wall agents

CIDAL

Fosfomycin · Cycloserine · Bacitracin

Fosfomycin inhibits MurA (PEP analogue). Cycloserine blocks alanine racemase and D-Ala ligase. Bacitracin prevents dephosphorylation and recycling of bactoprenol.

USE Fosfomycin: UTI · Cycloserine: MDR-TB · Bacitracin: topical

Cell membrane disruptors

Act like detergents or ion channels on bacterial membranes. Effective but more toxic, since host membranes are partly affected.

Polymyxins

CIDAL

Polymyxin B, colistin (polymyxin E)

Cationic peptide binds anionic lipid A of LPS, displaces $\text{Ca}^{2+}/\text{Mg}^{2+}$, then inserts its fatty tail and disrupts outer and inner membranes.

Contents leak out.

SPECTRUM Gram – (last resort for MDR
Pseudomonas, Acinetobacter)

TOXICITY Nephrotoxic, neurotoxic

Lipopeptides

CIDAL

Daptomycin

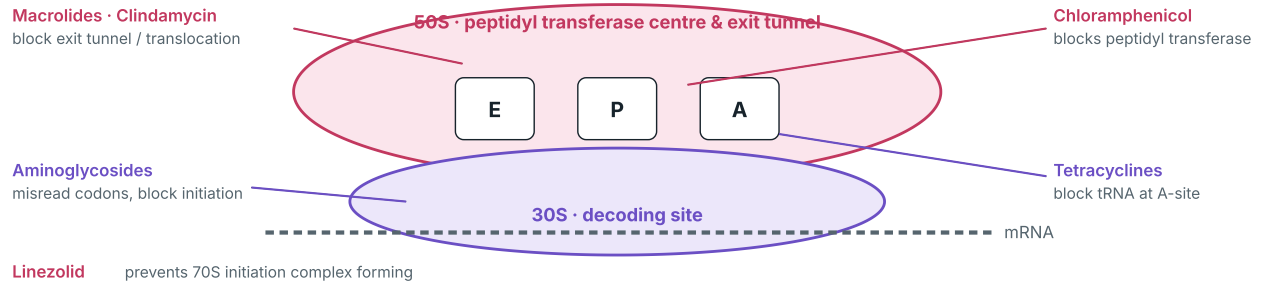
Calcium-dependent insertion into Gram + membrane forms channels; K^{+} efflux causes rapid depolarisation and arrest of DNA, RNA and protein synthesis.

SPECTRUM Gram + incl. MRSA, VRE

NOTE Inactivated by lung surfactant; not for pneumonia

Protein synthesis inhibitors: 30S subunit

The bacterial 70S ribosome (30S + 50S) differs from the human 80S (40S + 60S), giving selectivity. Mnemonic: **buy AT 30, CCEL at 50** (Aminoglycosides, Tetracyclines on 30S; Clindamycin, Chloramphenicol, Erythromycin, Linezolid on 50S).



Where each class binds on the 70S ribosome. E, P and A are the exit, peptidyl and aminoacyl tRNA sites.

Aminoglycosides

CIDAL

Streptomycin, gentamicin, tobramycin, amikacin, neomycin

Bind 16S rRNA of 30S; block initiation complex and cause mRNA misreading. Faulty proteins insert into the membrane, increasing drug uptake.

SPECTRUM Aerobic Gram $-$; uptake needs O_2 , so no anaerobe activity

TOXICITY Nephro- and ototoxic

Tetracyclines

STATIC

Tetracycline, doxycycline, minocycline

Bind 30S and prevent aminoacyl-tRNA from attaching to the A-site, halting chain elongation.

SPECTRUM Broad; Rickettsia, Chlamydia, Mycoplasma

NOTE Chelated by Ca^{2+} , Fe^{2+} ; stains teeth

Glycylcyclines

STATIC

Tigecycline

Tetracycline derivative that binds 30S more tightly and evades efflux and ribosomal-protection resistance.

SPECTRUM Broad incl. MRSA, VRE

Protein synthesis inhibitors: 50S subunit

Mostly bacteriostatic. Drugs sharing the 23S rRNA binding site (macrolides, clindamycin, chloramphenicol) antagonise each other.

Macrolides

STATIC

Erythromycin, azithromycin, clarithromycin

Bind 23S rRNA in the polypeptide exit tunnel, blocking translocation and release of the growing chain.

SPECTRUM Atypical pneumonia, Gram +

RESISTANCE erm methylation of 23S rRNA

Lincosamides

STATIC

Clindamycin, lincomycin

Bind 50S near macrolide site; inhibit peptide bond formation and translocation.

SPECTRUM Gram +, anaerobes above diaphragm

RISK C. difficile colitis

Chloramphenicol

STATIC

Chloramphenicol

Inhibits peptidyl transferase on 50S, preventing peptide bond formation.

SPECTRUM Broad; meningitis, typhoid

TOXICITY Aplastic anaemia, grey baby syndrome

Oxazolidinones

STATIC

Linezolid, tedizolid

Bind 23S rRNA of 50S and prevent formation of the 70S initiation complex. Unique step, so little cross-resistance.

SPECTRUM Gram + incl. MRSA, VRE

Streptogramins

CIDAL

Quinupristin + dalfopristin

Two components bind adjacent 50S sites synergistically: one blocks peptidyl transferase, the other blocks elongation.

SPECTRUM VRE (E. faecium), MRSA

Others on 50S / EF-G

STATIC

Lefamulin (pleuromutilin) · Fusidic acid · Mupirocin

Lefamulin binds the peptidyl transferase centre. Fusidic acid locks elongation factor G on the ribosome. Mupirocin inhibits isoleucyl-tRNA synthetase.

USE Mupirocin: topical, MRSA nasal decolonisation

Nucleic acid synthesis inhibitors

Target DNA replication enzymes, RNA transcription, or damage DNA directly.

Fluoroquinolones

CIDAL

Ciprofloxacin, levofloxacin, moxifloxacin, norfloxacin

Inhibit DNA gyrase (topoisomerase II; main Gram – target) and topoisomerase IV (main Gram + target). Trap the enzyme–DNA complex, causing double-strand breaks.

SPECTRUM Broad; UTI, Gram – incl. *Pseudomonas* (cipro)

TOXICITY Tendon rupture, QT prolongation

Rifamycins

CIDAL

Rifampicin, rifabutin, rifaximin

Bind β -subunit (rpoB) of DNA-dependent RNA polymerase, blocking transcription initiation.

SPECTRUM Mycobacteria, meningococcal prophylaxis

NOTE Orange body fluids; strong CYP450 inducer; resistance develops fast alone

Nitroimidazoles

CIDAL

Metronidazole, tinidazole

Prodrug reduced inside anaerobes to toxic nitro free radicals that break DNA strands.

SPECTRUM Anaerobes, protozoa (*Giardia*, *Entamoeba*, *Trichomonas*)

NOTE Disulfiram-like reaction with alcohol

Nitrofurans

CIDAL

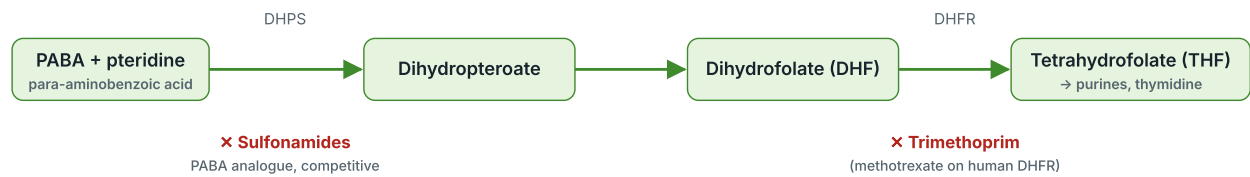
Nitrofurantoin

Reduced by bacterial nitroreductases to reactive intermediates that damage DNA, ribosomes and other macromolecules.

USE Uncomplicated lower UTI

Folate synthesis inhibitors (antimetabolites)

Bacteria must make their own folate; humans absorb it from diet. Blocking two sequential steps gives synergistic, cidal action.



Sulfonamides

STATIC

Sulfamethoxazole, sulfadiazine, sulfasalazine, dapsone (sulfone)

Structural analogues of PABA; competitively inhibit dihydropterolate synthase (DHPS).

TOXICITY Hypersensitivity, Stevens–Johnson, haemolysis in G6PD deficiency, kernicterus

DHFR inhibitors

STATIC

Trimethoprim, pyrimethamine

Inhibit bacterial dihydrofolate reductase about 50,000× more strongly than the human enzyme.

COMBINATION Co-trimoxazole (TMP-SMX):
CIDAL UTI, PCP pneumonia, toxoplasmosis

Anti-mycobacterial agents

Mycobacterium tuberculosis has a waxy mycolic-acid–arabinogalactan wall that needs its own drugs. First-line therapy is **RIPE**: Rifampicin, Isoniazid, Pyrazinamide, Ethambutol.

Isoniazid (INH)

CIDAL

Prodrug activated by catalase-peroxidase KatG

Inhibits InhA (enoyl-ACP reductase), blocking mycolic acid synthesis.

TOXICITY Hepatitis; peripheral neuropathy (give pyridoxine, B₆)

Ethambutol

STATIC

Ethambutol

Inhibits arabinosyl transferases (embB), blocking arabinogalactan synthesis.

TOXICITY Optic neuritis, red–green colour blindness

Pyrazinamide

CIDAL

Prodrug → pyrazinoic acid (by pncA)

Active at acidic pH inside macrophages; disrupts membrane energetics and translation. Exact target still debated.

TOXICITY Hepatotoxic, hyperuricaemia (gout)

Newer TB drugs

CIDAL

Bedaquiline • Delamanid / Pretomanid

Bedaquiline inhibits mycobacterial ATP synthase (subunit c). Delamanid and pretomanid are nitroimidazoles blocking mycolic acid synthesis.

USE MDR / XDR-TB (BP_aL regimen)



One-page summary

Use this for last-minute revision.

TARGET	CLASS	MOLECULAR TARGET	EXAMPLES	ACTION
 Cell wall	β -lactams	PBPs (transpeptidase)	Penicillin, ceftriaxone, meropenem, aztreonam	CIDAL
 Cell wall	Glycopeptides	D-Ala–D-Ala terminus	Vancomycin, teicoplanin	CIDAL
 Cell wall	Fosfomycin / Cycloserine / Bacitracin	MurA / Ala racemase / bactoprenol	—	CIDAL
 Membrane	Polymyxins	LPS lipid A	Colistin, polymyxin B	CIDAL
 Membrane	Lipopeptides	Membrane depolarisation	Daptomycin	CIDAL
 30S	Aminoglycosides	16S rRNA, misreading	Gentamicin, amikacin, streptomycin	CIDAL
 30S	Tetracyclines	A-site tRNA binding	Doxycycline, tigecycline	STATIC
 50S	Macrolides	23S rRNA exit tunnel	Azithromycin, erythromycin	STATIC
 50S	Lincosamides	Peptide bond / translocation	Clindamycin	STATIC
 50S	Chloramphenicol	Peptidyl transferase	Chloramphenicol	STATIC
 50S	Oxazolidinones	70S initiation complex	Linezolid	STATIC
 DNA	Fluoroquinolones	Gyrase, topoisomerase IV	Ciprofloxacin, levofloxacin	CIDAL
 RNA	Rifamycins	RNA polymerase β (rpoB)	Rifampicin	CIDAL
 DNA	Nitroimidazoles	Free-radical DNA damage	Metronidazole	CIDAL
 Folate	Sulfonamides	DHPS	Sulfamethoxazole	STATIC
 Folate	DHFR inhibitors	DHFR	Trimethoprim	STATIC
 Mycobacteria	Isoniazid	InhA (mycolic acid)	INH	CIDAL
 Mycobacteria	Ethambutol	Arabinosyl transferase	EMB	STATIC

Bactericidal set

"Very Finely Proficient At Cell Murder":
Vancomycin, Fluoroquinolones, Penicillins (β -lactams), Aminoglycosides, Cephalosporins, Metronidazole.

Bacteriostatic set

"ECSTaTiC": Erythromycin (macrolides), Clindamycin, Sulfonamides, Trimethoprim, Tetracyclines, Chloramphenicol.

Ribosome split

"Buy AT 30, CCEL at 50": Aminoglycosides and Tetracyclines on 30S; Clindamycin, Chloramphenicol, Erythromycin, Linezolid on 50S.

Cidal versus static depends on dose and organism; the labels above are the textbook default for exam answers. For study use only, not prescribing guidance.