Comprehensive Overview of Antimicrobial Agents

Educational RAG Reference for Medical & Pharmaceutical Learning

Purpose of This Document

This document provides a **comprehensive educational overview** of antimicrobial agents used in the treatment of infectious diseases.
It covers:

- Antibacterial agents
- Antifungal agents
- Antiviral agents
- Antiparasitic agents

⚠️ This document is **for academic and educational use only** and **does not provide prescribing dosages**.

What Are Antimicrobials? (Overview)

Antimicrobials are drugs that **kill or inhibit the growth of microorganisms**.

They are classified based on the type of organism they act against.

Main goals:

- Eliminate infection
- Prevent complications
- Reduce transmission

- Minimize resistance

🧪 CLASSIFICATION OF ANTIMICROBIAL AGENTS

🦠 1. ANTIBACTERIAL AGENTS (Antibiotics)

Overview

Antibiotics act against **bacterial infections** by targeting cell wall synthesis, protein synthesis, nucleic acid synthesis, or metabolic pathways.

Major Antibiotic Classes & Usage

🔹 **Penicillins**

Mechanism of Action: Penicillins inhibit bacterial cell wall synthesis by blocking peptidoglycan cross-linking, leading to cell lysis and death. They are bactericidal agents effective against gram-positive and some gram-negative bacteria.

Drug Examples:

- **Penicillin G** (Benzylpenicillin) - Injectable form
- **Penicillin V** (Phenoxymethylpenicillin) - Oral form
- **Amoxicillin** - Broad spectrum oral penicillin
- **Amoxicillin-Clavulanate** (Augmentin) - Beta-lactamase resistant
- **Ampicillin** - Broad spectrum, IV/Oral
- **Piperacillin-Tazobactam** - Extended spectrum, anti-pseudomonal
- **Flucloxacillin** - Anti-staphylococcal
- **Benzathine Penicillin** - Long-acting depot injection

Infections Treated:

- **Streptococcal pharyngitis** (Strep throat)

- **Acute otitis media** (Middle ear infection)
- **Sinusitis** and **Tonsillitis**
- **Community-acquired pneumonia**
- **Cellulitis** and **Erysipelas**
- **Impetigo** and other skin infections
- **Dental abscesses**
- **Bacterial endocarditis** (with other agents)
- **Syphilis** (all stages)
- **Rheumatic fever prophylaxis**
- **Lyme disease** (early stages)
- **Meningococcal meningitis**
- **Urinary tract infections**
- **Intra-abdominal infections** (with clavulanate)

General Use Notes:

- Usually first-line for susceptible gram-positive bacteria
- Hypersensitivity reactions possible (rash to anaphylaxis)
- Cross-reactivity with cephalosporins in some patients
- Resistance common in Staphylococcus aureus (MRSA)

🔹 Cephalosporins

Mechanism of Action: Similar to penicillins, cephalosporins inhibit cell wall synthesis. They are classified into generations (1st through 5th), with later generations having broader gram-negative coverage.

Drug Examples by Generation:

First Generation:

- **Cefazolin** - IV, surgical prophylaxis

- **Cephalexin** - Oral, skin infections
- **Cefadroxil** - Oral, UTIs

Second Generation:

- **Cefuroxime** - Oral/IV, respiratory infections
- **Cefoxitin** - IV, anaerobic coverage
- **Cefaclor** - Oral

Third Generation:

- **Ceftriaxone** - IV/IM, broad spectrum
- **Cefotaxime** - IV, meningitis
- **Cefixime** - Oral, gonorrhea
- **Ceftazidime** - IV, anti-pseudomonal

Fourth Generation:

- **Cefepime** - IV, broad gram-negative coverage

Fifth Generation:

- **Ceftaroline** - IV, MRSA coverage

Infections Treated:

- **Bacterial meningitis** (ceftriaxone, cefotaxime)
- **Community-acquired pneumonia**
- **Hospital-acquired pneumonia**
- **Typhoid fever** and **Paratyphoid**
- **Sepsis** and **Bacteremia**
- **Gonorrhea** (ceftriaxone)
- **Urinary tract infections**
- **Pyelonephritis** (kidney infection)
- **Skin and soft tissue infections**
- **Bone and joint infections** (Osteomyelitis, Septic arthritis)

- **Surgical site infection prophylaxis**
- **Pelvic inflammatory disease**
- **Intra-abdominal infections**
- **Lyme disease** (later stages)

Use Notes:

- Broad spectrum with good tissue penetration
- IV forms used in severe infections
- Third generation excellent for CNS penetration
- Some risk of C. difficile infection with prolonged use

🔹 Macrolides

Mechanism of Action: Macrolides inhibit bacterial protein synthesis by binding to the 50S ribosomal subunit. Generally bacteriostatic but can be bactericidal at higher concentrations.

Drug Examples:

- **Azithromycin** (Z-pack) - Once daily, 5-day course
- **Clarithromycin** - Twice daily
- **Erythromycin** - Original macrolide, multiple daily doses
- **Roxithromycin** - Once or twice daily
- **Spiramycin** - Used in toxoplasmosis

Infections Treated:

- **Atypical pneumonia** (Mycoplasma, Chlamydia, Legionella)
- **Community-acquired pneumonia**
- **Pertussis** (Whooping cough)
- **Chlamydia trachomatis** infections
- **Non-gonococcal urethritis**

- **Pelvic inflammatory disease**
- **Chancroid**
- **Campylobacter gastroenteritis**
- **Mycobacterium avium complex** (MAC) in HIV
- **Toxoplasmosis** (spiramycin in pregnancy)
- **Pharyngitis** (penicillin alternative)
- **Sinusitis**
- **Skin and soft tissue infections**
- **Acute bacterial exacerbation of COPD**
- **Helicobacter pylori** (clarithromycin in triple therapy)

Use Notes:

- Excellent alternative for penicillin-allergic patients
- Good intracellular penetration
- Anti-inflammatory properties
- QT prolongation risk with azithromycin

🔹 Fluoroquinolones

Mechanism of Action: Fluoroquinolones inhibit bacterial DNA gyrase and topoisomerase IV, preventing DNA replication and transcription. They are bactericidal with broad-spectrum activity.

Drug Examples:

- **Ciprofloxacin** - Broad spectrum, anti-pseudomonal
- **Levofloxacin** - Respiratory quinolone
- **Moxifloxacin** - Enhanced anaerobic and atypical coverage
- **Ofloxacin** - UTIs, eye infections
- **Norfloxacin** - UTIs primarily

- **Gatifloxacin** - Broad spectrum

Infections Treated:

- **Complicated urinary tract infections**
- **Pyelonephritis** (kidney infections)
- **Prostatitis** (bacterial)
- **Typhoid fever** and enteric fever
- **Bacterial gastroenteritis** (E. coli, Shigella, Salmonella)
- **Traveler's diarrhea**
- **Community-acquired pneumonia**
- **Hospital-acquired pneumonia**
- **Chronic bronchitis exacerbations**
- **Anthrax** (post-exposure prophylaxis)
- **Plague**
- **Tularemia**
- **Bone and joint infections**
- **Skin and soft tissue infections**
- **Intra-abdominal infections** (with metronidazole)
- **Gonorrhea** (increasing resistance)
- **Tuberculosis** (second-line)

Use Notes:

⚠️ **Reserved use due to resistance concerns and serious adverse effects**

- Risk of tendon rupture, especially Achilles tendon
- Peripheral neuropathy
- CNS effects (seizures, confusion)
- Avoid in children and pregnant women
- Should be reserved for serious infections when alternatives unavailable

🔹 Aminoglycosides

Mechanism of Action: Aminoglycosides bind to the 30S ribosomal subunit, causing misreading of mRNA and inhibiting protein synthesis. They are bactericidal and concentration-dependent.

Drug Examples:

- **Gentamicin** - Most commonly used
- **Amikacin** - Broader spectrum, less resistance
- **Tobramycin** - Preferred for Pseudomonas
- **Streptomycin** - Tuberculosis, plague
- **Neomycin** - Topical/oral (not absorbed)
- **Kanamycin** - Tuberculosis (second-line)

Infections Treated:

- **Severe gram-negative sepsis**
- **Hospital-acquired pneumonia**
- **Ventilator-associated pneumonia**
- **Pseudomonas aeruginosa infections**
- **Complicated urinary tract infections**
- **Endocarditis** (with beta-lactams for synergy)
- **Intra-abdominal infections** (with other agents)
- **Neonatal sepsis**
- **Pelvic inflammatory disease** (with other agents)
- **Tuberculosis** (streptomycin)
- **Plague** (Yersinia pestis)
- **Tularemia**
- **Bacterial meningitis** (neonates)
- **Cystic fibrosis** pulmonary exacerbations

Route: IV / IM (poor oral absorption)

Use Notes:

⚠️ **Requires therapeutic drug monitoring**

- Nephrotoxicity (kidney damage) - monitor creatinine
- Ototoxicity (hearing loss, vestibular damage) - irreversible
- Neuromuscular blockade risk
- Once-daily dosing preferred
- Adjust dose for renal function

🔹 Tetracyclines

Mechanism of Action: Tetracyclines inhibit bacterial protein synthesis by binding to the 30S ribosomal subunit. Bacteriostatic with broad-spectrum activity.

Drug Examples:

- **Doxycycline** - Most commonly used
- **Tetracycline** - Original formulation
- **Minocycline** - Good CNS penetration
- **Tigecycline** - Glycylcycline, IV only

Infections Treated:

- **Acne vulgaris** (long-term treatment)
- **Rosacea**
- **Lyme disease** (early and late stages)
- **Rocky Mountain spotted fever** and other rickettsial infections
- **Ehrlichiosis** and **Anaplasmosis**
- **Q fever**
- **Chlamydia trachomatis** infections
- **Mycoplasma pneumoniae**

- **Cholera**
- **Plague**
- **Brucellosis** (with other agents)
- **Malaria** (prophylaxis and treatment adjunct)
- **Anthrax**
- **Syphilis** (alternative therapy)
- **Periodontal disease**
- **Community-acquired pneumonia**

Use Notes:

- Avoid in pregnancy and children under 8 years (tooth discoloration)
- Take with full glass of water to prevent esophageal ulceration
- Photosensitivity reactions common

🔹 Carbapenems

Mechanism of Action: Carbapenems are beta-lactam antibiotics with the broadest spectrum of activity. They inhibit cell wall synthesis and are highly resistant to beta-lactamases.

Drug Examples:

- **Imipenem-Cilastatin** - Broad spectrum
- **Meropenem** - Broad spectrum, better CNS penetration
- **Ertapenem** - Once daily, limited anti-pseudomonal
- **Doripenem** - Anti-pseudomonal

Infections Treated:

- **Severe hospital-acquired infections**
- **Multi-drug resistant infections**
- **Extended-spectrum beta-lactamase (ESBL) producing organisms**

- **Intra-abdominal infections**
- **Complicated urinary tract infections**
- **Nosocomial pneumonia**
- **Bacterial meningitis**
- **Febrile neutropenia** (cancer patients)
- **Sepsis with unknown organism**
- **Polymicrobial infections**
- **Diabetic foot infections**

Use Notes:

⚠️ **Reserved for severe/resistant infections**

- Last-line broad-spectrum agents
- Risk of seizures (especially imipenem)
- Carbapenem resistance is a major public health threat

🔹 Glycopeptides

Mechanism of Action: Glycopeptides inhibit cell wall synthesis by binding to D-alanyl-D-alanine terminals, preventing peptidoglycan cross-linking.

Drug Examples:

- **Vancomycin** - IV (poor oral absorption except for C. diff)
- **Teicoplanin** - Longer half-life than vancomycin

Infections Treated:

- **Methicillin-resistant Staphylococcus aureus (MRSA)** infections
- **Coagulase-negative staphylococcal infections**
- **Endocarditis** (MRSA, enterococcal)
- **Meningitis** (MRSA, resistant pneumococcus)
- **Osteomyelitis** (MRSA)

- **Septic arthritis** (MRSA)
- **Hospital-acquired pneumonia** (MRSA)
- **Catheter-related bloodstream infections**
- **Clostridioides difficile colitis** (oral vancomycin)
- **Surgical prophylaxis** in beta-lactam allergic patients

Use Notes:

⚠️ **Reserved for resistant gram-positive infections**

- Requires therapeutic drug monitoring
- Nephrotoxicity and ototoxicity risks
- Red man syndrome (infusion reaction)
- Oral vancomycin only for C. difficile

🔹 Sulfonamides & Trimethoprim

Mechanism of Action: Sulfonamides and trimethoprim inhibit sequential steps in bacterial folate synthesis pathway. When combined, they are bactericidal with synergistic activity.

Drug Examples:

- **Trimethoprim-Sulfamethoxazole** (Co-trimoxazole, Bactrim)
- **Sulfadiazine** - Toxoplasmosis
- **Sulfasalazine** - Inflammatory bowel disease

Infections Treated:

- **Urinary tract infections**
- **Pneumocystis jirovecii pneumonia** (PCP in HIV/AIDS)
- **Toxoplasmosis** (with pyrimethamine)
- **Nocardiosis**
- **Stenotrophomonas maltophilia** infections

- **MRSA** skin infections (community-acquired)
- **Bacterial gastroenteritis** (Shigella, E. coli)
- **Traveler's diarrhea**
- **Chronic prostatitis**
- **Granuloma inguinale**
- **Cyclospora** infections
- **Otitis media** (alternative)

Use Notes:

- Generally well-tolerated
- Risk of Stevens-Johnson syndrome (rare)
- Contraindicated in late pregnancy
- Can cause hyperkalemia

🔹 Anti-Tubercular Drugs

Mechanism of Action: Various mechanisms targeting different aspects of mycobacterial metabolism. Always used in combination to prevent resistance.

Drug Examples:

First-Line Agents:

- **Isoniazid** (INH) - Inhibits mycolic acid synthesis
- **Rifampicin** (Rifampin) - Inhibits RNA polymerase
- **Pyrazinamide** - Disrupts membrane transport
- **Ethambutol** - Inhibits cell wall synthesis

Second-Line Agents:

- **Fluoroquinolones** (Levofloxacin, Moxifloxacin)
- **Aminoglycosides** (Streptomycin, Amikacin)
- **Linezolid**

- **Bedaquiline**
- **Cycloserine**
- **Ethionamide**

Infections Treated:

- **Pulmonary tuberculosis**
- **Extrapulmonary tuberculosis** (TB meningitis, miliary TB, bone TB)
- **Latent tuberculosis infection** (LTBI)
- **Multi-drug resistant tuberculosis (MDR-TB)**
- **Extensively drug-resistant tuberculosis (XDR-TB)**
- **Mycobacterium avium complex** (MAC)
- **Leprosy** (rifampicin)

Use Notes:

⚠️ **Always use combination therapy**

- Standard regimen: 6-9 months minimum
- MDR-TB: 18-24 months or longer
- Liver function monitoring required
- Directly observed therapy (DOT) recommended

🍄 2. ANTIFUNGAL AGENTS

Overview

Antifungals target fungal cell membranes or cell wall synthesis.

Major Antifungal Classes

🔹 Azoles

Mechanism of Action: Azoles inhibit ergosterol synthesis by blocking the enzyme lanosterol 14α-demethylase, disrupting fungal cell membrane integrity.

Drug Examples:

Imidazoles (Topical):

- **Clotrimazole** - Topical, vaginal
- **Miconazole** - Topical, oral gel
- **Ketoconazole** - Topical, limited oral use

Triazoles (Systemic):

- **Fluconazole** - Oral/IV, good CSF penetration
- **Itraconazole** - Oral, nail and endemic mycoses
- **Voriconazole** - Oral/IV, mold infections
- **Posaconazole** - Oral/IV, prophylaxis in immunocompromised
- **Isavuconazole** - IV, invasive aspergillosis

Fungal Infections Treated:

- **Oropharyngeal candidiasis** (Thrush)
- **Esophageal candidiasis**
- **Vulvovaginal candidiasis** (Yeast infections)
- **Invasive candidiasis** and **Candidemia**
- **Cryptococcal meningitis** (especially in HIV/AIDS)
- **Dermatophytosis** (Ringworm, athlete's foot, jock itch)
- **Tinea capitis** (Scalp ringworm)
- **Tinea corporis** (Body ringworm)
- **Tinea pedis** (Athlete's foot)
- **Tinea cruris** (Jock itch)
- **Onychomycosis** (Nail fungus)
- **Pityriasis versicolor**
- **Aspergillosis** (voriconazole first-line)
- **Invasive aspergillosis**

- **Histoplasmosis**
- **Blastomycosis**
- **Coccidioidomycosis**
- **Paracoccidioidomycosis**
- **Sporotrichosis**

Use Notes:

- Generally well-tolerated
- Fluconazole excellent oral bioavailability
- Hepatotoxicity monitoring required
- Drug interactions via CYP450 enzymes
- Voriconazole for invasive mold infections

🔹 Polyenes

Mechanism of Action: Polyenes bind to ergosterol in fungal cell membranes, creating pores that cause cell death. Fungicidal activity.

Drug Examples:

- **Amphotericin B deoxycholate** - Conventional formulation
- **Liposomal Amphotericin B** - Reduced toxicity
- **Amphotericin B lipid complex** - Alternative lipid formulation
- **Nystatin** - Topical/oral, not absorbed systemically

Fungal Infections Treated:

- **Life-threatening systemic fungal infections**
- **Invasive aspergillosis**
- **Invasive candidiasis** (fluconazole-resistant)
- **Cryptococcal meningitis** (induction therapy)
- **Mucormycosis** (Zygomycosis)

- **Histoplasmosis** (severe)
- **Blastomycosis** (severe)
- **Coccidioidomycosis** (severe)
- **Leishmaniasis** (visceral)
- **Fungal endocarditis**
- **Fungal keratitis** (eye infections)
- **Oral candidiasis** (nystatin)
- **Intestinal candidiasis** (nystatin)

Route: IV (amphotericin B), Topical/Oral (nystatin)

Use Notes:

⚠️ **High toxicity – hospital use only for systemic infections**

- Infusion-related reactions (fever, chills, rigors)
- Nephrotoxicity (kidney damage) - pre-hydration essential
- Electrolyte disturbances (hypokalemia, hypomagnesemia)
- Liposomal formulations reduce toxicity
- Nystatin safe for topical/oral use

🔹 Echinocandins

Mechanism of Action: Echinocandins inhibit β-(1,3)-D-glucan synthesis in the fungal cell wall, leading to cell death. Fungicidal against Candida, fungistatic against Aspergillus.

Drug Examples:

- **Caspofungin** - First echinocandin
- **Micafungin** - Once daily dosing
- **Anidulafungin** - No hepatic metabolism

Fungal Infections Treated:

- **Invasive candidiasis**

- **Candidemia** (bloodstream infections)
- **Esophageal candidiasis** (refractory)
- **Invasive aspergillosis** (salvage therapy)
- **Empiric therapy in febrile neutropenia**
- **Prophylaxis** in high-risk transplant patients
- **Candida peritonitis**
- **Candida endocarditis**

Route: IV only (not orally absorbed)

Use Notes:

- Excellent safety profile
- Minimal drug interactions
- Not effective against Cryptococcus or endemic mycoses
- Resistance rare but emerging

🔹 Allylamines

Mechanism of Action: Allylamines inhibit squalene epoxidase, blocking ergosterol synthesis earlier in the pathway than azoles.

Drug Examples:

- **Terbinafine** - Oral/topical, nail infections
- **Naftifine** - Topical only

Fungal Infections Treated:

- **Onychomycosis** (nail fungus) - terbinafine is first-line
- **Tinea pedis** (athlete's foot)
- **Tinea cruris** (jock itch)
- **Tinea corporis** (ringworm)
- **Tinea capitis** (scalp ringworm)

Use Notes:

- Oral terbinafine superior to azoles for nail infections
- Generally well-tolerated
- Rare hepatotoxicity
- Treatment duration 6 weeks (fingernails) to 12 weeks (toenails)

🔹 **Other Antifungals**

Griseofulvin:

- Mechanism: Disrupts fungal mitotic spindle
- Used for: Dermatophyte infections, especially in children
- Long treatment courses required

Flucytosine (5-FC):

- Mechanism: Inhibits fungal DNA and RNA synthesis
- Used for: Cryptococcal meningitis (with amphotericin B), Candida infections
- Always used in combination to prevent resistance

🧬 3. ANTIVIRAL AGENTS

Overview

Antivirals inhibit viral replication at different stages of the viral life cycle.

⚠️ **Antibiotics are ineffective against viruses**

Major Antiviral Groups

🔹 **Anti-Influenza Agents**

Mechanism of Action: Different mechanisms targeting viral entry, replication, or release.

Drug Examples:

Neuraminidase Inhibitors:

- **Oseltamivir** (Tamiflu) - Oral
- **Zanamivir** (Relenza) - Inhaled
- **Peramivir** - IV, single dose

Cap-dependent Endonuclease Inhibitor:

- **Baloxavir marboxil** (Xofluza) - Single-dose oral

M2 Inhibitors (rarely used due to resistance):

- **Amantadine**
- **Rimantadine**

Viral Infections Treated:

- **Influenza A**
- **Influenza B**
- **Seasonal flu** (treatment and prophylaxis)
- **Pandemic influenza**
- **Avian influenza** (H5N1, H7N9)

Use Notes:

- Most effective when started within 48 hours of symptom onset
- Reduces duration and severity of illness
- Used for prophylaxis in high-risk contacts
- Baloxavir single-dose advantage

🔹 Anti-Herpes Virus Agents

Mechanism of Action: These drugs are nucleoside analogues that inhibit viral DNA polymerase, preventing viral replication.

Drug Examples:

- **Acyclovir** - Oral/IV/Topical, first-line

- **Valacyclovir** - Oral, better bioavailability
- **Famciclovir** - Oral, alternative to valacyclovir
- **Ganciclovir** - IV, CMV infections
- **Valganciclovir** - Oral prodrug of ganciclovir
- **Foscarnet** - IV, resistant cases
- **Cidofovir** - IV, resistant CMV
- **Penciclovir** - Topical, cold sores

Viral Infections Treated:

Herpes Simplex Virus (HSV):

- **Genital herpes** (primary and recurrent)
- **Orolabial herpes** (cold sores)
- **Herpes keratitis** (eye infection)
- **Herpes encephalitis**
- **Neonatal herpes**
- **Herpes whitlow** (finger infection)
- **Eczema herpeticum**

Varicella-Zoster Virus (VZV):

- **Chickenpox** (Varicella)
- **Shingles** (Herpes zoster)
- **Post-herpetic neuralgia** (prevention)
- **Disseminated zoster** (immunocompromised)

Cytomegalovirus (CMV):

- **CMV retinitis** (in AIDS)
- **CMV colitis**
- **CMV pneumonitis**
- **CMV disease in transplant recipients**

- **Congenital CMV** (valganciclovir)

Epstein-Barr Virus (EBV):

- **Infectious mononucleosis** (limited efficacy)
- **Oral hairy leukoplakia**

Use Notes:

- Acyclovir safe in pregnancy
- Valacyclovir convenient (less frequent dosing)
- Ganciclovir has bone marrow suppression risk
- Resistance rare but occurs in immunocompromised

🔹 Anti-HIV Agents (Antiretroviral Therapy - ART)

Mechanism of Action: Multiple classes targeting different stages of HIV life cycle. Always used in combination (typically 3 drugs).

Drug Classes & Examples:

Nucleoside/Nucleotide Reverse Transcriptase Inhibitors (NRTIs):

- **Tenofovir** (TDF or TAF)
- **Emtricitabine** (FTC)
- **Lamivudine** (3TC)
- **Abacavir** (ABC)
- **Zidovudine** (AZT)

Non-Nucleoside Reverse Transcriptase Inhibitors (NNRTIs):

- **Efavirenz** (EFV)
- **Rilpivirine** (RPV)
- **Doravirine** (DOR)
- **Etravirine** (ETR)

Protease Inhibitors (PIs):

- **Darunavir** (DRV)
- **Atazanavir** (ATV)
- **Lopinavir** (boosted with ritonavir)

Integrase Strand Transfer Inhibitors (INSTIs):

- **Dolutegravir** (DTG) - Preferred
- **Bictegravir** (BIC)
- **Raltegravir** (RAL)
- **Elvitegravir** (EVG)

Entry/Fusion Inhibitors:

- **Maraviroc** (CCR5 antagonist)
- **Enfuvirtide** (Fusion inhibitor, injectable)

Conditions Treated:

- **HIV-1 infection** (treatment)
- **HIV-2 infection** (some agents)
- **Prevention of mother-to-child transmission** (PMTCT)
- **Post-exposure prophylaxis** (PEP)
- **Pre-exposure prophylaxis** (PrEP) - Tenofovir/Emtricitabine
- **AIDS-related opportunistic infections** (immune reconstitution)

Use Notes:

⚠️ **Always combination therapy (cART)**

- Modern regimens: 1-2 pills once daily
- Goal: Undetectable viral load
- Adherence critical to prevent resistance
- Regular monitoring required

🔹 **Anti-Hepatitis Agents**

Mechanism of Action: Various mechanisms including viral polymerase inhibition and direct-acting antivirals (DAAs).

Hepatitis B Agents:

- **Entecavir** - Nucleoside analogue
- **Tenofovir** (TDF/TAF) - Nucleotide analogue
- **Lamivudine** - Nucleoside analogue
- **Adefovir** - Nucleotide analogue
- **Telbivudine** - Nucleoside analogue
- **Interferon alfa** - Immunomodulator
- **Pegylated interferon alfa-2a**

Hepatitis C Agents (Direct-Acting Antivirals):

NS5A Inhibitors:

- **Ledipasvir**
- **Velpatasvir**
- **Elbasvir**

NS5B Polymerase Inhibitors:

- **Sofosbuvir** - Backbone of most regimens
- **Dasabuvir**

NS3/4A Protease Inhibitors:

- **Glecaprevir**
- **Grazoprevir**
- **Paritaprevir**

Combination Products:

- **Sofosbuvir/Velpatasvir** (Epclusa)
- **Glecaprevir/Pibrentasvir** (Mavyret)
- **Ledipasvir/Sofosbuvir** (Harvoni)

Viral Infections Treated:

Hepatitis B:

- **Chronic hepatitis B infection**
- **Prevention of HBV reactivation** (in chemotherapy/immunosuppression)
- **HBV-related cirrhosis**
- **Prevention of vertical transmission**

Hepatitis C:

- **Chronic hepatitis C** (all genotypes 1-6)
- **HCV-related cirrhosis**
- **HCV in HIV co-infection**
- **HCV in kidney disease**
- **Prevention of liver transplant reinfection**

Use Notes:

- HCV: Cure rates >95% with DAA combinations
- Treatment duration: 8-12 weeks for HCV
- HBV: Usually long-term/lifelong treatment
- Sofosbuvir-based regimens are pangenotypic

🔹 Anti-COVID-19 Agents

Drug Examples:

- **Nirmatrelvir/Ritonavir** (Paxlovid) - Oral protease inhibitor
- **Remdesivir** - IV nucleotide analogue
- **Molnupiravir** - Oral nucleoside analogue

Viral Infection Treated:

- **COVID-19** (SARS-CoV-2)
- **Mild to moderate COVID-19** (high-risk patients)

- **Severe COVID-19** (hospitalized)

Use Notes:

- Most effective when started early (within 5-7 days)
- Paxlovid: drug interactions common
- Remdesivir: hospital use for severe cases

🔹 Other Antiviral Agents

Ribavirin:

- Broad-spectrum antiviral
- Used for: Hepatitis C (with interferons historically), RSV in children, Lassa fever, viral hemorrhagic fevers

Palivizumab:

- Monoclonal antibody
- Used for: RSV prophylaxis in high-risk infants

🪱 4. ANTIPARASITIC AGENTS

Overview

Antiparasitic drugs act against protozoa and helminths.

Major Antiparasitic Drugs

🔹 Antimalarials

Mechanism of Action: Various mechanisms including interference with heme detoxification, mitochondrial function, and DNA synthesis.

Drug Examples:

Artemisinin-Based Combinations (ACTs) - First-Line:

- **Artemether-Lumefantrine** (Coartem)

- **Artesunate-Amodiaquine**
- **Artesunate-Mefloquine**
- **Dihydroartemisinin-Piperaquine**
- **Artesunate** (IV) - Severe malaria

4-Aminoquinolines:

- **Chloroquine** - Limited use due to resistance
- **Hydroxychloroquine** - Prophylaxis in sensitive areas

8-Aminoquinolines:

- **Primaquine** - Radical cure for P. vivax/ovale
- **Tafenoquine** - Single-dose radical cure

Others:

- **Mefloquine** - Prophylaxis and treatment
- **Atovaquone-Proguanil** (Malarone) - Prophylaxis and treatment
- **Quinine** - Severe malaria (alternative)
- **Doxycycline** - Prophylaxis and adjunctive treatment

Parasitic Infections Treated:

- **Plasmodium falciparum** malaria (most severe)
- **Plasmodium vivax** malaria
- **Plasmodium ovale** malaria
- **Plasmodium malariae** malaria
- **Plasmodium knowlesi** malaria
- **Cerebral malaria** (severe)
- **Complicated malaria**
- **Malaria prophylaxis** for travelers

Use Notes:

- ACTs are WHO-recommended first-line

- Primaquine requires G6PD testing (hemolysis risk)
- Resistance patterns vary by geographic region
- Severe malaria requires IV artesunate

🔹 Anti-Protozoal Agents

Mechanism of Action: Various mechanisms including DNA damage, enzyme inhibition, and disruption of metabolic pathways.

Drug Examples:

Nitroimidazoles:

- **Metronidazole** - Oral/IV, broad anti-protozoal
- **Tinidazole** - Oral, longer half-life
- **Secnidazole** - Single-dose treatment

Others:

- **Nitazoxanide** - Broad-spectrum antiparasitic
- **Paromomycin** - Intestinal amoebiasis
- **Iodoquinol** - Luminal amoebicide
- **Pentamidine** - Leishmaniasis, trypanosomiasis
- **Miltefosine** - Leishmaniasis
- **Nifurtimox** - Chagas disease
- **Benznidazole** - Chagas disease
- **Suramin** - African trypanosomiasis
- **Melarsoprol** - African trypanosomiasis (CNS)
- **Eflornithine** - African trypanosomiasis

Parasitic Infections Treated:

Intestinal Protozoa:

- **Amoebiasis** (Entamoeba histolytica)

- **Amoebic dysentery**
- **Amoebic liver abscess**
- **Giardiasis** (Giardia lamblia)
- **Cryptosporidiosis** (Cryptosporidium)
- **Cyclosporiasis** (Cyclospora cayetanensis)
- **Isosporiasis** (Cystoisospora belli)
- **Balantidiasis** (Balantidium coli)
- **Blastocystis** infection

Tissue Protozoa:

- **Trichomoniasis** (Trichomonas vaginalis)
- **Bacterial vaginosis** (synergistic bacteria)
- **Leishmaniasis** (visceral, cutaneous, mucocutaneous)
- **African trypanosomiasis** (Sleeping sickness)
- **Chagas disease** (American trypanosomiasis)
- **Toxoplasmosis** (with pyrimethamine and sulfadiazine)
- **Pneumocystis jirovecii pneumonia** (alternative)

Use Notes:

- Metronidazole: avoid alcohol (disulfiram reaction)
- Tinidazole better tolerated than metronidazole
- Nitazoxanide safe in children

🔹 Anti-Helminthic Agents (Anthelmintics)

Mechanism of Action: Mechanisms include paralysis of worms, disruption of microtubule formation, and inhibition of glucose uptake.

Drug Examples:

Benzimidazoles:

- **Albendazole** - Broad-spectrum, tissue penetration
- **Mebendazole** - Broad-spectrum, intestinal
- **Thiabendazole** - Topical/oral

Nicotinic Agonists:

- **Pyrantel pamoate** - Pinworm, roundworm
- **Levamisole** - Roundworm

Macrocyclic Lactones:

- **Ivermectin** - Oral, broad-spectrum

Praziquantel:

- Broad-spectrum for flukes and tapeworms

Others:

- **Diethylcarbamazine (DEC)** - Filarial infections
- **Niclosamide** - Tapeworms

Helminthic Infections Treated:

Nematodes (Roundworms):

- **Ascariasis** (Ascaris lumbricoides - common roundworm)
- **Hookworm** (Ancylostoma, Necator)
- **Pinworm** (Enterobius vermicularis)
- **Whipworm** (Trichuris trichiura)
- **Strongyloidiasis** (Strongyloides stercoralis)
- **Trichinellosis** (Trichinella spiralis)
- **Toxocariasis** (Toxocara)
- **Cutaneous larva migrans**

Filarial Nematodes:

- **Lymphatic filariasis** (Wuchereria bancrofti, Brugia malayi)
- **Onchocerciasis** (River blindness - Onchocerca volvulus)

- **Loiasis** (Loa loa)

Cestodes (Tapeworms):

- **Taeniasis** (Taenia solium, Taenia saginata)
- **Cysticercosis** (Taenia solium larvae in tissues)
- **Neurocysticercosis** (brain cysts)
- **Diphyllobothriasis** (Fish tapeworm)
- **Hymenolepiasis** (Dwarf tapeworm)
- **Echinococcosis** (Hydatid cyst disease)

Trematodes (Flukes):

- **Schistosomiasis** (Schistosoma species - blood flukes)
- **Liver flukes** (Fasciola, Clonorchis, Opisthorchis)
- **Lung flukes** (Paragonimus)
- **Intestinal flukes**

Use Notes:

- Albendazole preferred for tissue infections
- Mebendazole preferred for intestinal infections
- Ivermectin effective for many nematodes and ectoparasites
- Praziquantel is drug of choice for all flukes and most tapeworms
- Mass drug administration used in endemic areas

🔹 Antiparasitic Agents for Ectoparasites

Drug Examples:

- **Permethrin** - Topical, lice and scabies
- **Ivermectin** - Oral, scabies
- **Lindane** - Topical (limited use, toxicity)
- **Malathion** - Topical, lice

- **Benzyl benzoate** - Topical, scabies

Ectoparasitic Infections Treated:

- **Scabies** (Sarcoptes scabiei)
- **Head lice** (Pediculosis capitis)
- **Body lice** (Pediculosis corporis)
- **Pubic lice** (Pediculosis pubis - crabs)
- **Crusted scabies** (Norwegian scabies)

Use Notes:

- Usually require repeat application
- Treat all household contacts simultaneously
- Wash bedding and clothing in hot water

📊 ROUTE OF ADMINISTRATION (GENERAL)

- **Oral** → Mild to moderate infections
- **IV** → Severe or systemic infections
- **Topical** → Localized skin infections

(No dosage values provided)

🧠 GENERAL DOSING PRINCIPLES (NO NUMBERS)

Based on:

- Patient age
- Weight
- Organ function
- Severity of infection

Always guided by:

- Clinical diagnosis

- Laboratory results
- Local resistance patterns

⚠️ SAFETY & STEWARDSHIP (VERY IMPORTANT)

⚠️ Why Misuse Is Dangerous

- Antimicrobial resistance
- Treatment failure
- Toxicity
- Community risk

Golden Rules

- Never self-medicate
- Never stop treatment early
- Never share antimicrobials
- Use narrow-spectrum when possible

🔒 Final Safety Disclaimer

This document is for **educational and academic purposes only**.
It **does not provide drug dosages or prescribing instructions**.
All antimicrobial use must follow **clinical evaluation and official treatment guidelines**.