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Antimicrobial Drugs

Pharmacology

Antibiotics, antibacterial drugs, antifungal drugs, antiviral drugs, antitubercular drugs, antileprotic drugs and antimicrobial resistance.

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CHAPTER 14 / PHARMACOLOGY 14. Antimicrobial Drugs

1. Introduction

Antimicrobials inhibit or kill pathogenic microorganisms. They include antibacterials, antifungals, antivirals and antimycobacterial drugs. Selective toxicity means targeting a microbial process while minimizing harm to the host. Appropriate choice depends on infection site, organism, susceptibility, severity, immune status and patient characteristics.

2. Classification of antibacterial agents

Class / examples	Major mechanism	Key adverse effects / monitoring
Penicillins - amoxicillin, piperacillin-tazobactam	Inhibit cell wall synthesis	Allergy, diarrhoea, renal dosing; beta-lactamase inhibitor combination has distinct spectrum.
Cephalosporins - cefazolin, cefuroxime, ceftriaxone, cefepime	Inhibit cell wall synthesis; spectrum varies	Allergy, GI effects; drug-specific renal or biliary considerations; ceftriaxone neonatal calcium precautions.
Carbapenems - meropenem	Broad beta-lactam cell wall inhibition	Reserved selected serious infections; seizures in susceptible patients, interactions with valproate.
Glycopeptide - vancomycin	Inhibits bacterial cell wall assembly	Nephrotoxicity, infusion-related reactions; therapeutic monitoring as indicated.
Aminoglycosides - gentamicin, amikacin	Bind 30S ribosome; disrupt protein synthesis	Nephrotoxicity, ototoxicity; renal and drug-level monitoring.
Macrolides - azithromycin, clarithromycin	Bind 50S ribosome	GI effects, QT prolongation and interactions.
Tetracyclines - doxycycline	Inhibit 30S protein synthesis	Photosensitivity, oesophageal injury, interactions with minerals; indication-specific pregnancy/child precautions.
Fluoroquinolones - ciprofloxacin, levofloxacin	Inhibit DNA gyrase/topoisomerase	Tendon injury, neuropathy, CNS effects, QT effects; reserve for appropriate indications.
Sulfonamide/trimethoprim	Sequential folate pathway inhibition	Rash, hyperkalaemia, marrow effects; review renal status and interactions.
Nitroimidazole - metronidazole	Damages DNA in susceptible anaerobes and protozoa	GI symptoms, metallic taste, neuropathy with prolonged use; warfarin interaction.
Oxazolidinone - linezolid	Inhibits 50S initiation complex	Myelosuppression, neuropathy, serotonergic interactions.

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Lincosamide - clindamycin	Inhibits 50S protein synthesis	Diarrhoea, increased C. difficile risk.

3. Bactericidal and bacteriostatic action

Bactericidal drugs kill susceptible bacteria under defined test conditions; bacteriostatic drugs inhibit growth. Beta-lactams and aminoglycosides are commonly bactericidal, while tetracyclines are commonly bacteriostatic. Classification depends on organism, concentration and conditions, and does not by itself determine clinical superiority. MIC (minimum inhibitory concentration) is the lowest tested concentration preventing visible growth under standardized conditions. Culture and susceptibility results guide targeted therapy.

4. Antifungal drugs

Class / examples	Action	Nursing considerations
Azoles - fluconazole, itraconazole	Inhibit ergosterol synthesis	Liver effects, many interactions, drug-specific QT effects.
Polyenes - amphotericin B, nystatin	Bind ergosterol and disrupt membranes	Amphotericin: infusion reactions, renal injury, potassium/magnesium loss; nystatin mainly local uses.
Echinocandins - caspofungin	Inhibit fungal cell wall glucan synthesis	IV specialist therapy, liver and infusion monitoring.
Allylamines - terbinafine	Inhibits squalene epoxidase	Selected dermatophytes; oral therapy requires liver assessment.

5. Antiviral drugs

Acyclovir and valacyclovir inhibit viral DNA replication after activation in susceptible herpesviruses; monitor renal function and hydration within the care plan. Oseltamivir inhibits influenza neuraminidase and is used in selected influenza cases. HIV treatment combines antiretroviral classes such as nucleoside reverse transcriptase inhibitors (tenofovir, lamivudine), integrase inhibitors (dolutegravir) and other agents. Combination adherence, interaction review and viral-load monitoring are central. Hepatitis B and C regimens differ; direct-acting antivirals can cure many HCV infections, while HBV treatment often suppresses viral replication. Use current disease-specific regimens, not monotherapy assumptions.

6. Antitubercular drugs

First-line drug	Mechanism / major nursing concern
Isoniazid (H)	Inhibits mycolic acid synthesis; hepatitis and peripheral neuropathy; pyridoxine when indicated.
Rifampicin (R)	Inhibits bacterial RNA polymerase; orange body fluids, hepatotoxicity, strong enzyme induction.
Pyrazinamide (Z)	Activity in selected acidic intracellular environments; hepatotoxicity, hyperuricaemia.
Ethambutol (E)	Inhibits arabinosyl transferase; optic toxicity, assess visual acuity and colour vision as indicated.

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Drug-susceptible TB often uses a multidrug regimen based on HRZE; exact duration and eligibility for shorter regimens depend on national programme, disease site, resistance, age and patient factors. Drug-resistant TB requires specialist regimen selection, which may include bedaquiline, linezolid and other agents. Do not use a single drug for active TB. WHO treatment guidance and India's NTEP protocols should be consulted [7]. Report jaundice, vision changes, severe rash or neuropathy promptly; support adherence and infection prevention.

7. Antileprotic drugs

WHO multidrug therapy uses rifampicin, dapsone and clofazimine for both paucibacillary and multibacillary disease, with typical durations of six and twelve months respectively [8]. Dapsone may cause haemolysis, methaemoglobinaemia or severe hypersensitivity; clofazimine may cause skin discoloration and GI effects; rifampicin has interactions and hepatic risks. Assess skin sensation, nerve function and reactions. New weakness, eye symptoms or nerve pain require prompt assessment; reactions may occur during or after treatment.

8. Antimicrobial resistance (AMR) and stewardship

AMR arises when microorganisms survive medicines that previously acted effectively. Mechanisms include drug-inactivating enzymes, changed target, efflux pumps and reduced permeability. Inappropriate antibiotic exposure, poor infection prevention and transmission accelerate resistance. The WHO AWaRe framework groups antibiotics into Access, Watch and Reserve for stewardship [6]. Collect cultures when indicated without dangerously delaying urgent therapy, review results, use the prescribed targeted regimen and stop or narrow therapy when directed. Do not use antibiotics for routine viral illness or save leftover courses.

9. Nursing responsibilities

Verify allergy details and indication, check renal and hepatic function, cultures, timing, dose and compatibility. Monitor therapeutic response, renal injury, rash, diarrhoea, QT risk and infusion reactions. Severe diarrhoea after antibiotics may indicate C. difficile; initiate appropriate assessment and precautions. Educate about prescribed duration, side effects and follow-up. For sepsis, timely escalation and appropriately prescribed antimicrobials are essential.

10. Examination questions

Long answer questions

1. 1. Classify antibacterial drugs with mechanism, indications and adverse effects.
2. 2. Discuss antitubercular and antileprotic medicines with nursing care.
3. 3. Explain antimicrobial resistance and stewardship.

Short answer questions

- Aminoglycosides; vancomycin; tetracyclines; metronidazole; azoles; antiretrovirals; AWaRe.

Very short answer questions

- Which TB drug may affect colour vision? - Ethambutol.
- Aminoglycosides can harm which organs? - Kidneys and inner ear.

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- What does AWaRe stand for? - Access, Watch, Reserve.

11. Quick revision

Antibiotics differ by target and spectrum. Use susceptibility data and patient-specific precautions. HRZE is a common first-line TB framework, not a universal prescription. Monitor organ toxicity and support stewardship.

Conclusion

Effective antimicrobial use combines microbiological knowledge, safe administration, patient education and resistance prevention.

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B.SC. NURSING / STUDY NOTES

Practice questions

Choose one best answer. The answer key and explanations follow the questions.

1. Which adverse effects require particular monitoring during aminoglycoside therapy?

A. Myelosuppression and serotonergic interactions
B. Nephrotoxicity and ototoxicity
C. Tendon injury and QT prolongation
D. Photosensitivity and oesophageal injury

2. Which bacterial targets are inhibited by fluoroquinolones?

A. The bacterial 30S ribosome
B. Bacterial folate synthesis
C. DNA gyrase and topoisomerase
D. Cell wall synthesis

3. What does the minimum inhibitory concentration represent?

A. The largest dose tolerated by a patient
B. The peak plasma concentration after administration
C. The minimum concentration that always kills every organism
D. The lowest tested concentration preventing visible growth under standardized conditions

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Answer key and explanations

1. B - Nephrotoxicity and ototoxicity

Aminoglycosides can damage the kidneys and hearing or vestibular function.

2. C - DNA gyrase and topoisomerase

Fluoroquinolones inhibit bacterial DNA gyrase/topoisomerase.

3. D - The lowest tested concentration preventing visible growth under standardized conditions

MIC is a standardized measure of growth inhibition, not a patient dose or a guarantee of killing.

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