جامعة الجزيرة الخاصة
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Antibiotics

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What is an Antibiotic?

- **Antibiotic** is a chemical substance produced by a *microorganism* that inhibits the growth of or kills other microorganisms.
- **Antimicrobial agent** is a chemical substance derived from a *biological source* or produced by *chemical synthesis* that kills or inhibits the growth of microorganisms.
- The two terms are usually used synonymously and that practice will continue throughout this presentation.

Antibiotics

- Medications used to treat bacterial infections
- Ideally, before beginning antibiotic therapy, the suspected areas of infection should be cultured to identify the causative organism and potential antibiotic susceptibilities.

Antibiotics

- Empiric therapy: treatment of an infection before specific culture information has been reported or obtained
- Prophylactic therapy: treatment with antibiotics to prevent an infection, as in intra-abdominal surgery

Antibiotics

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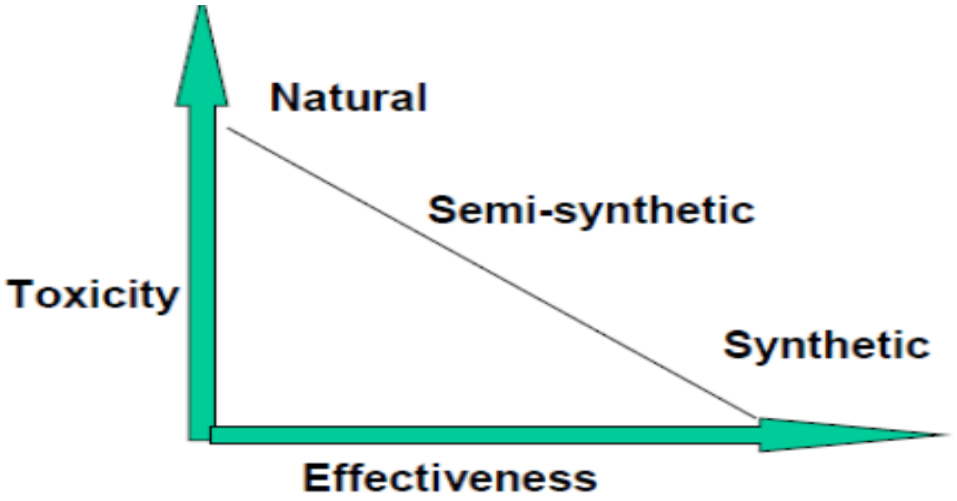
Sources of Antibacterial Agents



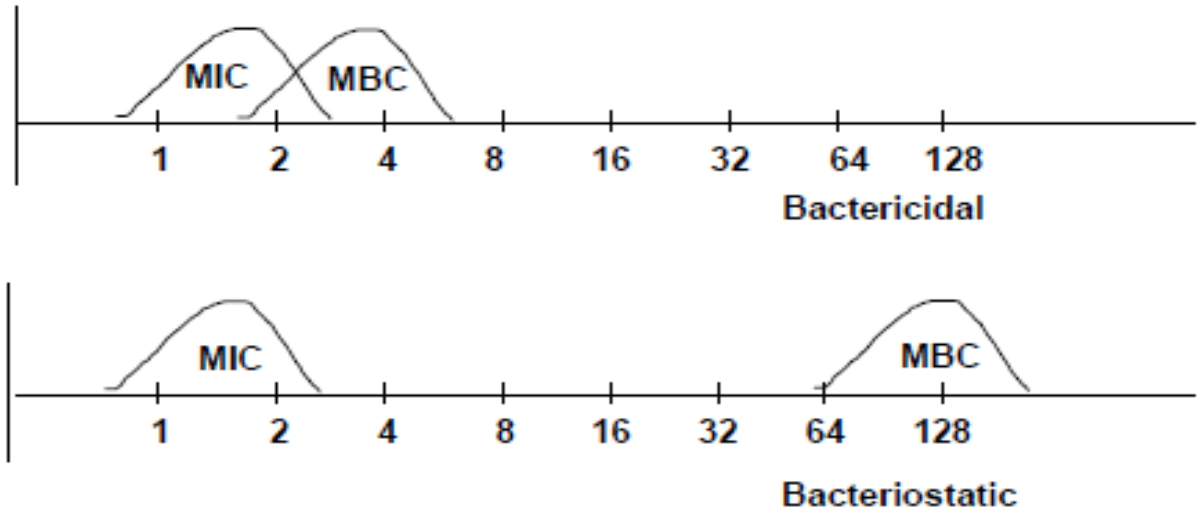
Sources of Antibacterial Agents

Role of Antibiotics

Antibiotics have a bacteriostatic effect.

Antibiotics have a bactericidal effect.

Relationship of MIC/MBC



Types of Bacteria

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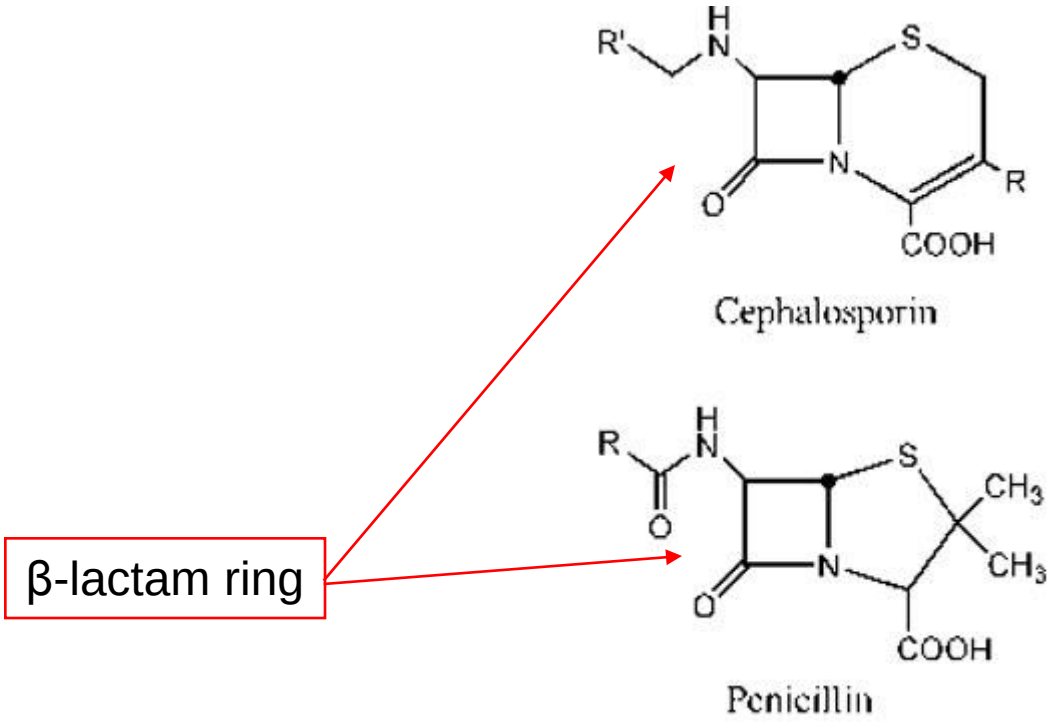
Antibiotic Classification

- Grouped by Structure and Function

The Beta-Lactam Antibiotics

- Cell wall active agents
  - Prevent the final step in the synthesis of the bacterial cell wall
- Range from very narrow spectrum to very broad spectrum

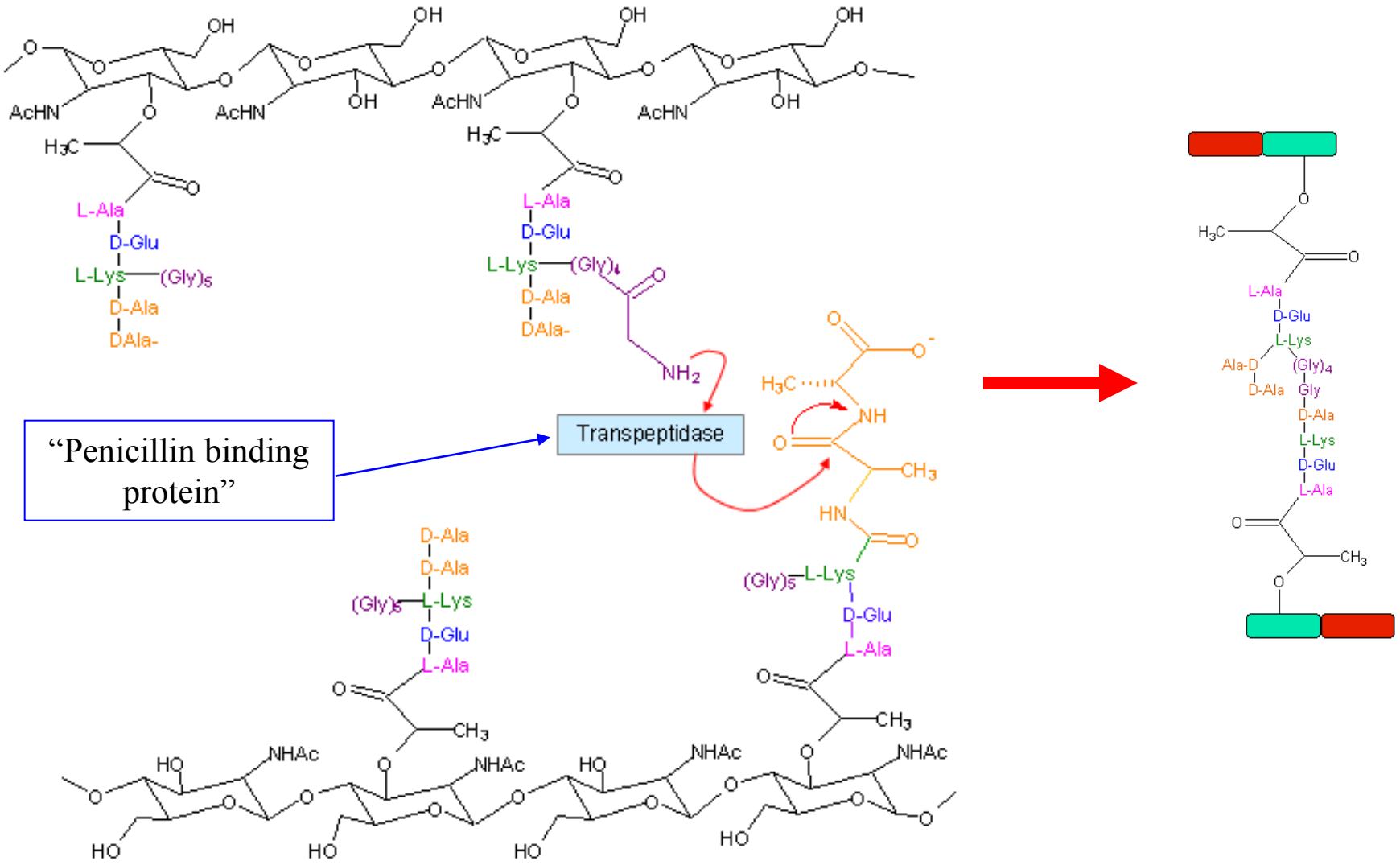
β-Lactams


β-lactam ring
R'
H
N
S
N
R
O
COOH
Cephalosporin
R
H
N
O
S
CH3
CH3
N
O
COOH
Penicillin

How do they work?

1. The β-lactam binds to Penicillin Binding Protein (PBP)
2. PBP is unable to crosslink peptidoglycan chains
3. The bacteria is unable to synthesize a stable cell wall
4. The bacteria is lysed

Peptidoglycan Synthesis



β-Lactam Characteristics

Basic characteristics:

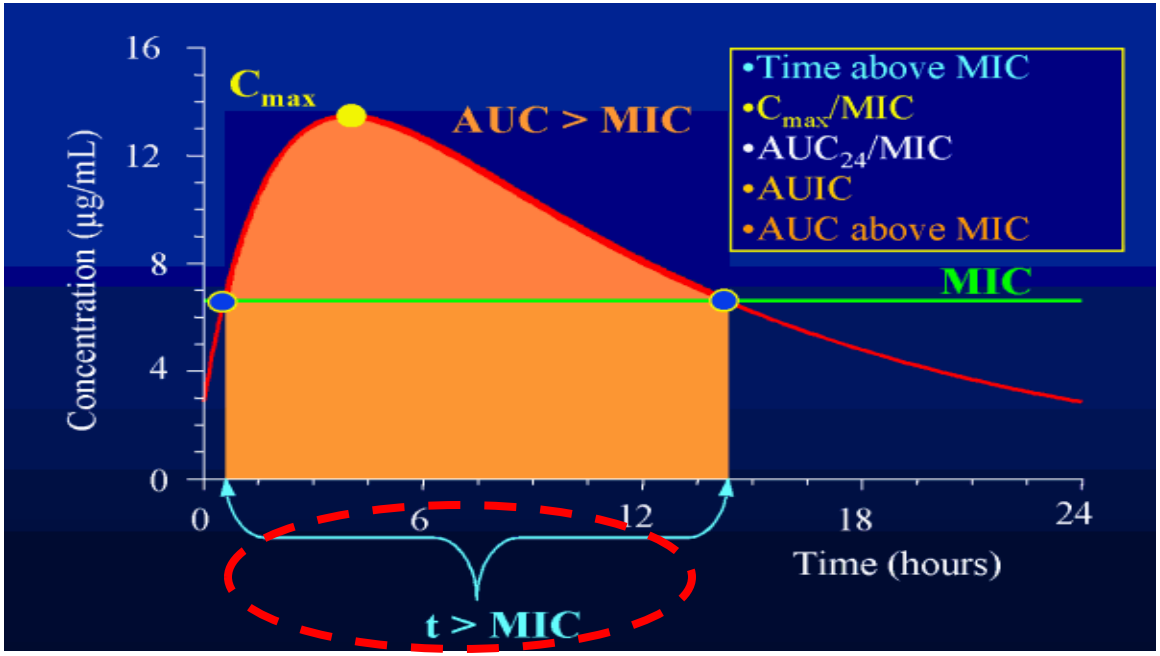
- Principally, the effect of beta-lactams is mostly expressed against multiplying bacteria that are building their cell wall intensively. On the other hand, beta-lactams could not be effective against microbes without the peptodoglycan-containing cell wall (chlamydiae, mycoplasmata, rickettsiae, mycobacteria).
  - Same MOA: Inhibit cell wall synthesis
  - Bactericidal (except against Enterococcus sp.)
  - Cross-allergenicity - except aztreonam

β-lactams
Pharmacology

- Pharmcokineticks
- Absorption: Variable depending on product
  - Many beta-lactams are acid-labile and decompose with gastric juice. In addition, absorption of beta-lactams from the gastrointestinal tract is limited
- Distribution
  - Widely distributed into tissues and fluids
  - Pens only get into CSF in the presence of inflamed meninges; parenteral 3rd and 4th generation cephs, meropenem, and aztreonam penetrate the CSF
- Elimination
  - most eliminated primarily by the kidney, dosage adj required in the presence of renal insufficiency except oxacillin, ceftriaxone-
  - The half-life of beta-lactams is rather short and varies from a half an hour (penicillin, oxacillin, cephalotin) to 2-2,5 hours. An exceptional long half time has ceftriaxone (8 hrs) allowing once daily administration

β-lactams
Pharmacology

- **Pharmacodynamics:** The effect of beta-lactams depends on the „time above MIC“. The target of dosing is to keep the level of antibiotic above MIC at the site of infection as long as possible. The peak concentration is not very important. In mild infections, the level of drug is sufficient that exceed MIC for 40-50% of the dosage interval



β-Lactams
Adverse Effects

- Hypersensitivity – 3 to 10 %
  - Higher incidence with parenteral administration or procaine formulation
  - Mild to severe allergic reactions – rash to anaphylaxis and death
  - Antibodies produced against metabolic by-products or penicillin itself
  - Desensitization is possible

β-Lactams
Adverse Effects

- Neurologic – especially with penicillins and carbapenems (imipenem and meropenem)
  - Especially in patients receiving high doses in the presence of renal insufficiency
  - Irritability, confusion, seizures
- Hematologic
  - Leukopenia, neutropenia, thrombocytopenia – prolonged therapy (> 2 weeks)

β-Lactams
Adverse Effects

- Gastrointestinal
  - Nausea, vomiting, diarrhea, pseudomembranous colitis (*C. difficile* diarrhea)
- Interstitial Nephritis
  - Cellular infiltration in renal tubules (Type IV hypersensitivity reaction – characterized by abrupt increase in serum creatinine; can lead to renal failure
  - Especially with methicillin or nafcillin

Classification

- Penicillins
  - Natural penicillins
    - PenG, PenVK, Benzathine Pen, Procaine Pen
  - Aminopenicillins
    - Ampicillin, Amoxicillin
  - Anti-Staph penicillins
    - Oxacillin, Dicloxacillin
  - Anti-Pseudomonal
    - [Carboxy] Ticarcillin
    - [Ureido] Piperacillin

Natural Penicillins
(penicillin G, penicillin VK)

Gram-positive

pen-susc *S. pneumoniae*

Group A/B/C/G strep

viridans streptococci

diaphragm

Enterococcus

Gram-negative

Neisseria sp.

Anaerobes

Above the

Clostridium sp.

Other

Treponema pallidum (syphilis)

Penicillinase-Resistant Penicillins
(nafcillin, oxacillin, methicillin)

Developed to overcome the penicillinase enzyme of *S. aureus* which inactivated natural penicillins

Gram-positive

Methicillin-susceptible *S. aureus*

Penicillin-susceptible strains of Streptococci

Aminopenicillins
(ampicillin, amoxicillin)

Developed to increase activity against gram-negative aerobes

Gram-positive

pen-susc *S. aureus*

Pen-susc streptococci

viridans streptococci

Enterococcus sp.

Listeria monocytogenes

Gram-negative

Proteus mirabilis

S*almonella,*

some *E. coli*

βL- *H. influenzae*

Carboxypenicillins
(carbenicillin, ticarcillin)

Developed to further increase activity against resistant gram-negative aerobes

Gram-positive	**Gram-negative**
marginal	*Proteus mirabilis* S*almonella, Shigella* some *E. coli* βL- *H. influenzae* *Enterobacter sp.* *Pseudomonas*
aeruginosa	

Ureidopenicillins
(piperacillin, azlocillin)

Developed to further increase activity against resistant gram-negative aerobes

Gram-positive

viridans strep
Group strep
some Enterococcus

Anaerobes

Fairly good activity

Gram-negative

Proteus mirabilis
S*almonella, Shigella*
E. coli
βL- *H. influenzae*
Enterobacter sp.
Pseudomonas aeruginosa
Serratia marcescens
some *Klebsiella sp.*

β-Lactamase Inhibitor Combos (Unasyn, Augmentin, Timentin, Zosyn)

Developed to gain or enhance activity against β-lactamase producing organisms (some better than others). Provides some or good activity against:

Gram-positive

S. aureus (MSSA)

Anaerobes

Bacteroides sp.

Gram-negative

H. influenzae

E. coli

Proteus sp.

Klebsiella sp.

Neisseria gonorrhoeae

Moraxella catarrhalis

Penicillin G

- Available PO, IM, IV (dosed in units)
- Drug of Choice (DoC) [2-4 MU IV q4h]
  - T. pallidum, N. meningitidis, Group A Strep, and Actinomycosis
- Long-acting forms
  - Procaine PenG (12 hrs)
  - Benzathine Pen (5 days)]
- Adverse Reactions – other than skin rash
  - Penicillin “serum sickness”/drug fever
  - Hemolytic anemia, pancytopenia, neutropenia

Ampicillin/Amoxicillin

- Amp (IV, PO) Amox (PO)
- Spectrum: PenG + H. flu and some E. coli
- DoC: Listeria monocytogenes and
  Enterococcus

Dental Prophylaxis

- Amox 1 gram PO x 1 prior to appt.

- Integral in H. pylori regimens
- ADRs
  - Non-allergic rashes (9%) – esp. when associated with a viral illness (mononucleosis - EBV)
  - Amox better tolerated PO and better absorbed (Amp must be taken on empty stomach)

Oxacillin

- IV
- DoC – MSSA, MSSE(methcellin sensitive staphilococcos auerus [2g IV q4h]
  - Actually less active against Pen susceptible isolates than Pen
  - More active than Vanc vs. MSSA
- Significant hepatic metabolism
  - No need to dose adjust for renal impairment
- ADRs
  - Hepatotoxicity (cholestatic hepatitis)
  - Neutropenia
  - Kernicterus in neonates

Piperacillin

- IV
- DoC: Pseudomonas
- Spectrum: most *Enterobacteriaceae* (E. coli, Proteus, Klebsiella, Enterbacter, Serratia, Citrobacter, Salmonella and Shigella)
- Most active penicillin vs. Pseudomonas
- Often used in combination with Aminoglycoside or Cipro/Levofloxacin
- ADRs
  - Bleeding (platelet dysfunction)
  - Neutropenia/Thrombocytopenia

β-Lactamase Inhibitors

- How do you evade a β-lactamase?
  1. Use a non-β-lactam agent
  2. Steric Inhibition
     - Penicillins with large side chains
     - Cephalosporins
  3. β-lactam + β-lactamase inhibitors
     - Not all β-lactamases are inhibitable (!)

Clavulanic Acid

- **Augmentin** (Amox/Clav) PO
- Spectrum: MSSA and upper respiratory infections (S. pneumo, H. flu, M. catarrhalis) and most anaerobes
- Clav is responsible for most of the GI side-effects seen with Amox/Clav
- Variable ratios of Amox/Clav in liquids/tabs/chewtabs

Sulbactam

- **Unasyn** (Amp/Sulbactam)
- Spectrum: Amp + most anaerobes + many enteric Gm (-) rods, OSSA
- DoC: for GNR mixed infection – E.coli, Proteus, anaerobes when Pseudomonas is not implicated
  - Diabetic foot (once Pseudomonas ruled out)
  - Wound infections

- Sulbactam alone is very active against Acinetobacter spp.

Tazobactam

- Zosyn (Pip/Tazo)
- THE most broad-spectrum penicillin
- Tazobactam may improve the activity of piperacillin vs. gram-negative rods, including anaerobes
- 4.5g IV q8h = 3.375g IV q6h
- 4.5g IV q6h for Pseudomonas

Classification

- Cephalosporins
  - 1st Generation
    - Cephalexin, Cefazolin
  - 2nd Generation
    - Cefoxitin, Cefuroxime, Cefotetan
  - 3rd Generation
    - Cefotaxime, Ceftriaxone, Ceftazidime
  - 4th Generation
    - Cefepime

Cephalosporins

- Have a mechanism of action similar to penicillins
- A person allergic to penicillin, about 10% chance of being allergic

Cephalosporins

Warning!

Be sure if a patient is not allergic to penicillins before receiving a cephalosporin prescription.

Cephalosporins

- First-generation

Cephalosporins

- First-generation
- cefalotin - , cefazolin – (for parenteral administration), cefadroxil , cefaclor –(for oral administration)
- Similar to penicillinase-resistant penicillins with greater gram-negative coverage
  - Used for
    - community-acquired infections
    - mild to moderate infections

Cephalosporins

- Second-generation

Cephalosporins

- Second-generation
  - Increased activity, especially against *Haemophilus influenzae*
  - *patogens.*
  - *cefuroxim , cefamandol – (for parenteral administration)*
  - *cefuroxim-axetil (for oral administration)*
    - Otitis media in children
    - Respiratory infections
    - UTIs
    - *They can be used for prophylaxis in surgery as well*

Cephalosporins

- Third-generation

Cephalosporins

- Third-generation
  - Active against a wide spectrum of gram-negative organisms
  - Cefotaxim, ceftriaxon (for parenteral administration, Cefpodoxim (oral adminstration)
  - Long half-life, so once-a-day dosing
  - Used for
    - Ambulatory patients
    - Children (dosing before or after school)

Cephalosporins

- 4th generation
- Antibiotics of this group have a broad spectrum summarizing the 1st, 2nd and 3rd generation.
- cefpirom, cefepim (only parenteral administration)
- These antibiotics are used in nosocomial infections of special resistance pattern or in nosocomial sepsis of unknown origin where covering the broad spectrum of pathogens is necessary (i.e. febrile neutropenia).

Cephalosporins Side Effects

- Share side effects of penicillin
- Few may initiate unique toxic reactions
- Lower frequency of toxicity than many other antibiotics

Antimicrobial spectrum of cephalosporins

Generation of cephalosporins	*Active towards*		***Stability towards beta-lactamase***	
	Gram-positive bacteria	Gram-negative bacteria	Staphylo cocci	Gram-negative bacteria
I	**+++**	**+/-**	**++**	**-**
II	**++**	**+**	**++**	**+/-**
III	**+**	**+++**	**+**	**+**
IV	**++**	**+++**	**++**	**++**

Drug List

- cefaclor (Ceclor) first generation
- cephalexin (Keflex)
- cefadroxil (Duricef)
- cefdinir (Omnicef)
- cefuroxime (Ceftin, Zinacef) 2nd generation
- ceftriaxone (Rocephin) third generation
- cefotaxime (Claforan)
- cefpodoxime (Vantin) 4th generation
- cefepime (Maxipime)

Cephalexin (keflex) /Cefazolin (Ancef)

- PO/IV
- Stable vs Staph penicillinase
- Spectrum: MSSA, most E. coli, and some Klebs
- DoC: surgical prophylaxis, bacterial peritonitis
- ADRs
  - Positive Coombs' test (though, hemolytic anemia is rare)

Cefuroxime (zinacef)

- IV/PO
- Extensive use in pediatrics
- Spectrum: Strep pneumo, Viridans Strep, most H. flu, N. meningitidis
- DoC: uncomplicated CAP (esp. H. flu), UTI/pyelo

Cefotaxime (Claforan)

- IV
- Spectrum: Strep pneumo, Neisseria spp., most Gram (-) enterics, M. catarrhalis and H. flu (including β-lactamase +)
- DoC: bact meningitis (esp. in peds + amp if < 4 weeks), CAP, complicated UTI/pyelonephritis, Bacterial Peritonitis

Ceftriaxone (Rocephine)

- IV
- Once daily dosing (95% protein bound = long half-life)
- Spectrum: Strep. pneumoniae, most Enterbacteriaceae,
- Excretion: 50% urine, 50% bile = no need to adjust for renal insufficiency
- CSF penetration: 5-15% in meningitis, 1.5% with out inflammation
- DoC: bacterial meningitis, CAP, Strep. viridans endocarditis (+ gent)
- ADRs
  - Cholestasis
  - Elevated bilirubin (displacement)
  - Diarrhea

Cefepime (Maxipime)

- IV
- NON-Spectrum: MRSA, C. diff, Burkholderia, Stenotrophomonas, gram-negative anaerobes
- Stable vs. de-repressed chromosomal β-lactamases, but not ESBL
- Less β-lactamase induction than 3rd Cephs
- DoC: HAP, febrile neutropenia

Carbapenems

- They are very potent antibiotics of extremely broad spectrum including majority of gram-positive and gram-negative pathogens. The group of not affected microbes embraces methicillin-resistant staphylococci, Clostridium difficile, Stenotrophomonas maltophilia, Pseudomonas
- imipenem, meropenem (only parenteral administration)
- These antibiotics are reserved for extreme resistant nosocomial infections/sepsis.

Carbapenems

- Imipenem, Meropenem,
- Broad-spectrum coverage:
  - Gram positive
  - Gram negative: most gram-negative organisms (Acinetobacter sp., Pseudomonas sp.)
  - All: Stenotrophomonas, Legionella sp., MRSA,

Carbapenems

- Distribution: similar to penicillins
- Excretion: renal clearance
- Adverse reactions:
  - Hypersensitivity: rash, urticaria, cross-reactivity
  - Imipenem: seizures (rare)
    - High doses
    - Renal dysfunction
    - Most likely can occur with all carbapenems at high doses

Monobactams

- Monobactams: Aztreonam (only parenteral administration)

- Spectrum: ONLY → Gram negative aerobic bacteria
  - This antibiotic is reserved for nosocomial infections/sepsis caused by resistant gramnegative bacteria. Because of its lack of cross-reactivity, it can be given patients with allergy to penicillin or cephalosporins.
- Pharmacokinetics:
  - Well distributed into tissues, esp. inflamed tissues
  - Excretion: renal clearance
- Adverse reactions:
  - Skin rash
  - No cross-reactivity with Beta-Lactam class

Inhibitors of Cell Wall synthesis

GLYCOPEPTIDES

- ***Basic characteristics*: They are bactericidal drugs inhibiting bacterial cell wall synthesis** in a step prior to beta-lactam action. They may also interfere with RNA synthesis.
- Their antibacterial spectrum is narrow and involves only gram-positive microbes.
- ***Pharmacokinetics*: The drugs are not absorbed from the gastrointestinal tract. Penetration across biological barriers is poor. The drugs are excreted almost exclusively by kidney.
- ***Pharmacodynamics*: The effect of glycopeptides depends on the „time above MIC“.
- ***Adverse effects***: Nephrotoxicity and ototoxcity

Vancomycin
Pharmacology

- Absorption
  - absorption from GI tract is negligible after oral administration except in patients with intense colitis
  - Use IV therapy for treatment of systemic infection
- Distribution
  - widely distributed into body tissues and fluids, including adipose tissue
- Elimination
  - primarily eliminated unchanged by the kidney via glomerular filtration
  - elimination half-life depends on renal function

Vancomycin
Clinical Uses

- Infections due to gram-positive infections in β-lactam allergic patients
- Infections caused by multidrug resistant bacteria
- Endocarditis or surgical prophylaxis in select cases
- Oral vancomycin for refractory *C. difficile* colitis

Vancomycin
Adverse Effects

Red-Man Syndrome

- flushing, pruritus, erythematous rash on face and upper torso
- related to RATE of intravenous infusion; should be infused over at least 60 minutes

Nephrotoxicity and Ototoxicity

- rare with monotherapy, more common when administered with other nephro- or ototoxins

Inhibitors of bacterial protein synthesis Aminoglycosides

Gentamicin, Tobramaycin, Streptomycin

Mechanism of Action

- Involves inhibition of protein synthesis by binding ribosome
- Wide Spectrum: Aerobes Gram+, Gram- and Mycobacteria: tuberculosis – streptomycin

  Atypical - streptomycin or amikacin
- Disposal: Aminoglycosides are preferably used in combination with other antibiotics.

a) severe infections or sepsis caused M.tuberculosis.

b) nosocomial infections caused by resistant gram-negative bacteria, infective endocarditis caused by streptococci or enterococci

Aminoglycosides
Pharmacology

- Absorption - poorly absorbed from GI tract (neomicin only)
- Distribution
  - primarily in extracellular fluid volume; are widely distributed into body fluids but NOT the CSF
- Elimination
  - eliminated unchanged by the kidney via glomerular filtration; 85-95% of dose
  - elimination half-life dependent on renal function
    - normal renal function - 2.5 to 4 hours
    - impaired renal function - prolonged

Aminoglycosides
Adverse Effects

Nephrotoxicity

- risk factors: prolonged high troughs, long duration of therapy (> 2 weeks), underlying renal dysfunction, elderly, other nephrotoxins

Ototoxicity

- 8th cranial nerve damage - vestibular and auditory toxicity; irreversible and saturable
- vestibular: dizziness, vertigo, ataxia
- auditory: tinnitus, decreased hearing

Antibiotics: Tetracyclines

- Tetracycline
- Doxycycline (Vibramycin)
- minocycline

- Natural and semi-synthetic
- Obtained from cultures of Streptomyces

TETRACYCLINES

- **Mechanism of action:** They are static antibiotics reversibly inhibiting protein synthesis.
- **Spectrum**: Wide from gram-negative, gram-positive, protozoa, Mycoplasma, Rickettsia, Chlamydia, syphilis, Lyme disease
- **Pharmacokinetics:**

  Well absorbed from the gastrointestinal tract.

  They are excreted into mucosal fluid, breast milk

Antibiotics: Tetracyclines

- Bind to Ca^{2+} and Mg^{2+} and Al^{3+} ions to form insoluble complexes
- Thus, dairy products, antacids, and iron salts reduce absorption of tetracyclines

Therapeutic Uses of Tetracyclines

- Acne
- Chronic bronchitis
- Lyme disease
- Some venereal diseases, such as *Chlamydia* infection
- Traveler's diarrhea (neomicin)

Tetracyclines: Side Effects

Strong affinity for calcium

- Discoloration of permanent teeth and tooth
  enamel in fetuses and children
- May retard fetal skeletal development if taken during pregnancy

Tetracyclines: Side Effects

Alteration in intestinal flora may result in:

- Superinfection (overgrowth of nonsusceptible organisms such as Candida)
- Diarrhea
- Pseudomembranous colitis

Tetracyclines' Dispensing Issues

- Avoid antacids to avoid chelation with minerals

- Photosensitization

- To be avoided by pregnant women and children

Antibiotics: Macrolides

- Erythromycin
- Azithromycin (Zithromax)
- Clarithromycin (Klacid)
- MoA: inhibit protein synthesis
  - They are batteriostatic, Cidal at high concentration

Macrolides: Therapeutic Uses

- Spectrum: Wide
- DoC: Respiratory infections, skin infections
- Absorption: Not well absorbed PO and food interferes
- Distribution: well distribuited
- Metabolism: Liver elimination

Clarithromycin is the only macrolide partially eliminated by the kidney

Macrolides: Side Effects

GI effects, primarily with erythromycin:

- nausea, vomiting, diarrhea, hepatotoxicity, flatulence, jaundice, anorexia
- Thrombophlebitis – IV Erythro and Azithro
  Dilution of dose; slow administration
- Azithromycin and clarithromycin: fewer side effects, longer duration of action,
  better efficacy, better tissue penetration

Macrolides' Dispensing Issues

Although most antibiotics should be taken on an empty stomach, Erythromycins usually cause severe GI distress, so should be taken with food

Antibiotics Independent of Classes

These antibiotics are independent of other classes and each other due to structural differences.

Chloramphenicol (Chloromycetin)
Clindamycin (Cleocin)
Metronidazole (Flagyl)
vancomycin (Vancocin)

Antibiotics Independent of Classes

Metronidazole (Flagyl)

MOF: Inhibits nucleic acid synthesis. Bactercidal action

Spectrum: Obligate anaerobes only

DoC: Trichmoniasis and amebiasis

Treatment of H. PYLORI in Ulcer

Side effect: G.I.

Thrombophlebitis if IV

Drink water

Take it with food

Avoid caffe

Antibiotics: Clindamaycin

- Spectrum of Action: Gram-positive skin infections and anaerobe infections.
- DoC: Main indications are skin and soft tissue infections, diabetic foot
- Undesirable effects: The antibiotic is not toxic. Allergic reactions or gastrointestinal intolerability can occur.

Antibiotics Independent of Classes

Uses of clindamycin (Cleocin)

- Acne
- Alternative to penicillin in dental prophylaxis
- Anaerobic pneumonia
- Bone infections
- Bowel infections
- Female genital infections
- Intra-abdominal infections

Antibiotics Independent of Classes

Clindamycin (Cleocin)

Warning!

If patient develops diarrhea,
the drug must be discontinued.

Antibiotics:**Chloramphenicol**

MoA: Protein synthesis inhibitors

- Spectrum of Action: Very active against many Gram-positive and Gram-negative Empiric treatment of meningitis, crosses blood/brain barrier well.
- Toxicity: High toxicity, causes bone marrow aplasia and other hematological abnormalities
- Its use is limited duo do its tox effects

Fluoroquinolones

- Novel group of synthetic antibiotics developed in response to growing resistance
- MoA: Inhibite the bacterial DNA replication
  - Improved PK properties – excellent bioavailability, tissue penetration, prolonged half-lives
  - Overall safety

FQs Spectrum of Activity

Gram+ e Gram-

Atypical Bacteria

Legionella pneumophila - DOC

- *Chlamydia sp.*
- *Mycoplasma sp.*
- *Ureaplasma urealyticum*

Other Bacteria – *Mycobacterium tuberculosis*, *Bacillus anthracis*

Fluoroquinolones
Pharmacology

- Concentration-dependent bacterial killing
- Absorption
  - Most FQs have good bioavailability after oral administration
  - Cmax within 1 to 2 hours; coadministration with food delays the peak concentration
- Distribution
  - Extensive tissue distribution – prostate; liver; lung; skin/soft tissue and bone; urinary tract
  - Minimal CSF penetration
- Elimination – renal and hepatic;

Fluoroquinolones
Adverse Effects

- Gastrointestinal – 5 %
  - Nausea, vomiting, diarrhea, dyspepsia
- Central Nervous System
  - Headache, agitation, insomnia, dizziness, rarely, hallucinations and seizures (elderly)
- Hepatotoxicity
- Phototoxicity
- Other adverse reactions: tendon rupture in elderly

Fluoroquinolones

Levofloxacin (Tavanic)

PO, IV

Spectrum broad

Well absorbed orally

DoC: Respiratory, UTI, Soft tissues, prostitis

Absorbtion: Very well absorbed PO

Metabolism: Renal elimination

Adverse effect: same of all the class