Antibiotics

What do Antibiotics Target?

In bacteria, the target unique and essential features required for growth

1. Cell wall - Penicillin
2. Protein synthesis - Streptomycin
3. RNA synthesis - Rifampin
4. DNA replication - Ciprofloxacin
5. Metabolism - Sulfa Drugs

Antibiotic Use

Antibiotic use can increase the chance of getting certain infections

Clostridium difficile is normally non-threatening because of many bacteria in colon

If antibiotics are taken, they are the only bacteria left because they are naturally antibiotic-resistant

C. difficile infection can be a life-threatening inflammation of the colon

Antibiotics are **not** very selective

Normal microbiota functions to keep pathogens at bay (metabolic competition)

→ Antibiotics kill many beneficial organisms as a side effect

How Did We Get Here?

1. Selection for antibiotic resistant bacteria
2. Spread of antibiotic-resistant bacteria
3. Spread of antibiotic-resistant genes between different bacteria

Ways for Bacteria to Become Antibiotic Resistant

1. Antibiotic inactivation / Degradation
2. Efflux (Removal of antibiotic) (Opposite of influx)
3. Decreased permeability (Antibiotics cannot cross cell wall)
4. Target Modification (Nothing for antibiotic to attatch to)

Bacteria can evolve new traits very quickly

→ Penicillin resistance was discovered before clinical use

Selection for Antibiotic Resistant Bacteria

Misuse (not following full treatment) / overuse of antibiotics **vs.** extensive use of antibiotics in agriculture

Selection and Spread of Bacteria

Antibiotics "weed out" succeptible bacteria

Spread of Antibiotic-Resistant Genes

Horizontal Gene Transfer - Conjugation

→ Mobile Plasmid (Circular DNA) duplicated and transferred between bacteria

Does not require the same species

E-S-K-A-P-E Pathogens

Most common nosocomial (hospital acquired) infections

High rates of antibiotic resistance

1. Enterococcus faecium
2. Staphylococcus aureus
3. Klebsiella pneumoniae
4. Acinetobacter baumannii
5. Pseudomonas aeruginosa
6. Enterobacter species

CDC estimates ESKAPE pathogens cause over 2 milion illnesses and 23,000 deaths per year in the US

Healthcare-Associated Infections

Staphylococcus Aureus

1. Bacteremia / Sepsis - Bacteria in the bloodstream
2. Pneumonia - Usually in patients with underlying lung disease or with mechanical ventilators
3. Endocarditis (infection of heart valves) - Can lead to heart failure of stroke
4. Osteomyelitis (bone infection) - Can happen after bacteremia or surgery / injury

Major causes of nosocomial infections

1. Catheter
2. Surgical site
3. Cancer treatments

4. Hemodialysis
5. Ventilators

Before antibiotics S. aureus has a mortality rate of 82%

Penicillin (1942) decreased deaths, but by 1950 almost 25% were resistant to penicillin

Methicillin and oxacillin developed to overcome resistance (failed within a year)

MRSA = Methicillin Resistant Staphylococcus Aureus

→ Responsible for 30% of hospital-acquired infections

→ Around 30% are in the nose

→ 43-58% of S. aureus in pneumonia and surgical sites were MRSA