

## How Resistance Occurs - Mechanisms of Resistance

Bacteria develop mechanisms of resistance in 4 ways; these are the bacterium's survival response to the antibiotics trying to kill it. Knowledge of individual classes of antibiotics can all be fitted into these groups.

### 1) Production of a Protein (▲) that Interferes Before the Action of Antibiotic

#### Enzymes

- Beta-lactams (e.g. ESBLs, AmpC)
- Macrolides and Lincosamides
- Aminoglycosides (e.g. aminoglycoside modifying enzymes)
- Nitroimidazoles (e.g. Catalase)
- Tetracyclines and Chloramphenicol (e.g. Acetyl transferases)

#### Inhibitors

- Tetracyclines (proteins knock Tetracyclines off ribosome)
- Nitrofurantoin (inhibition of activating enzyme)

### 2) Mutation or Change in Active Site Prevents Binding of the Antibiotic

#### At the Ribosome

- Macrolides, Lincosamides, Aminoglycosides, Oxazolidinones, Fusidic Acid and Chloramphenicol

#### At the Cell Wall

- Beta-lactams and Glycopeptides

#### At the Chromosome

- Diaminopyrimidines, Quinolones and Rifampicin

#### Excessive Target Site

- Diaminopyrimidines and Glycopeptides

#### No Target Site

- Colistin in Gram-positive bacteria

### 3) Reduced Entry of the Antibiotic into the Cell

#### Reduced Cell Membrane Permeability

- Beta-lactams, Diaminopyrimidines and Chloramphenicol

#### Gram-negative Cell Membrane Blocks Entry

- Macrolides, Lincosamides, Glycopeptides and Lipopeptides

#### Loss of Porin

- Quinolones

### 4) Efflux Pumps Remove the Antibiotic from the Bacterium before its Action

- Beta-lactams, Diaminopyrimidines, Macrolides, Lincosamides, Aminoglycosides, Quinolones and Tetracyclines

