**Al-Anbar University**

**Medicine College**

**Microbiology department**

Antimicrobial" is a general term that refers to a group of drugs that includes antibiotics, antifungals, antiprotozoals, and antivirals. Antimicrobial medicines can be grouped according to the microorganisms they act primarily against. For example, antibacterial are used against bacteria and antifungals are used against fungi. They can also be classified according to their function.

## Classification of antibacterial agents

Antimicrobials are classified in several ways, including:

1. **Spectrum of activity**
2. **Effect on bacteria**
3. **Mode of action**

### 1-Classification according to spectrum of activity:

Depending on the range of bacterial species susceptible to these agents, antibacterials are classified as broad-spectrum, narrow- spectrum.

#### a-**Broad spectrum antibacterials** :

An antibiotic that is effective against a wide range of bacteria, both gram-positive and gram-negative examples the aminoglycosides, the 2nd and 3rd generation cephalosporins.

#### b-Narrow spectrum antibacterials:

Antibiotics that kill just gram-positive or gram-negative bacteria or could be specific to one type of bacteria examples penicillins (penG), and vancomycin

**2-Effect on Bacteria** :Because of differences in the mechanisms by which antibiotics affect bacteria, the clinical use of antibacterials may have very different effects on bacterial agents, leading to an endpoint of either inactivation or actual death of the bacteria.

#### a-Bactericidal drugs :

a-An antibiotics kill bacteria examples of bactericidal drugs include aminoglycosides, cephalosporins, penicillins, and quinolones.

**b-Bacteriostatic drugs**:

An antibiotics inhibit bacterial growth examples of such include tetracyclines, sulfonamides, and macrolides.

## 3- Mode of action

Different antibiotics have different modes of action, owing to the nature of their structure and degree of affinity to certain target sites within bacterial cells.

**1-Inhibitors of cell wall synthesis**. While the cells of humans do not have cell walls, this structure is critical for the life and survival of bacterial species. A drug that targets cell walls can therefore selectively kill or inhibit bacterial organisms. Examples: penicllins, cephalosporins, bacitracin and vancomycin.

**2-Inhibitors of cell membrane function**. Cell membranes are important barriers that segregate and regulate the intra- and extracellular flow of substances. A disruption or damage to this structure could result in leakage of important solutes essential for the cell's survival. Because this structure is found in both eukaryotic and prokaryotic cells, the action of this class of antibiotic are often poorly selective and can often be toxic for systemic use in the mammalian host. Most clinical usage is therefore limited to topical applications. Examples: polymixin B and colistin.

**3-Inhibitors of protein synthesis**. Enzymes and cellular structures are primarily made of proteins. Protein synthesis is an essential process necessary for the multiplication and survival of all bacterial cells. Several types of antibacterial agents target bacterial protein synthesis by binding to either the 30S or 50S subunits of the intracellular ribosomes. This activity then results in the disruption of the normal cellular metabolism of the bacteria, and consequently leads to the death of the organism or the inhibition of its growth and multiplication. Examples: Aminoglycosides, macrolides, lincosamides, streptogramins, chloramphenicol, tetracyclines.

**4-Inhibitors of nucleic acid synthesis**. DNA and RNA are keys to the replication of all living forms, including bacteria. Some antibiotics work by binding to components involved in the process of DNA or RNA synthesis, which causes interference of the normal cellular processes which will ultimately compromise bacterial multiplication and survival. Examples: quinolones, metronidazole, and rifampin.

**5-Inhibitors of other metabolic processes**. Other antibiotics act on selected cellular processes essential for the survival of the bacterial pathogens. For example, both sulfonamides and trimethoprim disrupt the folic acid pathway, which is a necessary step for bacteria to produce precursors important for DNA synthesis. Sulfonamides target and bind to dihydropteroate synthase, trimethophrim inhibit dihydrofolate reductase; both of these enzymes are essential for the production of folic acid, a vitamin synthesized by bacteria, but not humans.

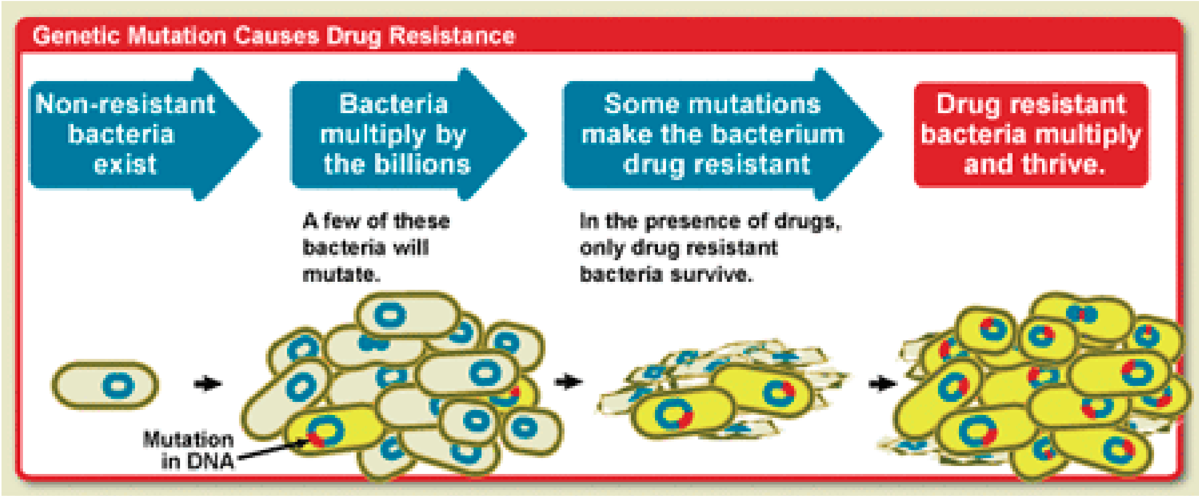
**Antibiotic resistance:** The ability of bacteria to resist the effects of an antibiotic .Antibiotic resistance occurs when an antibiotic has lost its ability to effectively control or kill bacterial growth; in other words, the bacteria are "resistant" and continue to multiply in the presence of therapeutic levels of an antibiotic.

## Resistance cause

### 1-Mutation

Most and some of these mutations may help an individual microbe survive exposure to an microbes reproduce by dividing every few hours, allowing them to evolve rapidly and adapt quickly to new environmental conditions. During replication, mutations arise antimicrobial.

**1.** The act or process of being altered or changed.
**2.** An alteration or change, as in nature, form, or quality.
**3.** *Genetics*
**a.** A change of the DNA sequence within a gene or chromosome of an organism resulting in the creation of a new character or trait not found in the parental type.
**b.** The process by which such a change occurs in a chromosome, either through an alteration in the nucleotide sequence of the DNA coding for a gene or through a change in the physical arrangement of a chromosome.

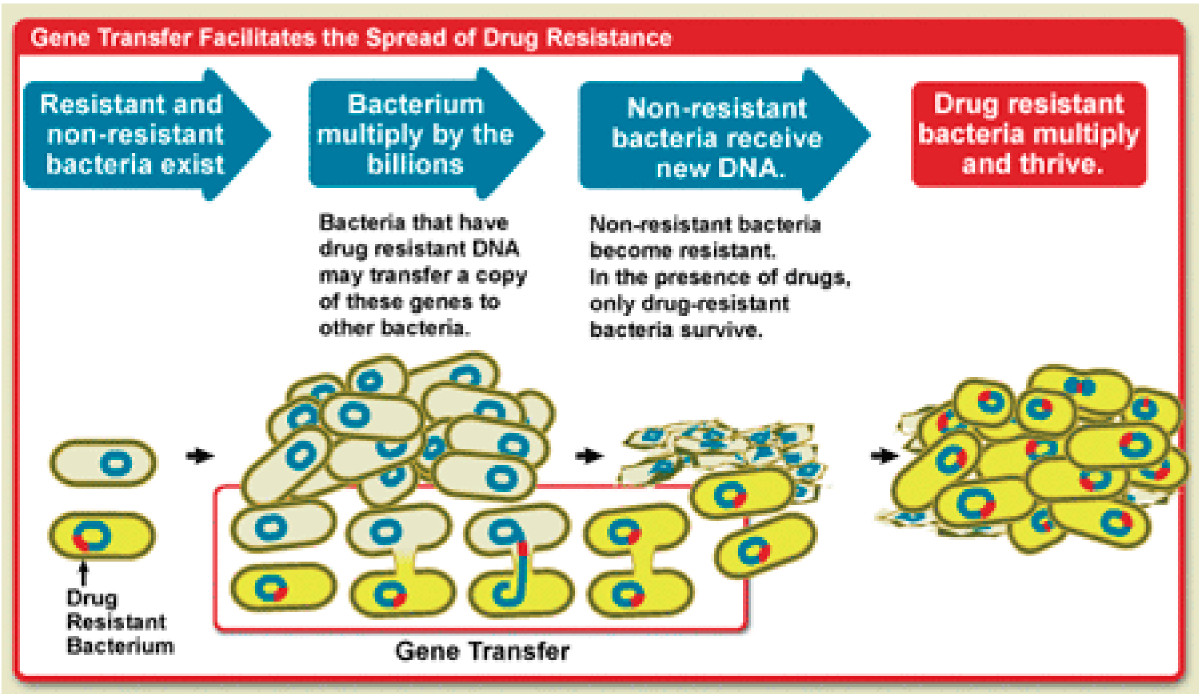



**Picture of Mutation Causes of Drug Resistance**

## <u>2-Gene Transfer</u>

Microbes also may get genes from each other, including genes that make the microbe drug resistant.

**bacterial transformation** the exchange of genetic material between strains of bacteria by the transfer of a fragment of naked DNA from a donor cell to a recipient cell, followed by recombination in the recipient chromosome.



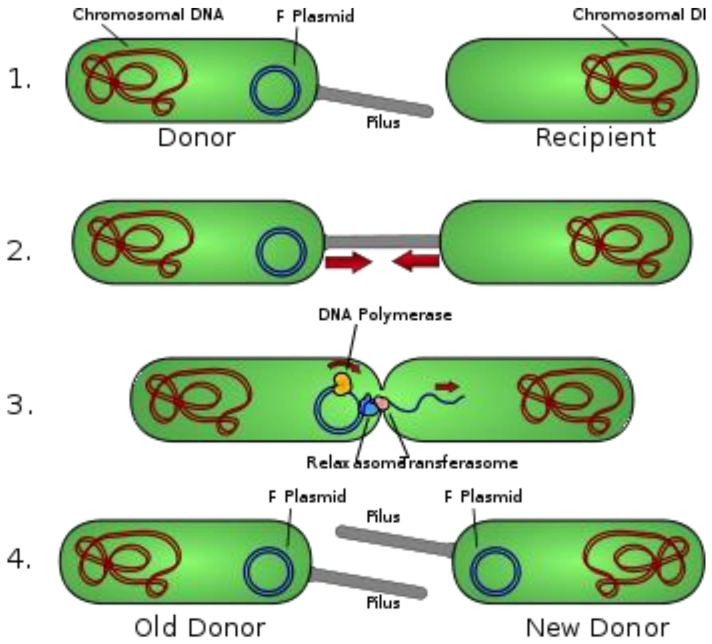

**Picture of Gene Transfer Facilitates Drug Resistance**

## 3-Bacterial conjugation

Bacterial conjugation is the transfer of genetic material between bacterial cells by direct cell-to-cell contact or by a bridge-like...

The process in bacterial cells in which two bacterial cells come together in a temporary fusion to transfer genetic material via the plasmid (either as solitary or as part of a chromosome) from the donor cell to the recipient cell.

Bacterial conjugation is a beneficial process in bacteria since they can acquire a gene that confers survival or a novel characteristic which enables them to thrive in harmful conditions or to utilize a new metabolite. It is through this process that resistance to antibiotics can be transferred from one bacterial cell to another.




**Schematic drawing of bacterial conjugation. Conjugation diagram4**

**Steps of conjugation:**

**1- Donor cell produces <u>pilus</u>.**

**2- Pilus attaches to recipient cell and brings the two cells together.**

**3- The mobile plasmid is nicked and a single strand of DNA is then transferred to the recipient cell.**

**4- Both cells synthesize a complementary strand to produce a double stranded circular plasmid and also reproduce pili; both cells are now viable donors.**