Mode of Action of antibiotics

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Introduction

- Antibiotics or antibacterials are a type of antimicrobial used in the treatment and prevention of bacterial infection.
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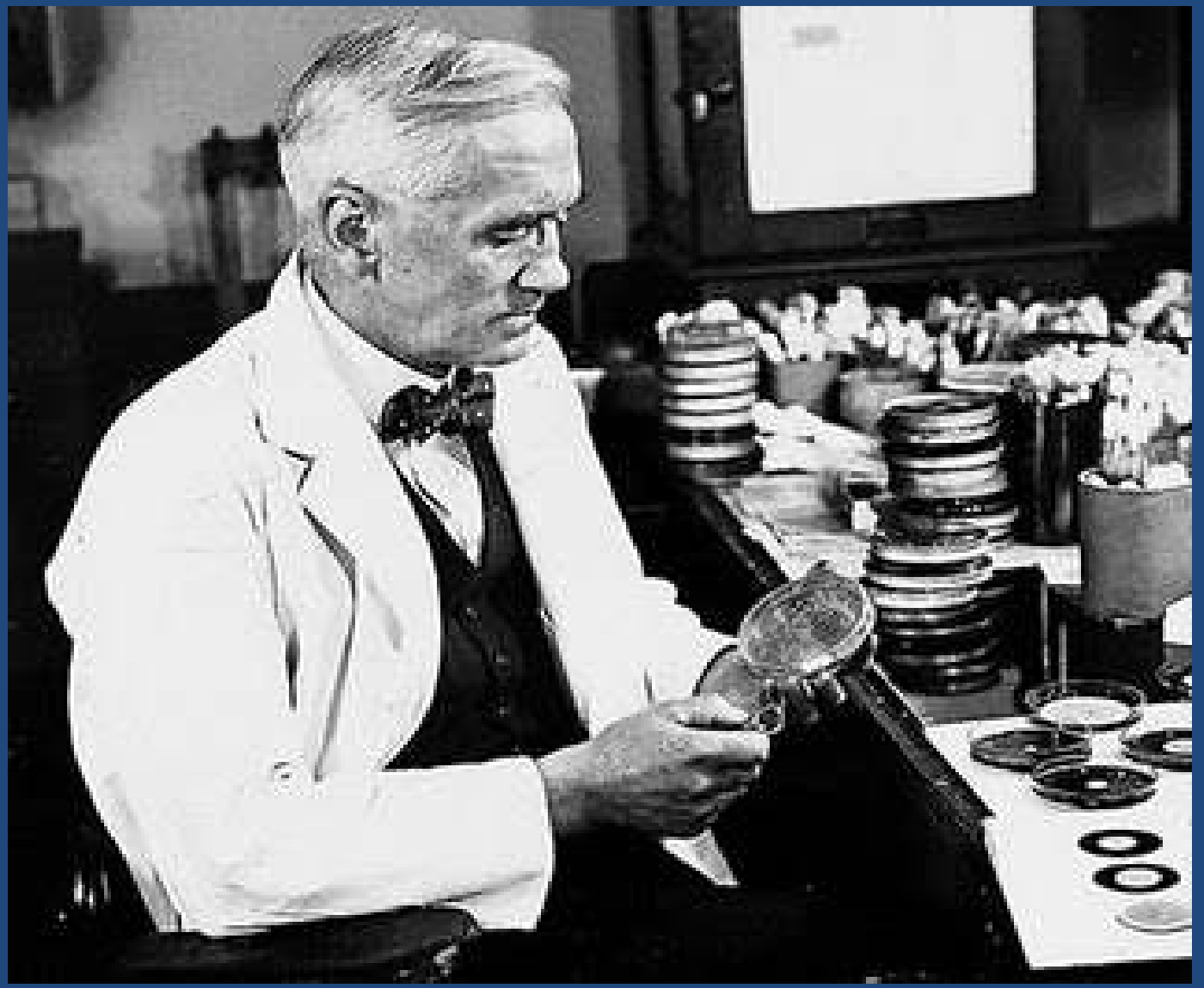
- They may either kill or inhibit the growth of bacteria. Several antibiotics are also effective against fungi and protozoans, and some are toxic to humans and animals, even when given in therapeutic dosage.

Intro . . .

- Antibiotics are not effective against viruses such as the common cold or influenza, and may be harmful when taken inappropriately.

Intro . . .

- In 1929, Alexander Fleming identified penicillin, the first chemical compound with antibiotic properties.
- Fleming was working on a culture of disease-causing bacteria when he noticed the spores of little green mold in one of his culture plates.
- He observed that the presence of the mold killed or prevented the growth of the bacteria.



Intro . . .

- Antibiotics revolutionized medicine in the 20th century, and have together with vaccination led to the near eradication of diseases such as tuberculosis in the developed world.
- Their effectiveness and easy access led to overuse, especially in live-stock raising, prompting bacteria to develop resistance. This has led to widespread problems with antimicrobial and antibiotic resistance

Classes of Antibiotics

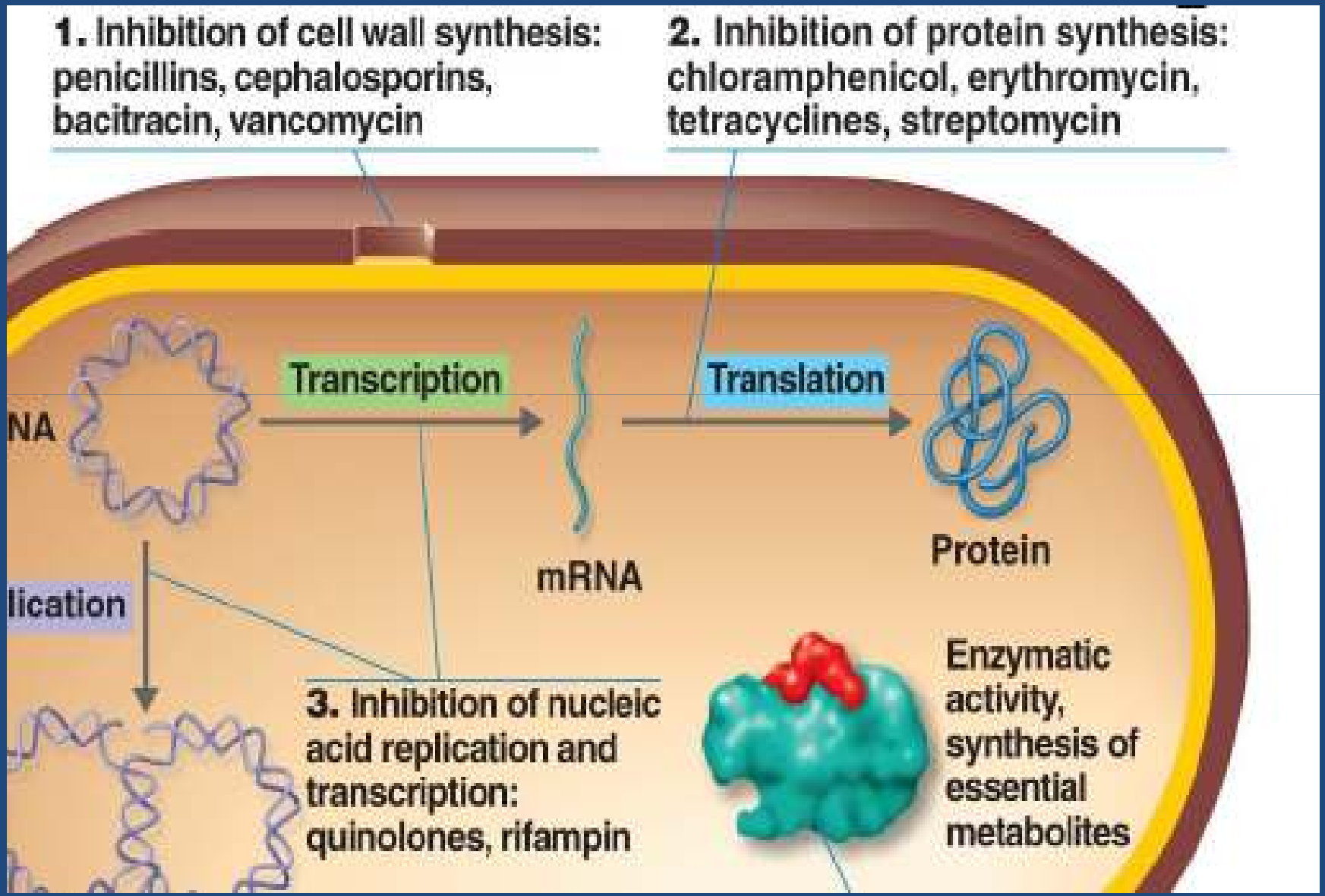
- Antibacterial antibiotics are commonly classified based on their mechanism of action, chemical structure, or spectrum of activity. Most target bacterial functions or growth processes.
- Those that target the bacterial cell wall (penicillins and cephalosporins) or the cell membrane (polymyxins),
- Interfere with essential bacterial enzymes (rifamycins, lipiarmycins, quinolones, and sulfonamides) have bactericidal activities.
- Those that target protein synthesis (macrolides, lincosamides and tetracyclines)

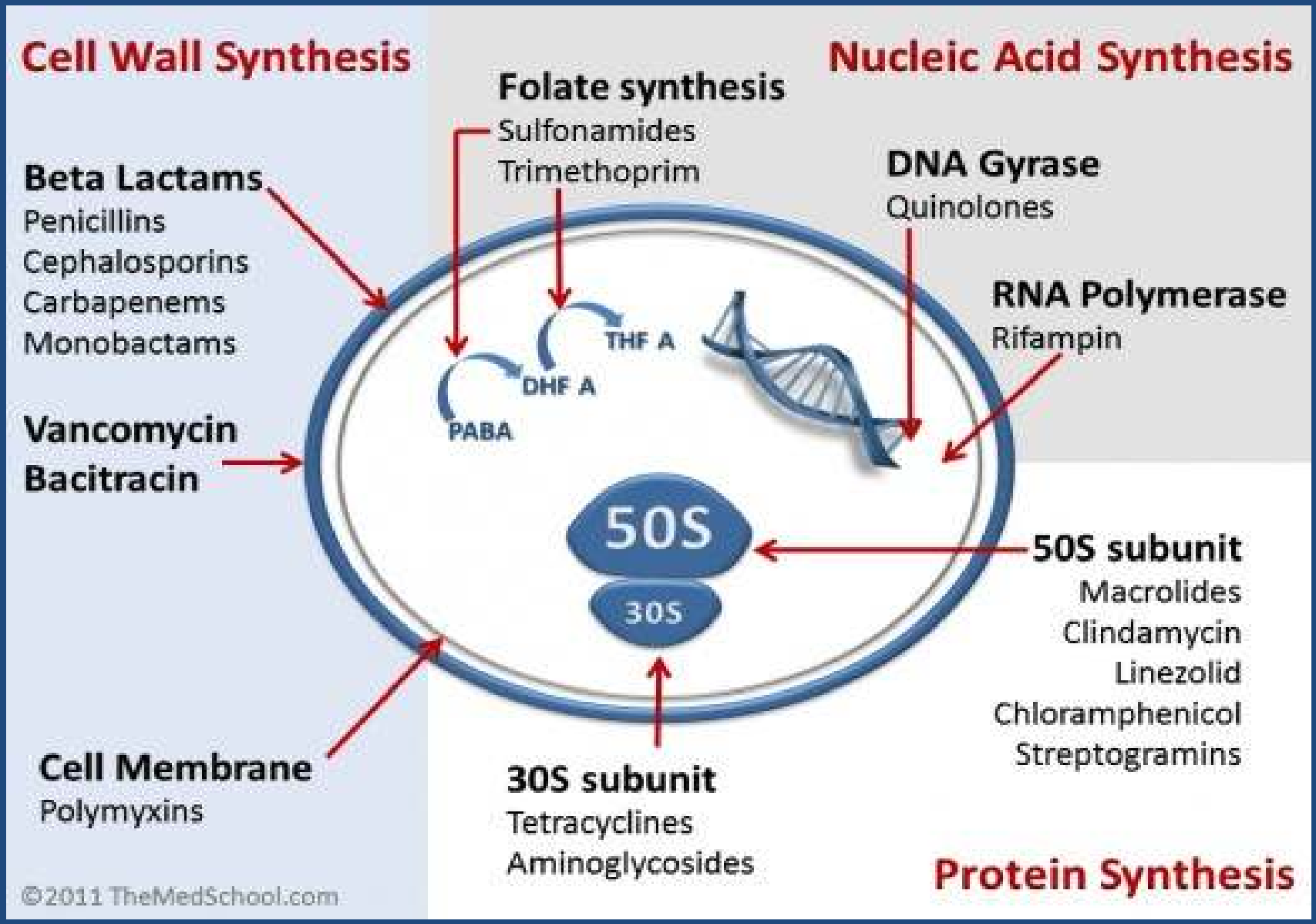
Classes of Antibiotics

- Further categorization is based on their target specificity. "Narrow-spectrum" antibacterial antibiotics target specific types of bacteria, such as Gram-negative or Gram-positive bacteria, whereas broad-spectrum antibiotics affect a wide range of bacteria.

Mode of Action of antibiotics

- Antibacterial action generally follows some of the mechanisms such as inhibition or regulation of enzymes involved in the synthesis of cell wall, nucleic acid synthesis and repair, or protein biosynthesis. Antibiotics target the cell functioning of rapidly dividing cells.


1. Inhibition of cell wall synthesis: penicillins, cephalosporins, bacitracin, vancomycin
2. Inhibition of protein synthesis: chloramphenicol, erythromycin, tetracyclines, streptomycin
Transcription
Translation
NA
mRNA
Protein
lication
3. Inhibition of nucleic acid replication and transcription: quinolones, rifampin
Enzymatic activity, synthesis of essential metabolites


Cell Wall Synthesis
Nucleic Acid Synthesis
Folate synthesis
Sulfonamides
Trimethoprim
Beta Lactams
Penicillins
Cephalosporins
Carbapenems
Monobactams
DNA Gyrase
Quinolones
RNA Polymerase
Rifampin
THF A
DHF A
PABA
Vancomycin
Bacitracin
50S
30S
50S subunit
Macrolides
Clindamycin
Linezolid
Chloramphenicol
Streptogramins
Cell Membrane
Polymyxins
30S subunit
Tetracyclines
Aminoglycosides
Protein Synthesis
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Inhibition of Cell Wall Synthesis

- Some of the antibacterial compounds interfere with the cell wall synthesis by weakening the peptidoglycan structures in bacterial cell wall, by this integrity of bacterial cell wall structure weakens and eventually disrupts.

Inhibition of Cell Wall Synthesis . .

- Mammalian cells only have plasma membrane so these antibiotics specifically target only bacterial cells. That is these antibiotics do not induce any negative effect on the host mammalian cells.
- The specificity of antibacterial compound βlactam is by their ability to prevent the assembly of peptidoglycan layer via inhibiting transpeptidase enzyme activity.

Inhibition of Cell Wall Synthesis . .

- Antibacterial compound βlactam can be used against both Gram positive and Gram negative bacterial cells.
- But this compound can be used effectively against Grampositive bacteria, as it is unable to penetrate the outer cytoplasmic membrane of Grampositive bacteria.

Inhibition of Cell Wall Synthesis . .

- Some of the antibacterial examples for this type of action are Bacitrasin extracted from Bacillus licheniformis, D cycloserine, antibacterial compound Tunicamycine extracted from Streptomyces species, another antibacterial compound called as Vancomycin hydrochloride extracted from Streptomyces orientalis potency.

Inhibition of Cell Wall Synthesis . .

- During normal bacterial growth, bacterial enzymes called autolysins put breaks in the peptidoglycan in order to allow for insertion of peptidoglycan building blocks (monomers of NAG-NAM-peptide).
- These monomers are then attached to the growing end of the bacterial cell wall with transglycosidase enzymes. Finally, transpeptidase enzymes join the peptide of one monomer with that of another in order to provide strength to the cell wall.
- Penicillins and cephalosporins bind to the transpeptidase enzyme and block the formation of the peptide cross-links.
- This results in a weak cell wall and osmotic lysis of the bacterium.

Inhibition of Nucleic Acid Synthesis

- This category of antibacterial compounds interferes in the synthesis of nucleic acid of bacterial cells.
- For example compound quinonoles interfere with synthesis of DNA molecule by inhibiting activity of enzyme topoisomerase.
- This enzyme is involved in the DNA (deoxy nucleic acid) replication. The second generation quinolones like levofloxacin, norfloxacin and ciprofloxacin all can be used against both Grampositive and Gramnegative bacteria.
- These compounds specifically inhibit the bacterial topoisomease II.

Inhibition of Nucleic Acid Synthesis . .

- Some antibiotics inhibit the action of enzyme RNA polymerase, hence interfere with RNA (ribonucleic acid) synthesis in the cells.
- Antibiotics such as asdoxorubicin and actinomycin D interfere with RNA biosynthesis in both bacterial cells as well as in mammalian cells.
- These compounds are used in treating rapidly growing tumor cells in cancer patients. Some of the examples are Doxorubicin hydrochloride, Levofloxacin, Irinotecan hydrochloride, Rifampcin.

Inhibition of Protein Synthesis

- Some of the antibiotic compounds inhibit bacterial cell multiplication by inhibiting protein synthesis in them.
- Protein synthesis is a multistep process. Majority of antibiotics inhibit the process that occurs in the 30S or 50S subunit of 70S bacterial ribosome, this in turn inhibits the protein biosynthesis.

Inhibition of Nucleic Acid Synthesis . .

- Most of the antibiotics inhibits the formation of 30S initiation complex or altogether inhibits the formation of 70S ribosome by the 30S and 50S ribosome subunits or they inhibit assembling of amino acids into a polypeptide chain.
- Tetracyclines, includingdoxycycline, block protein synthesis by preventing the binding of aminoacyltRNA in 30S ribosome subunit.
- These compounds block protein synthesis in both prokaryotic and eukaryotic system.

Inhibition of Nucleic Acid Synthesis . .

- Streptomycin interferes with the formation of 30S initiation complex hence inhibits the protein biosynthesis.
- Erythromycin interferes with the assembly of 50S subunit of ribosome hence inhibit the protein synthesis.
- Antibiotics lincomycin and clindamycin inhibits enzyme peptidyl transferase, hence prevent the protein synthesis.
- Whereas antibiotic puramycin does not inhibits the enzymatic process, but they act as an analoge of 3'terminal end of aminoacyltRNA, hence disrupts protein synthesis and causes premature polypeptide chain termination.

Inhibition of Nucleic Acid Synthesis . .

- In other words this antibiotic produces non functional proteins in the cell. Some of the examples for this category of antibiotics are Doxocycline hyclate, Erythromycin, Hygromycin B, Kanamycin disulfate salt and much more.

Thankyou