Module 2 Worksheet:

Disclaimer: This is a public Google document in which the answers are filled in by your fellow classmates. This is where any answers that we go through during my sessions will appear. Feel free to add on and reference back to your slides/notes to verify any information.

*Anything denoted in red are important takeaways to understand or are things that I have seen on the exam. -William

Color code:

-Inhibitors of the cell wall =>*The best class to target bacteria with (most selectively toxic)

-Protein synthesis inhibitors:

-Metabolic antagonists

-Nucleic acid synthesis inhibitors => *The worst class to target bacteria with (least selectively toxic)

Name	**Mode of Action**	**Special Characteristics**	**Examples**	**Possibles side effects/Resistance**
Penicillins	Cell wall synthesis inhibitors 1. Blocks enzyme (**transpeptidase**) that catalyzes transpeptidation 2. Acts on growing bacteria 3. Inhibits bridge formation; inhibits peptide bonds 4. May activate bacterial **autolysins** and murein hydrolases 5. Can bind to **PBP's** and help inhibit peptidoglycan biosynthesis	6-aminopenicillanic acid derivatives; **β-lactam** ring structure 1-5% of adults in the U.S are allergic to penicillin ***Penicillin is the first true antibiotic** **(**Made by a **FUNGUS)**	***Naturally occurring penicillin (V and G are OG)** are narrow spectrum - Only work on gram-positives ***Ampicillin (semisynthetic)** has a broader spectrum and works against gram-negatives	*Organisms that produce **β-Lactamase** (Penicillinase) can be resistant
Cephalosporins	Cell wall synthesis inhibitor (similar to Penicillin) **B-lactam ring**	***True** antibiotic made from the **fungus** ***Acremonium***	Broad spectrum and is used on patients who are allergic to Penicillin	*N.Gonorrhoeae* (causative agent for gonorrhea) and *Enterobacteriaceae* HAI (found in hospital-acquired infections)
Carbapenem & other β-lactams	Cell wall synthesis inhibitor ***β-lactam**	**(*Semi-synthetic)** *modified versions of Penicillin and Cephalosporin	Broad spectrum	

		*B-lactam ring contains a carbon atom (where there would be a sulfur) and a double bond where there would be a single bond		
Vancomycin	Inhibits transpeptidation (similar to Penicillin) and inhibits peptide bonds between the 3rd and 4th amino acid ***Inhibits the removal of the terminal D-alanine**	***NO B-Lactam ring** *__**True**__ antibiotic made from the __**bacterium *Streptomyces orientalis***__ (true antibiotic) **Important for treating antibiotic-resistant staphylococcal and enterococcal infections** *Was **previously** known as the "__drug of last resort__"	**Narrow spectrum** Only works against Gram-positives (*Staphylococcus*, *Clostridium Bacillus*, *Streptococcus*, and go *Enterococcus*)	*Vancomycin-resistant enterococcus* Lid (**VRE**)
Aminoglycosides	Protein synthesis inhibitor Binds to the 30s small subunit of the ribosome	**True** antibiotic - made from Bacteriocidal **bacteria *Streptomyces*** **(*True** antibiotics Streptomycin,	Narrow spectrum - aerobic gram-negative bacteria	Can be toxic and cause renal damage

		kanamycin, neomycin**)** Structure is cyclohexane ring		
Tetracyclines	Inhibits rRNA from binding, inhibits translation Binds to the 30S small subunit	***4-ringed structure** **Bacteriostatic, very broad spectrum,** includes true and semi-synthetic antibiotics Works against intracellular pathogens (*Atypical bacteria → ***Rickettsia***, ***Chlamydiae***, and ***Mycoplasma***)	Broad spectrum Can be used against atypical bacteria	*Vibrio Cholerae* Causes ***black teeth** in adults/children as a side effect
Macrolides	Inhibits alignment with amino acid to prevent polypeptide from forming Binds to **23S rRNA** (large subunit of the ribosome) **ribozyme** that catalyzes peptide	"Massive" 12-22 carbon lactone ring Generally bacteriostatic	**Erythromycin** - Broad spectrum, bacteriostatic, works against Gram-positives, *Mycoplasma* and some Gram-negatives Broad spectrum **Azithromycin** is used to treat	

	bond formation		chlamydia Used for patients allergic to penicillin	
Lincosamides	Prevents polypeptide chain growth Binds to **23s rRNA**	Broad spectrum, bacteriostatic *__True__ antibiotic made by ***Streptomyces*** *lincolnensis*	Broad spectrum Used against **anaerobic microbes**, Gram-negative bacteria in our gut Clindamycin- Can cause *C. diff* to bloom in gut by destroying competition Clindamycin treats CA-MRSA	
Chloramphenicol	Protein synthesis inhibition Binds to **23S rRNA** Can also bind to mitochondrial ribosome	*__True__ antibiotic produced by bacterium ***Streptomyces*** *venezuelae* Very toxic antibiotic	*__First broad-spectrum antibiotic__ Bacteriostatic against domain bacteria Bactericidal to sensitive bacteria	**Toxic** with numerous side effects Ex. Aplastic anemia, leukemia, neurotoxin reactions
Oxazolidinones	Protein synthesis inhibition Binds to **23S rRNA**	**Bacteriostatic** **Synthetic** antibiotic	Only used in hospitals *Considered the __new__ “__drug of last resort__”	Works against many resistant bacteria (VRE, MRSA, penicillin-resistant

				S. pneumoniae) **Very few side effects**
Sulfonamides/Sulfa Drugs	*Inhibits the making of **folic acid** **Selectively toxic** due to competitive inhibition	Sulfa binds to active site of enzyme instead of PABA, prevents folic acid production ***PABA analog,** **Synthetic** antibiotic, Broad spectrum, bacteriostatic	**Sulfanilamide** Works against bacteria and some protozoa	*Bacteria can learn to absorb folic acid from the environment to become resistant Can also change enzyme to select for PABA
Trimethoprim	Inhibits binding from substrate to product	*Often given with Sulfa drugs (**Bactrim**) for a **synergistic outcome** Synthetic	Broad spectrum	Works against bacteria resistant to sulfa Side effects: photosensitivity & abdominal pain
Fluoroquinolones	*Inhibits **DNA gyrase** and **topoisomerase IV** from uncoiling the DNA to inhibit access	**Synthetic** **Bactericidal** Enteric (grows in gut) Commonly prescribe for UTIs	**Norfloxacin**, **nalidixic acid** Broad spectrum	Many different side effects, used selectively
Rifamycins	*Inhibits transcription by **binding** to **β-subunit** in RNA	**Semisynthetic** Can be given before coming into contact with a pathogen	**Rifampin** Broad spectrum, can work against domain bacteria and	*Red sweat and urine

	polymerase	Bacteriostatic	*Mycwsdobacterium*	

Color code:

-Antiviral

-Antifungal

-Antiprotozoal

Microorganism / Disease	**Examples and Treatment**
Influenza	**Amantadine -** Blocks penetration and uncoating of the virus (prevention) ***Tamiflu** (**oseltamivir**) - Neuraminidase inhibitor, stops binding and replication **NOT a cure** for the flu
Herpes	***Acyclovir (Ex. of an Antiviral)** - inhibits viral DNA polymerase **Adenine arabinoside (vidarabine)** - inhibits DNA/RNA synthesis and function
HIV	*5 Drug cocktail = **"HAART"** (most successful) For preexposure = **"PrEP"**

Mycoses	*Antifungals work to identify and attack **Ergosterol** = **or**(**unique sterol** in **FUNGAL** cell membranes) *Systemic mycoses: Deadliest form of mycoses (all throughout the body) ● **Amphotericin B** - binds ergosterol, highly toxic (from *Streptomyces* spp.) ● **5-flucytosine** - disrupts/inhibits DNA and RNA function, toxic ● **Fluconazole** - low side effects, used prophylactically, HIV & immunocompromised patients
Plasmodium	**Chloroquine** **Mefloquine**
Entamoeba and *Trichomonas*	**Metronidazole**
Toxoplasma gondii	**Combination drug therapy** *Anti-protozoan drugs **exist!**

	However, mechanisms not entirely known

Practice Questions: (Chapter 9) *Answers are highlighted

1. All of the following antibiotics are protein synthesis inhiitors **except:**

   A. Erythromycin Macrolides
   B. Rifamycins
   C. Clindamycin Lincosamides
   D. Tetracyclines
   E. Kanamycin Aminoglycoside

2. Which of the following antibiotics is/are **not** involved with inhibiting the catalytic center of peptide bond formation?

   A. Macrolides 23S
   B. Oxazolidinones 23S
   C. Lincosamides 23S
   D. Aminoglycosides 30S and tetracyclines only ones that are 30S
   E. Both A and C

3. Vancomycin: **(select <u>all</u> that apply)**

A. Was previously considered the “drug of last resort”
B. Has a narrow spectrum and can only be used on gram-positives
C. Can be inhibited by β-lactamase
D. Is made by a fungus
E. Is considered a true antibiotic that inhibits transpeptidation

4. Which of the following is **true**?

A. *Streptomyces* is a gram-positive soil bacterium that produces a majority of antibiotics
B. Metabolic antagonists are considered to be the most specific antimicrobial drugs
   Most specific are cell wall inhibitors
C. Tetracyclines are broad spectrum antibiotics responsible for black teeth
D. Both A and B
E. Both A and C

5. Which of the following is **false**?

A. The larger the therapeutic index, the more toxic the drug is
B. Salvarsan is considered to be the first synthetic antibiotic
C. Ampicillin is a semisynthetic penicillin that can work against gram-negative bacteria
D. Rifamycins are a class of nucleic acid synthesis inhibitors that can cause red sweat and urine
E. All of the above are true

6. Which of the following is paired **incorrectly**?

A. Chloramphenicol - first broad spectrum antibiotic
B. Rifamycin - may cause red sweat and urine
C. Tamiflu - cure for the flu
D. Acyclovir - antiviral
E. Oxazolidinones - “new drug of last resort”

7. An antibiotic that only works on a small subset of bacteria is known as:

A. A broad-spectrum antibiotic
B. A narrow spectrum antibiotic
C. Strain-specific antibiotic
D. A selective toxicity antibiotic

8. It is difficult to identify antivirals because:

A. Viruses use our cellular machinery to replicate
B. They are also eukaryotes
C. They have an impermeable capsid
D. Viruses can only replicate inside bacterial cells
E. It is very easy to identify antivirals

9. Which category of antibiotics is the least selectively toxic?

A. Protein synthesis inhibitors
B. Cell wall synthesis inhibitors
C. Nucleic acid synthesis inhibitors

D. Metabolic antagonists
E. All of the above have similar selective toxicity

10. An antibiotic that is produced by a microorganism:

A. Is known as a synthetic antibiotic
B. Includes penicillin
C. Is often more broad spectrum than their semi-synthetic counterparts
D. All of the above
E. Both B and C

(Chapter 13,16)

1. According to the central dogma of biology, which of the following represents the flow of genetic information in cells?

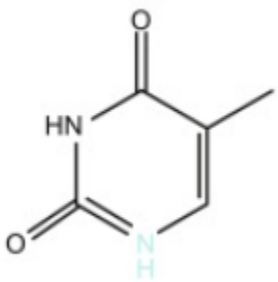
A. DNA to protein to RNA
B. RNA to protein to DNA
C. DNA to RNA to protein
D. RNA to DNA to protein
E. None of the above

2. The following is the antisense strand sequence. What is the mRNA sequence?

3' – TAC AGT TCC GGA CTA – 5'

A. 3' – ATG TCA AGG CCT GAT – 5'
B. 5' – ATG TCA AGG CCT GAT – 3'
C. 5' – AUG UCA AGG CCU GAU – 3'
D. 3' – AUG UCA AGG CCU GAU – 5'

3. The following picture is an example of what?



A. A pyrimidine
B. A purine
C. A nucleotide
D. A nucleoside
E. Uracil

4. What are key differences between DNA and RNA **(select <u>all</u> that apply)**

A. RNA lacks a hydroxyl group at the 2' carbon, while DNA has it It has it whereas DNA doesnt "Deoxy"
B. DNA contains a deoxyribose sugar while RNA has a ribose sugar
C. Uracil is only present in RNA, not DNA
D. DNA is double stranded while RNA is typically single stranded in living organisms
E. DNA contains a 6 carbon sugar while RNA has a 5 carbon sugar Both have 5 carbon sugars

5. Which of the following is **true**?

A. 23s rRNA is a ribozyme that catalyzes peptide bond formation

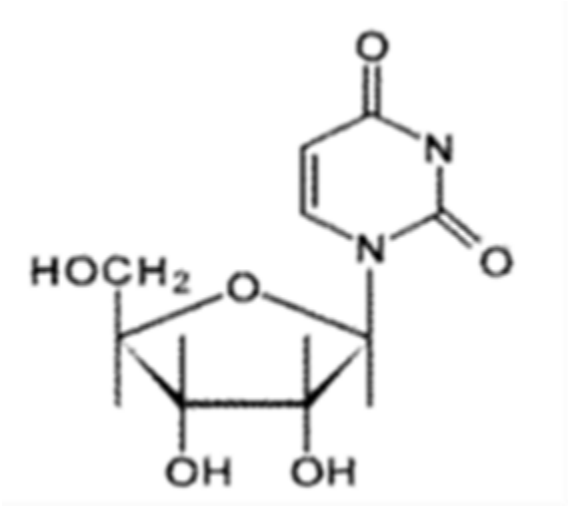
B. T4SS (Type IV Secretion System) utilizes ATP and can be found in gram-positives and gram-negatives Yes uses HGT in gram + & -

C. Mutations in the bacterial genome can only be spontaneous Can be induced

D. Both A and B

E. Both B and C

6. The following picture is an example of a what?



A. DNA nucleoside

B. DNA nucleotide

C. RNA nucleotide

D. RNA nucleoside OH group means RNA, no group means DNA. Its not a nucleotide bc there is no phosphate group.

7. Which of the following is **true** regarding the Hershey-Chase experiment?

A. Used a “smooth” and “rough” bacteria

B. They labeled the DNA with ^{35}S and the protein coat ^{32}P (switched abbreviations)

C. Both the labeled DNA and the protein coat entered the cell (no protein coat didnt which is how to tell them apart)

D. It used phages and bacteria to identify what the genetic material was

E. All of the above are true

8. DNA replication: **(select <u>all</u> that apply)**

A. Happens once per cell cycle

B. Is conservative (It is semi-conservative)

C. Replicates the whole genome

D. Is semi-conservative

E. Starts at the *oriC* site and ends at the *ter* site in bacteria

9. Which of the following is **true**?

A. Bacteria can transcribe polycistronic mRNA - (Yes eukaryotes do monocistronic mRNA)

B. The *lac* operon contains information for the *lac* permease

C. Transcription and translation are coupled in eukaryotes (No bc eukaryotes have nucleus)

D. All of the above

E. Both A and B

10. Which of the following is a **false** statement?

A. All living organisms contain both DNA and RNA

B. Both DNA and RNA have cytosine

C. In living organisms RNA is single stranded (In viruses they can be double stranded)

D. RNA uses thymine instead of uracil

E. None of the above is false