REFERENCE MATERIAL FOR THE MICB 201 FINAL EXAM

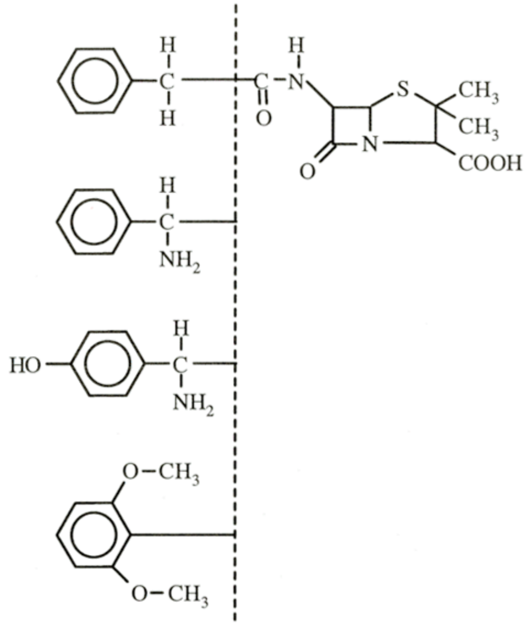
β-lactam antibiotics

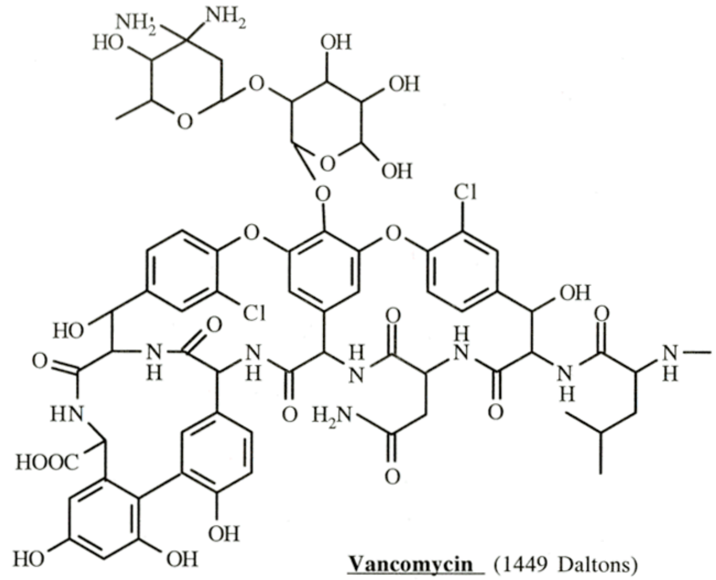
Penicillin (334 Daltons)

Ampicillin (349 Daltons)

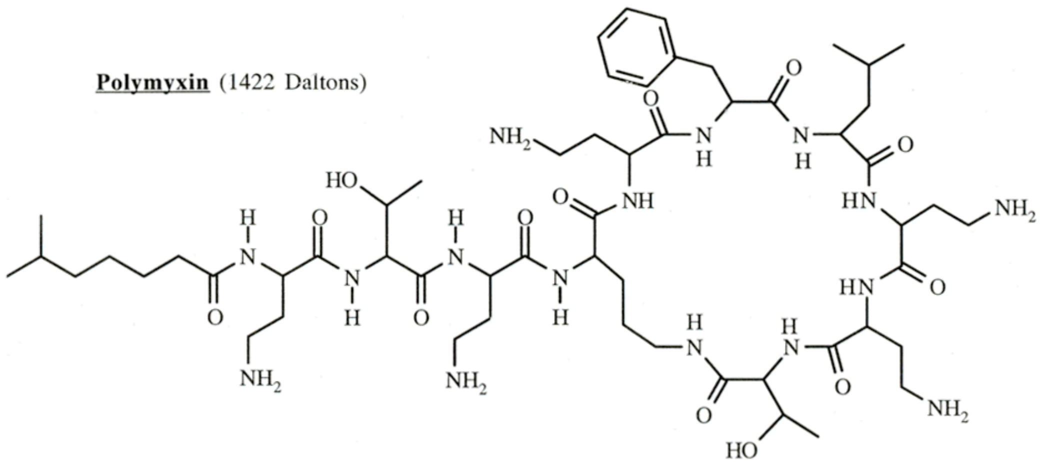
Amoxicillin (365 Daltons)

Methicillin (380 Daltons)



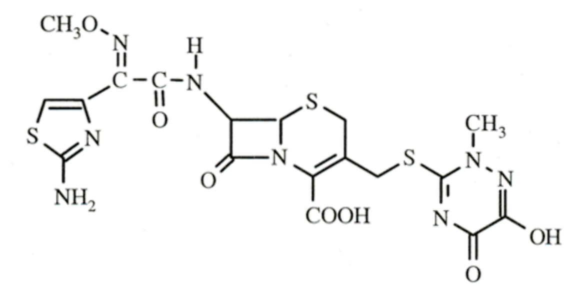


Vancomycin (1449 Daltons)



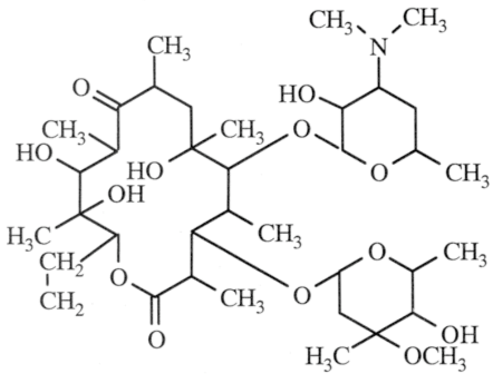
Polymyxin (1422 Daltons)

Cephalosporin antibiotics



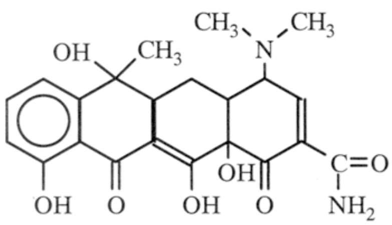
Ceftriaxone (554 Daltons)

Macrolide antibiotics



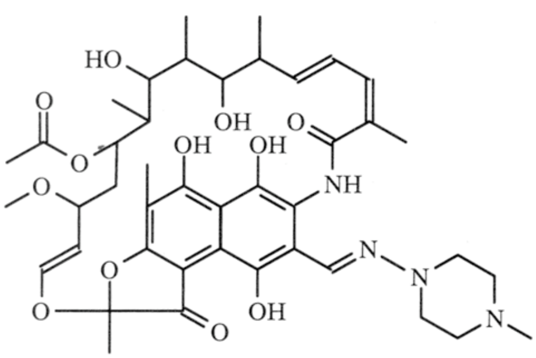
Erythromycin (733 Daltons)

Tetracyline antibiotics

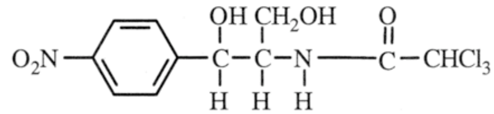


Tetracycline (444 Daltons)

Rifamycin antibiotics

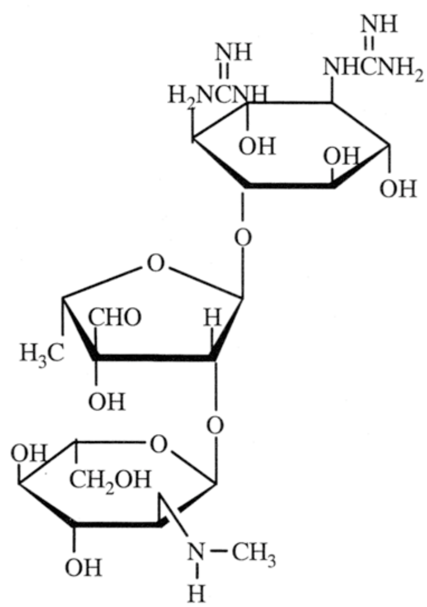


Rifampin (822 Daltons)



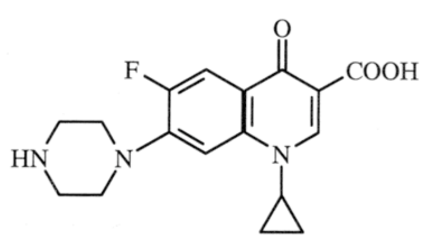
Chloramphenicol (323 Daltons)

Aminoglycoside antibiotics



Streptomycin (581 Daltons)

Quinolone antibiotics



Ciprofloxacin (331 Daltons)

Antibiotic class	**Producing Organism**		**Affects**	**Mode of action**	**Side effects**	**Other comments**
	Domain	**Specifics**				
β–lactams	Eukarya Bacteria	Filamentous fungus (Penicillium sp.) Streptomyces sp.	Bacteria	Binds to and inhibits the transpeptidase enzyme involved in PG X-linking, disrupting cell wall synthesis	Allergic reactions	Most important class of antibiotics clinically

Examples:

Penicillin: Natural antibiotic

Ampicillin, amoxicillin, methicillin: Chemically modified (= semi synthetic) penicillins

Antibiotic class	**Producing Organism**		**Affects**	**Mode of action**	**Side effects**	**Other comments**
	Domain	**Specifics**				
Cephalosporins	Eukarya	Filamentous fungus (Cephalosporium sp.)	Bacteria	Binds to and inhibits the transpeptidase enzyme involved in PG X-linking, disrupting cell wall synthesis	Allergic reactions	Very important class of antibiotics

Example:

Ceftriaxone: Chemically modified form of a natural cephalosporin antibiotic

Antibiotic	**Producing Organism**		**Affects**	**Mode of action**	**Side effects**	**Other comments**
	Domain	**Specifics**				
Vancomycin	Bacteria	A species of Streptomyces a member of the "Actinomycetes" (filamentous Gram +ve bacteria)	Bacteria	Binds to amino acid portion of the the disaccharide pentapeptide unit blocking the transpeptidase X-linking reaction, disrupting cell wall synthesis	Serious side effects are rare	

Antibiotic class	**Producing Organism**		**Affects**	**Mode of action**	**Side effects**	**Other comments**
	Domain	**Specifics**				
Tetracyclines	Bacteria	Species of the genus Streptomyces, see vancomycin above.	Bacteria	Binds to the 30S ribosomal subunit, disrupting translation	Not serious in low doses	Primary use is to eliminate the bacterium that causes acne (Propionibacterium acne)

Antibiotic class	**Producing Organism**		**Affects**	**Mode of action**	**Side effects**	**Other comments**
	Domain	**Specifics**				
Aminoglycosides	Bacteria	Species of the genus Streptomyces, see vancomycin above.	Bacteria	Binds to the 30S ribosomal subunit, disrupting translation	Serious	Last resort antibiotics when less toxic ones fail

Example:

Streptomycin: One of the first natural antibiotics discovered.
Still used to treat tuberculosis (Mycobacterium tuberculosis) even though side effects are serious

Antibiotic class	**Producing Organism**		**Affects**	**Mode of action**	**Side effects**	**Other comments**
	Domain	**Specifics**				
Macrolides	Bacteria	Species of the genus Streptomyces, see vancomycin above.	Bacteria	Binds to the 50S ribosomal subunit, disrupting translation	Not serious	Account for 10% of the antibiotics produced and used

Example:

Erythromycin: Natural antibiotic
Used when a patient is allergic to the penicillin antibiotics

Antibiotic	**Producing Organism**		**Affects**	**Mode of action**	**Side effects**	**Other comments**
	Domain	**Specifics**				
Chloramphenicol	Bacteria	A species of Streptomyces, see vancomycin above	Bacteria	Binds to the 50S ribosomal subunit, disrupting translation	Serious	Last resort antibiotics when less toxic ones fail

Antibiotic class	**Producing Organism**		**Affects**	**Mode of action**	**Side effects**	**Other comments**
	Domain	**Specifics**				
Rifamycins	Bacteria	Species of the genus Streptomyces, see vancomycin above.	Bacteria	Binds to and inhibits RNA polymerase, disrupting transcription	Potential liver damage	

Example: Rifampin-Used to treat tuberculosis (Mycobacterium tuberculosis) despite risk of liver damage.

Antibiotic class	**Producing Organism**		**Affects**	**Mode of action**	**Side effects**	**Other comments**
	Domain	**Specifics**				
Quinolone	Not applicatible-synthetic molecules		Bacteria	Binds to and inhibits an enzyme involved in DNA replication	Serious side effects are rare	

Example: Ciprofloxacin-Used to treated anthrax (Bacillus anthracis)

Antibiotic	**Producing Organism**		**Affects**	**Mode of action**	**Side effects**	**Other comments**
	Domain	**Specifics**				
Polymyxin	Bacteria	Bacillus polymyxa, a Gram +ve, endospore-forming rod	Bacteria	Binds to LPS of OM, then somehow leads to disruption of the CM	Nervous system kidney damage	Last resort antibiotic when less toxic ones fail. Used in antibiotic ointments (“Polysporin’) & eye drops

Group	**Growth in relation to temperature**	**Some habitats**
Psychrophiles	Growth between ~ 0-15^{o}C Some grow at < 0^{o}C where elevated solute concentration keeps water from freezing	The ocean (most ocean water never gets much above 5^{o}C) Snow, glacial streams and run-off Under arctic/antarctic ice and icebergs
Mesophiles	Growth between ~15^{o}C-50^{o}C	Ubiquitous in soil and water and on plant surfaces in temperate and tropical latitudes Bodies of warm blooded animals
Thermophiles	Growth between ~50^{o}C-80^{o}C	Spill-over areas from hot springs Surface soils which are exposed to direct sunlight; temperatures can reach 50-70^{o}C even in northern latitudes. Soil thermophiles that find their way into hot water heaters, hot tubs/saunas. Compost piles (they get quite hot, 70^{o}C) during decomposition of organic matter
Extreme (hyper) thermophiles	Growth between ~80^{o}C-100^{o}C Some grow at > 100^{o}C where elevated pressure keeps water from boiling	Geothermally heated mud pots, hot springs; temperatures at the boiling point of water Hydrothermal vent areas under pressure on ocean floor

Group	**Growth in relation to pH**	**Some habitats**
Extreme acidophiles	< 2	Sulfurous volcanic soils, volcanic hot springs
Acidophiles	~2-5	Stomachs of animals, volcanic soils
Neutralophiles	~5-8	Ubiquitous
Alkaliphiles	~8-11	Ubiquitous in soils
Extreme alkaliphiles	~11-14	Alkaline salt lakes

Group	Growth in relation to [NaCl]	Some habitats
Nonhalophiles	Do not require NaCl and grow optimally at [NaCl] less than that of seawater ~3% w/v NaCl	Ubiquitous
Moderate halophiles	Require NaCl and grow optimally near the [NaCl] characteristic of seawater ~3% w/v NaCl	**Oceans**: the [NaCl] in seawater is about 3% w/v NaCl (other dissolved salts are also present)
Extreme halophiles	Require a minimum concentration of ~ 10 % w/v NaCl in the environment and grow optimally at concentrations of NaCl characteristic of a saturated salt solution.	**Hypersaline lakes**: [NaCl] ~ 25-30 % w/v NaCl. Example: the **Dead Sea** (pH ~ 6, so not an alkaline salt lake like the Great Salt Lake) Salt ponds
Halotolerant nonhalophiles	Do not require NaCl. Optimal growth < 3% w/v NaCl but still significant growth rates up to 10% w/v NaCl.	Ubiquitous Example: ***S. aureus*** and other skin bacteria. Skin is a salty environment; [NaCl] fluctuates with sweating

Organism		**Glucose-metabolizing pathway**
Bacteria	Some	Glycolysis (Embden-Myerhoff, EM pathway)
	Some	Entner-Doudorff (ED) pathway
	Some	Other
Archaea	Some	Archaeal variant of the EM pathway
	Some	Archaeal variant of the ED pathway
	Some	Archaeal variants of both the EM and ED pathways

Bacteria	**Reaction pathways**
Cyanobacteria	Calvin cycle
Purple bacterial lithoautotrophs	Calvin cycle
Purple bacterial photoautotrophs	Calvin cycle
Green sulfur bacteria	Reverse TCA cycle
Green nonsulfur bacteria	Hydroxypropionate pathway
Lithoautotrophic Planctomyces	Acetyl CoA pathway

	TEA							
	O_2	**NO_3^-**	**NO_2^-**	**Fe^{+3}**	**SO_4^{-2}**	**S^o**	**CO_2**	**No TEA**
ENERGY SOURCE								
Organic								
CHX	+	+	+	+	+	+	+	+
Special case: CH_4	+	+	-	?	+	?	-	-
Inorganic								
H_2	+	+	+	+	+	+	+	-
H_2S	+	+	-	-	-	-	-	-
S^o	+	+	-	-	-	-	-	-
Fe^{+2}	+	+	-	-	-	-	-	-
NH_4^+ (NH_3)	+	-	+	-	-	-	-	-
NO_2^-	+	-	-	-	-	-	-	-
Light	N R	NR	NR	NR	NR	NR	NR	NR

Type	**Group**	**Photosystem(s)**	**Electron sources**
Type I	Green sulfur bacteria	PS I-bacteriochlorophyll	H_2, H_2S
	Cyanobacteria	PS I-bacteriochlorophyll	H_2S
	Gram-positive	PS I-bacteriochlorophyll	See below, Figure 11-7.
Type II	Purple bacteria	PSII-bacteriochlorophyll	H_2, H_2S, Fe^{+2}, NO_2^-, CHX_{Red}
	Green nonsulfur bacteria*	PSII-bacteriochlorophyll	H_2, H_2S, CHX_{Red}
TypeI/ Type II	Cyanobacteria	PSI and PSII-chlorophyll	H_2O
	Chloroplasts in Eukarya	PSI and PSII-chlorophyll	H_2O

Energy Source/TEA		**Waste**	**Electrons transferred**	**Energy produced**	**Energy produced/2e-**
				(kJ/reaction standard conditions)	
CH_4 + 2 O_2	$\longrightarrow$	CO_2 + 2 H_2O	8	816	204
H_2 + 1/2 O_2	$\longrightarrow$	H_2O	2	237	237
H_2**S** + 2 O_2	$\longrightarrow$	SO_4^{-2} + 2 H^+	8	800	200
NH_4^+ + 2 O_2	$\longrightarrow$	NO_3^- + H_2O + 2 H^+	8	349	87
2 **Fe**$^{+2}$ + 2 H^+ + 1/2 O_2	$\longrightarrow$	2 Fe^{+3} + H_2O	2	66	66

Reactions			**e^- transferred**	**Energy produced**	**Energy produced/2e^-**
				(kJ/reaction, standard conditions)	
Energy Source/TEA		**Waste**			
H_2 + 1/2 O_2	$\longrightarrow$	H_2O	2	237	237
H_2 + 2 Fe^{+3}	$\longrightarrow$	2 Fe^{+2} + 2 H^+	2	220	220
H_2 + NO_3^-	$\longrightarrow$	NO_2^- + H_2O	2	163	163
4 H_2 + SO_4^{-2} + 2 H^+	$\longrightarrow$	H_2S + 4 H_2O	8	152	38
4 H_2 + CO_2	$\longrightarrow$	CH_4 + 2 H_2O	8	131	33

Reactions			**e^- transferred**	**Energy produced**	**Energy produced/2e^-**
				(kJ/reaction, standard conditions)	
Energy Source/TEA		**Products**			
H_2 + NO_3^-	$\longrightarrow$	NO_2^- + H_2O	2	163	163
5 H_2 + 2NO_3^- + 2 H^+	$\longrightarrow$	N_2 + 6 H_2O	10	1120	254
3 H_2 + SO_4^{-2} + 2 H^+	$\longrightarrow$	S^o + 4 H_2O	6	124	41
4 H_2 + SO_4^{-2} + 2 H^+	$\longrightarrow$	H_2S + 4 H_2O	8	152	38