Table 1. Antimicrobials for growth promotion and antibiotics used for treatment of infections in food animals (Shea, 2003).

Antimicrobials Approved by the FDA for Growth Promotion in Food animals	**Antibiotics Used for Treatment of Infections in Food Animals**
Amprolium, Arsanilic acid, Bacitracin§, Bambermycins, Carbadox, Chlortetracycline§, Erythromycin§, Laidlomycin, Lasalocid, Lincomycin§, Monensin, Oxytetracycline§, Penicillin§, Sulfonamides§, Roxarsone Tiamulin, Tylosin§ , Virginiamycin§,	Amoxicillin, Bacitracin, Cephalosporins, Erythromycins, Fluoroquinolones, Gentamicin, Lincomycin, Neomycin, Penicillin, Streptomycin, Tetracycline, Sulfonamides

§Identical or chemically similar to human drugs

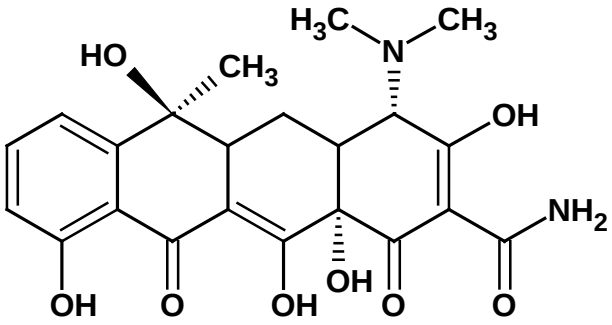


Figure 1. Molecular structure of tetracycline.

Table 2. Properties of tetracycline.

Property	**Value**
CAS No.	60-54-8
Other names	Tetraciclina; Tetraciklin;Tetraciklinas, etc.
Formula	$C_{22}H_{24}N_2O_8$
Molecular Weight	444.4 g mol^{-1}
Water solubility	1500 mgL^{-1} at 29 ^oC
Melting point	175 ^oC ~177^oC
Excretion rate (%)	80~90[1]
Biodegradability[3]	Persistent [2]
pKa	3.3/7.7/9.3[4]

[1]Kuhne et al.(2000)
[2]Richardson and Bowron (1985**)**
[3]$T_{1/2}$ is the duration it takes for half the compound to be degraded.
[4]Thiele-Bruhn, S. (2003)

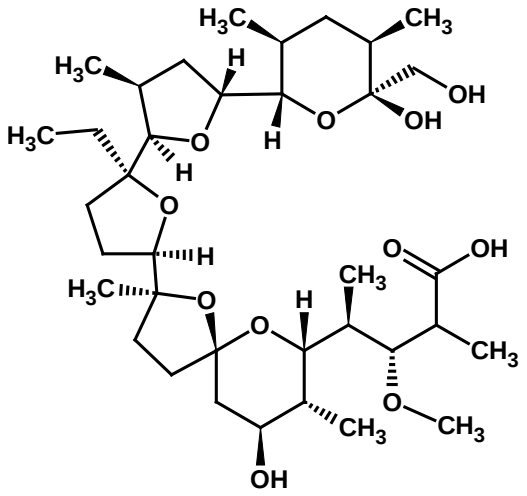


Figure 2. Molecular structure of monensin.

Table 3. Properties of monensin.

Property	Value
Formula	$C_{36}H_{62}O_{11}$
CAS	17090-79-8
Molecular weight	670.9 g mol^{-1}
Melting point	104°C
Water solubility	0.85~63[1]
Oral (pig) LD50:	17 mg kg^{-1}
Oral (chicken) LD50:	145 mg kg^{-1}
Log Kow	2.75~4.24[1]
pKa	6.7[1]
K_d	9.3(sandy loam)[1]
Biodegradability[2]	3.3~3.8(sandy loam)[3]

[1]Elanco Products company (1989)
[2]$T_{1/2}$ is the duration it takes for half the compound to be degraded
[3]Carlson and Mabury(2006)

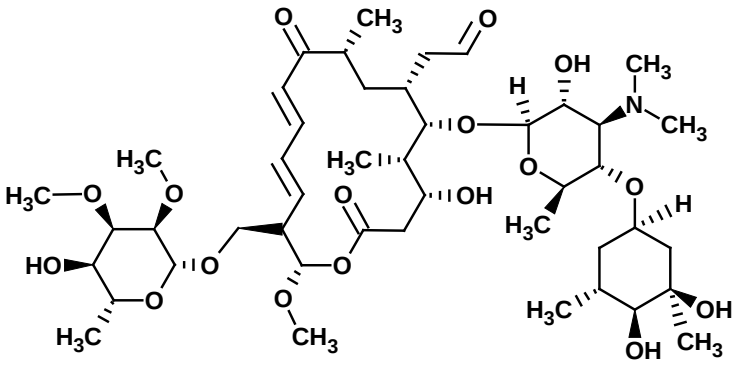


Figure 3 Molecular structure of tylosin

Table 4. Properties of tylosin

Properties	Values
CAS No.	1401-69-0
Formula	$C_{46}H_{77}NO_{17}$
Molecular Weight	916.1 g mol^{-1}
Water solubility	5000 mg L^{-1} at 29 ^{o}C[7]
Melting point	128 ^{o}C ~132 ^{o}C
Excretion rate (%)	28~60[1]
Biodegradability[2]	$T_{1/2}$ =3~8 day (soil)[3] ; <2 (slurry)[5] 4.5~6.1 (sandy loam)[9]
K_{oc}($1kg^{-1}$)[4]	553~7988
Log Kow	1.63 ~2.5[5]
pKa	3.3/7.5[6]
K_d	8.3 (loamy sand); 62.3 (sandy loam)[8]

[1]Feinman and Matheson (1978)
[2]$T_{1/2}$ is the duration it takes for half the compound to be degraded.
[3]Ingerslev and Halling-Sørensen (2001)
[4]Organic carbon sorption coefficient
[5]Loke et al. (2000)
[6]Qiang and Adams. (2004)
[7]O'Neil et al (2001)
[8]Rabølle and Spliid (2000)
[9]Carlson and Mabury(2006)

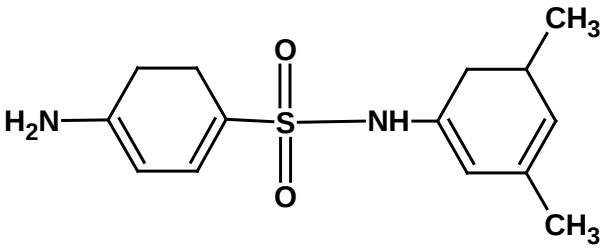
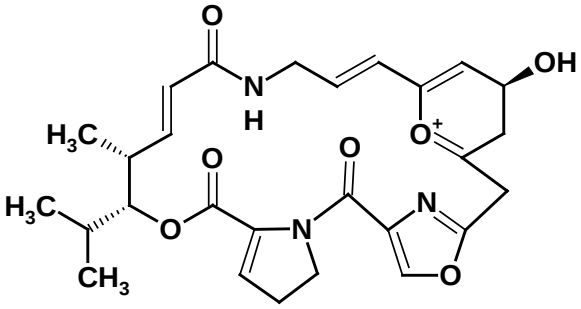


Figure 4. Molecular structure of sulfamethazine.

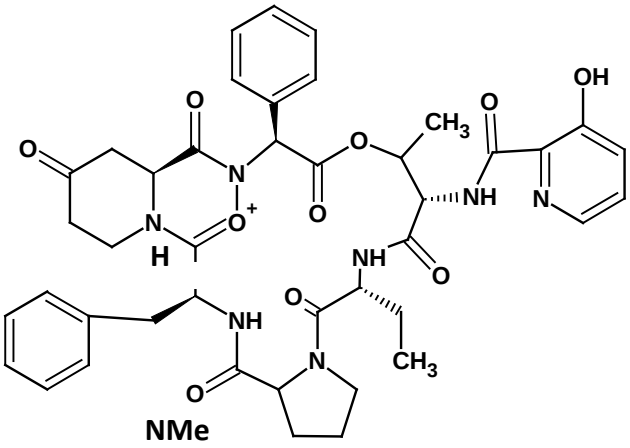
Table 5. Properties of sulfamenthazine.

Properties	Value
CAS No.	57-68-1
Other names	Sulfadine, sulfamethazine, sulfamethiazine, sulfadimethylpyrimidine, sulfodimesin, etc.
Formula	$C_{12}H_{14}N_4O_2S$
Molecular Weight	278.3[1]
Water solubility	1900 mg L^{-1} [1]
Melting point	178 ^oC ~179 ^oC
Log Kow	0.89[2]
pKa	2.1/7.5[3]
K_d	1.2~3.1 (loamy sand); 2.0 (loam) 1.0 (silt loam);0.6 (clay loam)[2]
Biodegradability[4]	$T_{1/2}$ =18.6 day (soil)[5]

[1]O'Neil et al. (2001)
[2]Tolls(2001)
[3]Qiang and Adams (2004)
[4]$T_{1/2}$ is the duration it takes for half the compound to be degraded
[5]Accinelli et al. (2007)



Virginiamycin M_1



Virginiamycin S_1

Figure 5**.** Molecular structure of viginiamycin.

Table 6. Properties of virginiamycin.

Property	**Value**
Description	Virginiamycin complex is a solid powder mixture of 75% virginiamycin M1 (Ostreogrycin A, sc-202269) and 25% virginiamycin S1
CAS No.	11006-76-1
Other names	Cebin V, Eskalin V, Eskamicin, Stafac, Stephylomycin, Mikamycin, Ostreogrycin, Patricin, Pristinamycin, Streptogramin, Vernamycin
Formula	C28H35N3O7 for M1 C43H49N7O10 for S1
Molecular Weight	525.6g mol^{-1} for M1 : 823.9 g $mol^{-1}$for S1
Solubility	Virginiamycin M1 has only limited solubility in ethanol and methanol.
Appearance	White solid
Excretion rate (%)	0~311
Biodegradability2	T1/2 =3~8 day(slurry)3

[1]Feinman and Matheson (1978)
[2]$T_{1/2}$ is the duration it takes for half the compound to be degraded.
[3]Weerasinghe and Towner (1997)

Table 7. Residue limits for veterinary drugs in meat products.[1]

Compound	**Fat**	**Meat**	**Liver**	**Kidney**	**Edible Tissue**	**Reference**
	Residue Limit, mg kg^{-1}					
Monensin	NA	0.05	0.1	0.05	0.05	21 CFR 556.420
Sulfamethazine	0.1[3]	0.1[3]	0.1[3]	0.1[3]	0.1	21 CFR 556.670
Tetracycline[2]	12	2	6	12	NA	21 CFR 556.720
Tylosin	0.2	0.2	0.2	0.2	NA	21 CFR 556.740
Virginiamycin	0.4	0.1	0.3	0.4	NA	21 CFR 556.75

[1] This table provides information on the residue limits (tolerances) for veterinary drugs in meat products as of March 9, 2001. These tolerances, set by the Food and Drug Administration (FDA), are used by the Food Safety and Inspection Service (FSIS) in its regulatory programs. The official source of these tolerances is Title 21 of the Code of Federal Regulations (CFR): those for animal drugs are found in Title 21, Part 556 (21 CFR 556)

[2] Tolerances are for the sum of all approved tetracycline residues (i.e., tetracycline, chlortetracyline, and oxytetracyline)

[3] Food Additives and contaminants recommended maximum residue limits (MRLs)