

Additional Information for

Photodegradation of pharmaceuticals in the aquatic environment: A review

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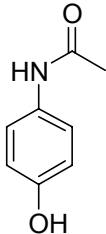
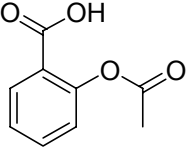
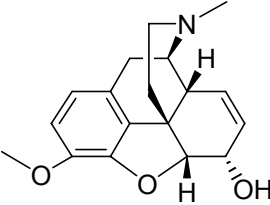
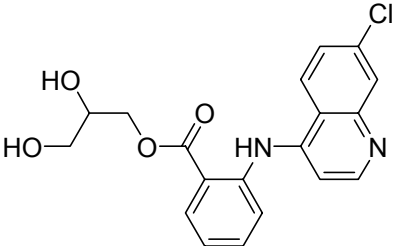
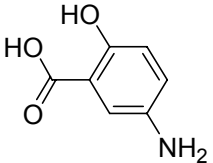
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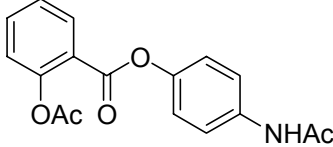
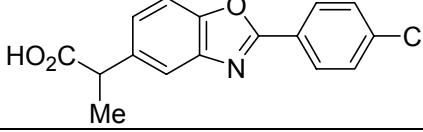
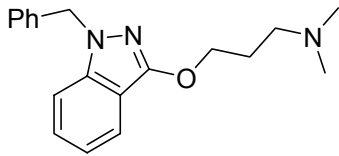
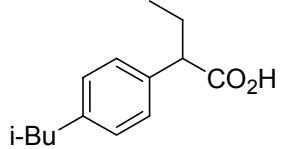
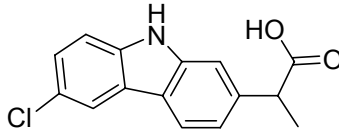
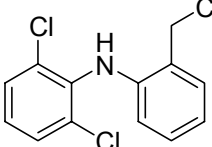
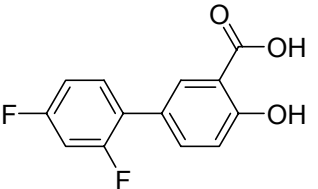
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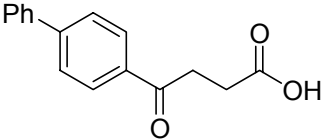
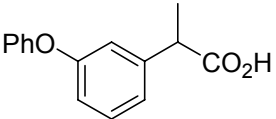
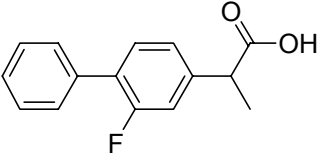
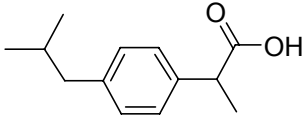
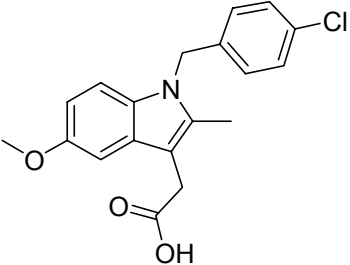
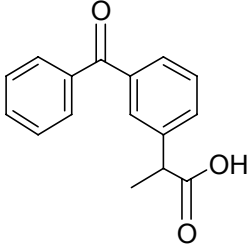
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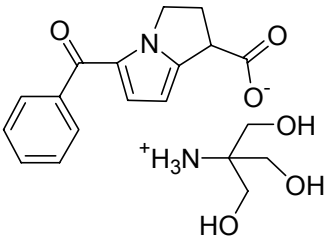
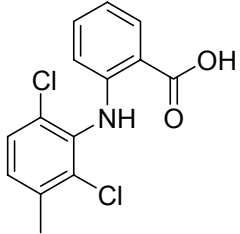
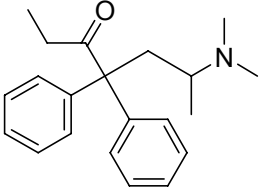
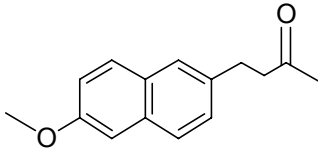
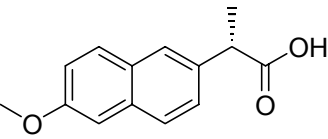
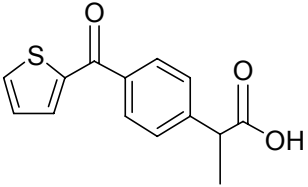
Table A1. Pharmaceuticals and personal care products, their structures, and references regarding their occurrence in the environment and their photochemistry.

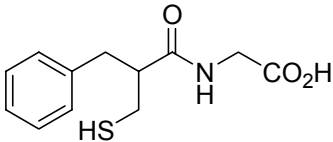
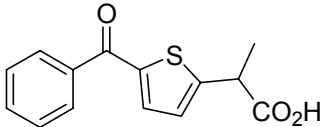
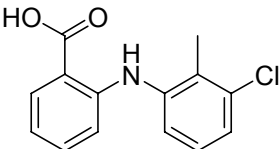
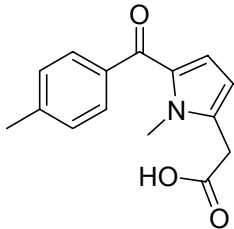
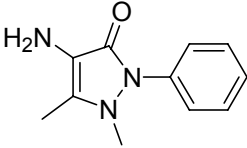
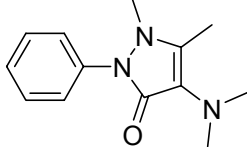
CAS number	Structures	Detected in field samples	Environmental photochemistry studies	Photochemistry studies relevant to environmental conditions (aqueous, $\lambda > 300$ nm)	Other photochemistry studies
Anti-Inflammatory, Analgesic, and Immunosuppressant Drugs					

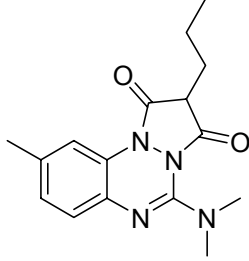
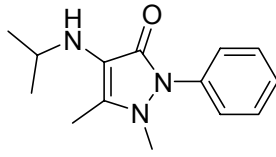
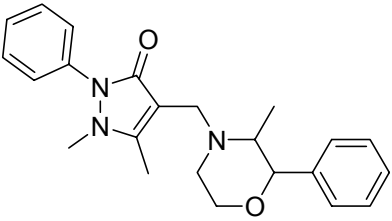
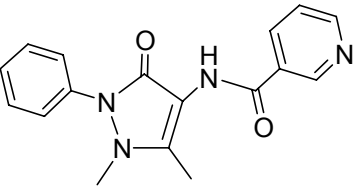
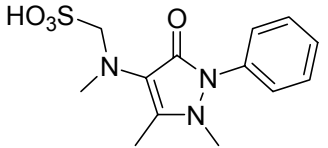
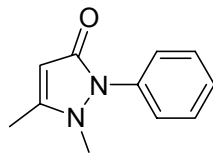
acetaminophen	103-90-2		1 ^a , 2-4	
acetylsalicylic acid	50-78-2		1, 3-5	6
codeine	76-57-3		2, 3	
glaphenine	3820-67-5			7
<i>Non-Steroidal Anti-inflammatory Drugs</i>				
5-aminosalicylic acid	89-57-6			8 9

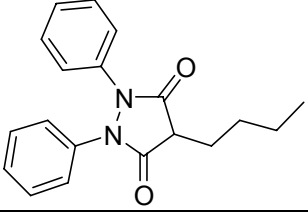
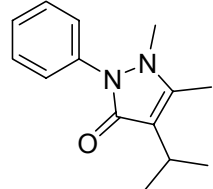
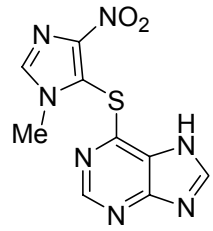
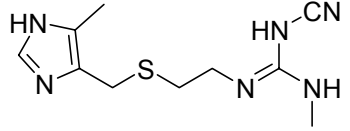
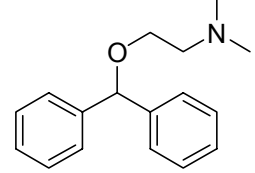
benorylate	5003-48-5					9, 10
benoxaprofen	51234-28-7		11-13			9, 14-16
benzydamine	642-72-8		17			9, 18
butibufen	55837-18-8					9, 14, 15, 19
carprofen	53716-49-7		11			14, 15
diclofenac	15307-86-5		1, 3-5, 20	21-24, 25	26	9, 27, 28
diflunisal	22494-42-4					29, 30

fenbufen	36330-85-5				31	32
fenoprofen	29679-58-1		1, 4 ^a			
flurbiprofen	5104-49-4					9, 14, 15, 19
ibuprofen	15687-27-1		1-5, 20, 33-35	22, 36, 25		9, 14, 15, 37
indomethacin	53-86-1		1, 3-5, 35		12	9, 38-42
ketoprofen	22071-15-4		1, 3-5, 20	22	11, 43-45	9, 14, 15, 46, 47

ketorolac tromethamine	74103-07-4		48	9		
meclofenamic acid	644-62-2		1, 4 ^a	9, 49		
methadone	76-99-3			9, 50		
nabumetone	42924-53-8		51	52, 53, 54		
naproxen	22204-53-1		1, 3-5, 20	22, 25	11, 12, 55	9, 14, 15, 56-58
suprofen	40828-46-4		11, 44, 59	9, 15, 60		

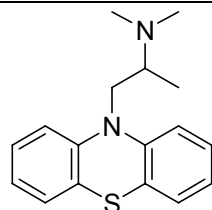
thiorphan	76721-89-6			9, 61
tiaprofenic acid	33005-95-7		11, 44, 62, 63	9, 14, 15, 60, 64
tolfenamic acid	13710-19-5		1, 5	
tolmetin	26171-23-3			65
<i>Pyrazolone Analgesic and Antipyretic Drugs</i>				
aminoantipyrine	83-07-8		3	66, 67
aminopyrine	58-15-1		1	9, 68

apazone	13539-59-8		9
isopyrine	3615-24-5		66, 67
morazone	6536-18-1		66, 67
nifenazone	2139-47-1		66, 67
noraminophenazone	68-89-3		66, 67
phenazone	60-80-0		1, 3, 4, 20 66, 67

phenylbutazone	50-33-9				9, 69
propyphenazone	479-92-5		1, 3		66, 67
<i>Immunosuppressant and Anti-histamic Drugs</i>					
azathioprine	446-86-6			70	9
cimetidine	51481-61-9		2	71	
diphenhydramine	58-73-1			72	9, 73-75

promethazine

60-87-7

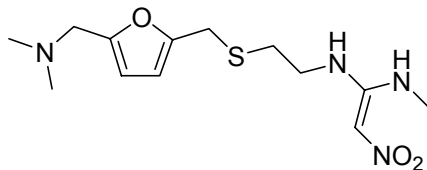


76

9, 77

ranitidine

66357-35-5



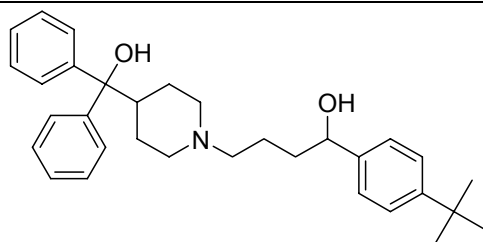
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terfenadine

50679-08-8

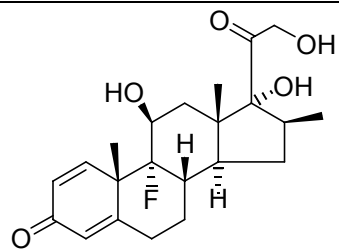


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Glucocorticosteroids

betamethasone

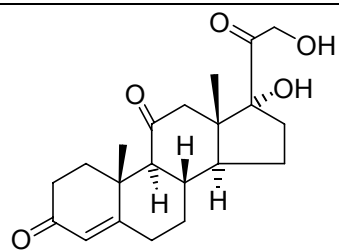
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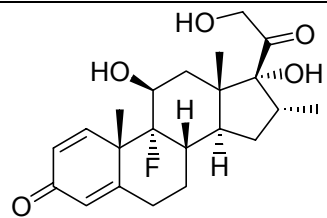
cortisone

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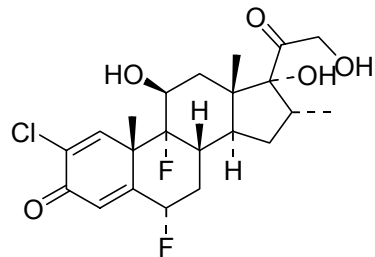
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dexamethasone 50-02-2



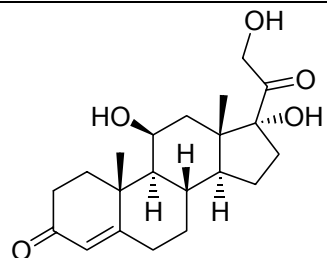
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halomethasone 50629-82-8



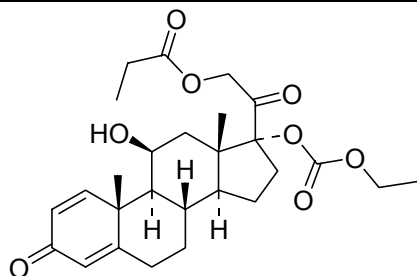
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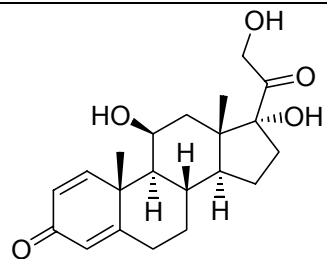
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prednicarbate 73771-04-7



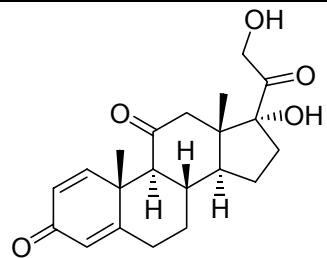
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prednisolone 50-24-8



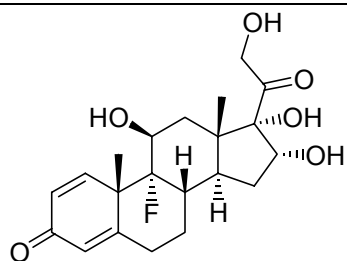
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prednisone 53-03-2



9, 81

triamcinolone 124-94-7

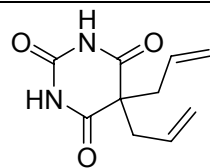


9

**Drugs Acting on the
Central Nervous System**

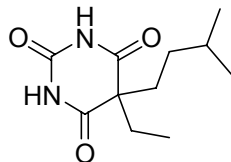
Barbituric Acid Derivatives

allobarbital 52-43-7

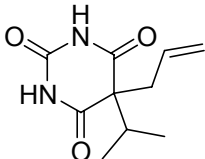
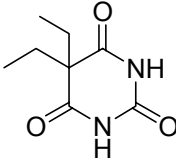
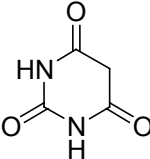
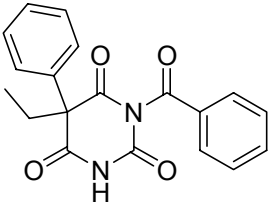
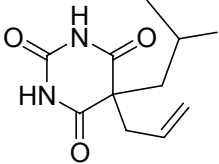
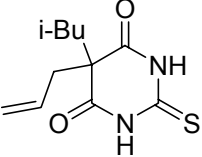


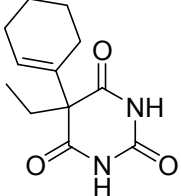
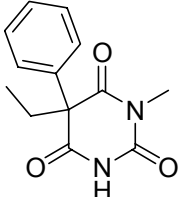
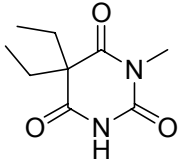
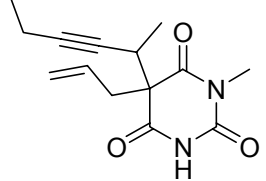
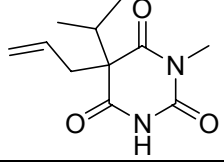
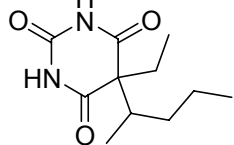
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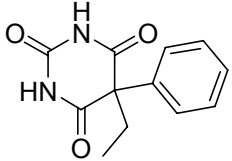
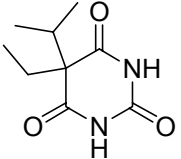
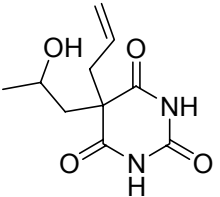
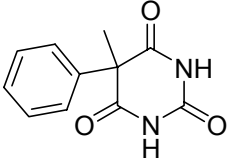
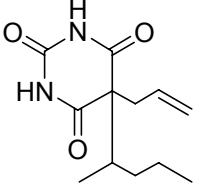
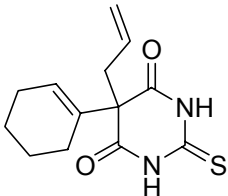
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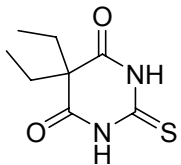
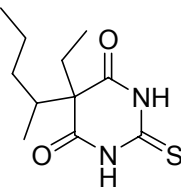
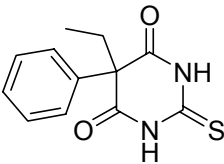
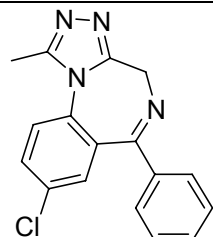
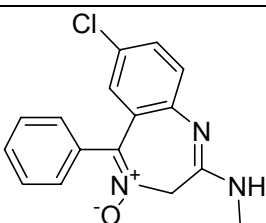


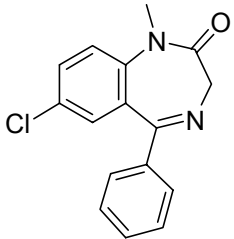
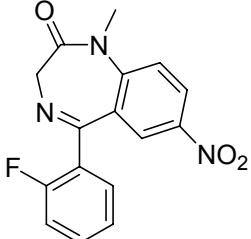
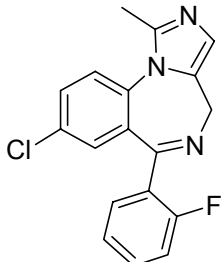
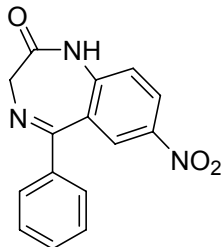
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barbital	57-44-3		9, 82-84
barbituric acid	67-52-7		9
benzonal	744-80-9		83
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rutonal	76-94-8		83
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thialbarbital	467-36-7		83

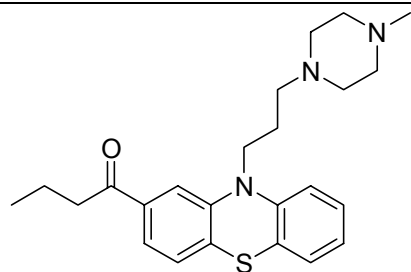
thiobarbital	77-32-7		82, 83
thiopental	76-75-5		83
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*Thioxanthine and Phenothiazine
Psychotherapeutic Agents*

butaperazine

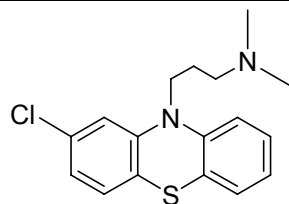
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101, 102

chlorpromazine

50-53-3

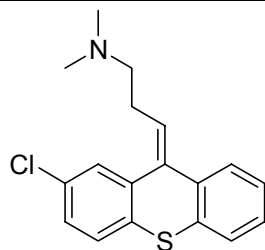


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9, 74, 75, 77, 106-110

chlorprothixene

113-59-7

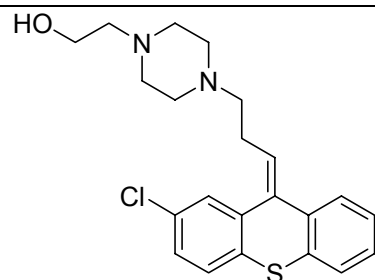


111

9

clopenthixol

982-24-1

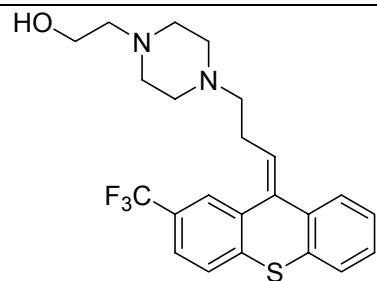


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flupenthixol

2709-56-0

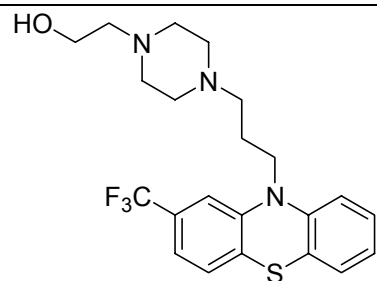


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fluphenazine

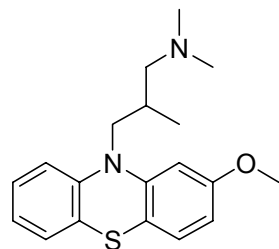
69-23-8



112

levomepromazine

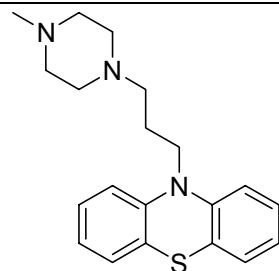
60-99-1



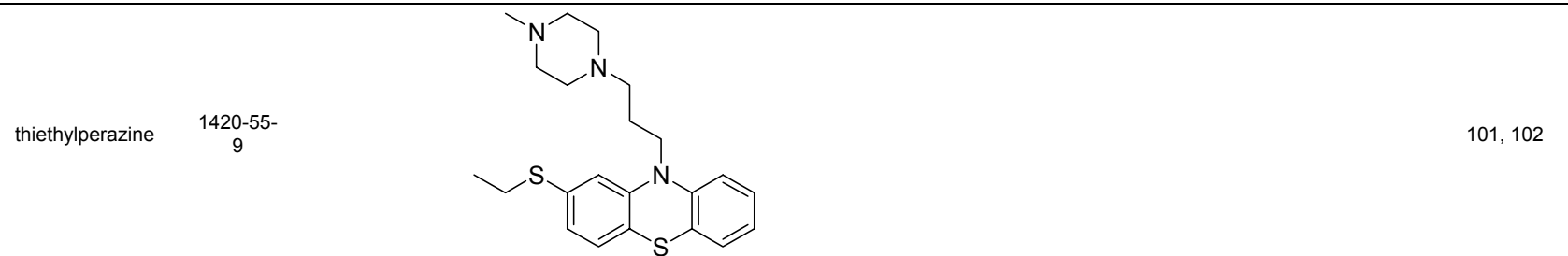
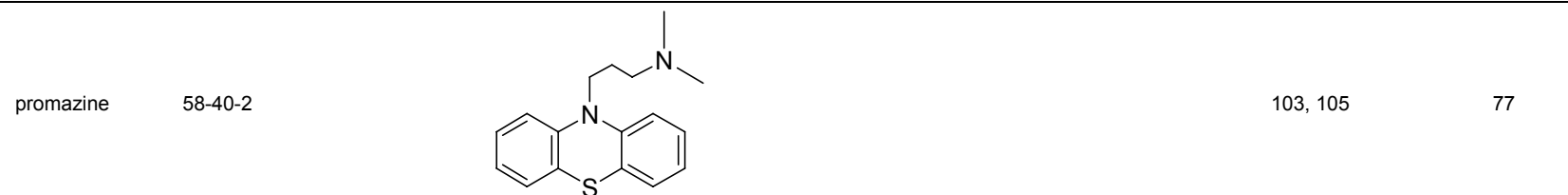
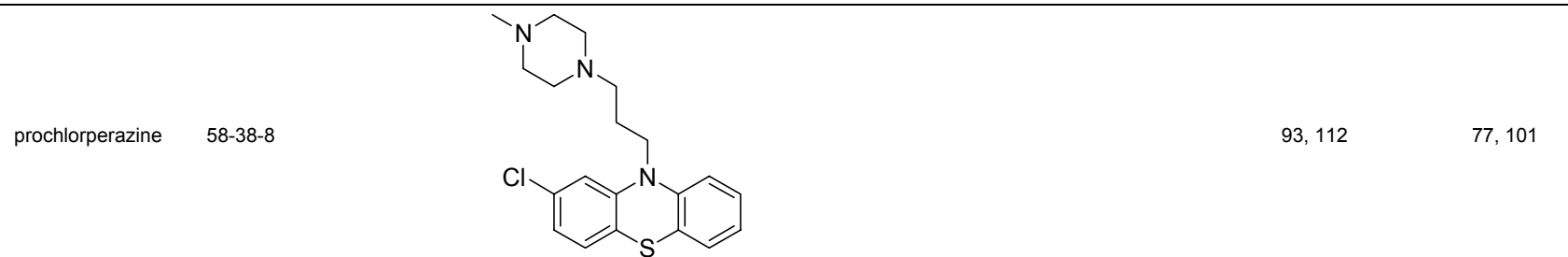
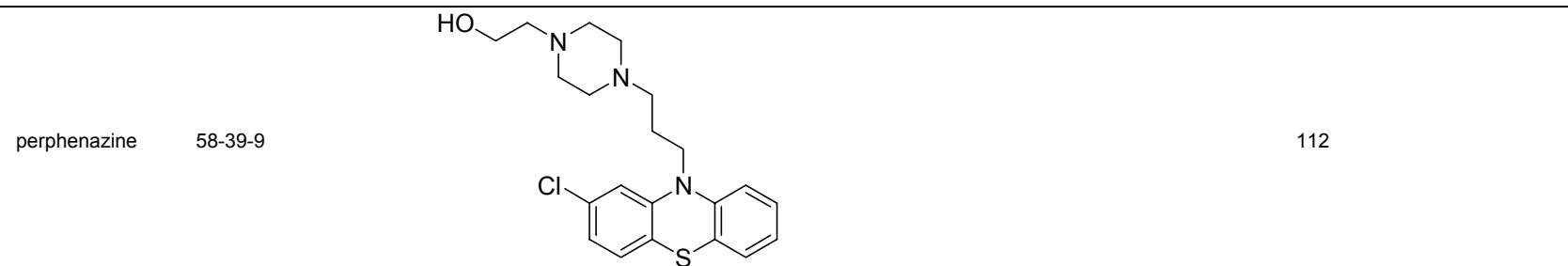
113

perazine

84-97-9

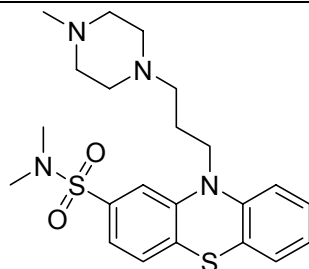


101, 102



thiopropazine

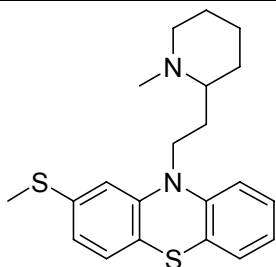
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101, 102

thioridazine

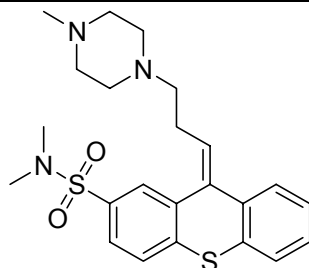
50-52-2



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tiotixene

3313-26-6

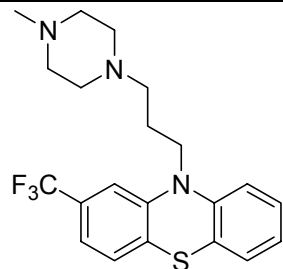


111

9

trifluoperazine

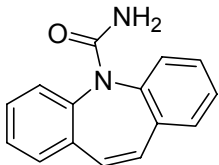
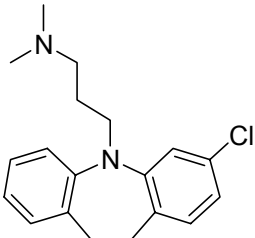
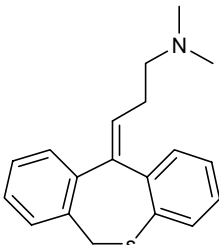
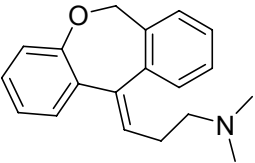
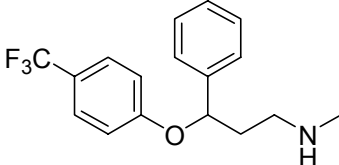
117-89-5

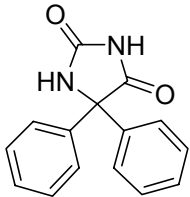
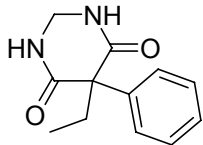
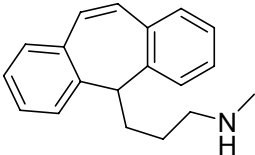


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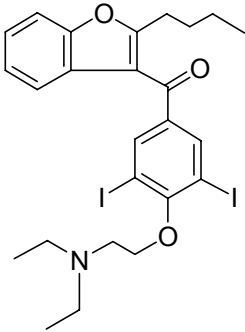
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clomipramine	303-49-1			120
dothiepin	113-53-1		121	9
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phenytoin	57-41-0			9
primidone	125-33-7		3	
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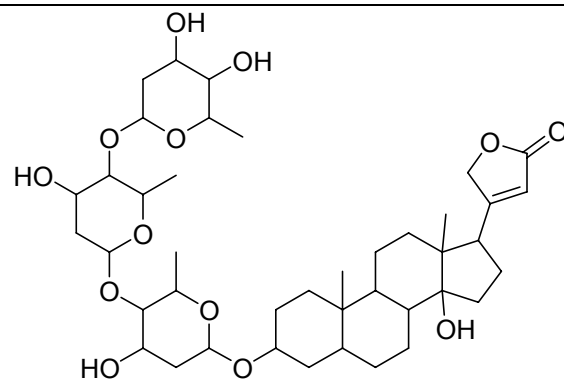
Cardiovascular, Diuretic, and Hemotherapeutic Drugs

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digitoxin

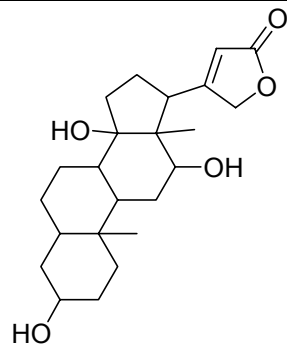
71-63-6



9

digoxigenin

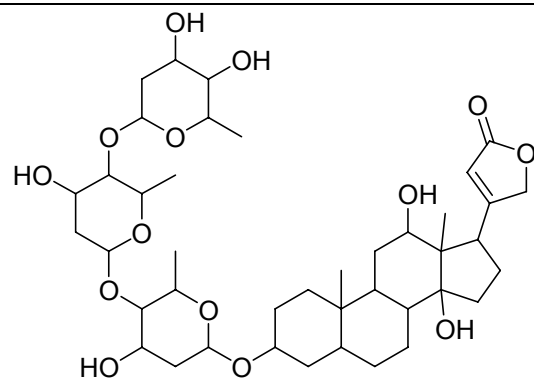
1672-46-4



2^a

digoxin

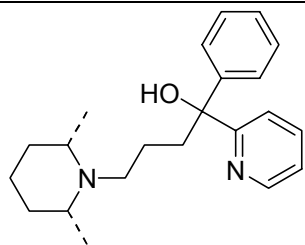
20830-75-5



2^a

pirmenol

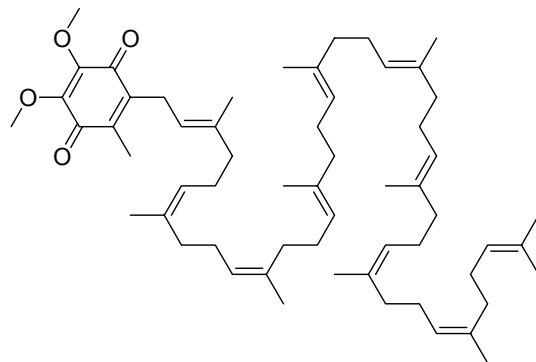
68252-19-7



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ubidecarenone

303-98-0

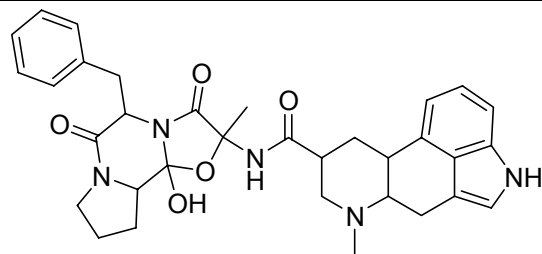


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Blood Pressure Regulating Drugs

9,10-Dihydroergotamine

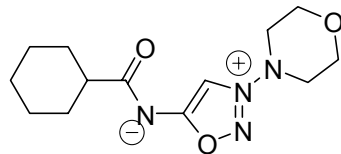
511-12-6



9

ciclosidomine

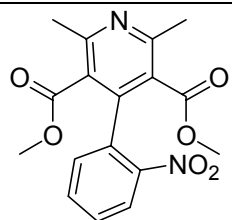
66564-16-7



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dehydronifedipine

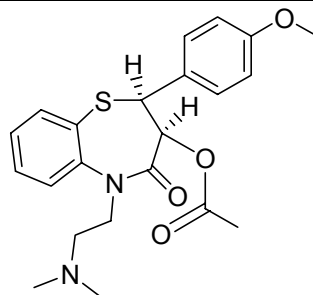
67035-
22-7



2

diltiazem

42399-
41-7



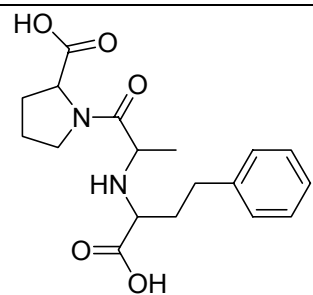
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enalaprilat

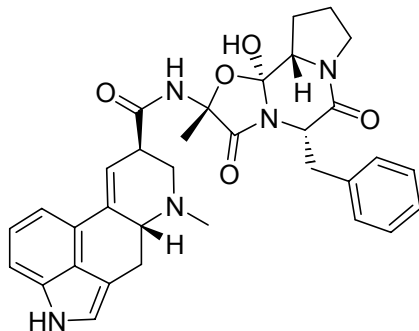
76420-
72-9



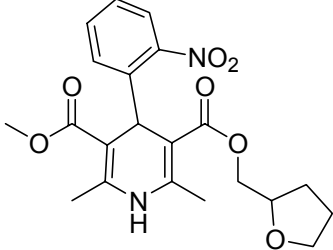
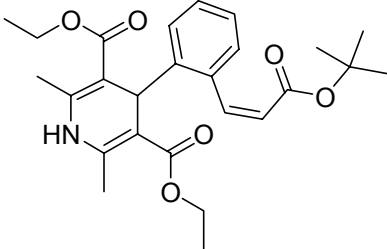
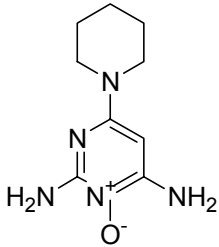
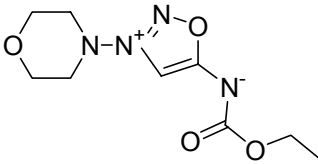
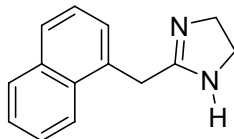
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ergotamine

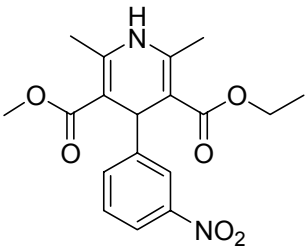
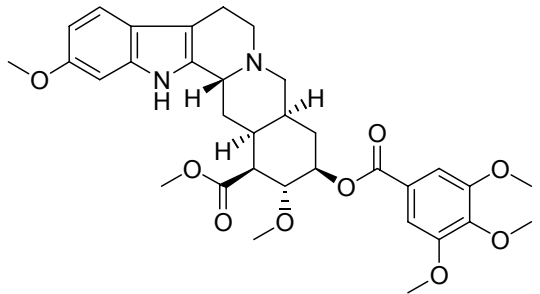
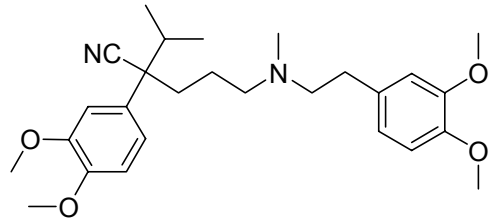
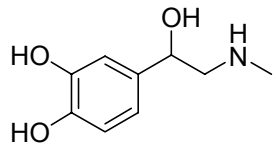
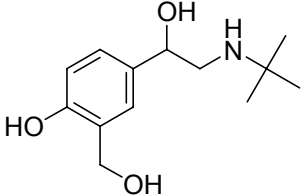
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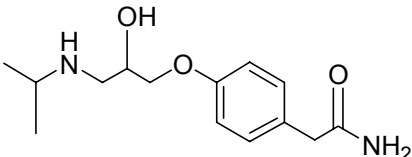
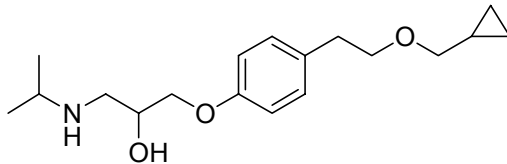
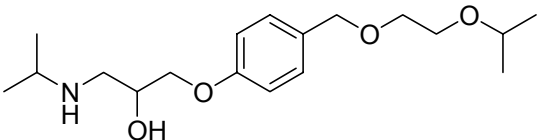
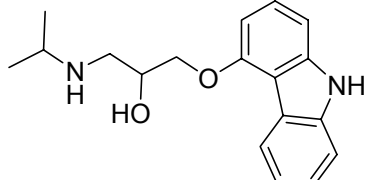
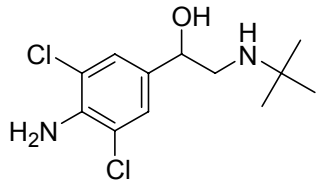
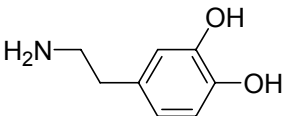
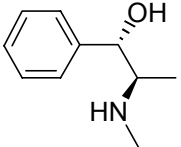


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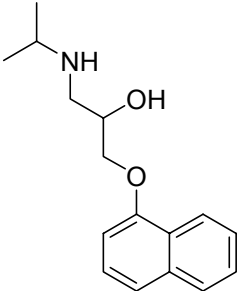
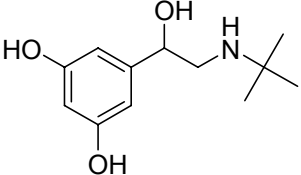
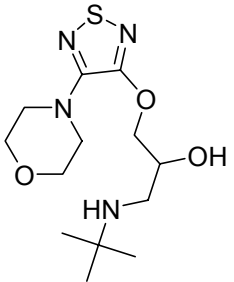
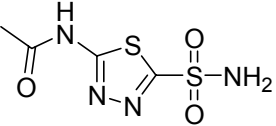
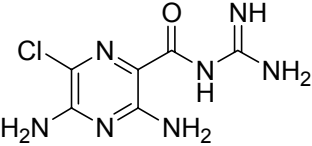
furnidipine	138661-03-7		131	9
lacidipine	103890-78-4		132	
minoxidil	38304-91-5			9
molsidomine	25717-80-0			9, 133
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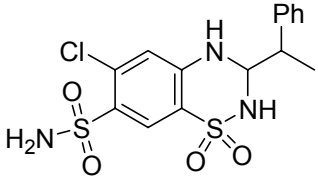
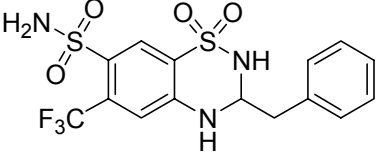
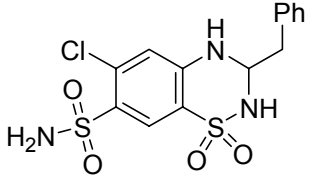
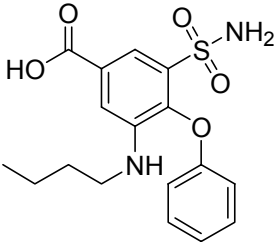
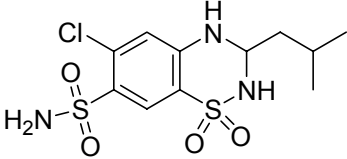
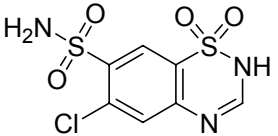
nicardipine	55985-32-5		9, 137
nifedipine	21829-25-4		55, 138, 139 9, 74, 75, 110, 140-148
nilvadipine	75530-68-6		149, 150
nimodipine	66085-59-4		151 9

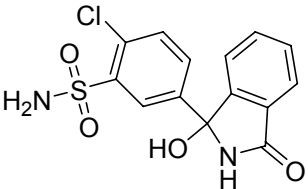
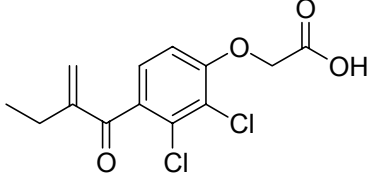
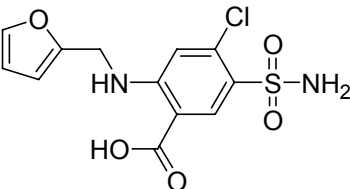
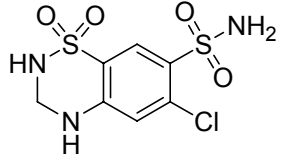
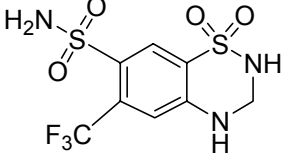
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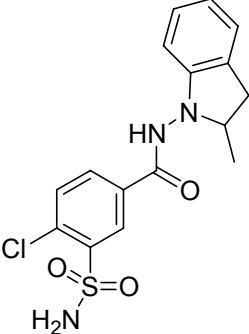
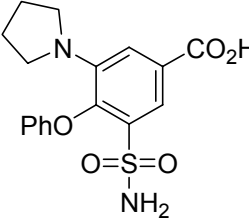
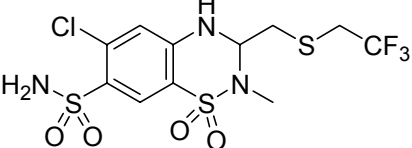
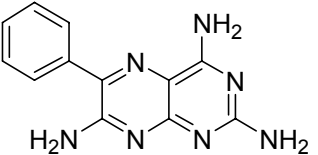
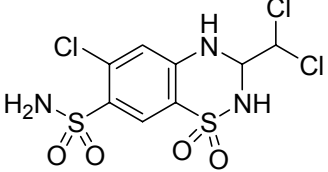
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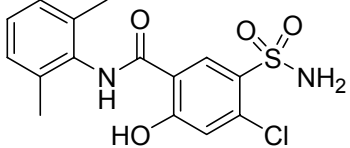
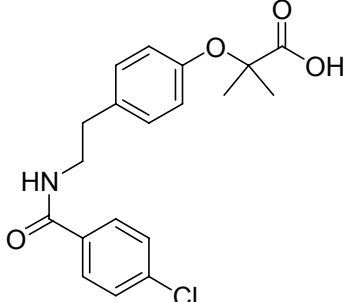
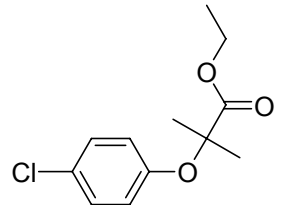
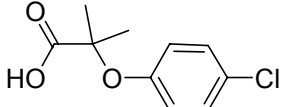
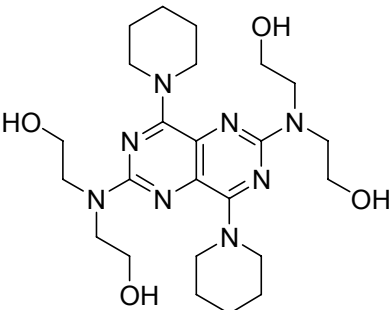
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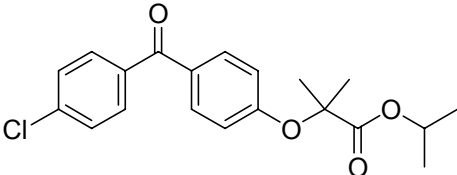
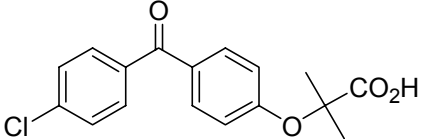
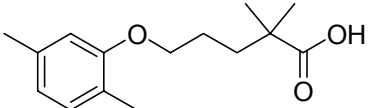
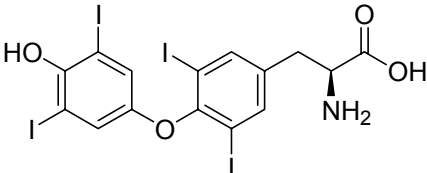
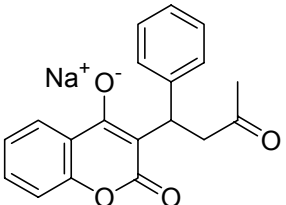
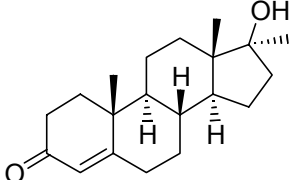
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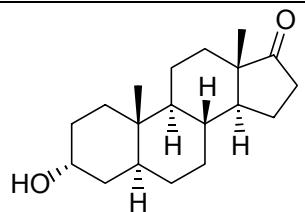
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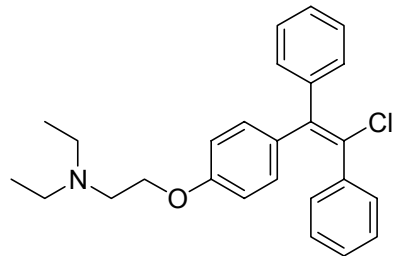
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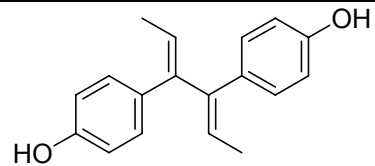
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clomiphene 911-45-5



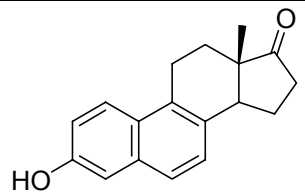
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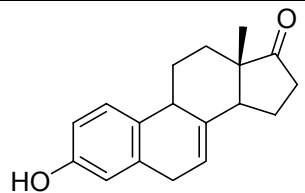
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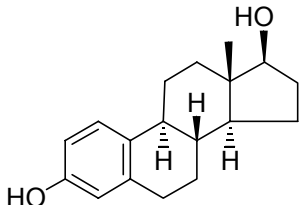
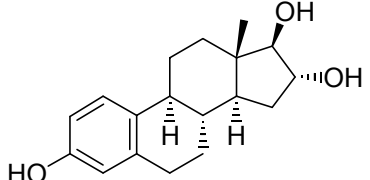
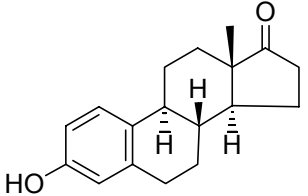
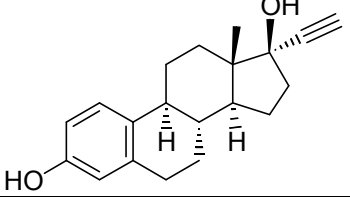
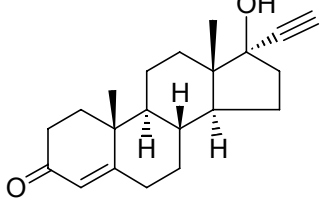


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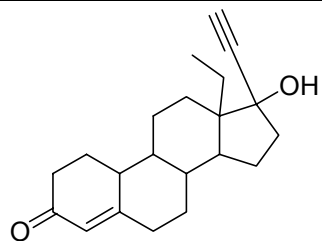


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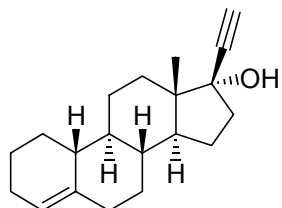
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lynestrenol

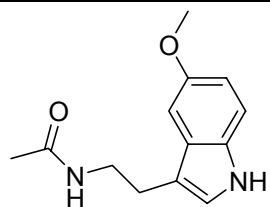
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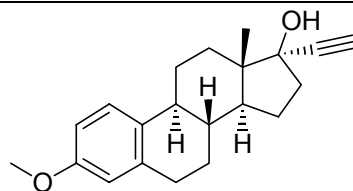
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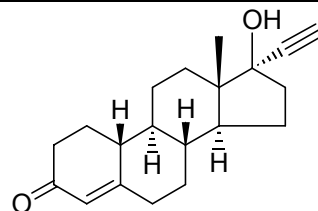


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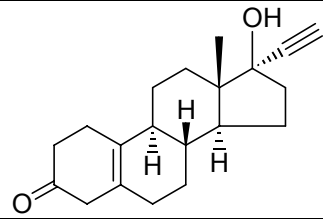


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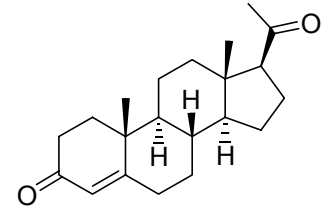
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57-83-0

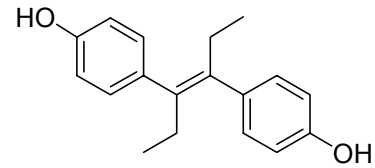


2

9

stilboestrol

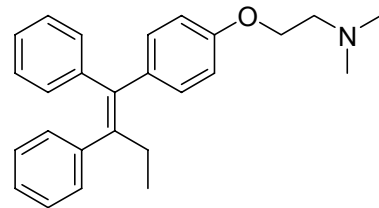
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tamoxifen

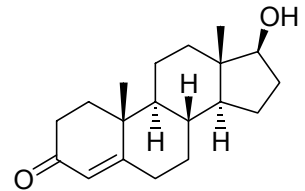
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testosterone

58-22-0

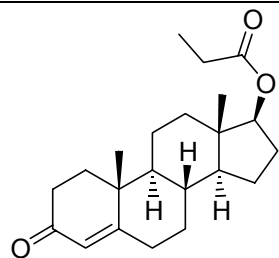


2

9

testosterone
propionate

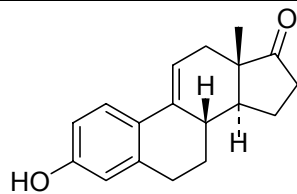
57-85-2



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$\Delta^9(11)$ -dehydroestrone

1089-80-
1

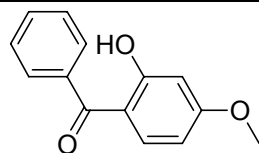


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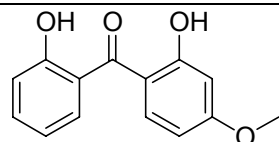
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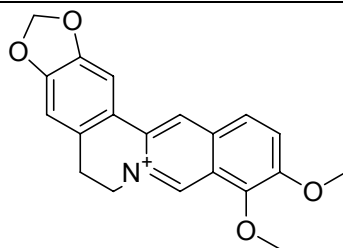
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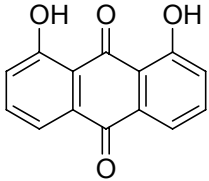
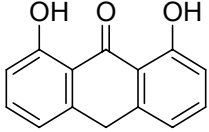
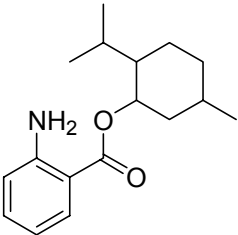
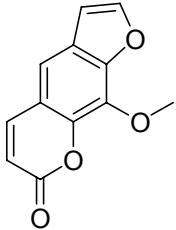
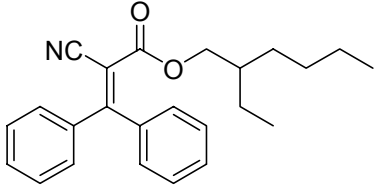
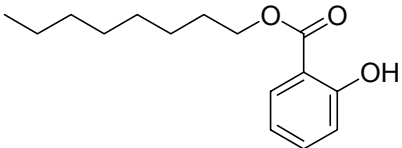
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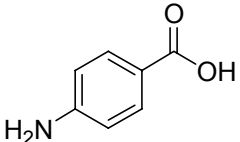
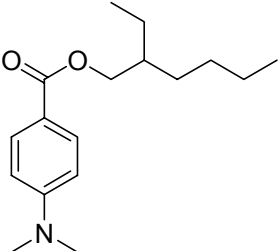
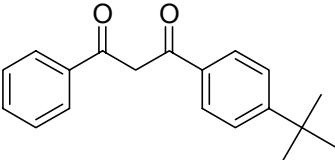
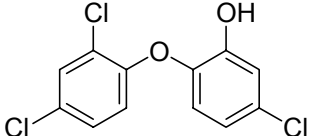
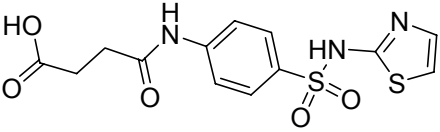
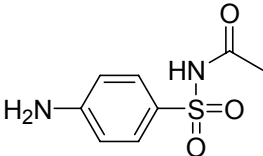
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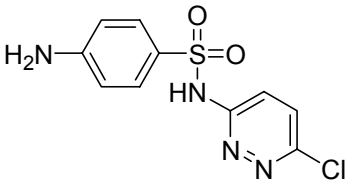
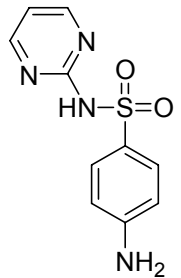
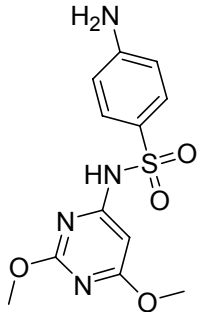
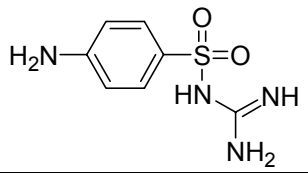
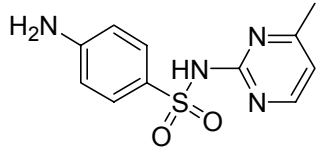
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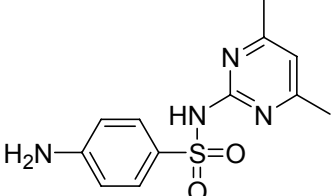
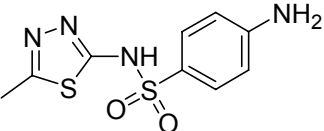
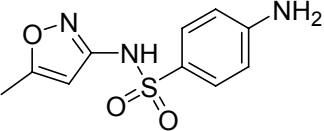
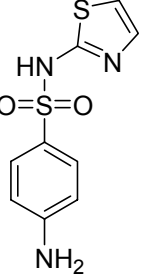
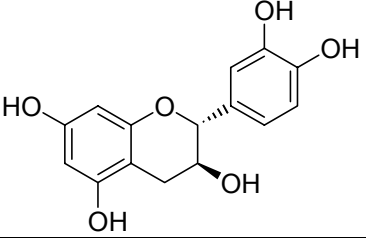


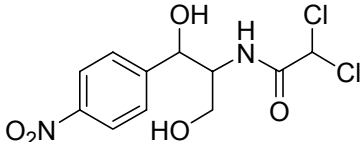
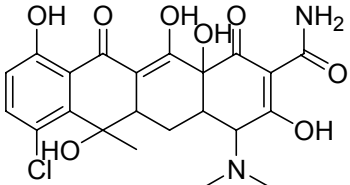
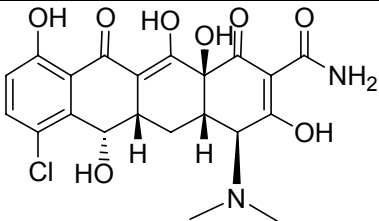
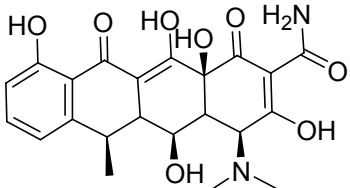
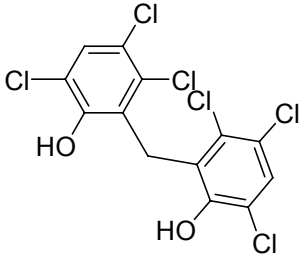
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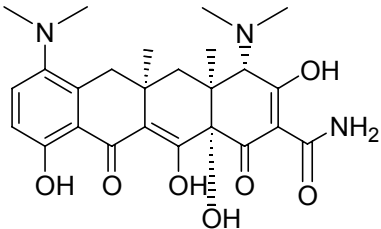
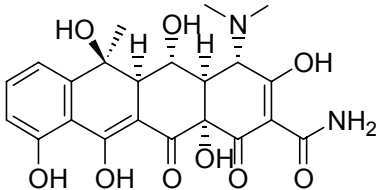
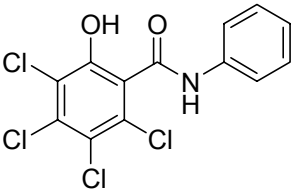
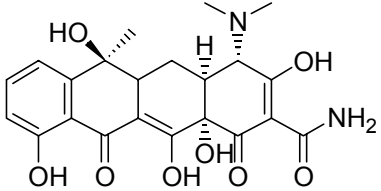
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dithranol	1143-38-0		9
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methoxsalen	298-81-7		9
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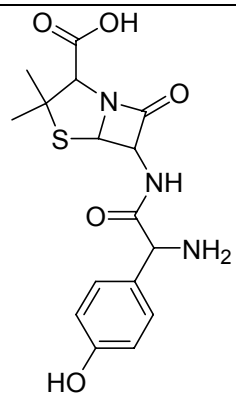
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amoxicillin

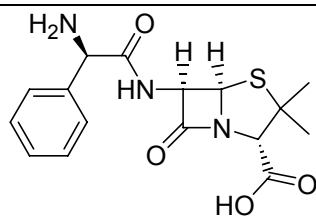
26787-78-0



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ampicillin

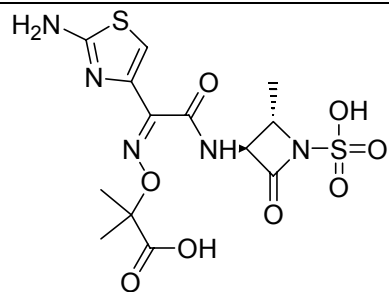
69-53-4



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aztreonam

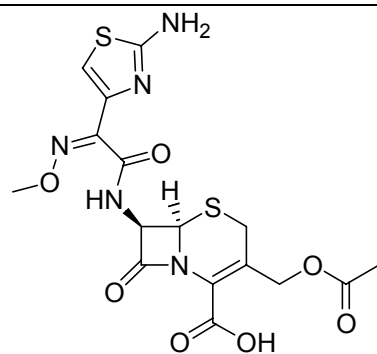
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cefotaxime

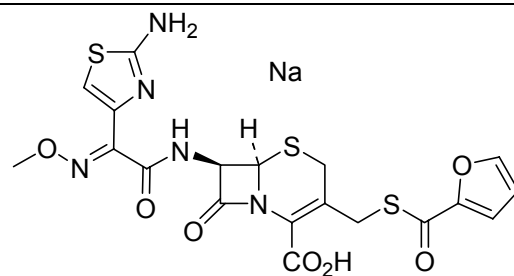
63527-52-6



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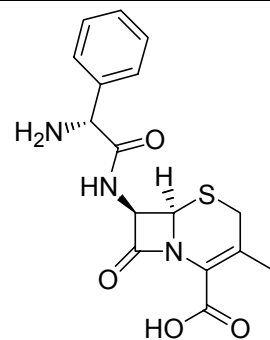
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cephalexin

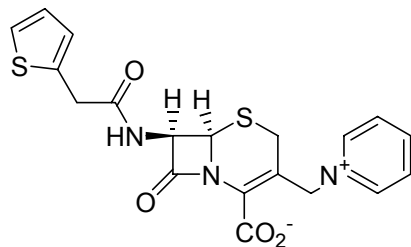
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cephaloridine

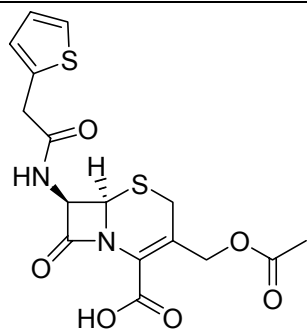
50-59-9



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cephalothin

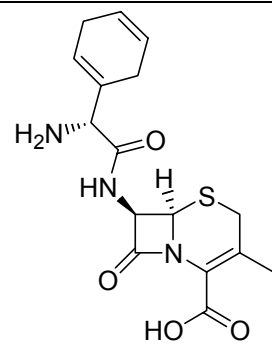
153-61-7



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cephradine

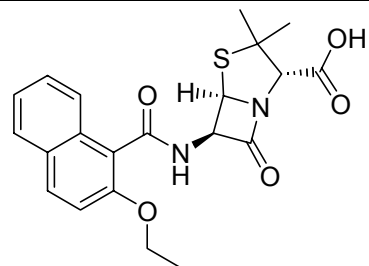
38821-53-3



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nafcillin

147-52-4



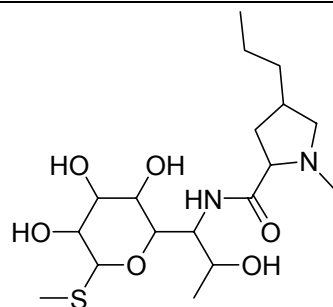
205^a

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Macrolide Antibiotics

lincomycin

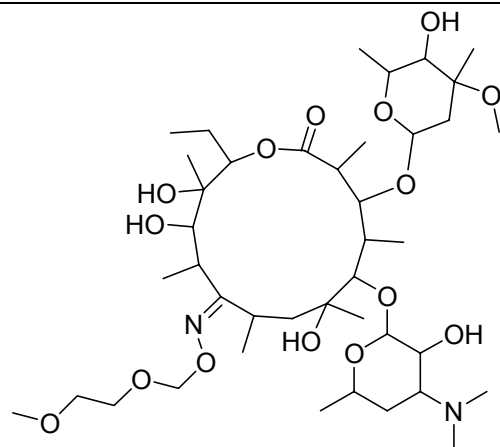
154-21-2



2, 3, 33, 34

roxithromycin

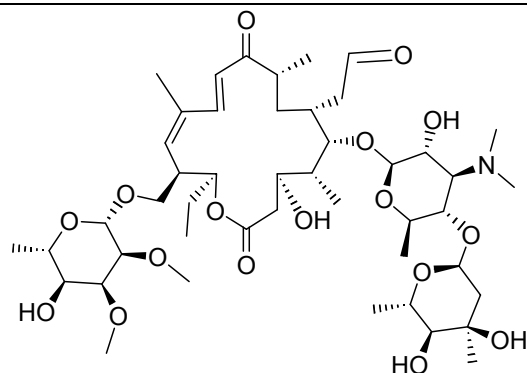
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tylosin

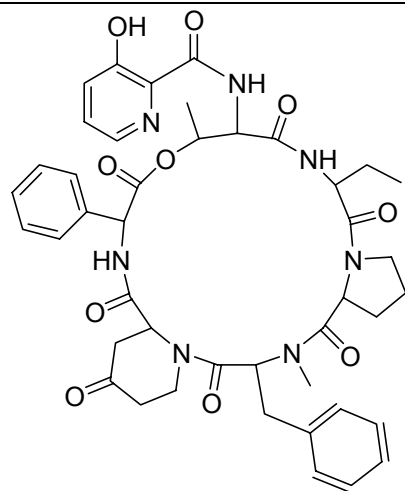
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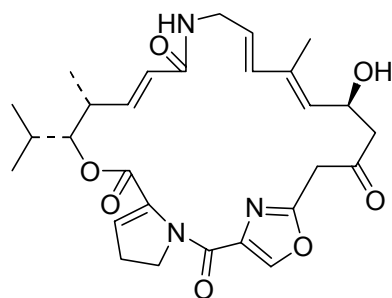
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virginiamycin

11006-76-1



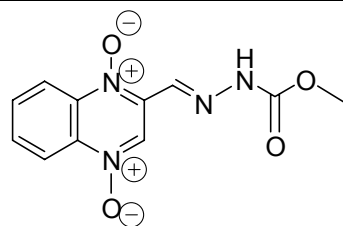
2^a



Antibacterials: Heterocyclic Drugs

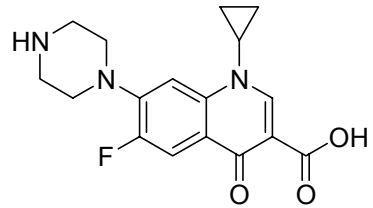
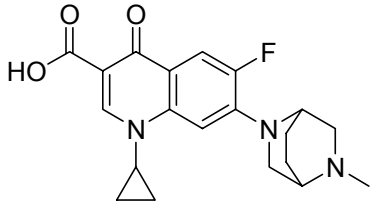
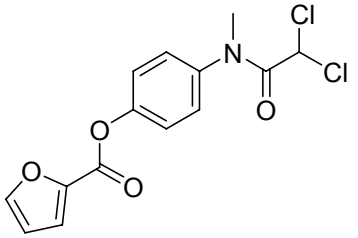
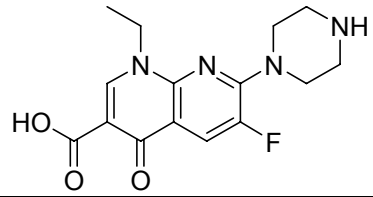
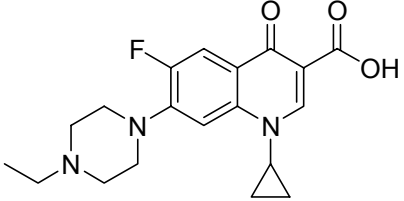
carbadox

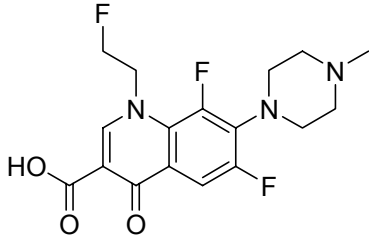
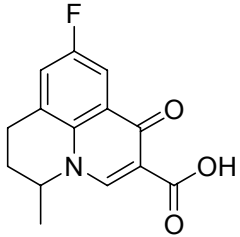
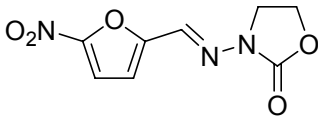
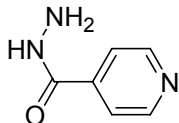
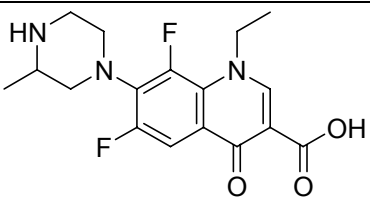
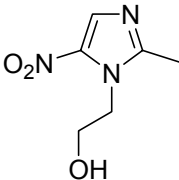
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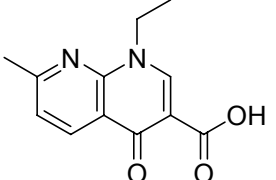
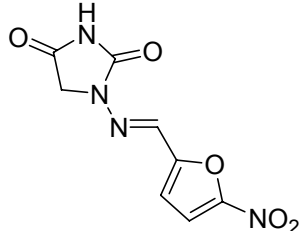
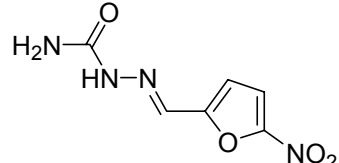
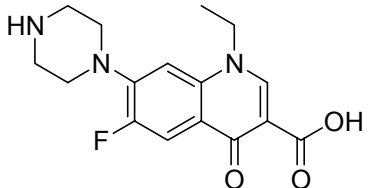
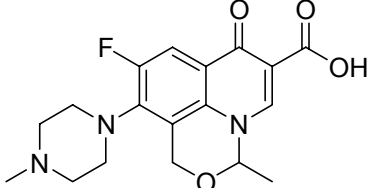
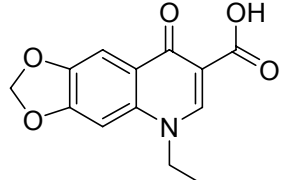


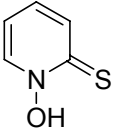
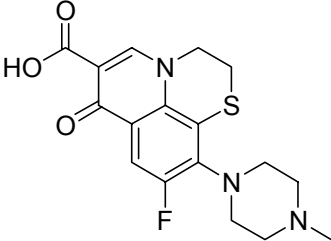
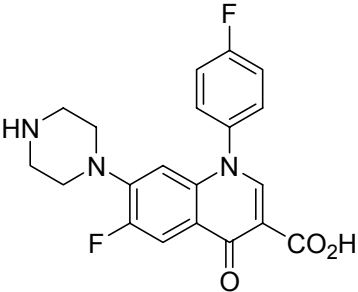
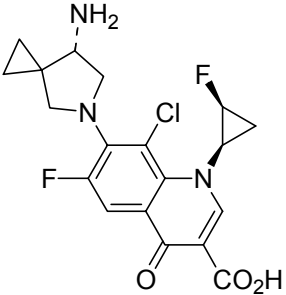
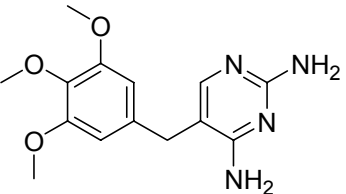
2^a

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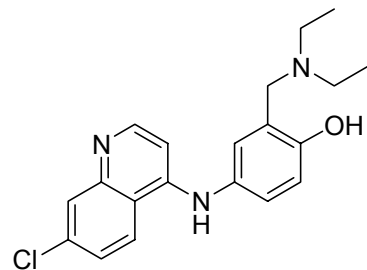
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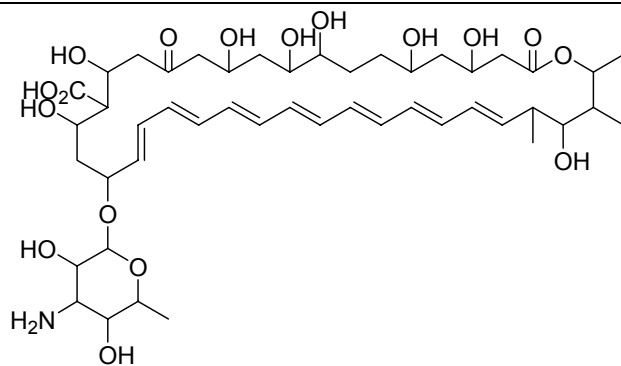


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amphotericin B

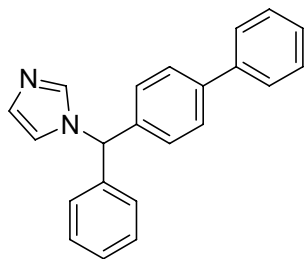
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bifonazole

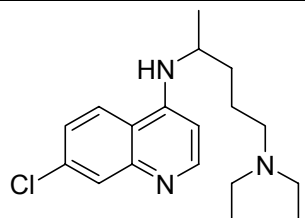
60628-96-8



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chloroquine

54-05-7

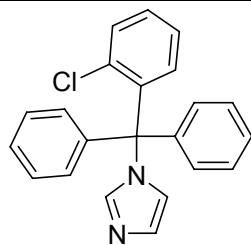


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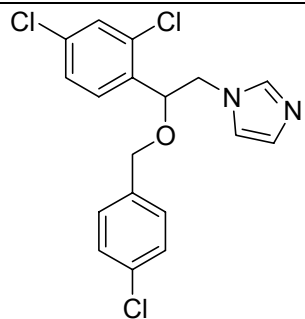
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econazole

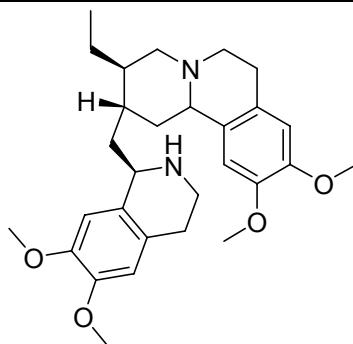
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emetine

483-18-1

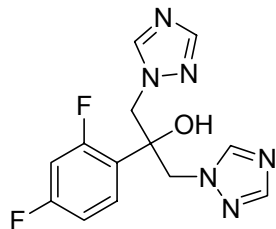


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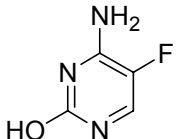
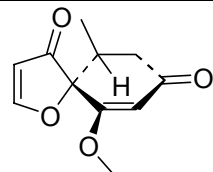
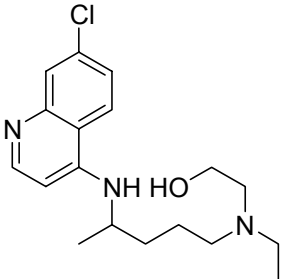
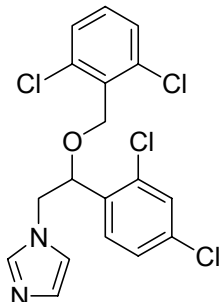
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fluconazole

86386-73-4

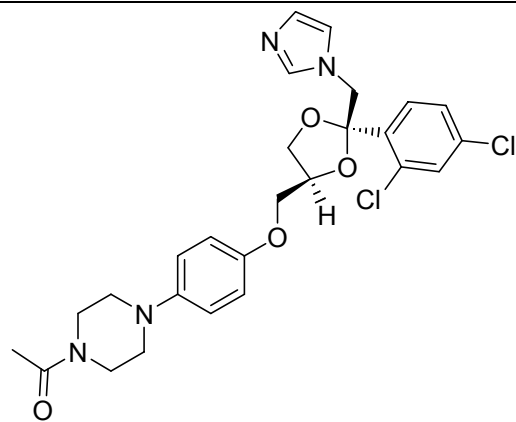


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ketoconazole

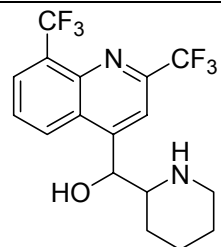
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mefloquine

53230-10-7

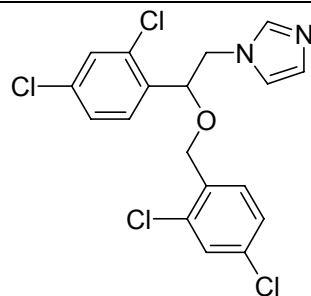


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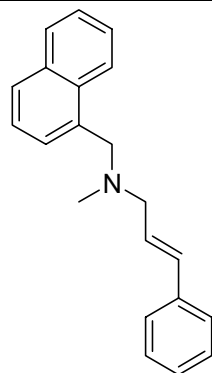
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naftifine

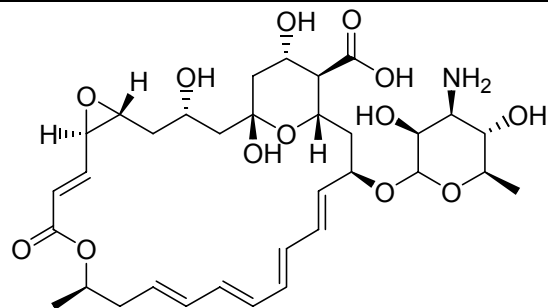
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natamycin

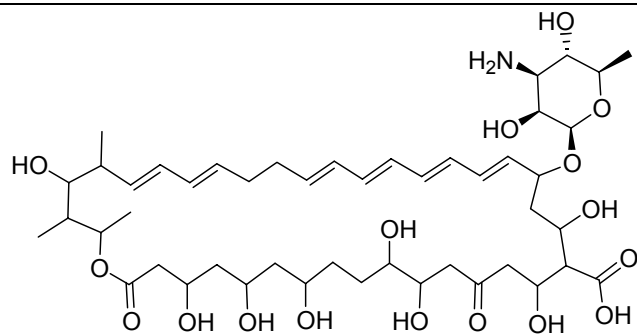
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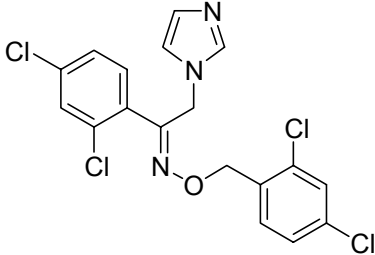
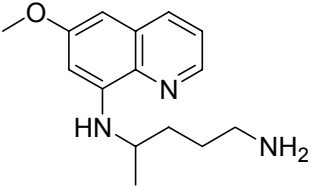
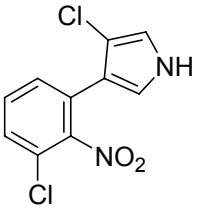
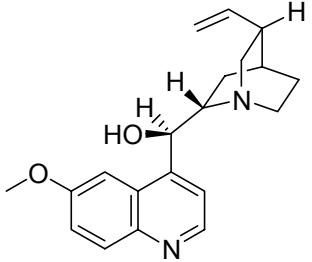
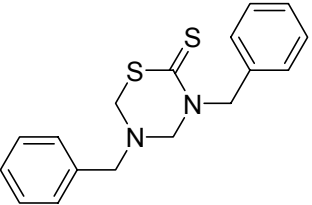
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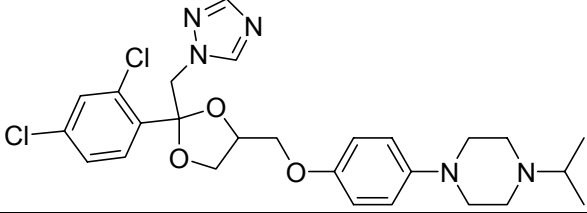
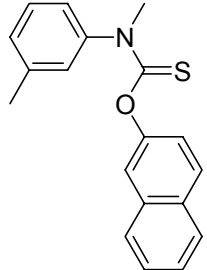
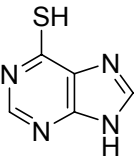
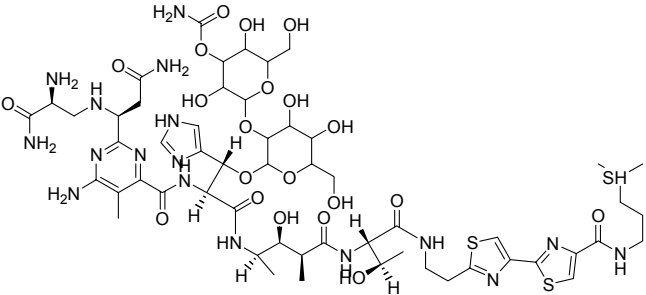
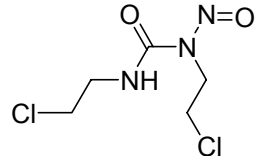
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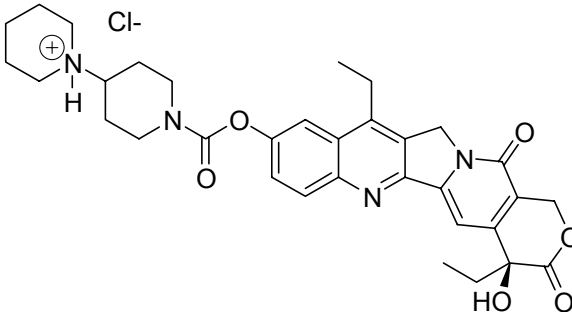
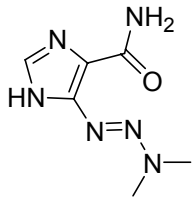
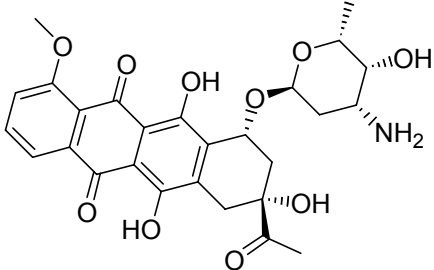
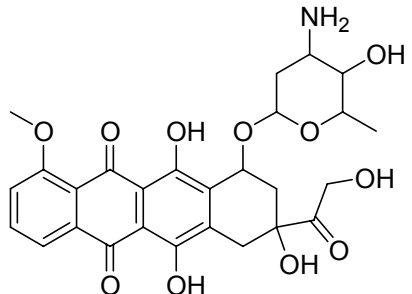
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223, 263

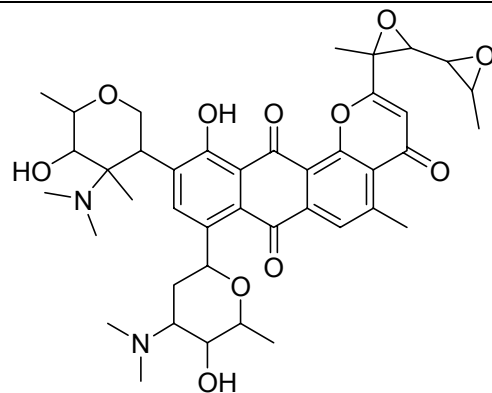
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pyrrolnitrin	1018-71-9		276	
quinine	130-95-0		55	9, 77
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11048-97-8

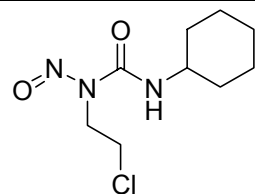


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9

lomustine

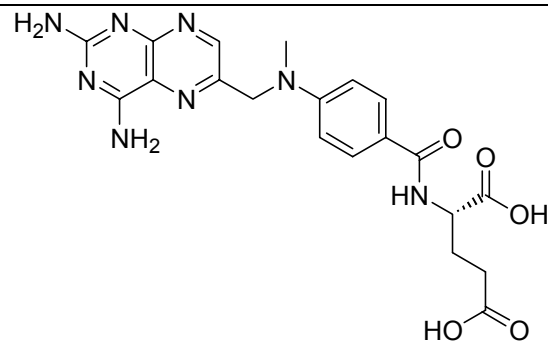
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methotrexate

59-05-2

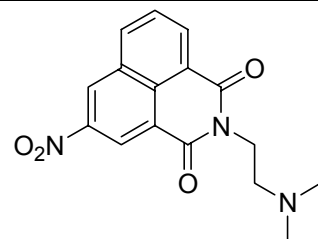


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mitonafide

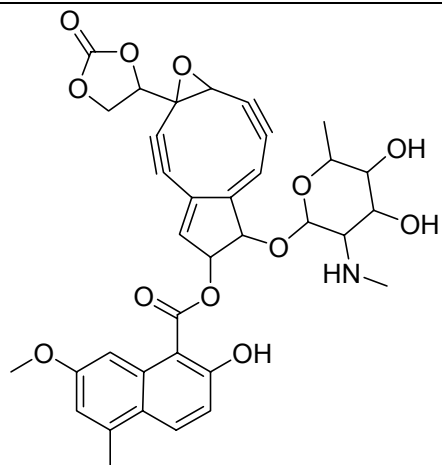
54824-17-8



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neocarzinostatin

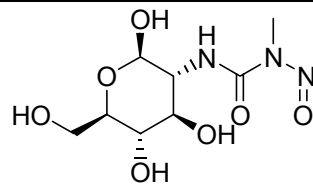
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streptozocin

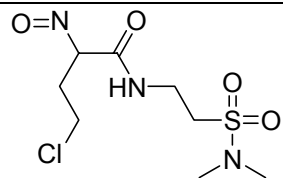
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66-4



156

tauromustine

85977-
49-7

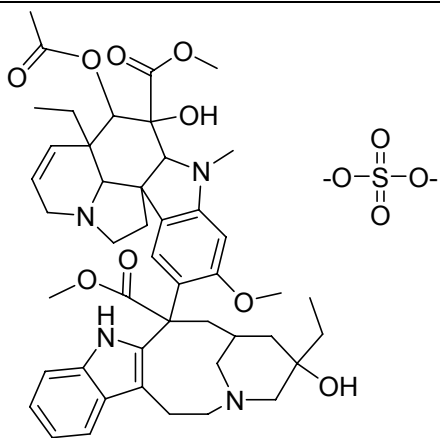


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vinblastine sulfate

143-67-9



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zinostatin

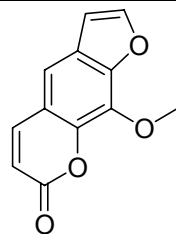
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9

Furocoumarins

8-MOP

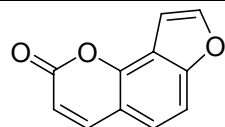
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75, 295

angelicin

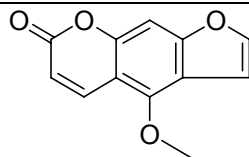
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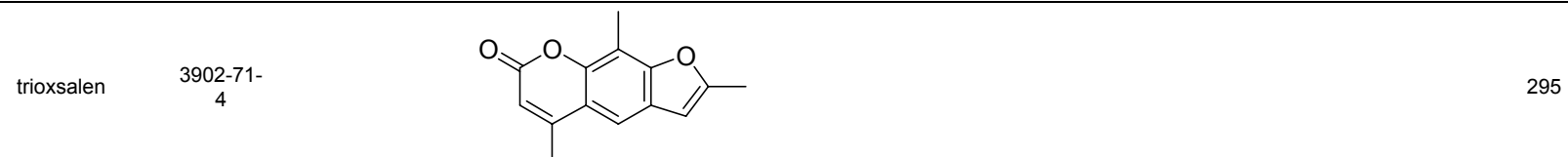
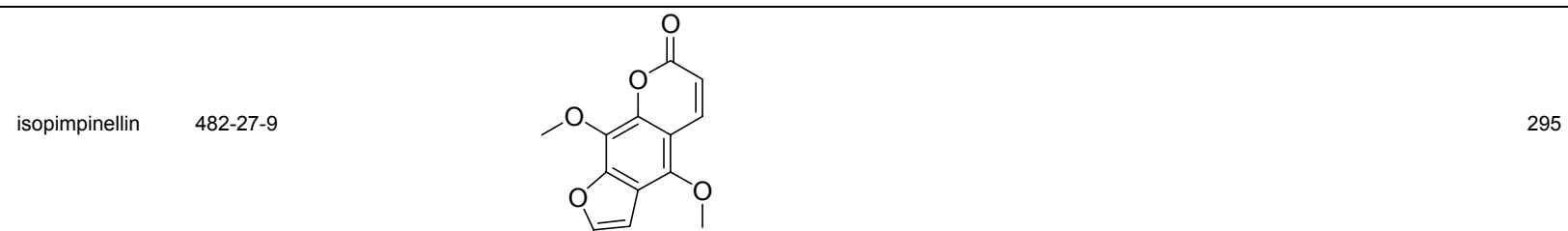
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bergapten

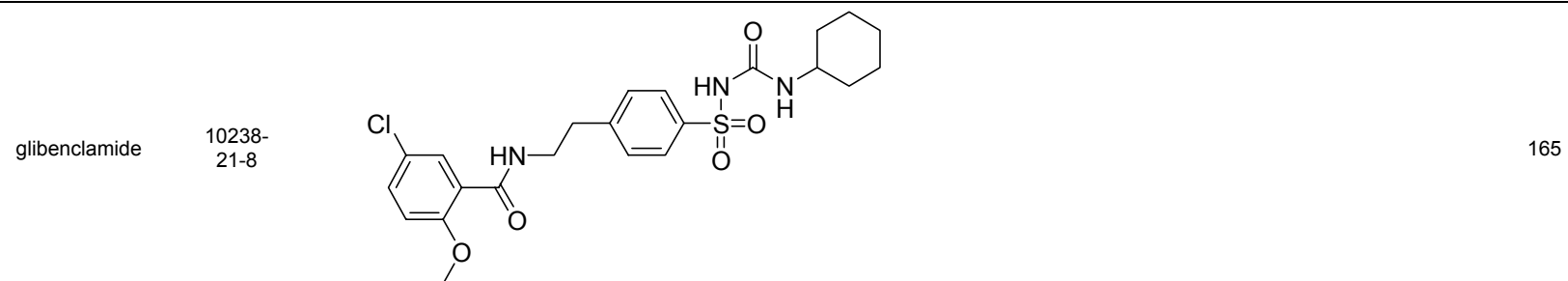
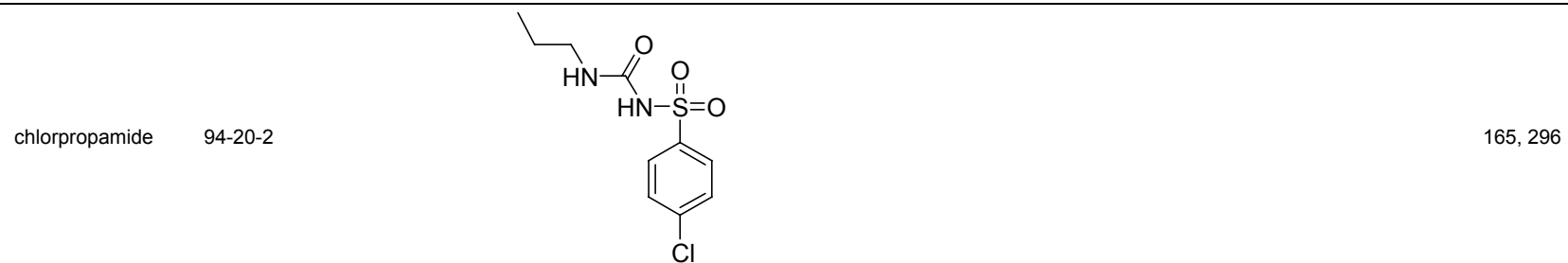
484-20-8



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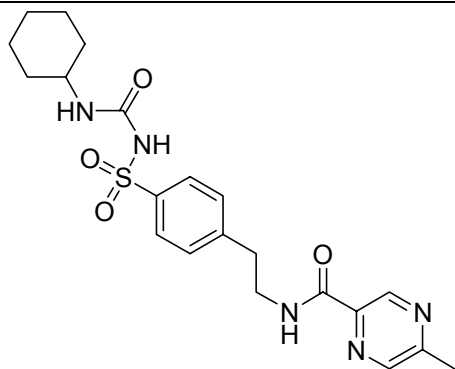


Anti-diabetics



glipizide

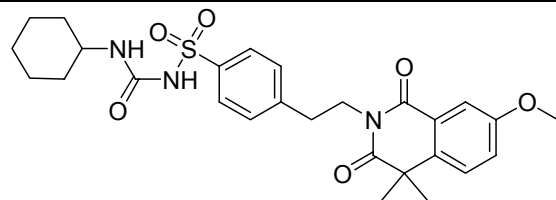
29094-61-9



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gliquidone

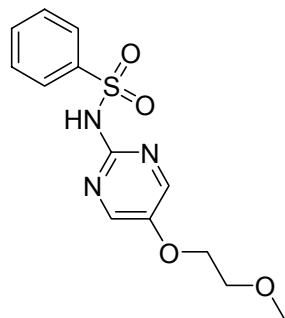
33342-05-1



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glymidine

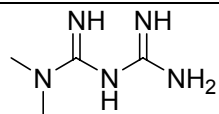
339-44-6



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metformin

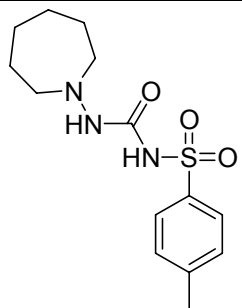
657-24-9



2

tolazamide

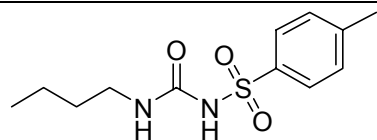
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tolbutamide

64-77-7

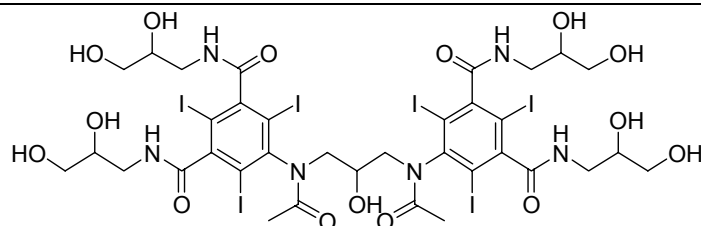


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Diagnostic Agents

iodixanol

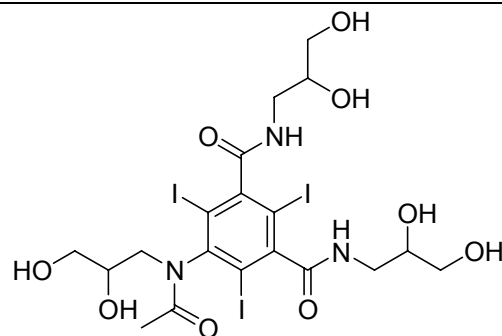
92339-11-2



297

iohexol

66108-95-0



3

iomeprol	78649-41-9		119	
iopamidol	60166-93-0		1	
iopromide	73334-07-3		1, 3	298
metyrapone	54-36-4		299	300

^a Denotes the compound was not detected in the field samples.

¹(Daughton and Ternes, 1999). ²(Kolpin, et al., 2002). ³(Heberer, 2002). ⁴(Ternes, 1998). ⁵(Stumpf, et al., 1999). ⁶(Reid and Subramanian, 1966). ⁷(Al-Omari, et al., 1997). ⁸(Jensen, et al., 1992). ⁹(Albini and Fasani, 1998). ¹⁰(Castell, et al., 1987b). ¹¹(Bosca, et al., 2001). ¹²(Moore and Chappuis, 1988). ¹³(Navaratnam, et al., 1985). ¹⁴(Vargas, et al., 1991). ¹⁵(Condorelli, et al., 1993). ¹⁶(Reszka and Chignell, 1983). ¹⁷(Wang and Moore, 1992). ¹⁸(Vargas, et al., 1993a). ¹⁹(Castell, et al., 1992). ²⁰(Jones, et al., 2001). ²¹(Andreozzi, et al., 2003). ²²(Tixier, et al., 2003). ²³(Buser, et al., 1998). ²⁴(Poiger, et al., 2001). ²⁵(Packer, et al., 2003). ²⁶(Moore, et al., 1990a). ²⁷(Ravina, et al., 2002). ²⁸(Encinas, et al., 1998a). ²⁹(Sortino, et al., 1999b). ³⁰(Sortino, et al., 2000b). ³¹(Sortino, et al., 2001). ³²(Navaratnam and Jones, 2000). ³³(Zuccato, et al., 2000). ³⁴(Calamari, et al., 2003). ³⁵(Halling-Sorensen, et al., 1997). ³⁶(Buser, et al., 1999). ³⁷(Castell, et al., 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