

フッ素系医薬のレビュー

(公財)相模中央化学研究所

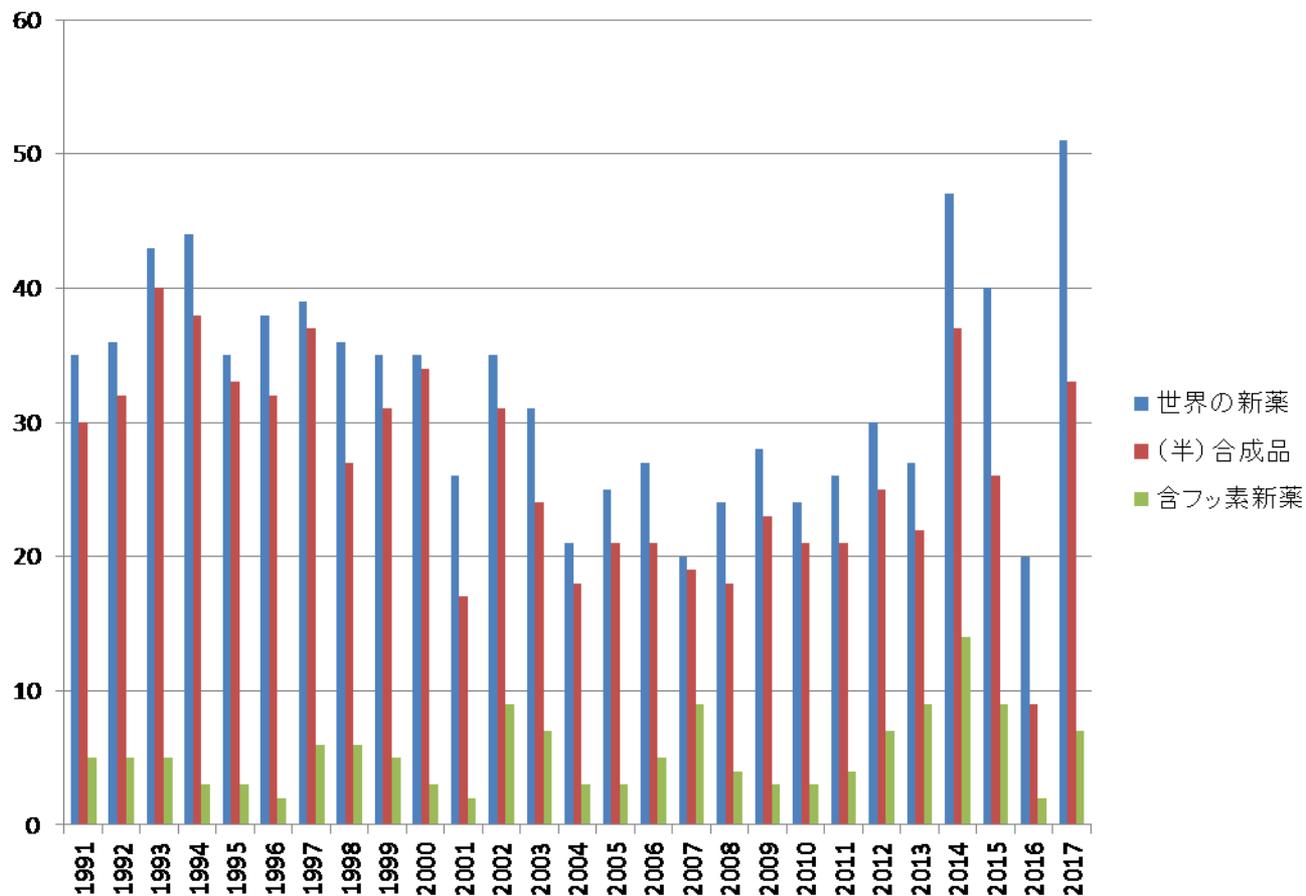
井上 宗宣

2018年6月8日

世界の新薬数と含フッ素医薬数(1991~2017)

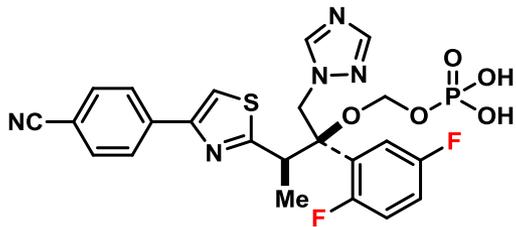
27年間で878品目の新薬(うち720品目が(半)合成品)が上市
含フッ素新薬は143品目(新薬中の約16%、合成品中の約20%)*

*(Annual Reports in Medicinal Chemistryより(2014年まで)、
KEGG DRUG HP(http://www.kegg.jp/kegg/drug/drug_ja.html)より(2015年以降、日米欧のみ))

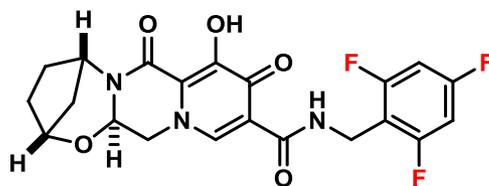


2018年承認含フッ素医薬

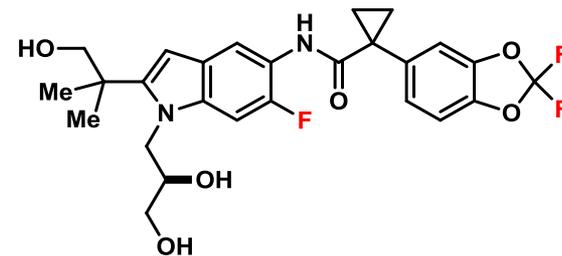
2018年：下記含フッ素医薬品(5品目)が認可



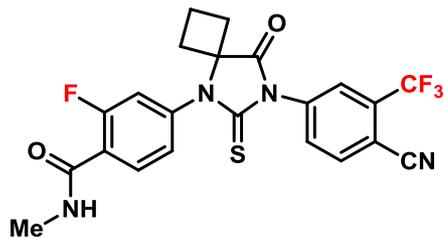
forsavuconazole
抗真菌剤



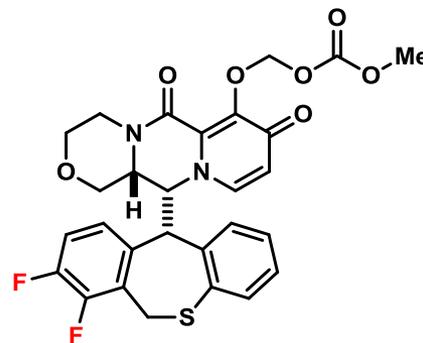
bictegrovir
抗HIV薬



tezacaftor
嚢胞性線維症治療薬



apalutamide
抗がん剤



baloxavir
抗菌剤

医薬品のATC分類

Anatomical Therapeutic Chemical Classification by WHO

- A: alimentary tract and metabolism
(消化器官用薬、代謝器官用薬)
- B: blood and blood forming organs
(血液・体液用薬)
- C: cardiovascular system
(循環器官用薬)
- D: dermatologicals
(外皮用薬)
- G: genito-urinary system and sex hormones
(泌尿生殖器用薬、性ホルモン剤)
- H: systemic hormonal preparations, excluding sex hormones and insulins
(性ホルモン及びインスリンを除いたホルモン剤)
- J: anti-infectives for systemic use
(抗感染症剤)
- L: antineoplastic and immunomodulating agents
(抗癌剤、免疫調節薬)
- M: musculo-skeletal system
(筋骨格系薬)
- N: nervous system
(神経系用薬)
- P: antiparasitic products, insecticides and repellents
(寄生動物に対する薬)
- R: respiratory system
(呼吸器官用薬)
- S: sensory organs
(感覚器官用薬)
- V: various
(そのほか)

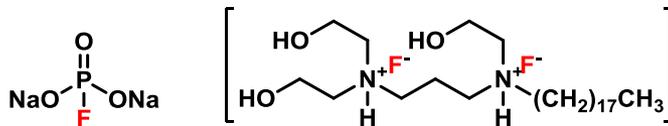
含フッ素医薬の構造

分類	含フッ素 医薬	2000年- 2017年 上市 含フッ素 医薬	C_{sp^2}				C_{sp^3}							エーテル				スルフィド		酸誘導体		アミン		その他
			Ar-		Het-		alkyl-							ArO-				S-		RC(=O)S	NC(=O)-	N-		
			F	CF ₃	F	CF ₃	CH ₂ F	CHF ₂	CF ₃	C ₂ F ₅	GRF	CF ₂ R	その他	CF ₃	CHF ₂	CH ₂ CF ₃	その他	CH ₂ CF ₃	CHF ₂	CH ₂ F	CF ₃	CH ₂ CF	CH ₂ CF ₃	
	298	112	144	47	18	7	6	2	4	1	48	9	4	3	3	4	6	1	1	2	1	2	3	2
A 消化官・代謝作用	23	15	11	9		2			1			1			1	2								
B 血液と造血器官	5	4	3	1					1															
C 循環器系	21	6	15	4											1		1					1		
D 皮膚科用薬	41	1	1				1				39								2					
G 泌尿生殖器系と性ホルモン	5	4		2						1	1				1									
H 全身ホルモン製剤	2	2		1					1															
JO1 全身用抗菌薬	33	10	27		5		1				1				1			1				2		
JO2 全身用抗真菌薬	8	6	7		2																			
JO4 抗マイコバクテリア薬	1	1												1										
JO5 全身用抗ウイルス薬	15	13	5	1	3	1		1		2	3													
LO1 抗悪性腫瘍薬	38	26	19	9	7	1				1	1	2		1							1			
LO4 免疫抑制薬	2	1		2																				
M01 非ステロイド系抗炎症薬	15	2	7	7		1																		
M09 その他の筋骨格系疾患用薬	1	1	1																					
N01 麻酔薬	8	0	1						1			1					5							
N02 鎮痛薬	1	0	1																					
N03 抗てんかん薬	3	2	3																					
N03 抗パーキンソン病薬	1	1	1																					
N05A 統合失調症治療薬	22	4	18	4																				
N05B 抗不安薬	5	0	4																				1	
N05C 催眠薬	8	0	8																				1	
N06 抗うつ薬	6	1	3	3																				
N07 その他の神経系薬	3	0	1				1							1										
P 抗寄生虫薬	3	0	1	2		1																		
R 呼吸器系	9	2	5	1			1				1				1									
S 感覚器	6	4		1	1	1					1	1												1(P-F)
V そのほか	12	5	2				3				2		4											1(SF ₆)
なし	1	1															1							

A:消化器官用薬・代謝器官用薬

A01: 歯科口腔用薬

虫歯予防薬
(フルオリド)

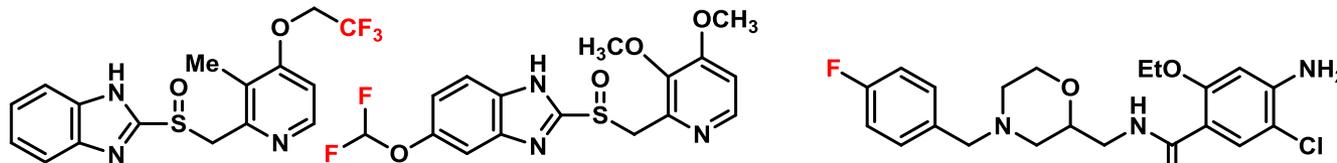


olafur

A02: 消化性潰瘍治療薬

制酸剤
H₂-受容体アンタゴニスト

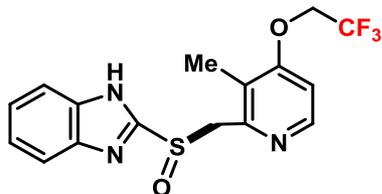
⇒ プロトンポンプ阻害剤



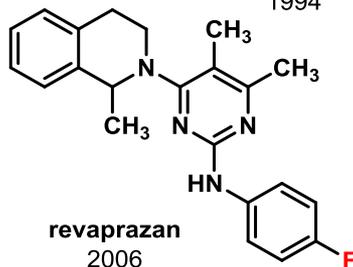
lansoprazole (J)
1992

pantoprazole
1994

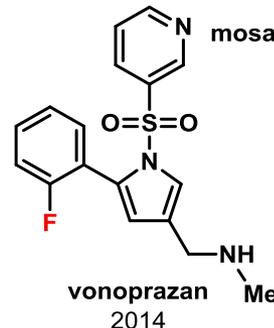
mosapride citrate (J)
1998
慢性胃炎



dexlansoprazole
2009



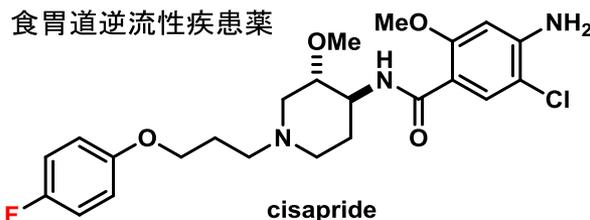
revaprazan
2006



vonoprazan
2014

A03: 腸

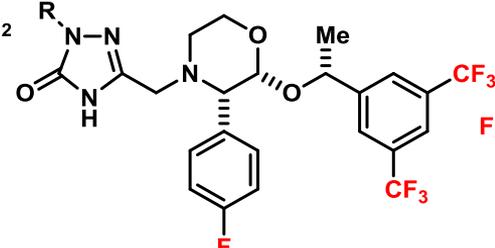
食胃道逆流性疾患薬



cisapride
1988

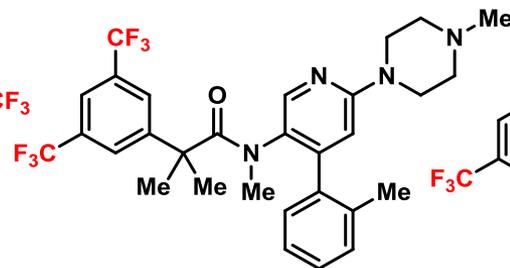
(使用されているが、限定的)

A04: 制吐薬

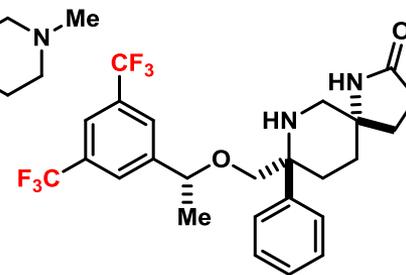


aprepitant (J) (R = H)
2003

fosaprepitant
(R = P(O)(OH)₂)
2008



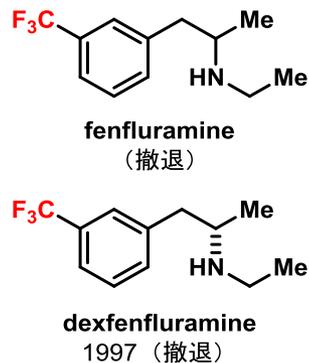
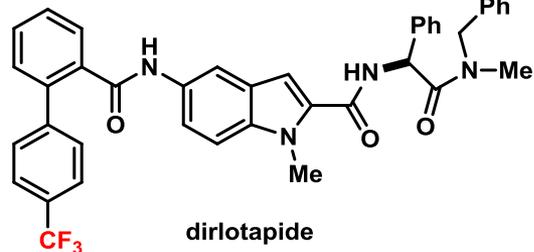
netupitant
2014



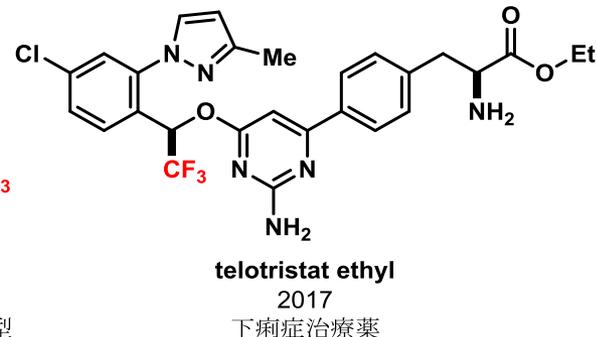
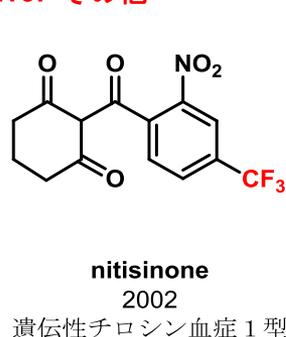
rolapitant
2015

A:消化器官用薬・代謝器官用薬

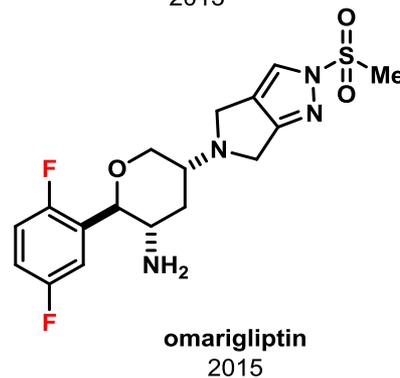
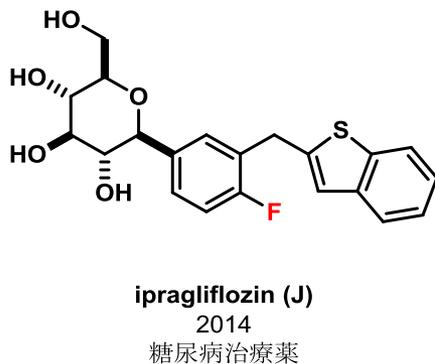
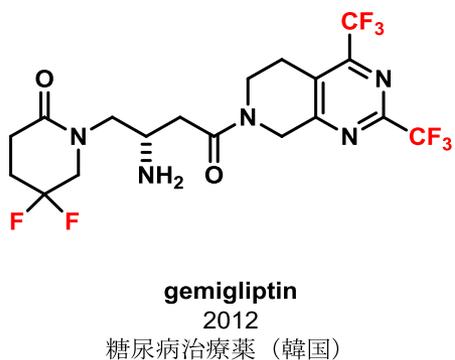
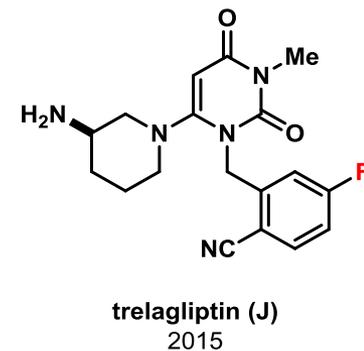
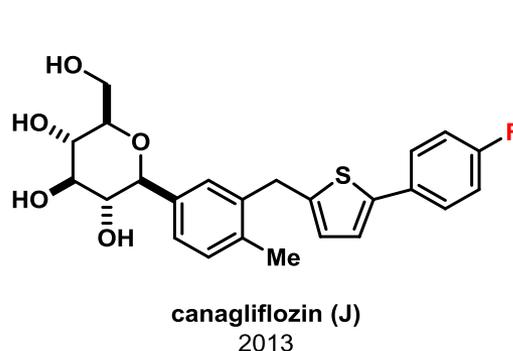
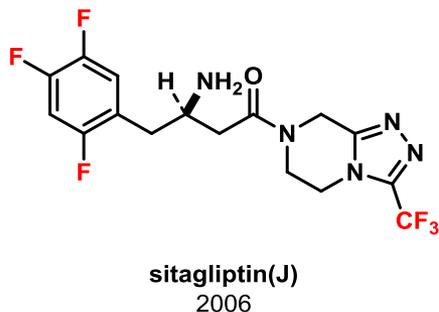
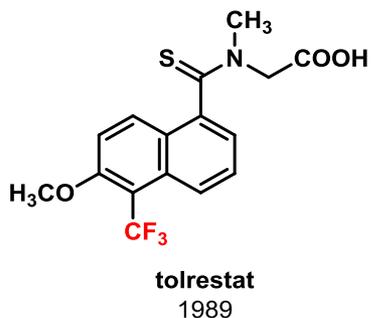
A08: 抗肥満薬



A16: その他

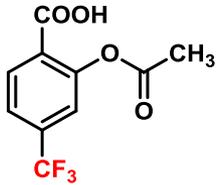


A10: 糖尿病治療薬

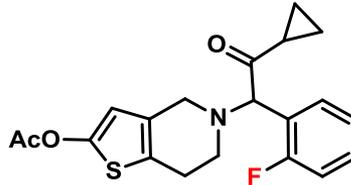


B:血液·体液用薬

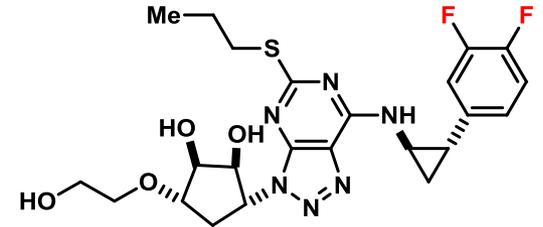
B01: 抗血栓症



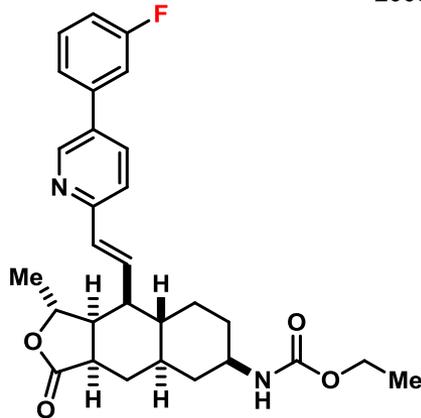
triflusal



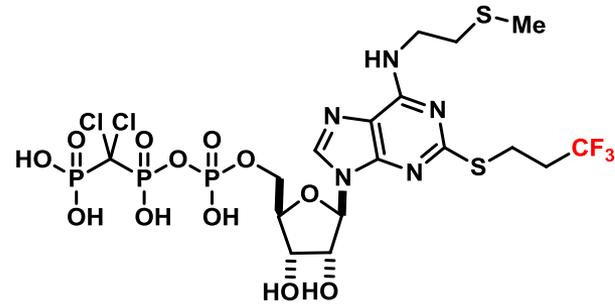
prasugrel
2009



ticagrelor
2010



vorapaxar
2014



cangrelor
2015

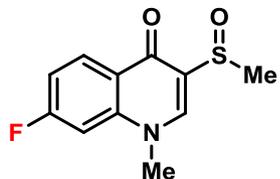
B05: 人工血液

perfluorodecalin or
perfluorotributylamine
in Fluosol-DA and
Fluosol-43

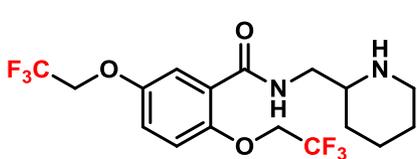
Fluosol

C:循環器官用薬

C01: 心臓病治療

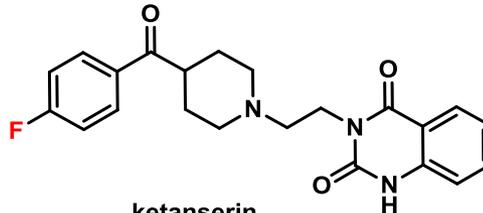


flosequinan
1992
血管拡張剤

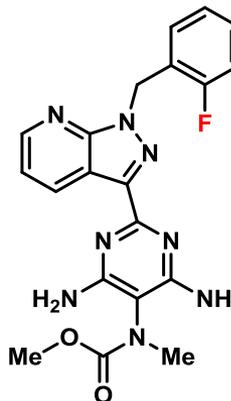


flecainide (J)
抗不整脈薬

C02: 血圧降下剤

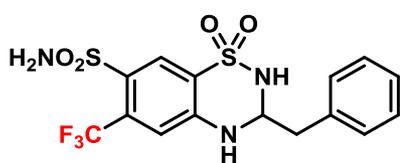


ketanserin
1985
5HT₂ & α 受容体
遮断薬

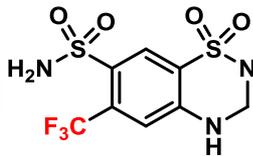


riociguat (J)
2013
高血圧症薬

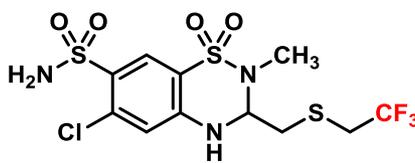
C03: 利尿薬



bendroflumethiazide

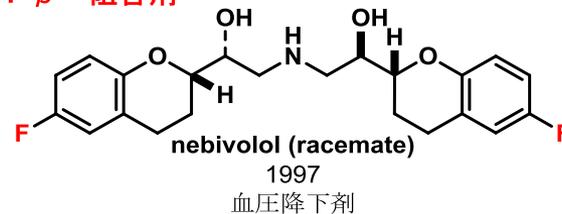


hydroflumethiazide



polythiazide

C07: β-阻害剤

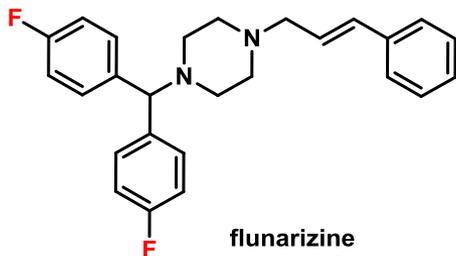


neбивол (racemate)
1997
血圧降下剤

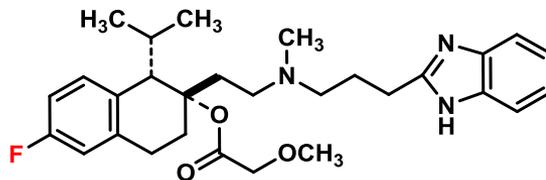


butofilolol
血圧降下剤

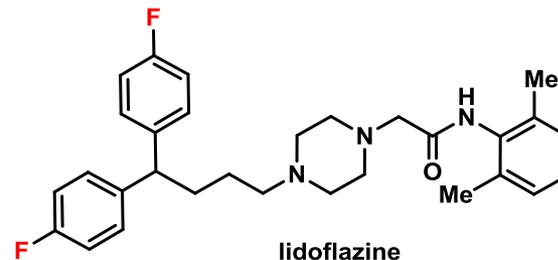
C08: カルシウムチャンネル阻害剤



flunarizine
血管拡張剤



mibefradil
1997(withdrawn in 1998)
血圧降下剤

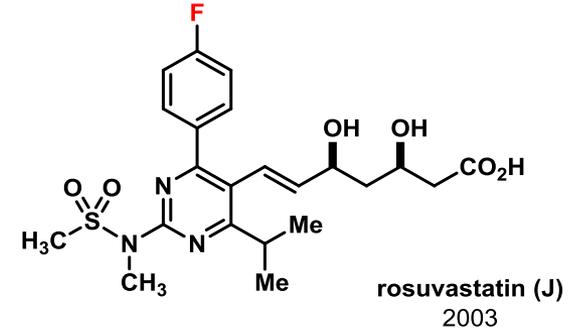
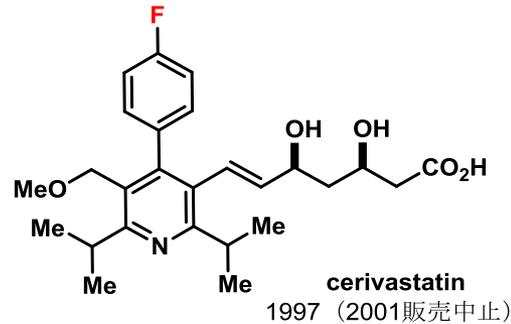
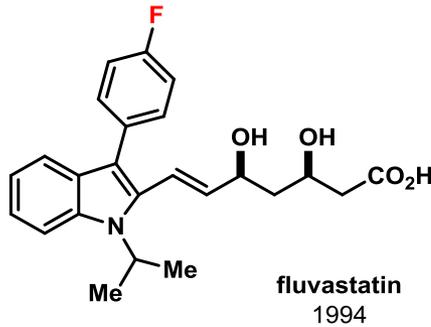
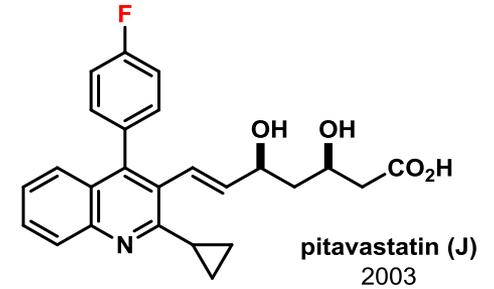
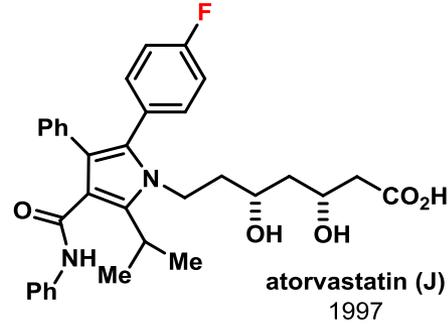
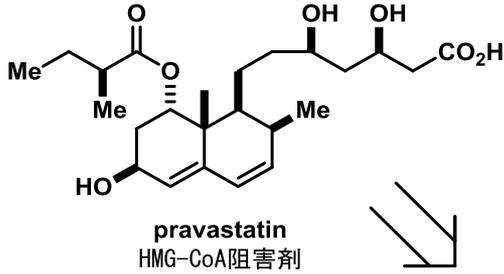


lidoflazine

C:循環器官用薬(抗高脂血症用薬)

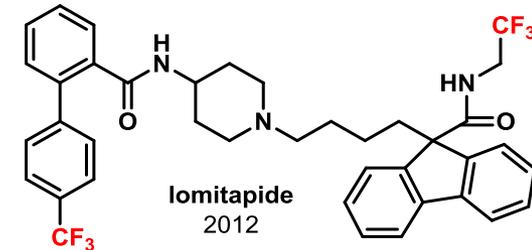
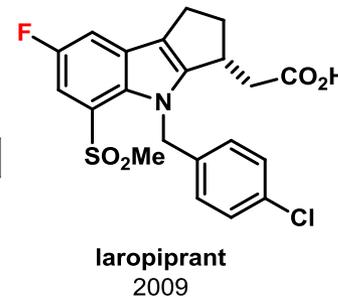
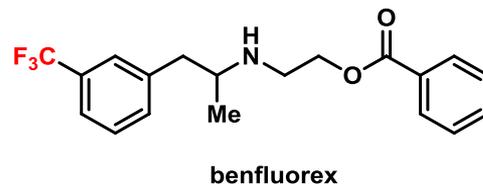
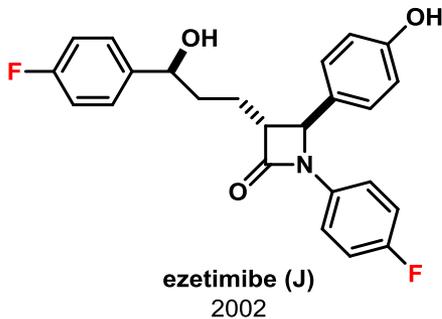
C10 高脂血症用薬

C10-1 プラバスタチン誘導体



C10-2 その他

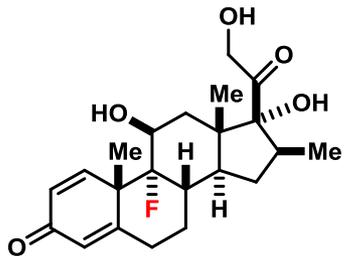
コレステロール吸収阻害剤



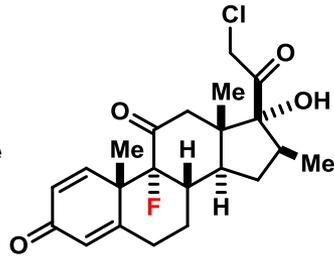
D07:副腎皮質ステロイド(抗炎症薬) - 1

9位フッ素化体

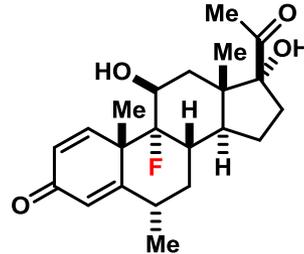
17-オール



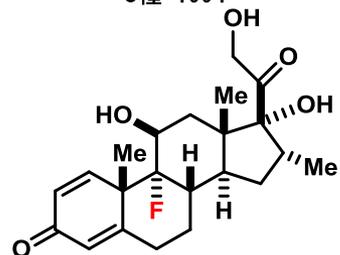
betametasone (J)
(17 and/or 21-ester)
6種 1994



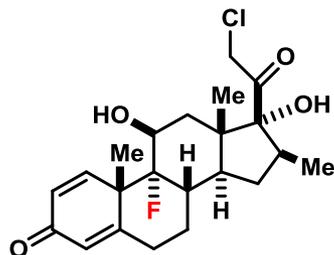
clobetasone (J)
(17-ester)



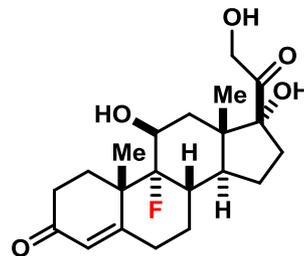
fluorometholone (J)



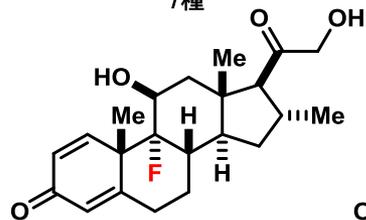
dexamethasone (J)
(17 and/or 21-ester)
7種



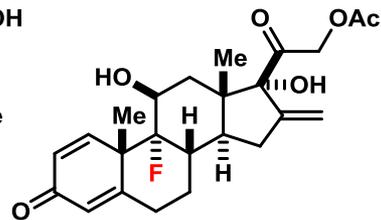
clobetasol (J)
(17 ester)



fludrocortisone (J)
(21-ester)

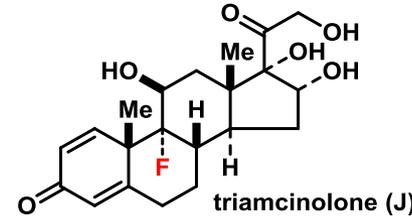


desoximetasone

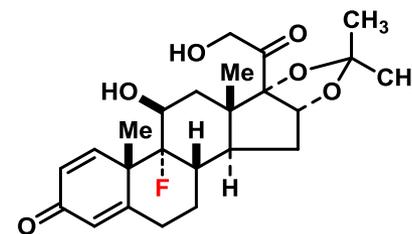


flupredniden acetate

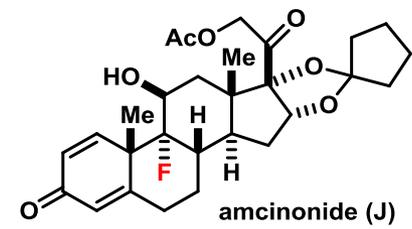
16, 17-ジオール



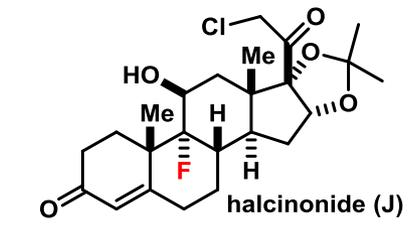
triamcinolone (J)



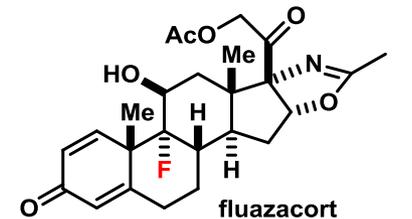
triamcinolone acetonide (J)



amcinonide (J)

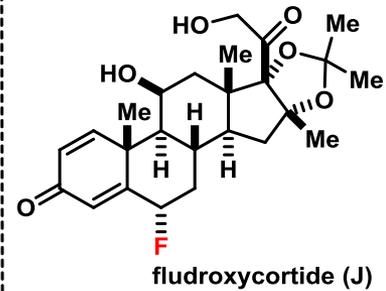


halcinonide (J)

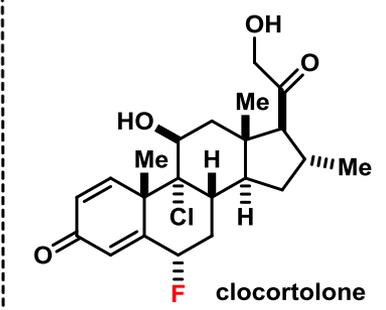


fluazacort

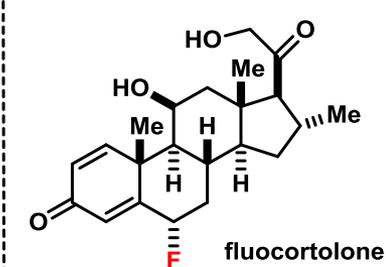
6位フッ素化体



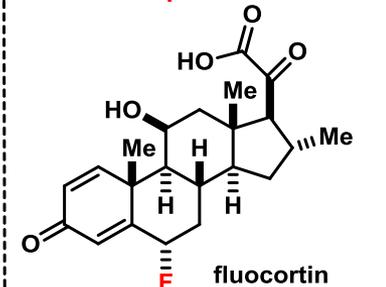
fludroxycortide (J)



clocortolone



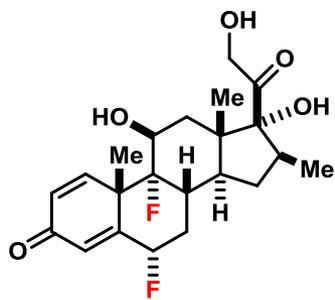
fluocortolone



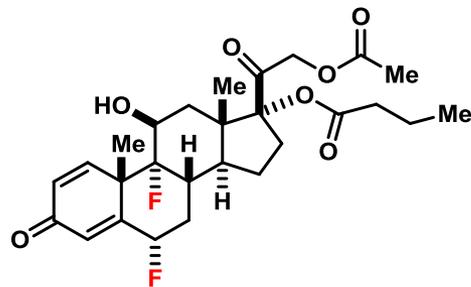
fluocortin

D07:副腎皮質ステロイド(抗炎症薬) - 2

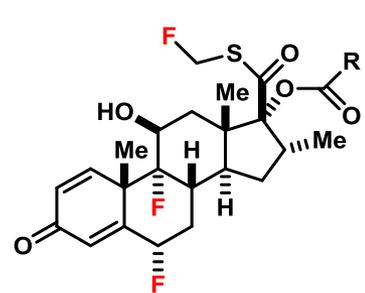
6, 9位ジフッ素化体



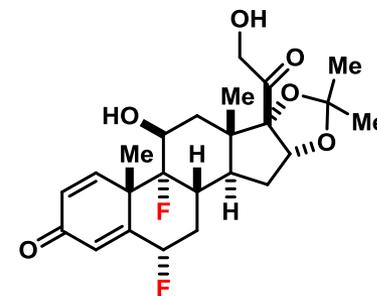
diflorasone
(21- ester)



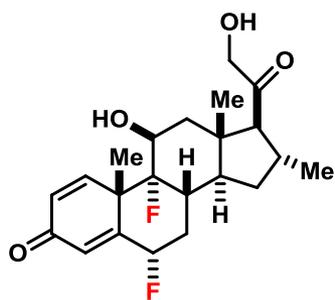
difluprednate (J)
1986



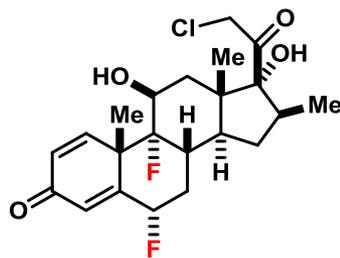
fluticasone propionate (J) (R = Et)
fluticasone furoate
(R = 2-furanyl, 2007)



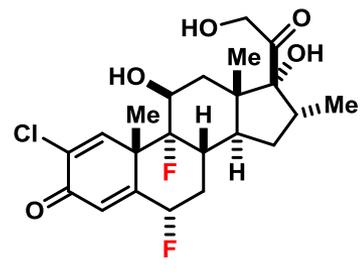
fluocinolone acetonide (J)



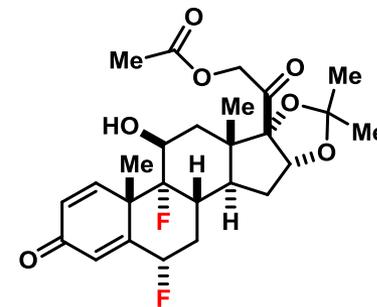
diflucortolone (J)
(ester)



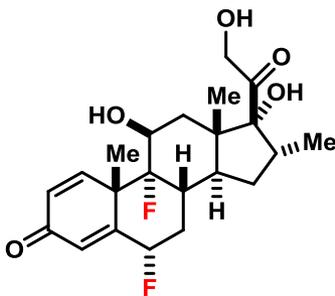
ulobetasol
(halobetasol)



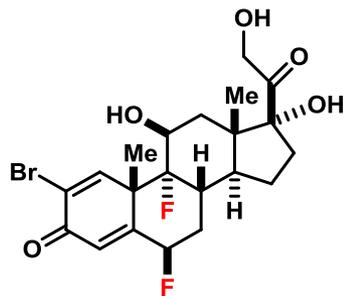
halometasone
1983



fluocinonide (J)



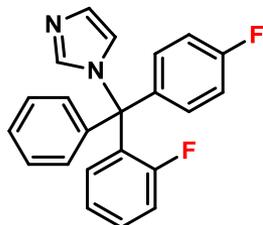
flumetasone (J)
(ester)



halopredone

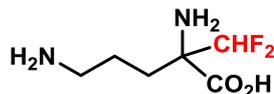
D:その他皮膚薬、G:泌尿器官用薬、H:ホルモン剤

D01: 抗菌剤



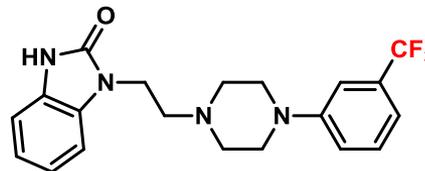
flutrimazole
1995

D11: 他の皮膚用薬



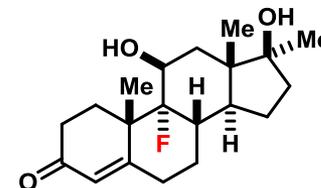
eflornithine
多毛症用薬

G02: 婦人科用薬



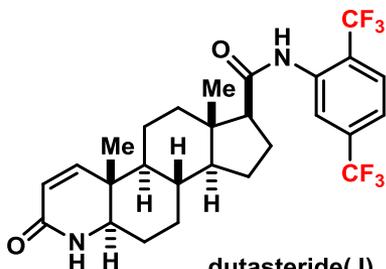
flibanserin
2015
性的欲求低下障害 (女性)

G03: 性ホルモン剤

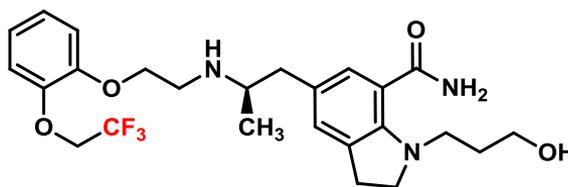


fluoxymesterone

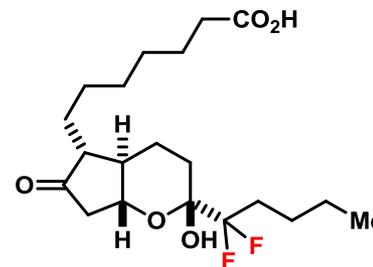
G04: 泌尿器系薬



dutasteride(J)
2002
前立腺肥大症

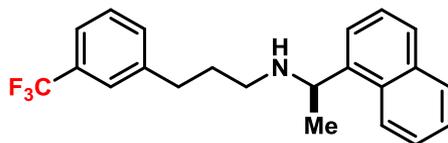


silodosin (J)
2006
排尿障害改善剤

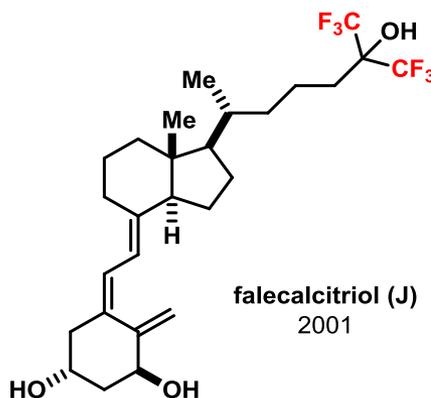


lubiprostone
2006
便秘薬

H05: 副甲状腺機能亢進症



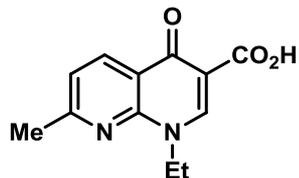
cinacalcet (J)
2004



falecalcitriol (J)
2001

J01:抗菌剤(キノロン系)ー1

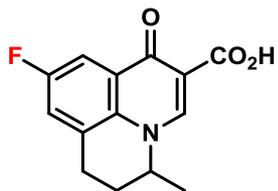
オールドキノロン



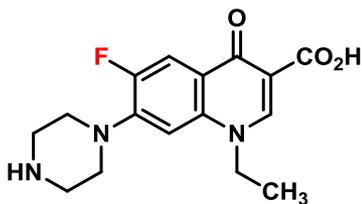
nalidixic acid

抗菌スペクトルの拡大

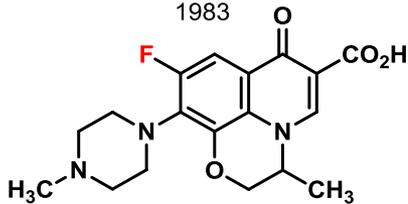
6位フッ素導入



flumequine

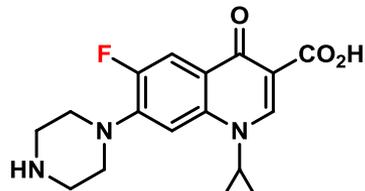


norfloxacin (J)
1983



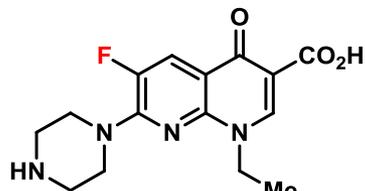
ofloxacin (J)
1985

代表的なニューキノロン

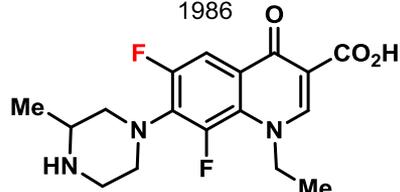


ciprofloxacin (J)
1986

1位シクロプロピル基は
グラム陰性菌に対する
抗菌力アップ

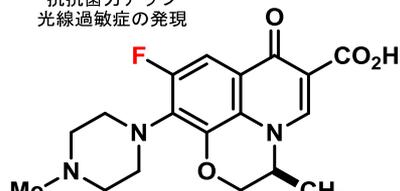


enoxacin (J)
1986



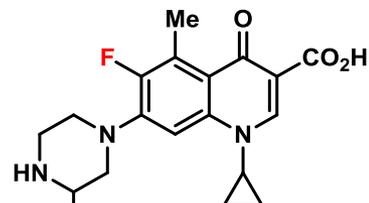
lomefloxacin (J)
1989

8位フッ素原子の導入は
抗抗菌力アップ
光線過敏症の発現

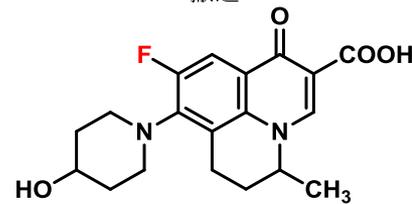


levofloxacin (J)
1993

その他のニューキノロン

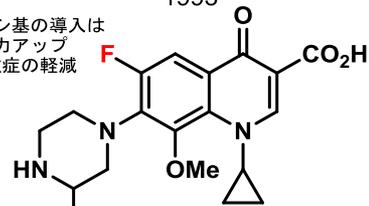


grepafloxacin
撤退

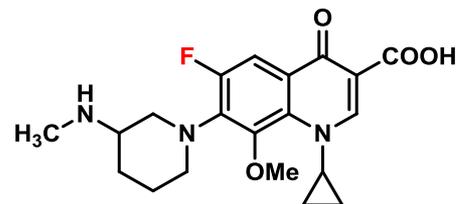


nadifloxacin (J)
1993

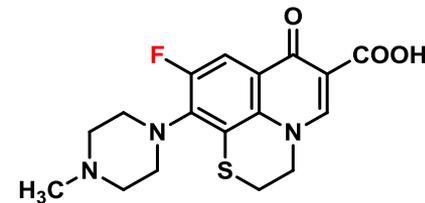
8位メトキシ基の導入は
抗抗菌力アップ
光線過敏症の軽減



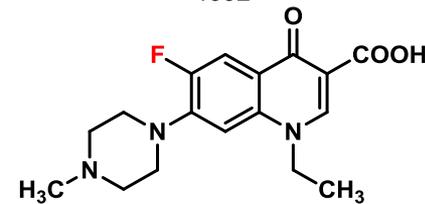
gatifloxacin (J)
1999



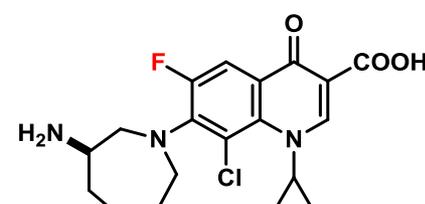
balofloxacin
(韓国のみ)



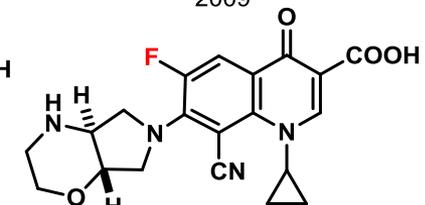
rifloxacin
1992



pefloxacin
1985



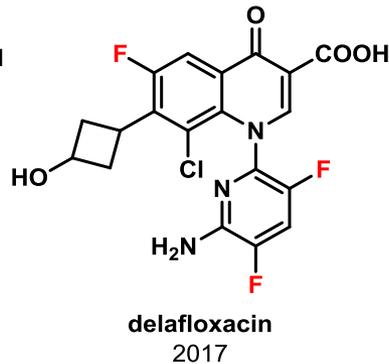
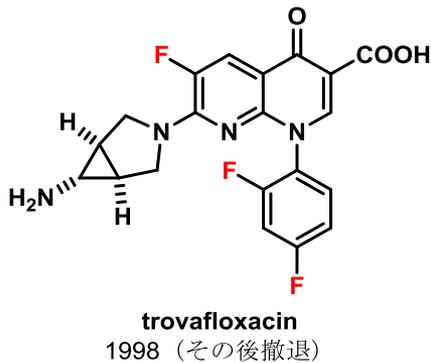
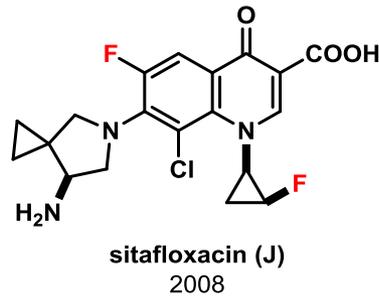
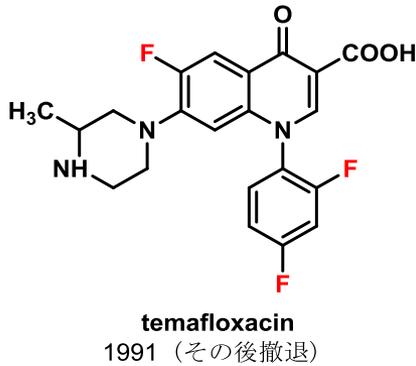
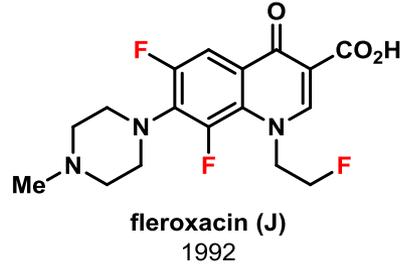
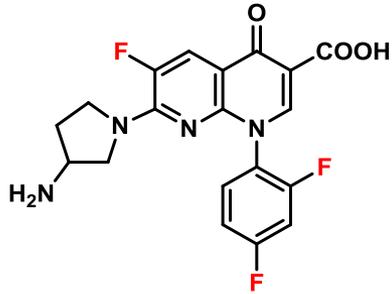
besifloxacin
2009



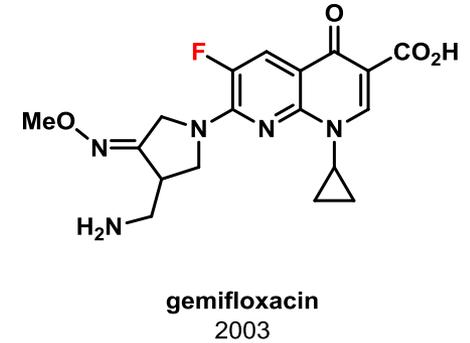
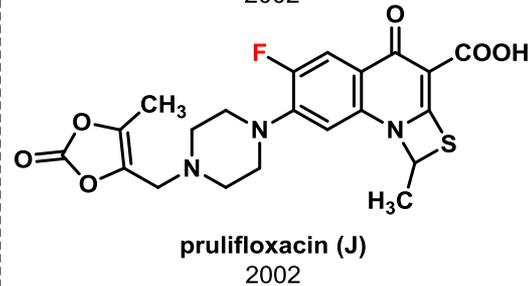
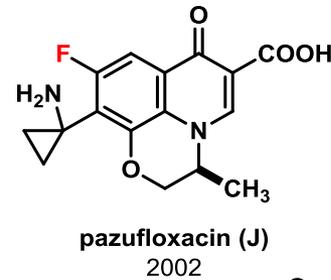
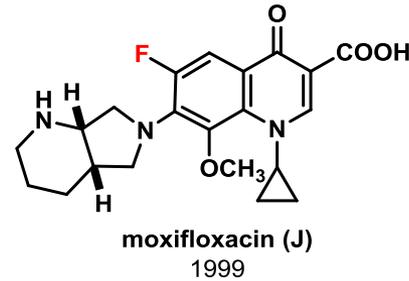
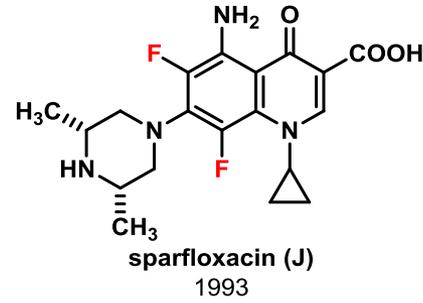
finafloxacin
2014

J01:抗菌剤(キノロン系)ー2

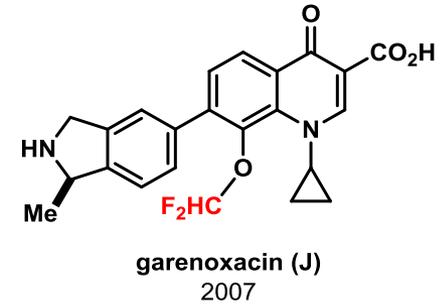
1 位置換基にフッ素原子の導入



7 位置換基の改変

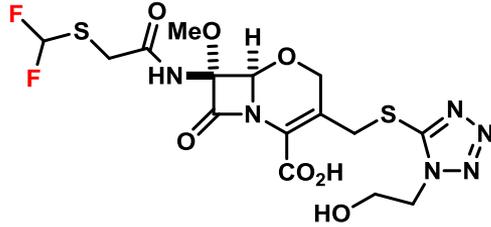


6 位脱フッ素体

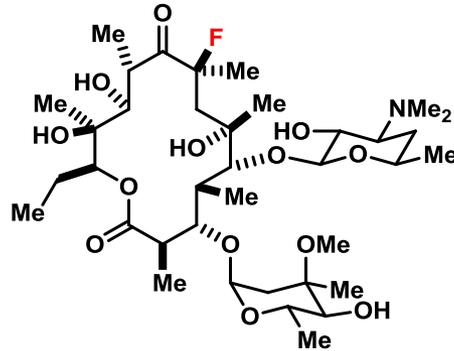


J01:抗菌剤(その他) & P:抗寄生虫剤

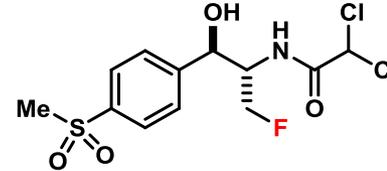
J01: そのほかの抗菌剤



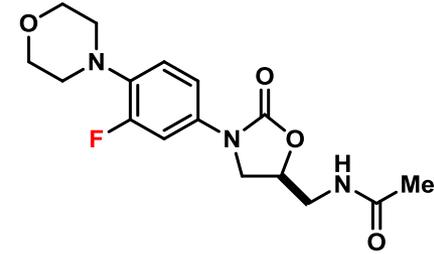
flomoxef (J)
1988



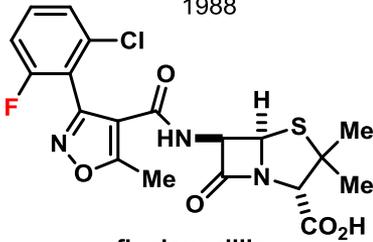
flurithromycin
ethylsuccinate
1997



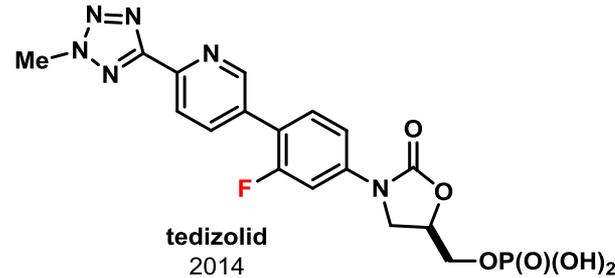
florfenicol (J)



linezolid
2000

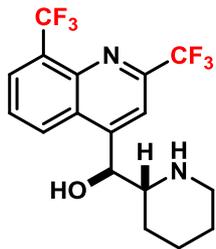


flucloxacillin

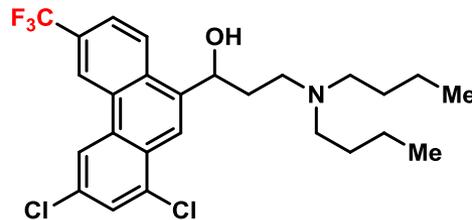


tedizolid
2014

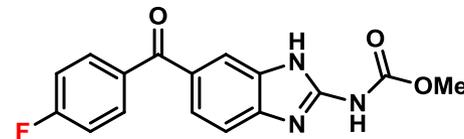
P01: 抗寄生虫薬



mefloquine (J)
1985
抗マラリア剤



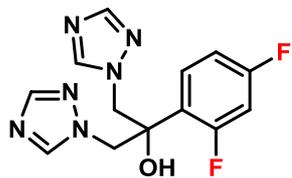
halofantrine
1988
抗マラリア剤



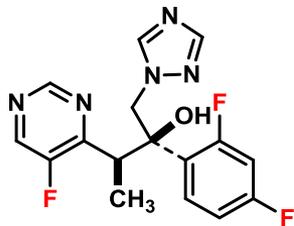
flubendazole
1980
駆虫薬

J02:抗真菌薬, J04:抗マイコバクテリア薬

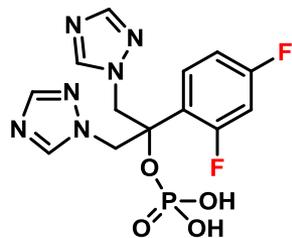
J02: 抗真菌薬



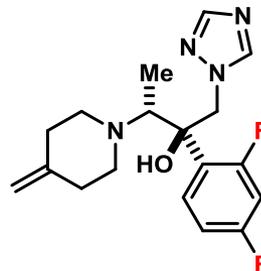
fluconazole (J)
1989



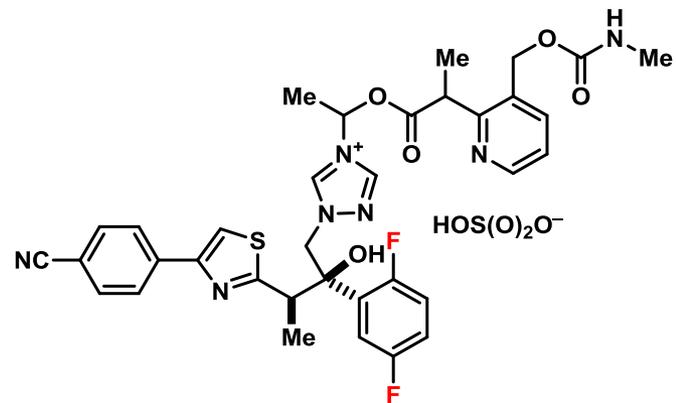
voriconazole (J)
2002



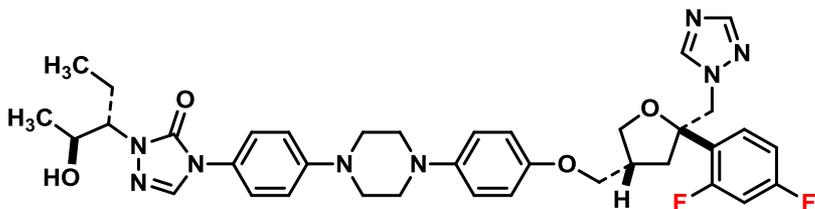
fosfluconazole (J)
2003



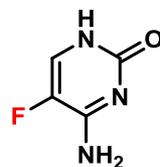
efinaconazole (J)
2013
ATC分類なし



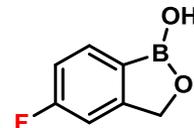
isavuconazonium sulfate
2015



posaconazole
2006

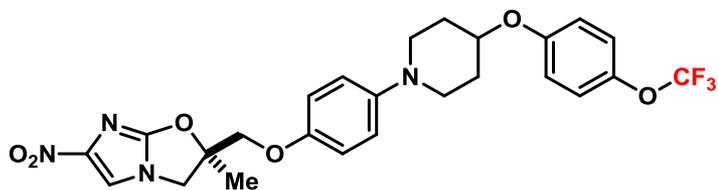


flucytosine
(J)



tavaborole
2014

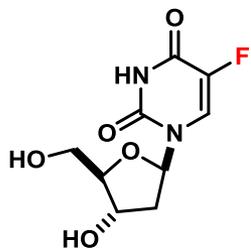
J04: 抗マイコバクテリア薬



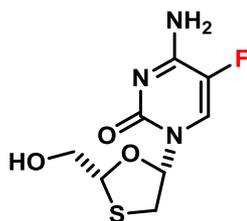
delamanid
2014

J05:抗ウイルス薬

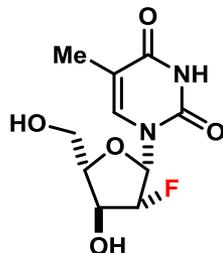
J05: 抗ウイルス薬



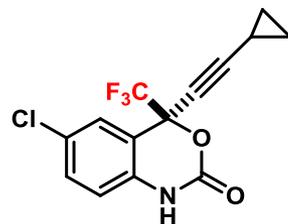
floxuridine
1970



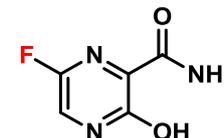
emtricitabine (J)
2003
anti-HIV



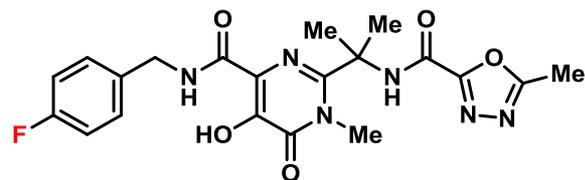
clevidine
2007



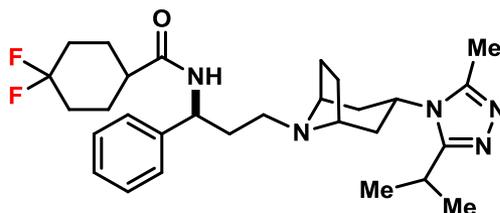
efavirenz (J)
1998
anti-HIV



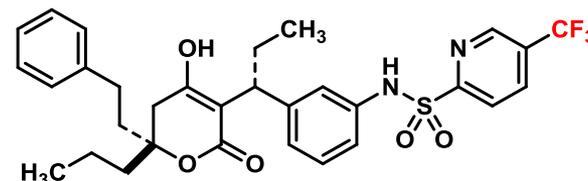
favipiravir
2014



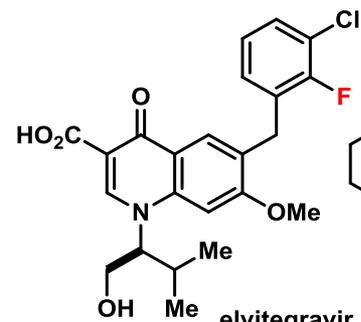
raltegravir
2007
anti-HIV



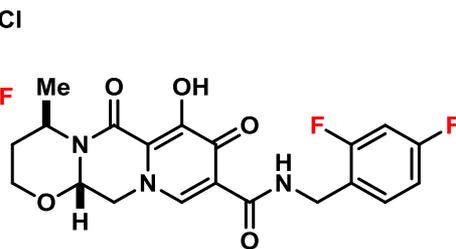
maraviroc (J)
2007
anti-HIV



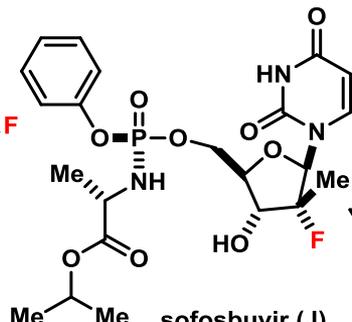
tipranavir
2005
anti-HIV



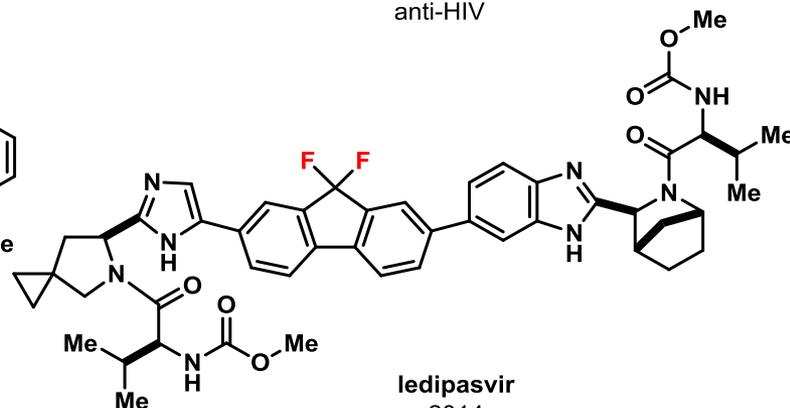
elvitegravir
2013
anti-HIV



dolutegravir
2013
anti-HIV



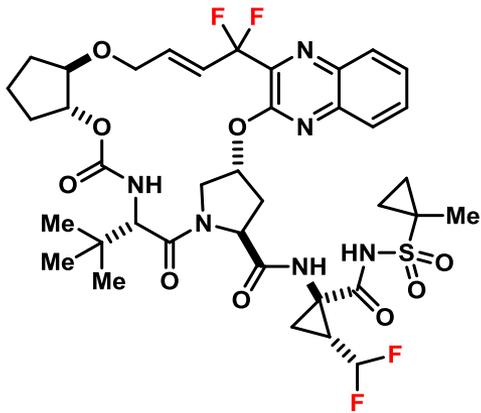
sofosbuvir (J)
2013
HCV治療薬



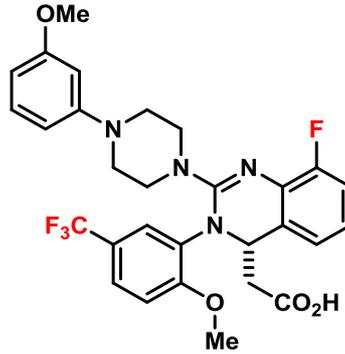
ledipasvir
2014
HCV治療薬

J05:抗ウイルス薬

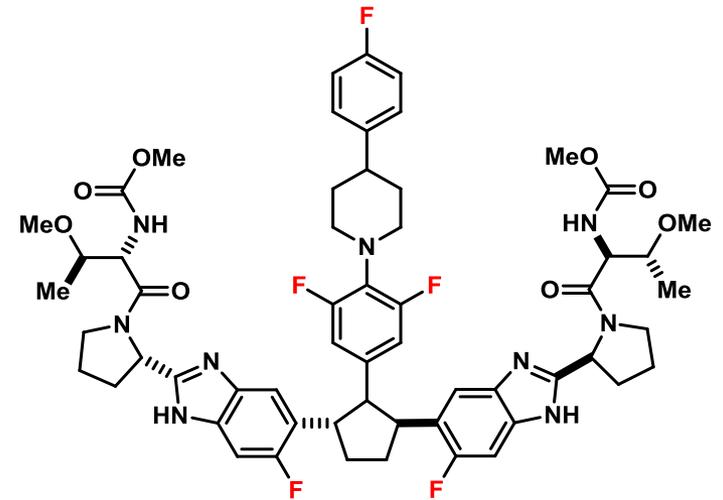
J05: 抗ウイルス薬



glecaprevir
2017



letemovir
2017

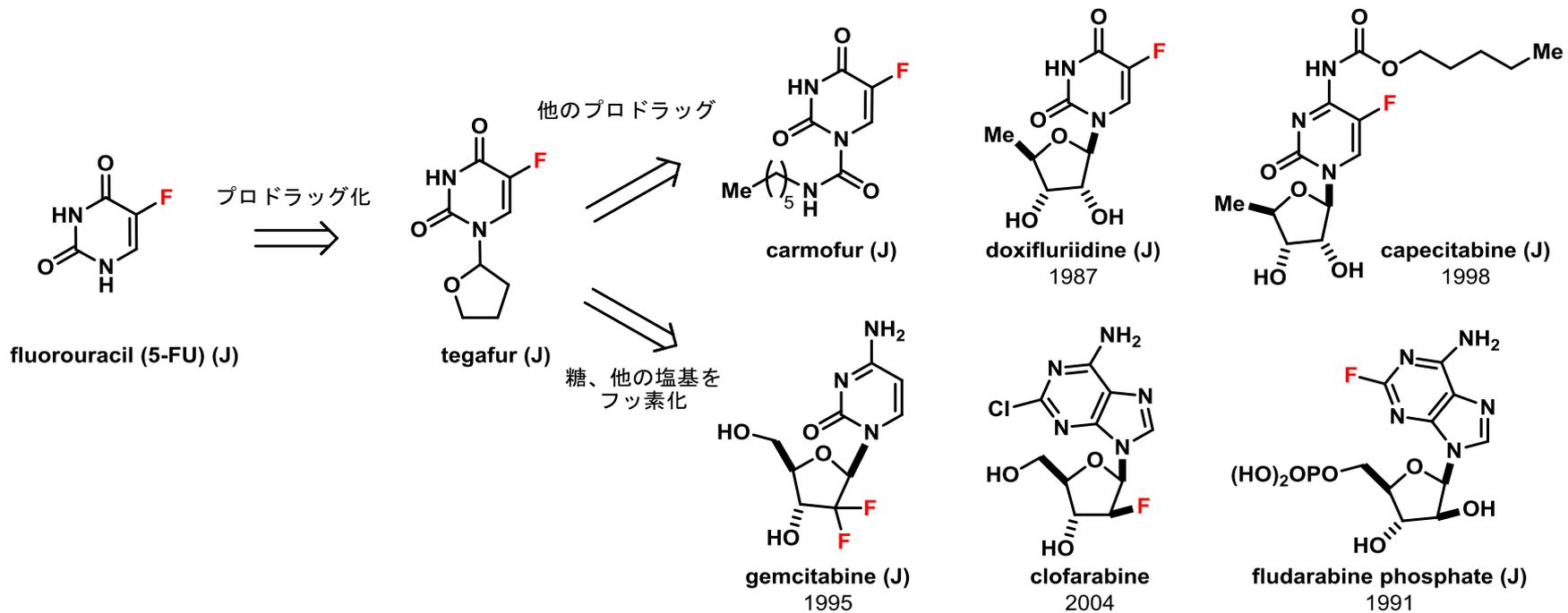


pibrentasvir
2017

L:抗癌剤(核酸医薬)

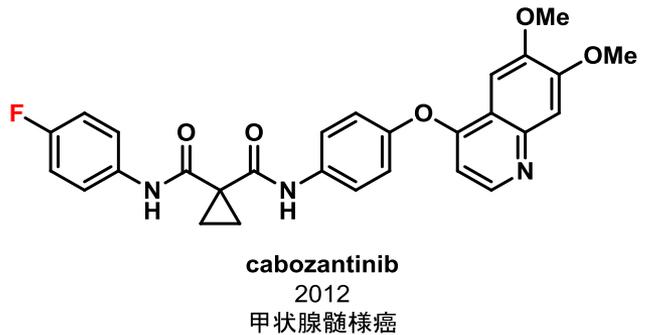
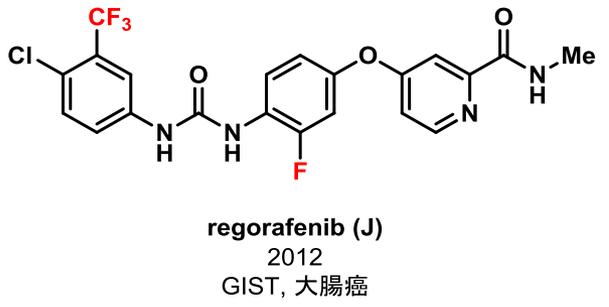
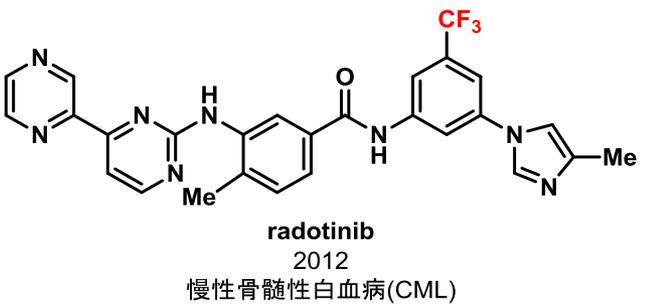
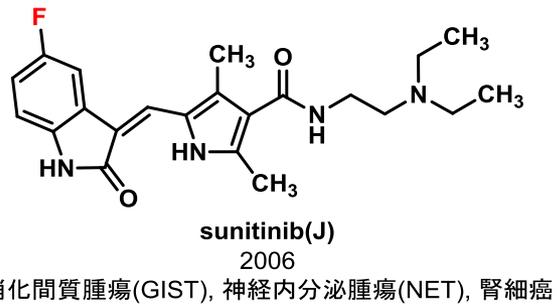
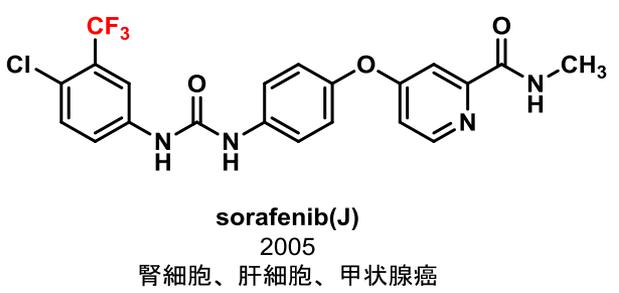
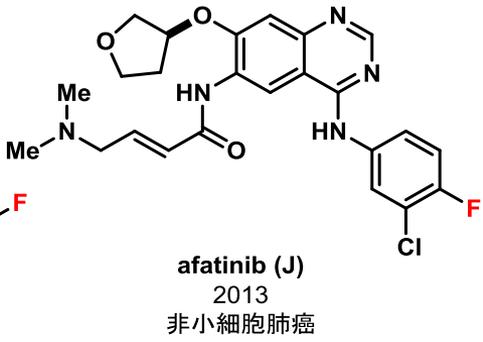
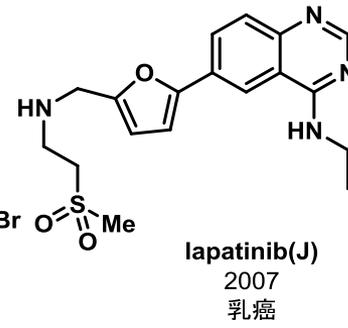
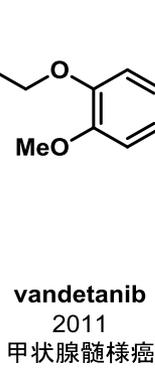
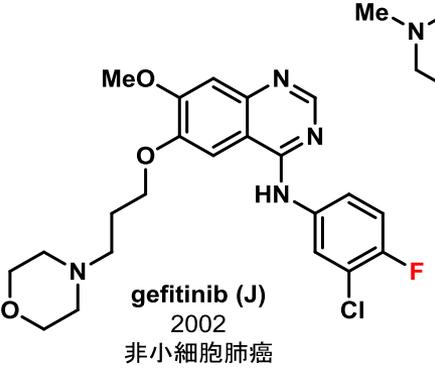
L01: 抗癌剤

L01 フッ化核酸誘導体



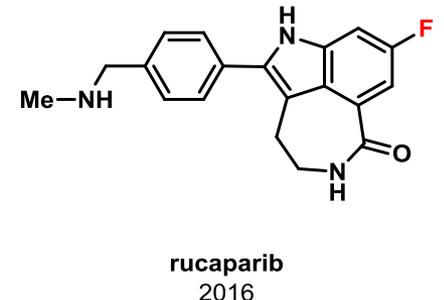
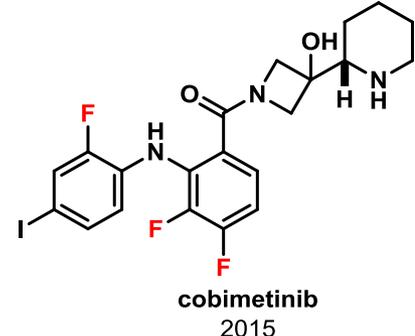
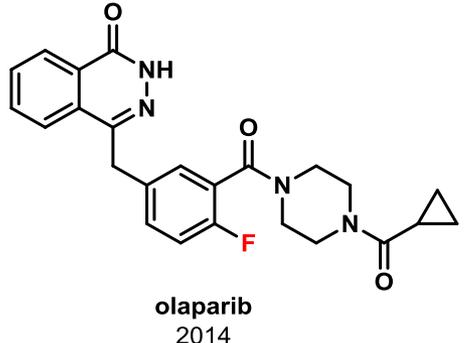
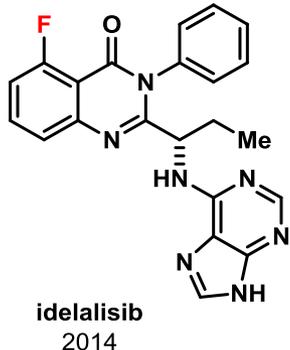
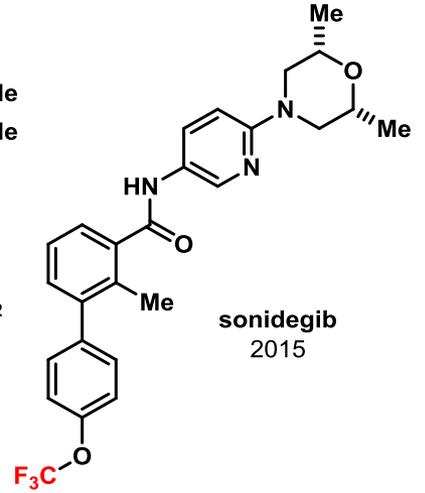
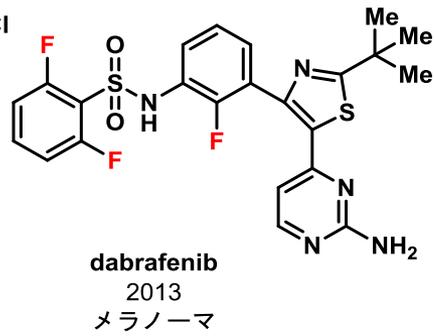
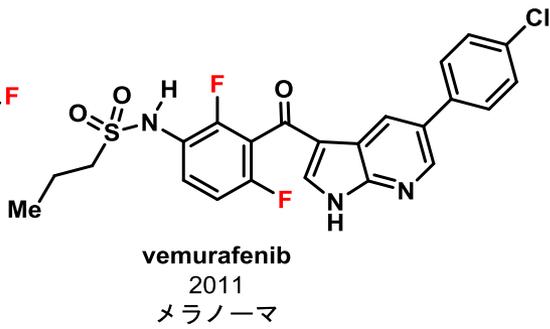
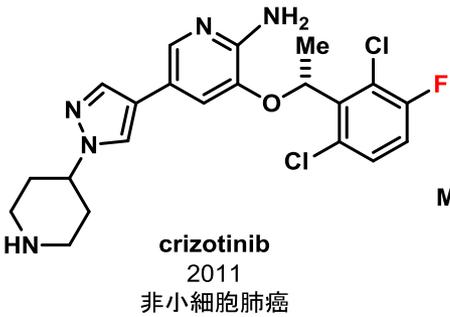
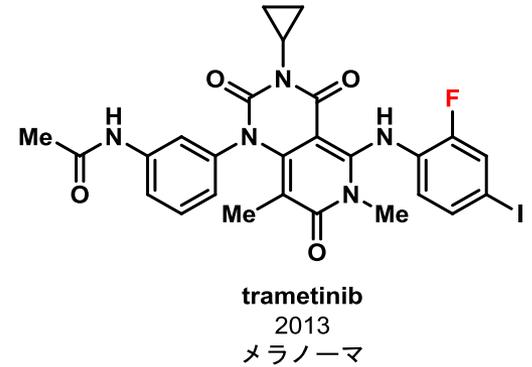
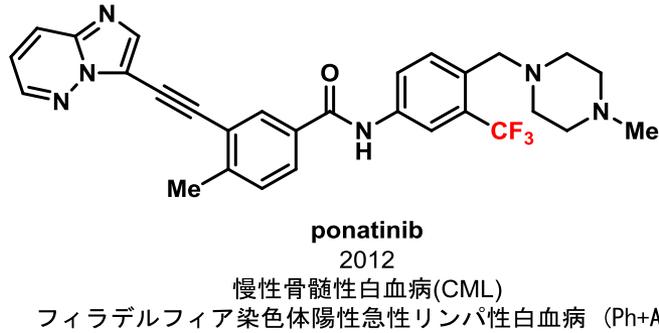
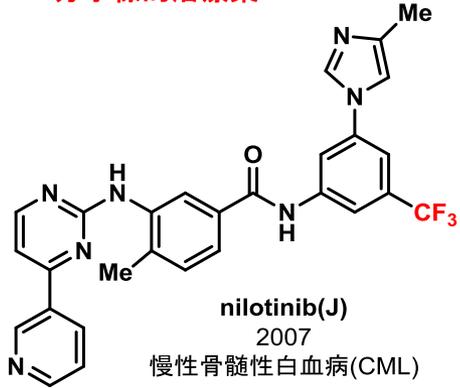
L:抗癌劑(分子標的治療藥)

L01 分子標的治療藥



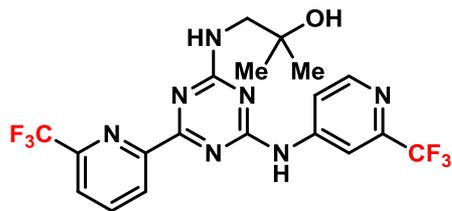
L:抗癌剤(分子標的治療薬)

L01 分子標的治療薬

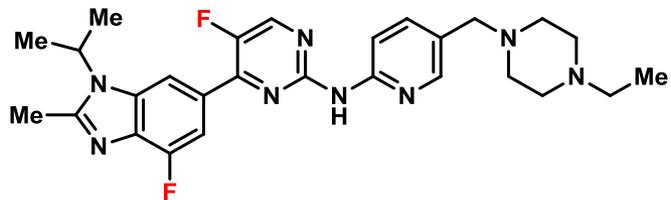


L:抗癌劑(分子標的治療藥)

L01 分子標的治療藥



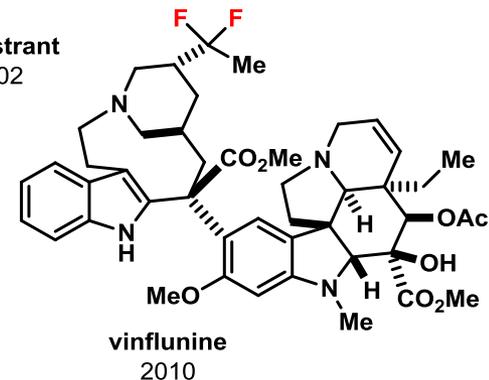
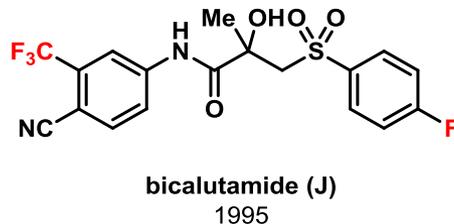
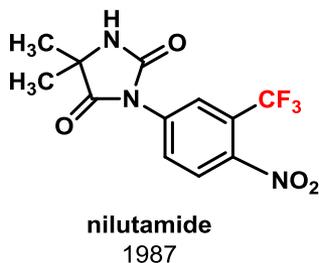
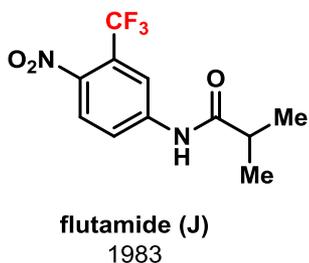
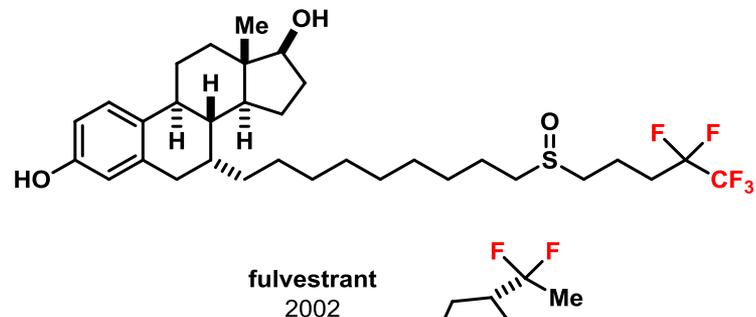
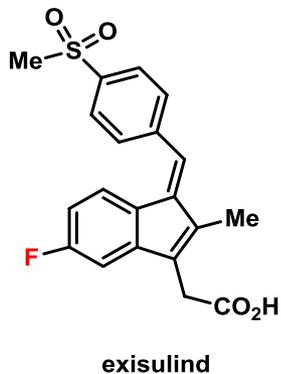
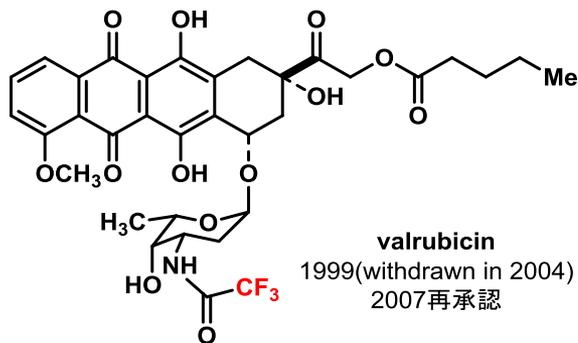
enasidenib
2017



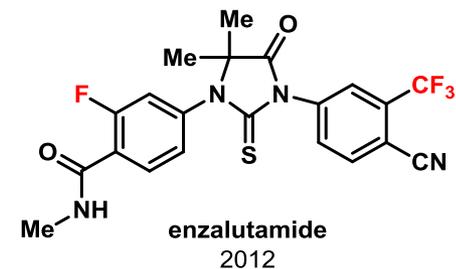
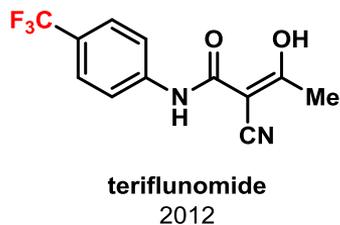
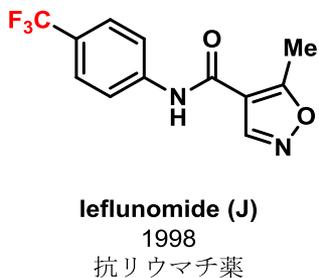
abemaciclib
2017

L:その他の抗癌剤と免疫抑制剤

L01,02: そのほかの抗癌剤

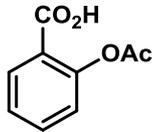


L04: 免疫抑制剤

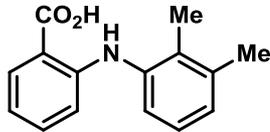


M01:非ステロイド系抗炎症剤、M09:その他の骨格系疾患治療薬

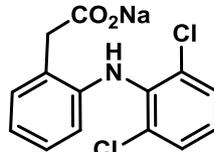
M01: NSAIDs (非ステロイド系抗炎症薬)



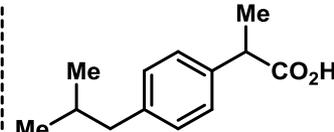
aspirin



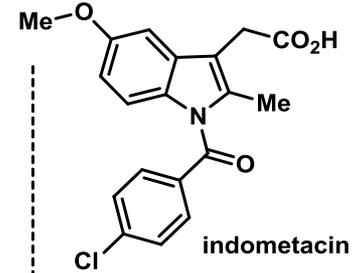
mefenamic acid



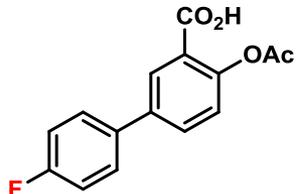
diclofenac sodium



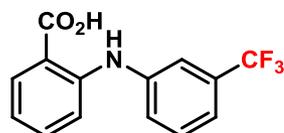
ibuprofen



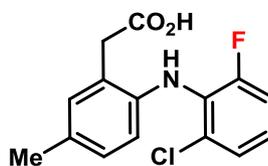
indometacin



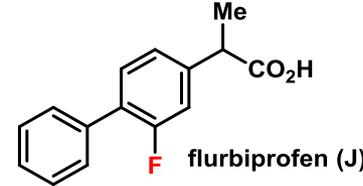
flufenisal



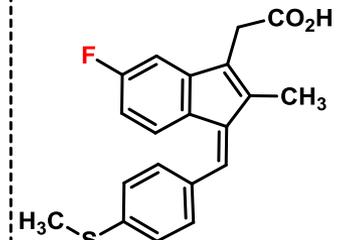
flufenamic acid (J)



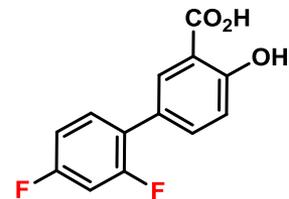
lumiracoxib
2003



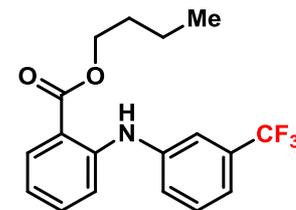
flurbiprofen (J)



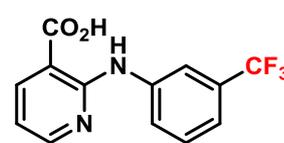
sulindac (J)



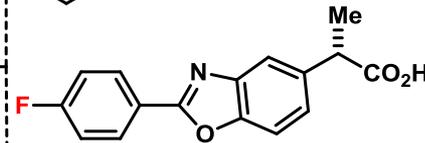
diflunisal



ufenamate (J)



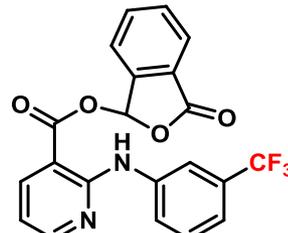
niflumic acid



flunoxaprofen
1987



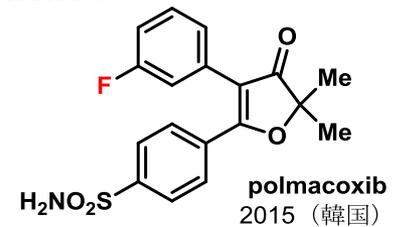
etofenamate



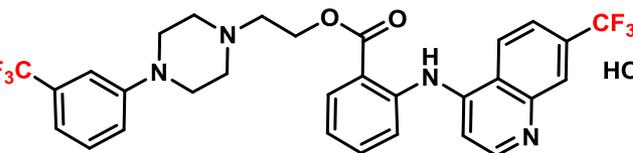
talniflumate



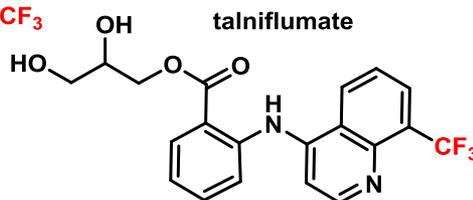
celecoxib (J)
1999
抗リウマチ剤



polmacoxib
2015 (韓国)



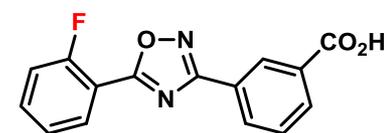
antrafenine
(replaced by other drugs)



floctafenine

選択的COX-2阻害剤

M09: その他の骨格系疾患治療薬



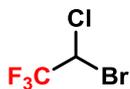
ataluren
2014

筋ジストロフィー治療薬

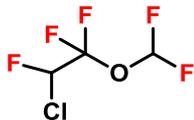
N:神経系薬(麻醉、鎮痛、抗てんかん薬)

N01: 麻醉薬

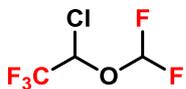
吸入麻醉薬



halothane (J)
1956



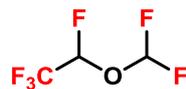
enflurane (J)
1972



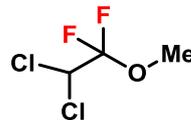
isoflurane (J)
1981



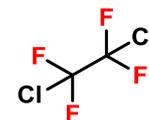
sevoflurane (J)
1990



desflurane
1992

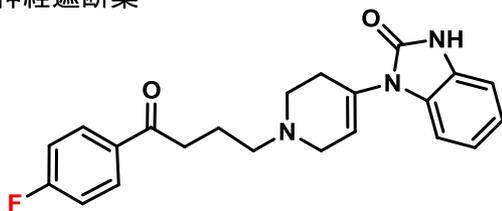


methoxyflurane
withdrawn



cryofluorane

神経遮断薬



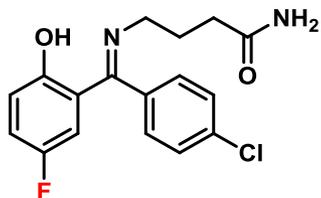
droperidol (J)

N02: 鎮痛薬

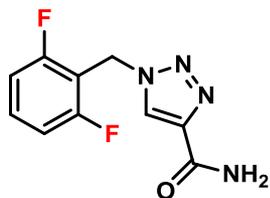


flupirtine
1985

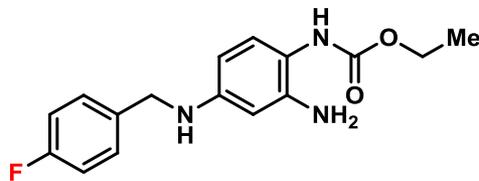
N03: 抗てんかん薬



progabide
1985

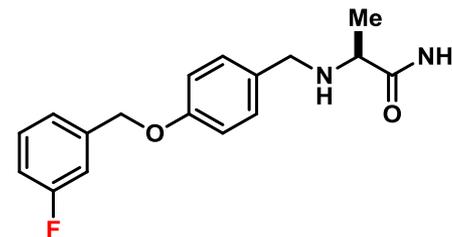


rufinamide
2007



ezogabine
2011

N04: 抗パーキンソン病薬

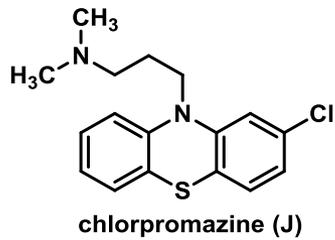


safinamide
2015

N05A:神経系薬(統合失調症治療薬)

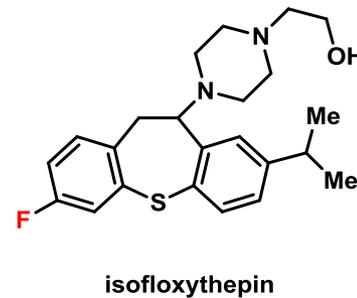
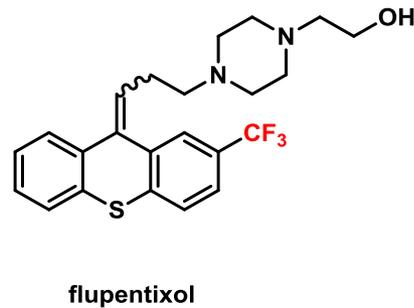
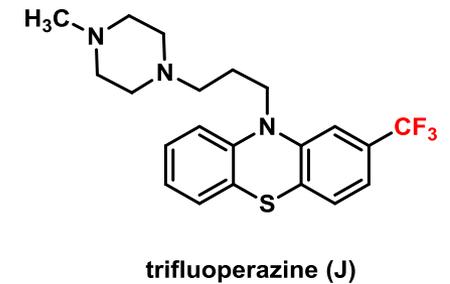
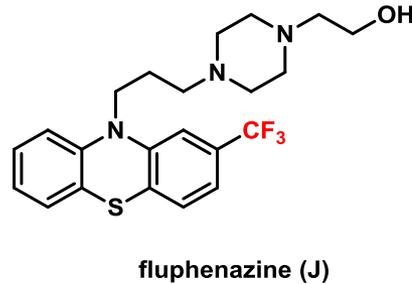
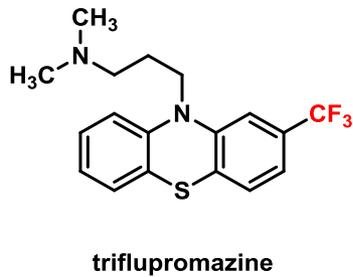
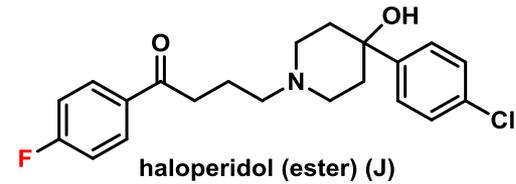
N05A: 統合失調症治療薬

1950年代
reserpine



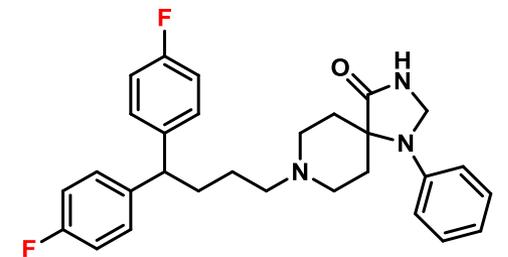
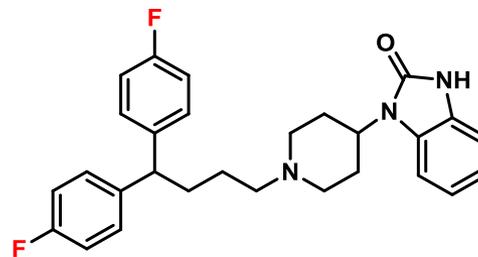
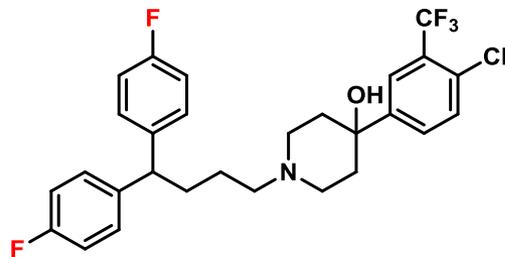
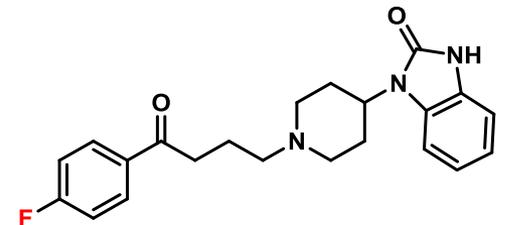
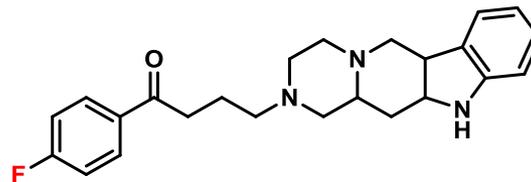
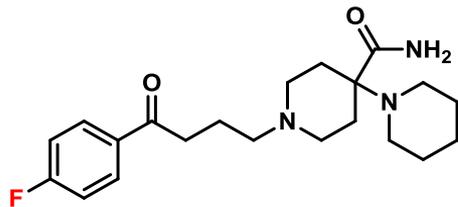
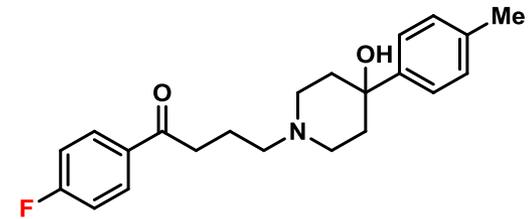
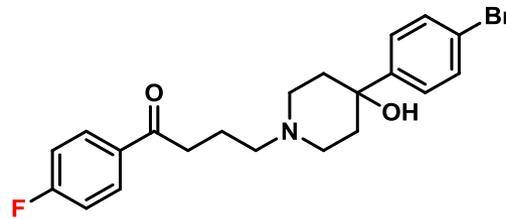
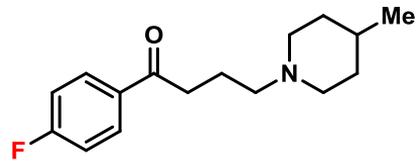
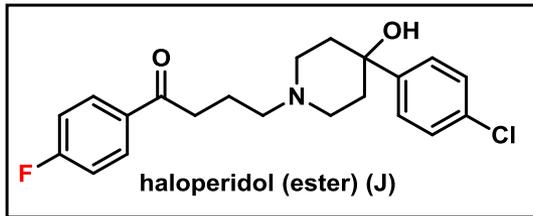
1958年

haloperidolの発見。
下痢止め薬としての開発中に抗精神作用
が認められた。



N05A: 神經系藥 (統合失調症治療藥)

N05A: 統合失調症治療藥



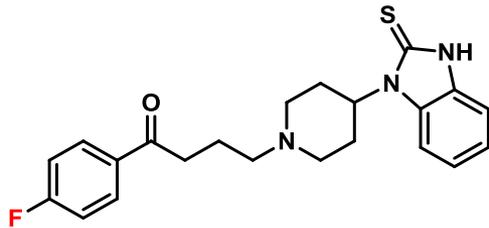
penfluridol

pimozide (J)

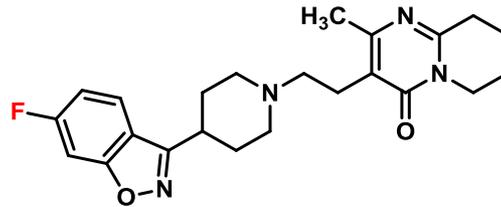
fluspirilene

N05A:神經系藥(統合失調症治療藥)

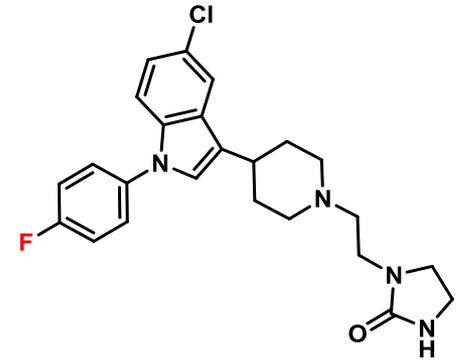
N05A: 統合失調症治療藥



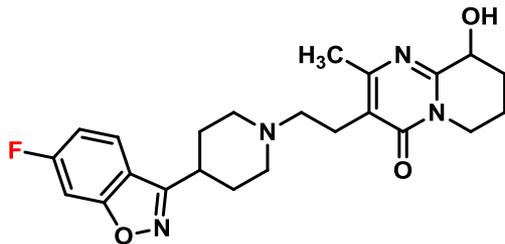
timiperone (J)
1984



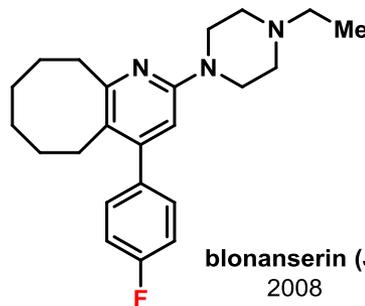
risperidone (J)
1993



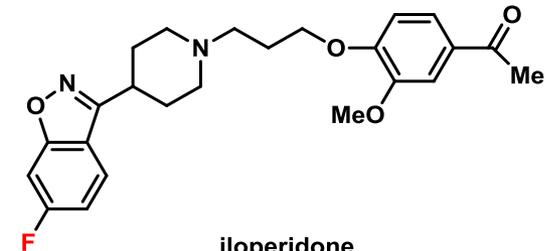
sertindole
1996



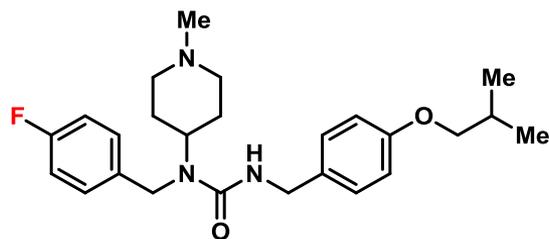
paliperidone (J)
2007



blonanserin (J)
2008



iloperidone
2011

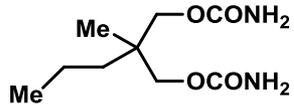


pimavanserin

N05B,C:神經系藥(抗不安藥、催眠藥)

N05B: 抗不安藥

第一世代

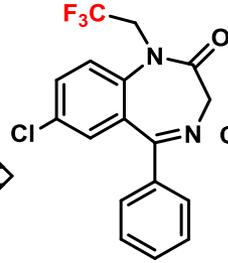


meprobamate

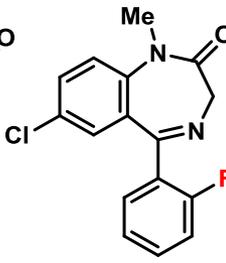
第二世代



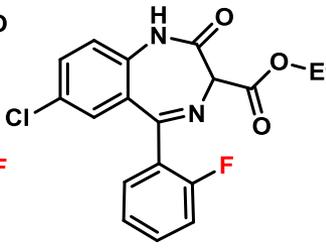
chlordiazepoxide



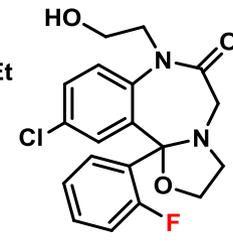
halazepam



fludiazepam (J)

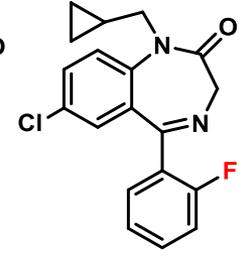


ethyl loflazepate (J)



flutazolam (J)

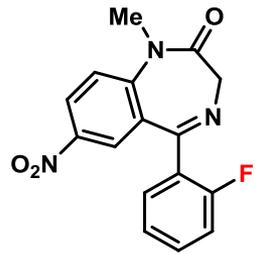
1984



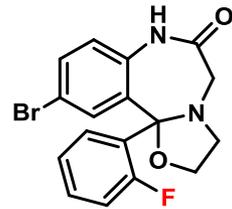
flutoprazepam (J)

1986

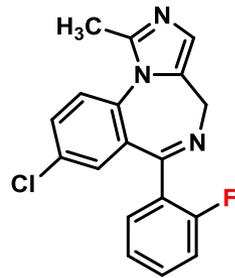
N05C: 催眠藥



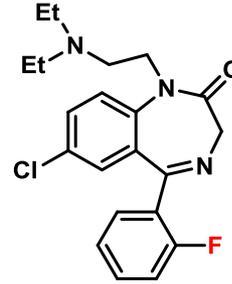
flunitrazepam (J)



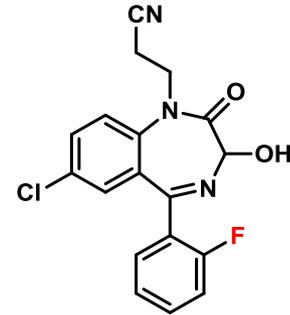
haloxazolam (J)



midazolam (J)

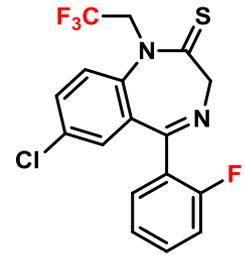


flurazepam (J)



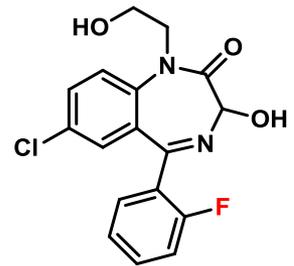
cinolazepam

1993



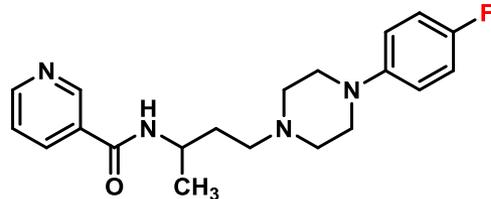
quazepam (J)

1985



doxefazepam

1985



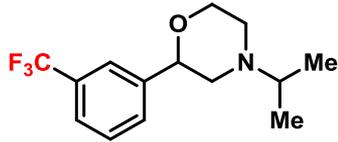
niaprazine

N06,07:神経系薬(抗うつ薬、その他)

N06: 抗うつ薬

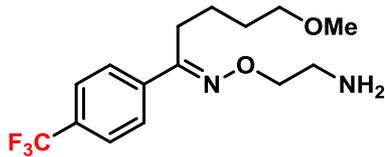
第一世代 三環系抗うつ薬

第二世代 三環系抗うつ薬、四環系抗うつ薬、その他

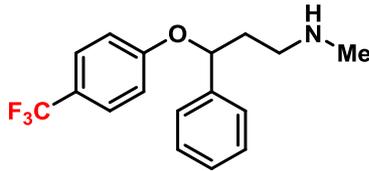


oxaflozane
1982 (フランス)

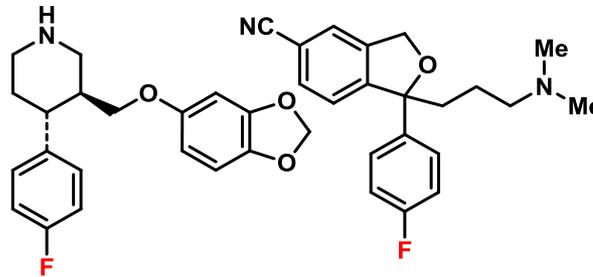
第三世代 SSRI (選択的セロトニン再取り込み阻害薬)



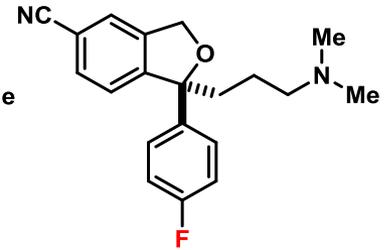
fluvoxamine (J)
1983



fluoxetine (Prozac)
1986



paroxetine (J)
1991

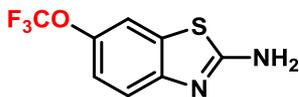


citalopram
1989

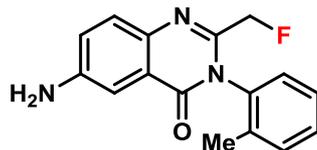
escitalopram
2002

第四世代 SNRI (セロトニン・ノルアドレナリン再取り込み阻害薬)

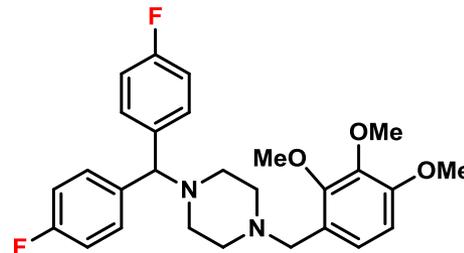
N07: その他



riluzole (J)
1996
筋萎縮性側索硬化症



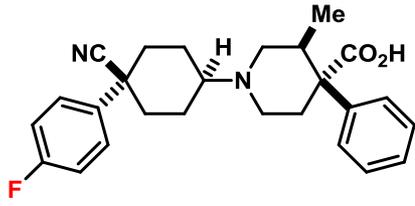
afloqualone (J)
1983
筋緊張性疾患治療薬



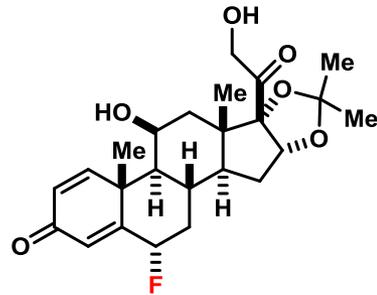
lomerizine (J)
1999
片頭痛治療薬

R:呼吸器官用薬

R01: 点鼻剤

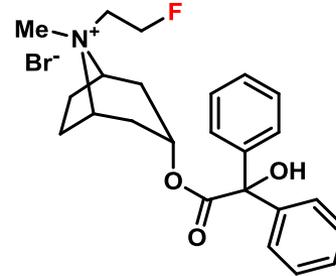


levocabastine (J)
1991

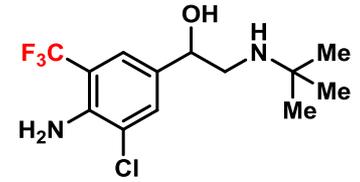


flunisolide

気管支拡張剤

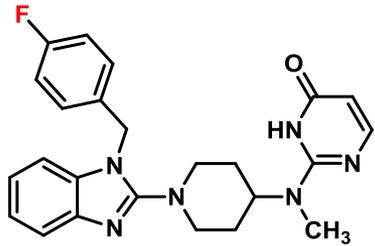


flutropium bromide
1988

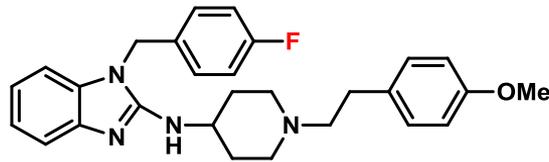


mabuterol (J)
1986

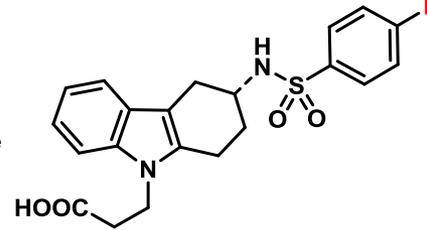
気管支喘息・アレルギー性鼻炎



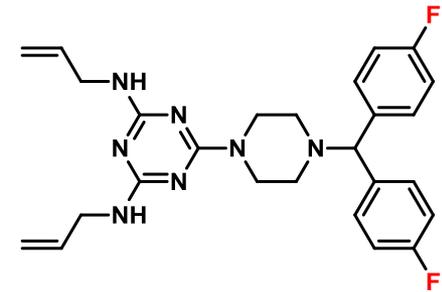
mizolastine
1998



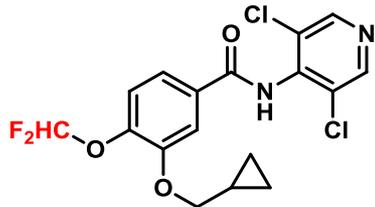
astemizole
1983
(殆どの国から撤退)



ramatroban (J)
2000



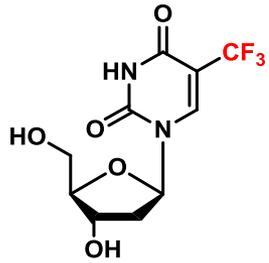
almitrine



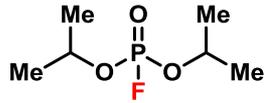
roflumilast
2010

S:感覺器官用藥

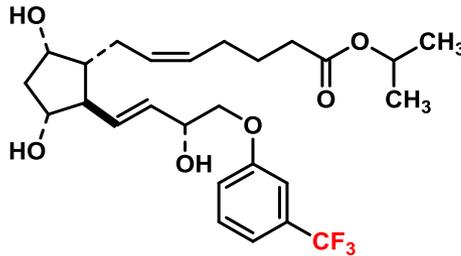
S01: 眼科用藥



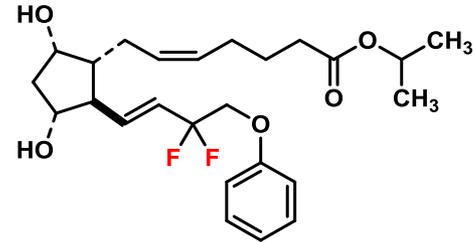
trifluridine



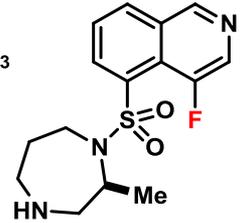
diisopropyl fluorophosphate



travoprost (J)
2001
緑内障治療薬

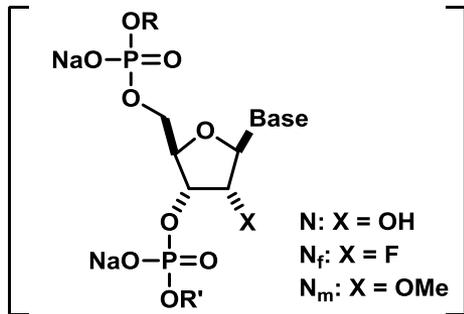


tafluprost (J)
2008
緑内障用剤



ripasudil
2014
緑内障治療薬

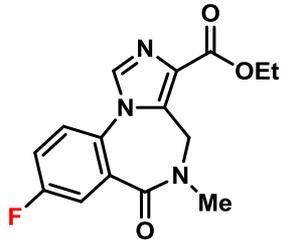
polymer-C_fG_mG_mAAU_fC_fA_mG_mU_fG_mA_mA_mU_fG_mC_fU_fA_mU_fA_mC_fA_mU_fC_fG_mT



pegaptanib
2004

V: その他、分類無し

V: そのほか



flumazenil
1987
解毒剤



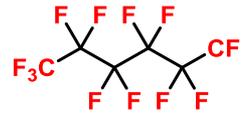
sulfur hexafluoride
網膜はく離の手術



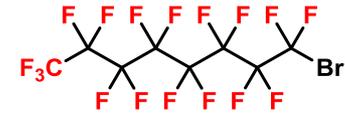
perflubutane (J)
1999
造影剤



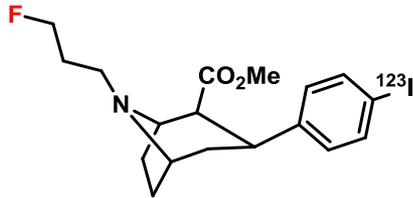
optizon



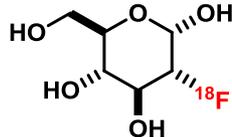
perflhexane
造影剤



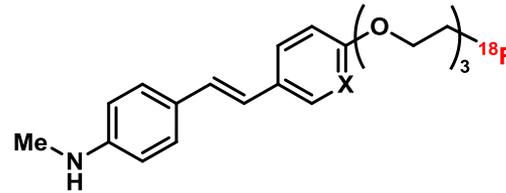
perflubron (Imagent GI)
1993
造影剤



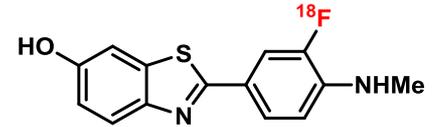
¹²³I-ioflupane
2000
診断薬 (パーキンソン病)



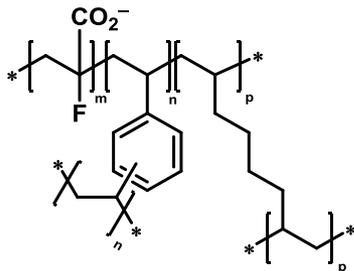
fludeoxyglucose F18
診断薬 (PET用)



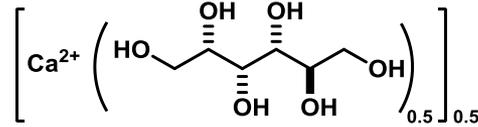
florbetapir F18 (X = N)
2012
florbetaben (X = CH)
2014
診断薬 (アルツハイマー)



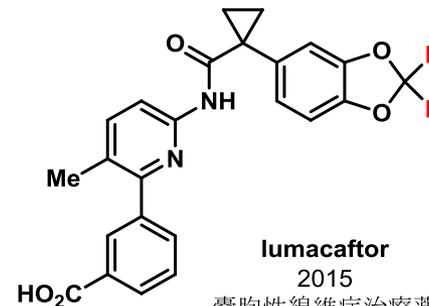
flumetamol
2013
診断薬 (アルツハイマー)



patiomer
2015
カリウム吸着薬



分類なし



lumacaftor
2015
嚢胞性線維症治療薬

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Kirk, K. L. *Org. Process Res. Deve.* **2008**, 12, 305-321.
Begue, J.-P.; Bonnet-Delpon, D. *Bioorganic and Medicinal Chemistry of Fluorine*, John Wiley&Sons, Inc., **2008**.
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