KAPLAN MEDICAL

Pharmacodynamics and Pharmacokinetics

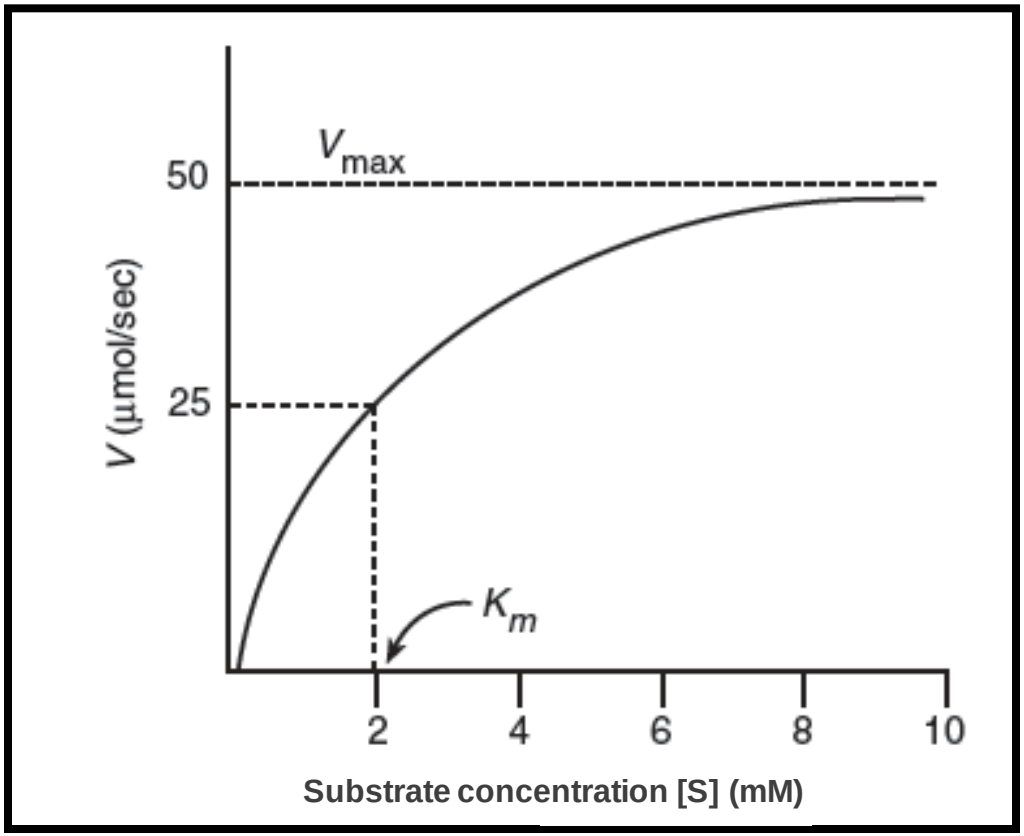
Matthew B. Wilkinson, PhD, M4
Mount Sinai School of Medicine

Enzyme kinetics

V_{max} = maximum reaction velocity for a given amount of enzyme

- Proportional to enzyme concentration

Michaelis-Menten plot



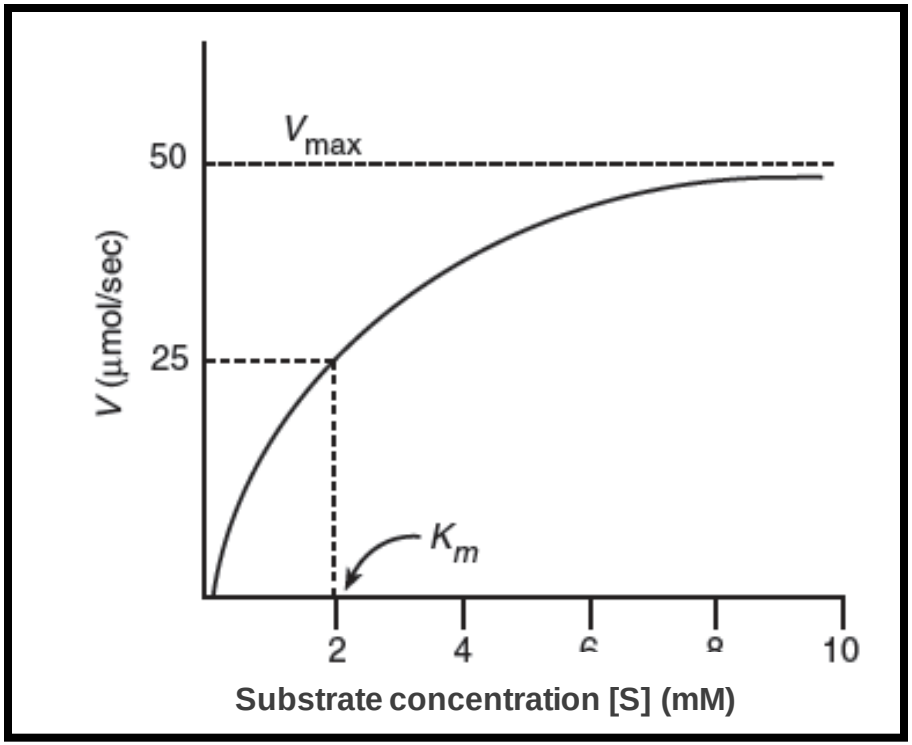
Kaplan Biochemistry 2011: Figures I-8-4

Enzyme kinetics

Michaelis constant (K_m): Substrate concentration required to reach half V_{max} = $1/affinity$

- High K_m ® low affinity
- Low K_m ® high affinity

Michaelis-Menten plot



Kaplan Biochemistry 2011: Figures I-8-4

Enzyme kinetics

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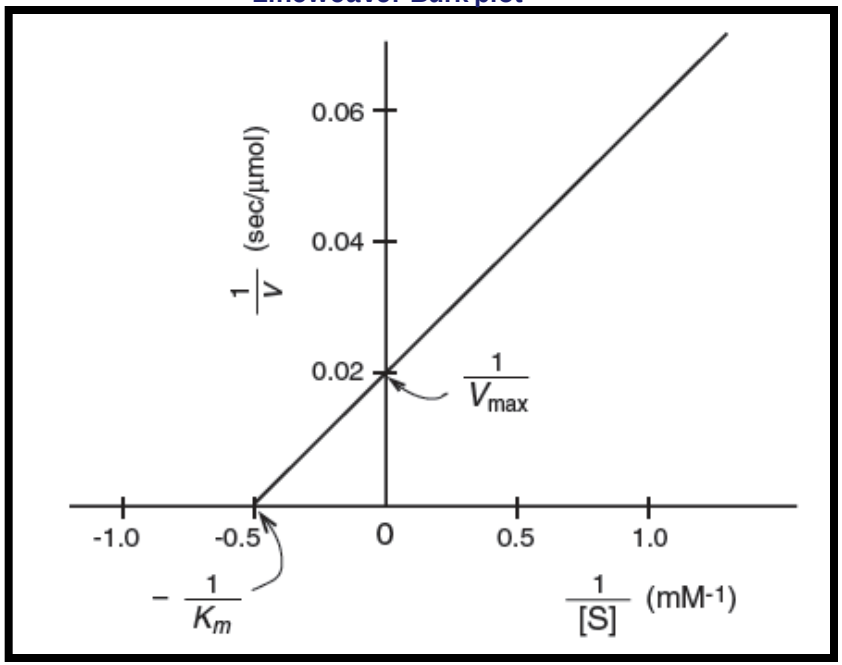
- Low K_m ® high affinity

V_{max} = maximum reaction velocity for a given amount of enzyme

- Proportional to enzyme concentration

Lineweaver-Burk plot



Kaplan Biochemistry 2011: Figure: I-8-5

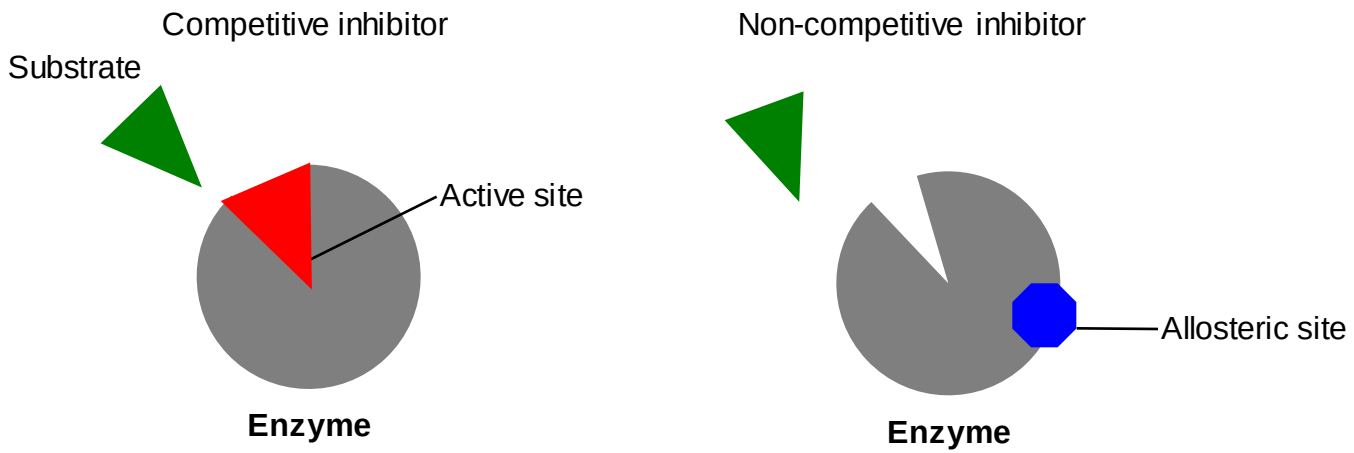
Enzyme inhibitors

Competitive inhibitors

- Resemble substrate, bind at active site
- Increasing substrate concentration can overcome inhibition
- Decrease *potency*

Non-competitive inhibitors

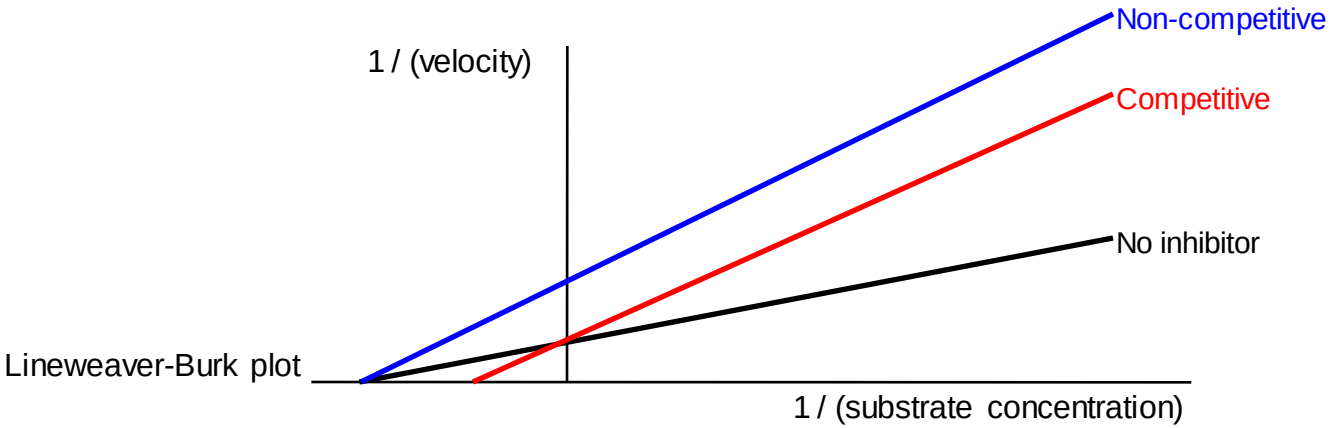
- Typically bind at allosteric site, not near active site
- Cannot be overcome with increased substrate concentration
- Decrease *efficacy*



Enzyme inhibitors

Competitive vs. Non-competitive inhibitors

	Competitive	Non-competitive
Resemble substrate	Yes	No
Overcome with - substrate concentration	Yes	No
Bind active site	Yes	No
V_{max}	No effect	¯
K_m	-	No effect
Pharmacodynamics	¯Potency	¯Efficacy
Graphs cross?	Yes	No



• FA 2013: 226.1 • FA 2012: 258.1 • FA 2011: 232.1
• ME 3e: 55 • ME4e: 55

Volume of distribution

$$\text{Volume of distribution, } V_d = \frac{\text{total amount of drug in body}}{[\text{drug}]_{plasma}} \quad (\textit{liters})$$

Low V_d (4-8 L)	mostly in blood
Mid V_d (12-14 L)	mostly extracellular fluid
High V_d (>total body water)	distributed in all tissues, non-fluid compartments (fat)

V_d of plasma protein bound drugs are altered in liver and kidney disease

- Hepatic disease: ê synthesis of plasma proteins
- Renal diseases: Plasma proteins (and bound drugs) are excreted in the urine

Drug clearance

$$\textbf{Clearance (Cl)} = \frac{\text{Rate of drug elimination}}{\text{Plasma drug concentration}} = V_d \times k_e$$

- Clearance refers to the volume of blood totally cleared of drug per unit time

- Units:
  - Rate of drug elimination: (mass)/(units of time)
  - Plasma drug concentration: (mass)/(volume of plasma)
  - Elimination rate constant (k_e): t^{-1}

- Renal clearance:
  - Clearance:
    - Equals **glomerular filtration rate (GFR)** when there is no reabsorption, secretion, or plasma protein binding
    - Inulin and creatinine clearance are used to estimate GFR
  - Protein-bound drugs are not cleared
    - Clearance = (free fraction) x GFR

Drug half-life

- Amount of time it takes for an amount of drug in the body to change by one half

$$t_{1/2} = \frac{0.7 \times V_d}{\text{Clearance}}$$

- Half-life relates to both a <u>decrease</u> in plasma concentration via elimination or an <u>increase</u> in plasma concentration via drug infusion
- Steady state is reached in 4-5 half-lives with continuous infusion

n $t_{1/2}$	1 $t_{1/2}$	2 $t_{1/2}$	3 $t_{1/2}$	4 $t_{1/2}$	5 $t_{1/2}$
[drug]	50 %	75 %	87.5 %	93.75 %	96.9 %

• FA 2013: 227.1 • FA 2012: 259.1 • FA 2011: 232.2
• ME 3e: 166 • ME4e: 166

Loading and maintenance doses

C_p blood plasma conc.

Cl clearance

F bioavailability

Loading dose

- Large initial dose given to fill up V_d
- Can increase plasma concentration in less than 4-5 half-lives

$$LD = \frac{V_d \times C_p}{F}$$

Maintenance dose

- Given to maintain constant blood plasma levels
- Lowered if hepatic/renal function is impaired

$$MD = \frac{Cl \times C_p}{F}$$

Bioavailability (F)

F = 1 for IV infusion

- Fraction of administered drug that reaches systemic circulation
- Some drugs fail to be absorbed, or are metabolized before reaching circulation

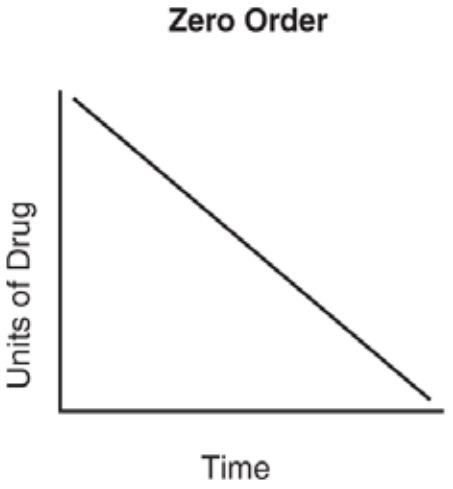
• FA 2013: 227.2 • FA 2012: 259.2 • FA 2011: 233.1
• ME 3e: 167 • ME4e: 167

Drug elimination

Zero order elimination

- Constant **amount** of drug eliminated with time
- Phenytoin, aspirin, ethanol

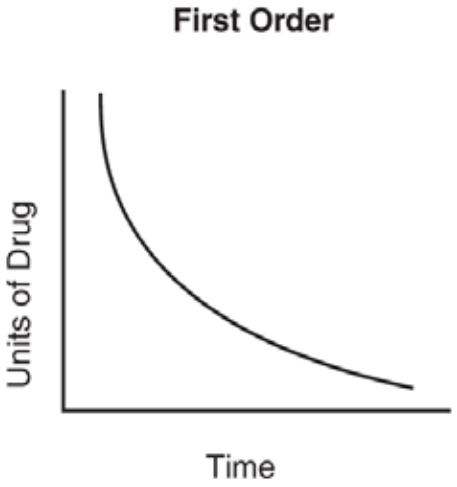
100 mg ® 90 mg ® 80 mg ® 70 mg ® …



First order elimination

- Constant **fraction** of drug eliminated with time
- Most drugs follow first-order kinetics

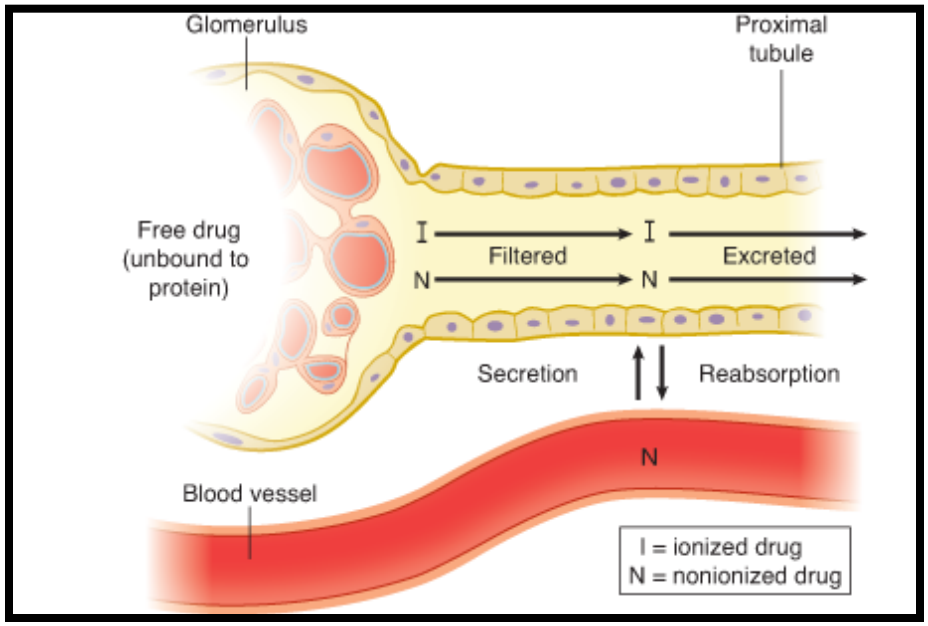
100 mg ® 50 mg ® 25 mg ® 12.5 mg ® …



• FA 2013: 228.1 • FA 2012: 260.1 • FA 2011: 233.2
• ME 3e: 166 • ME4e: 166

Renal excretion

- Both ionized (I) and nonionized (N) forms are filtered
- Only non-ionized forms are actively secreted or reabsorbed
- Ionized forms of drug are “trapped” in filtrate
- Drugs that are weak acids:
  - Barbiturates, methotrexate, aspirin,
- Drugs that are weak bases:
  - Amphetamines



Kaplan Pharmacology 2011: Figure I-1-3

Alkalinization of urine [(HCO_3^-) + Weak Acid]: R–COOH (crosses membranes) ⇌ $R–COO^- + H^+$ (better cleared)

Acidification of urine [(NH_4Cl) + Weak Base]: $R–NH_2 + H^+$ (crosses membranes) ⇌ $R–NH_3^+$ (better cleared)

• FA 2013: 228.2 • FA 2012: 260.2 • FA 2011: 233.3
• ME 3e: 166 • ME4e: 166

Biotransformation

•Occurs in the liver

•Conversion of lipid soluble drugs into water soluble metabolites à é renal excretion

•Two forms of drug metabolism: Phase 1 and 2

Phase I:

•Three mechanisms of metabolization: Oxydation, reduction, and hydrolysis

• Cytochrome P450 enzymes:

- Located in smooth endoplasmic reticulum of the liver (to lesser extent GI, lungs, kidneys
- Require O2 and NADP
- Mechanisms of cytochrome P450 enzyme metabolism:
  - Reduction
  - Oxidation
    - Hydroxylation and dealkylation

Cytochrome P-450 interactions

Inducers	Inhibitors
Quinidine	HIV protease inhibitors
Barbiturates	Isoniazid (INH)
St. John's wort	Sulfonamides
Phenytoin	Cimetidine
Rifampin	Ketoconazole
Griseofulvin	Grapefruit juice
Carbamazepine	Omeprazole
Chronic alcohol use	Chloramphenicol
Glucocorticoids	Marcolides
	Ritonavir

Biotransformation

Phase I Metabolism

- Leads to polar, water-soluble metabolites
- Non-cytochrome P450 enzyme metabolism
  - Mechanisms of metabolism:
    - Hydrolysis: Addition of H_20 to drugs to assist metabolism
      - Esterase
      - Amiidase
  - Monoamine oxidase: Metabolizes amines
    - Endogenous amines: Dopamine, norepinephrine, serotonin
    - Exogenous amines: Tyramine
  - Alcohol metabolism

Biotransformation

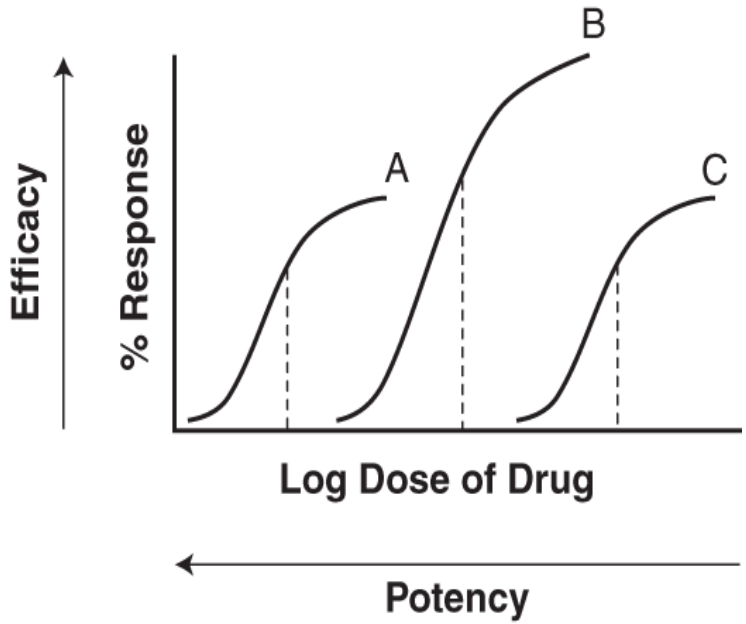
Phase II Metabolism

- Conjugation of functional groups to a drug
- Converts polar molecules to inactive molecules à é renal excretion
- Mechanisms of metabolism:
  - Acetylation
  - Glucuronidation
  - Sulfation
  - Methylation
  - Glutathione conjugation

Potency vs. efficacy

Potency: measure of how much drug required to give desired effect
typically expressed as EC_{50} - concentration that gives 50% of max. response

Efficacy: maximal effect that a drug can produce



B = full agonist
A = partial agonist (low efficacy) with high potency
C = partial agonist with low potency

Kaplan Pharmacology 2011: Figure I-2-2

Potency vs. efficacy

Competitive Antagonists

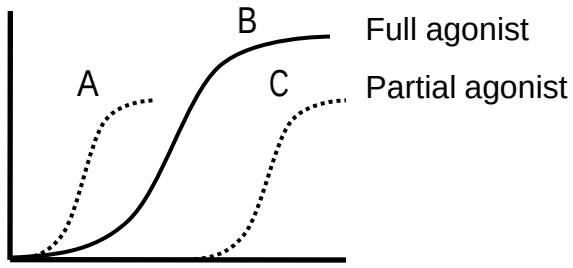
Potency: ↓
Efficacy: no effect

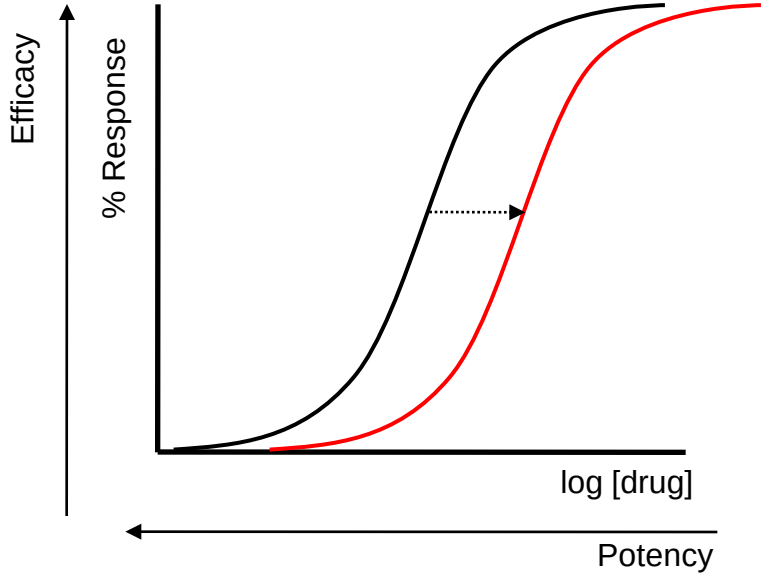
Non-competitive Antagonists

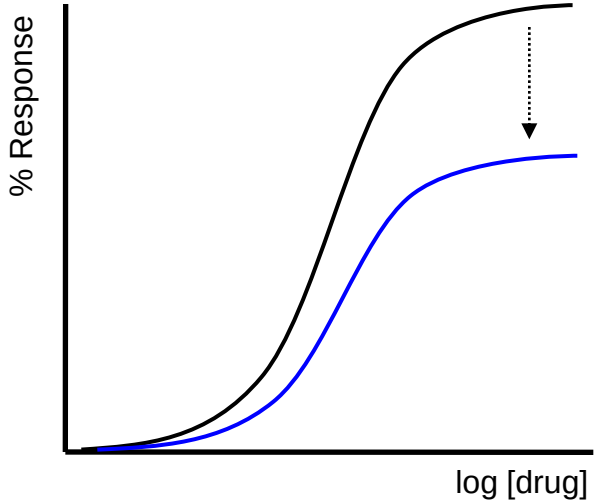
Potency: no effect
Efficacy: ↓

Partial Agonist

Acts at same site as agonist, but lower efficacy
Can have higher or lower potency than agonist





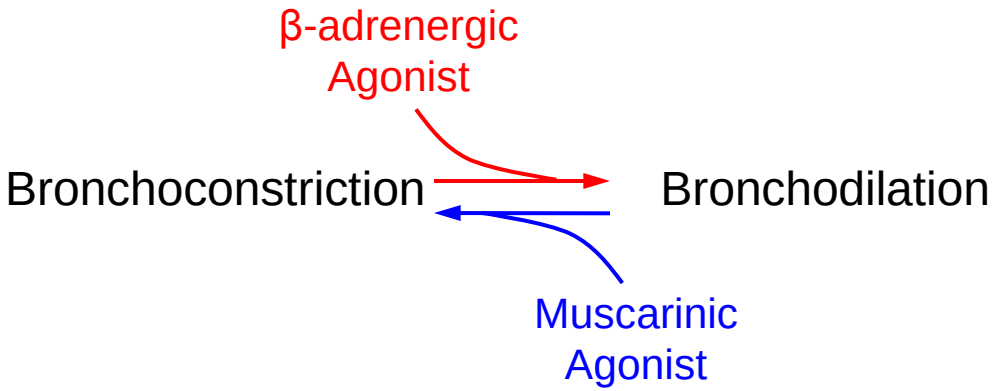


• FA 2013: 229.2 • FA 2012: 261.2 • FA 2011: 234.1
• ME 3e: 168 • ME4e: 168

Physiologic antagonists

Substrate that produces opposite effect of an agonist, but acts through different receptor/pathway

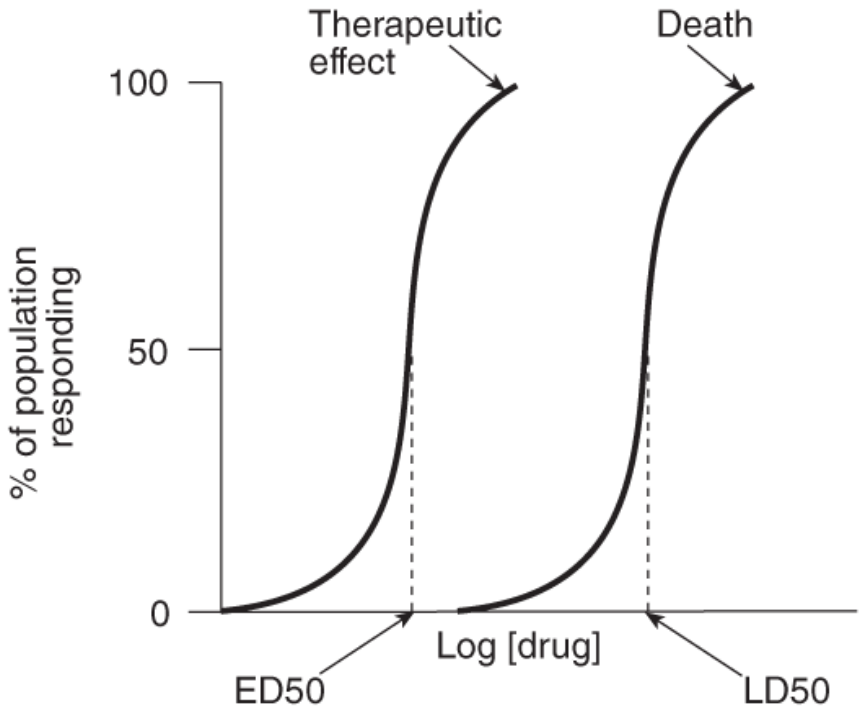
Example:



Therapeutic index

Measure of drug safety. Higher therapeutic index indicates safer drug.

$$\textbf{TI} = \frac{\text{median dose that produces toxic or lethal effect}}{\text{median dose required to produce therapeutic effect}} = \frac{LD_{50}}{ED_{50}}$$



LD - lethal dose
ED - effective dose

Kaplan Pharmacology 2011: Figure I-2-5

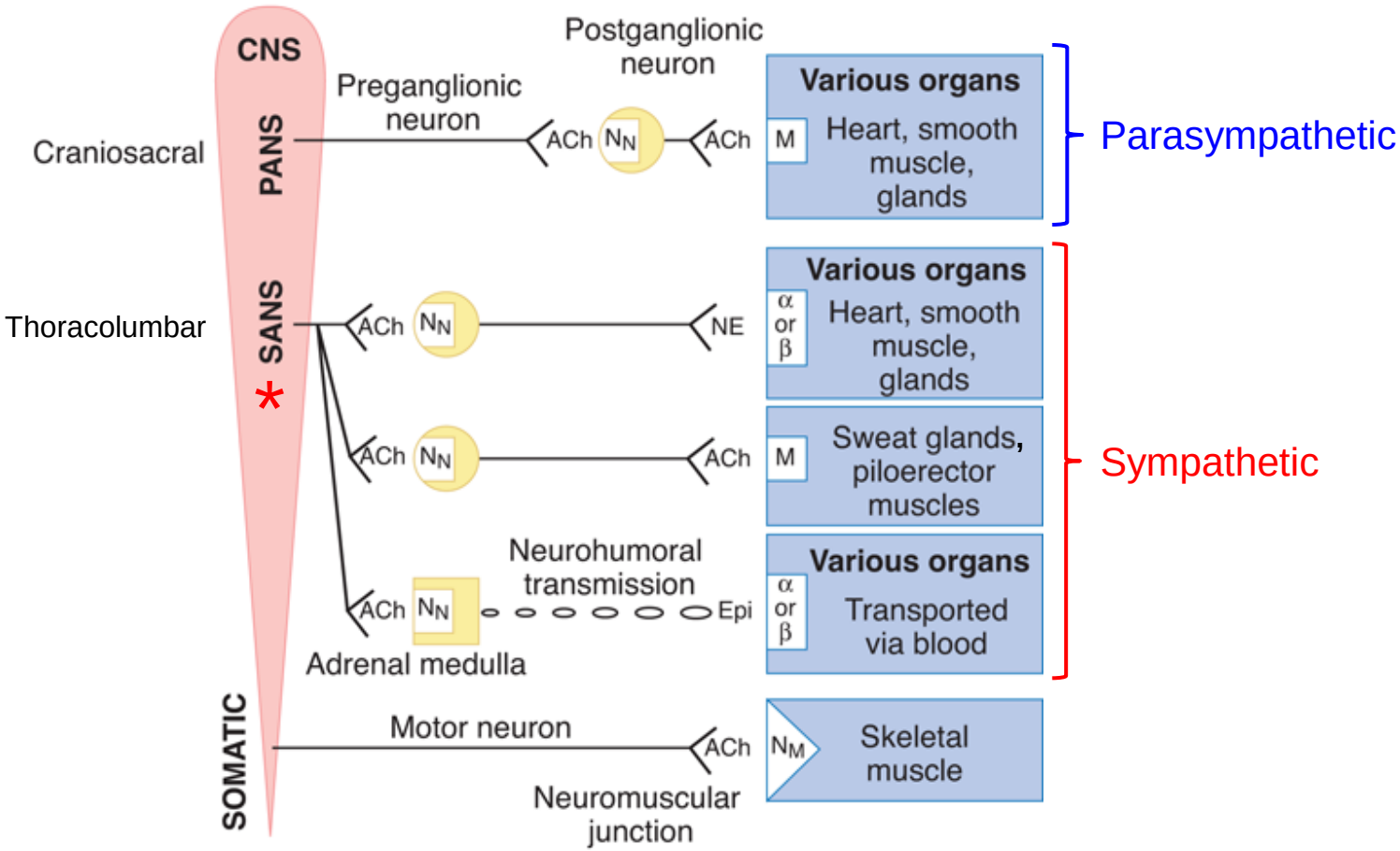
• FA 2013: 229.3 • FA 2012: 261.3 • FA 2011: 234.3
• ME 3e: 168 • ME4e: 168

KAPLAN MEDICAL

Sympathetic and Parasympathetic Nervous Systems

Matthew B. Wilkinson, PhD, M4
Mount Sinai School of Medicine

Autonomic nervous system



* Sympathetic fibers release dopamine to activate renal vascular smooth muscle via D1 receptors

Kaplan Pharmacology 2011: Figure II-1-1

• FA 2013: 230.1 • FA 2012: 262.1 • FA 2011: 235.1
• ME 3e: 186 • ME4e: 186

Acetylcholine receptors

Nicotinic ACh receptors (nAChRs)

Ligand-gated Na^+/K^+ channels

N_N: autonomic
N_m: somatic muscular (neuromuscular junction)

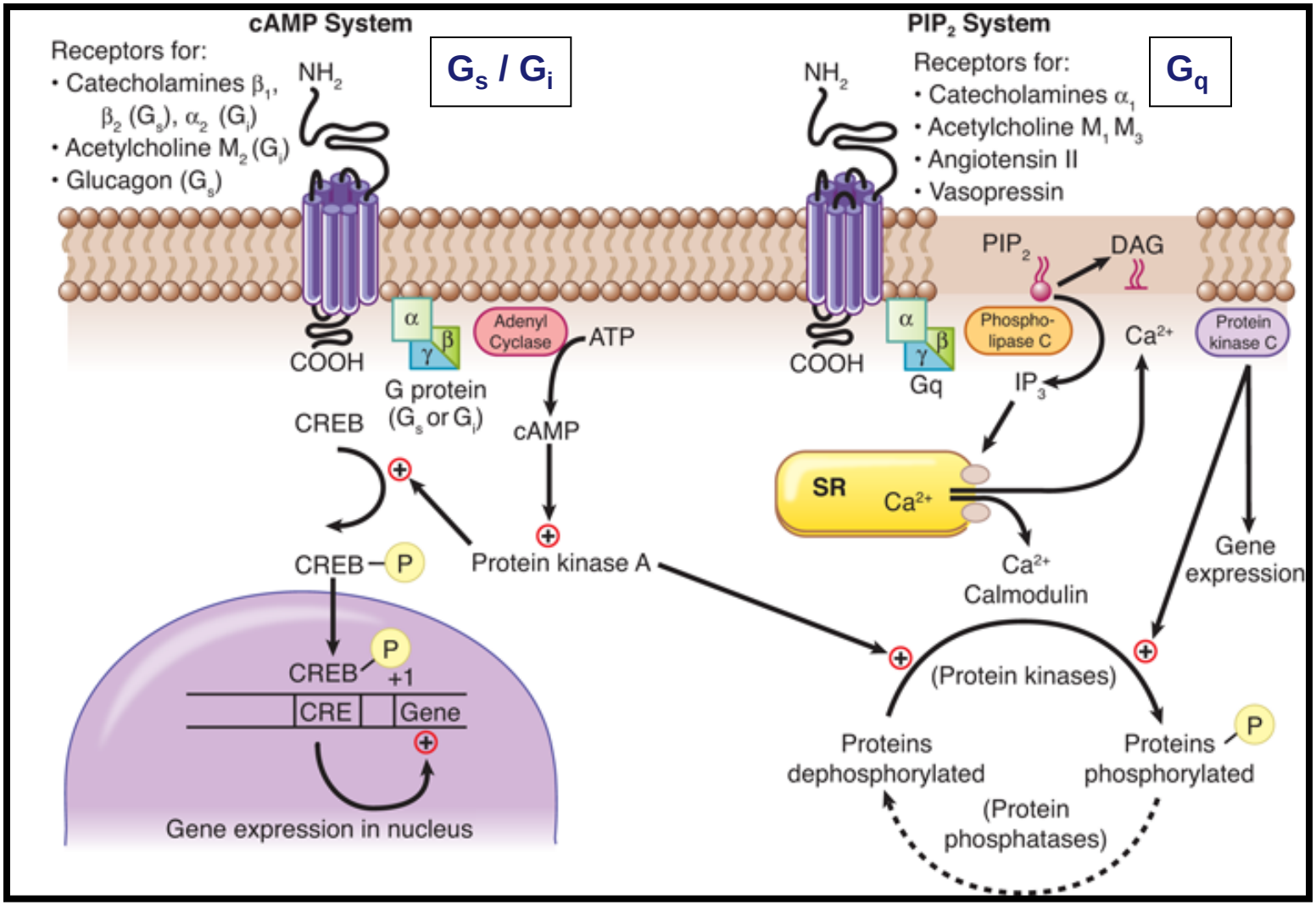
Muscarinic ACh receptors (mAChRs)

G protein-coupled receptor

M_1 M_2 M_3 — Autonomic Nervous System

M_4 M_5 — CNS

G protein-coupled receptor

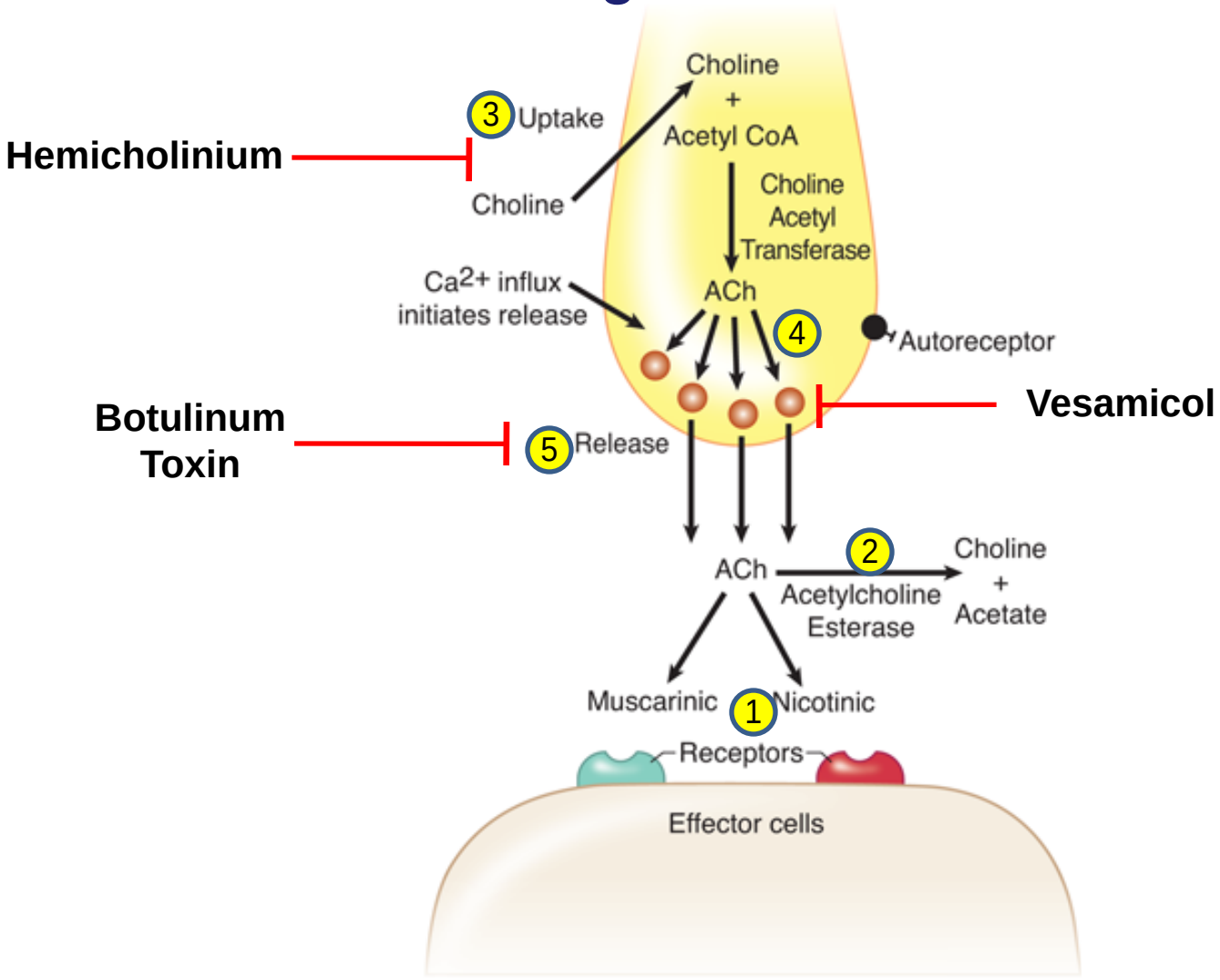


• FA 2013: 231.1 • FA 2012: 263.1 • FA 2011: 236.1
• ME 3e: 169 • ME4e: 169

GPCR physiology

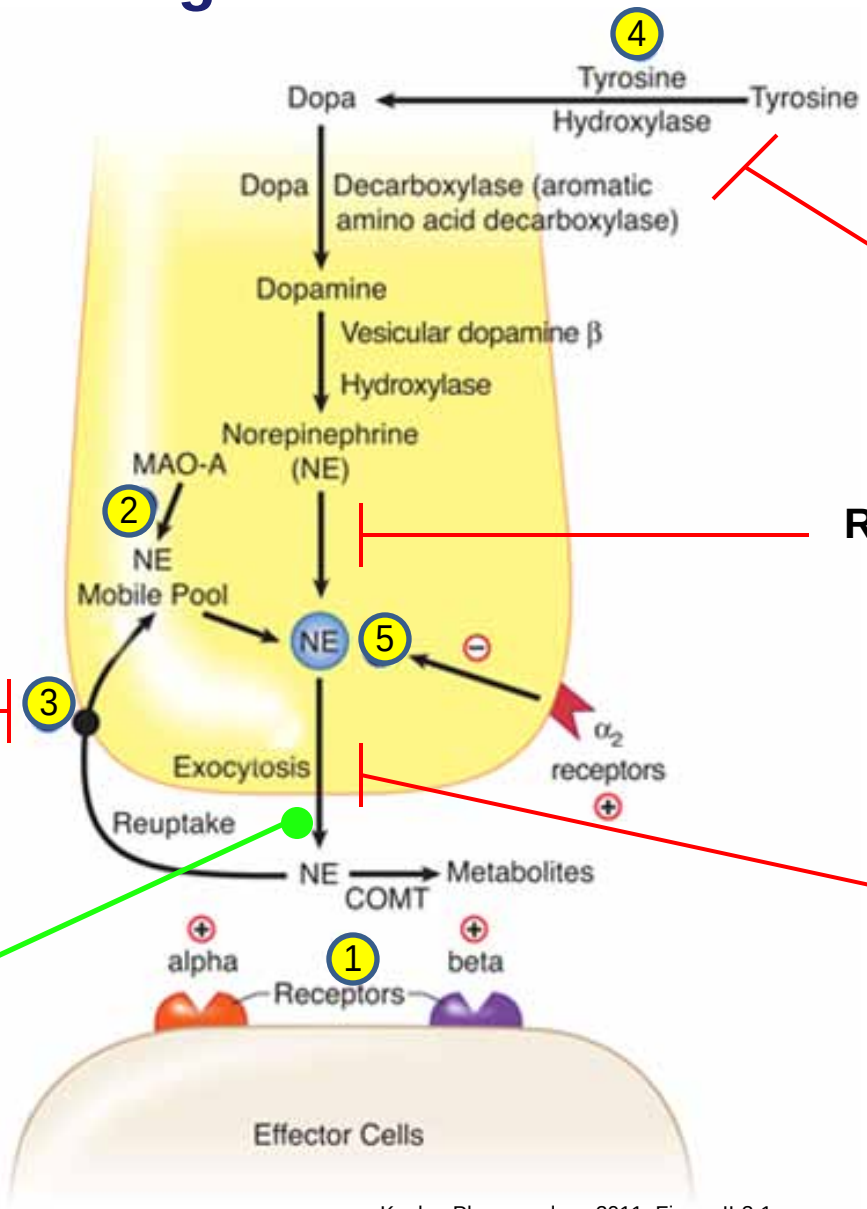
Class	Receptor	Functions
q	α_1	vascular smooth muscle contraction, pupillary dilation (mydriasis), intestinal and bladder sphincter contraction
i	α_2	↓sympathetic release, ↓insulin release
s	β_1	↑heart rate and contractility, ↑renin release
s	β_2	vasodilation, bronchodilation, ↓uterine tone
q	M_1	CNS, gastric parietal cells
i	M_2	↓heart rate, ↓atrial contractility
q	M_3	stimulates glandular secretions (sweat, gastric acid), ↑gut peristalsis, pupillary sphincter muscle contraction (miosis), ciliary muscle contraction (accommodation)
s	D_1	renal vascular smooth muscle relaxation
i	D_2	↓sympathetic release
q	H_1	↑sinus and bronchial mucus production, bronchiole constriction, itching/pain
s	H_2	↑gastric acid secretion
q	V_1	vascular smooth muscle contraction
s	V_2	↑water reabsorption in collecting tubules of kidneys

Cholinergic nerve terminal



Kaplan Pharmacology 2011: Figure II-2-1

Adrenergic nerve terminal



Metyrosine

Reserpine

Cocaine
TCAs
Amphetamines

Guanethidine

Amphetamines

Kaplan Pharmacology 2011: Figure II-3-1

Cholinomimetics

Cholinomimetic Drugs (parasympathomimetics)

Bethanechol	Muscarinic agonist. Longer acting than ACh (resistant to esterase). Treatment of ileus and urinary retention (**B**owels and **B**ladder)
Carbachol	Muscarinic/nicotinic agonist. Applied to eye to cause contraction of ciliary muscle, relief of open-angle glaucoma. Also constricts pupil
Pilocarpine	Muscarinic agonist. Stimulates tears, sweat, saliva. Constricts pupil and ciliary muscle. Also used for acute glaucoma
Methacholine	Muscarinic agonist. Causes bronchoconstriction when inhaled. Used for asthma challenge test

Anticholinesterases

Anticholinesterases (indirect cholinomimetics)

Neostigmine	Quaternary amine (no entry into CNS). Treatment of ileus, urinary retention, and myasthenia gravis. Post-operative reversal of neuromuscular junction blockade
Pyridostigmine	Quaternary amine. Treatment of myasthenia gravis
Edrophonium	Very short acting (10-20 mins.) Diagnosis of myasthenia gravis
Physostigmine	Tertiary amine (can enter CNS). Treatment of glaucoma. Antidote for atropine toxicity
Echothiophate	Treatment of glaucoma

Cholinesterase inhibitor poisoning

Cholinesterase inhibitor poisoning (high systemic acetylcholine)

Symptoms:

Diarrhea
Urination
Miosis
Bronchoconstriction
Bradycardia
Excitation (skeletal muscle and CNS)
Lacrimation
Salivation
Sweating

Treatment:

Atropine (muscarinic antagonist)

Pralidoxime a.k.a 2PAM (regenerates cholinesterase)

Muscarinic receptor antagonists

Classic example: Atropine

- Tertiary amine à can enter the CNS
- Effects: the opposite of DUMBBELSS

- ↓ Epithelial secretions
- Mydriasis, cycloplegia
- Hyperthermia
- Vasodilation

- Tachycardia
- Sedation
- Urinary retention
- Constipation

Muscarinic receptor antagonists:

Drug	Clinical Uses and/or Characteristics
Atropine	Antispasmodic, antisecretory, management of AChE inhibitor OD, antidiarrheal, ophthalmology (but long action)
Tropicamide	Ophthalmology (topical)
Ipratropium	Asthma and COPD (inhalational)—no CNS entry, no change in mucus viscosity
Scopolamine	Used in motion sickness, causes sedation and short-term memory block
Benztropine, trihexyphenidyl	Lipid-soluble (CNS entry) used in parkinsonism and in acute extrapyramidal symptoms induced by antipsychotics

Kaplan Pharmacology 2010: Table II-2-6

Nicotinic antagonists

Hexamethonium (nicotinic antagonist)

Used to prevent vagal reflexes due to sympathetic stimulation

Example: can be used to prevent reflex bradycardia caused by increased blood pressure due to increased norepinephrine

Excess hexamethonium can cause orthostatic hypotension, blurred vision, constipation

Direct sympathomimetics

Epinephrine:

- Function:
  - α,β agonist
  - Low doses selective for β_1 receptors

- Clinical usage:
  - Treatment for anaphylaxis, open-angle glaucoma, asthma, hypotension
  - Prolongs the effect of local anesthesia

- Adverse effects:
  - ↑systolic blood pressure + ↓diastolic blood pressure = *widened* pulse pressure

Norepinephrine:

- Function:
  - Mainly α-receptor agonist, but has some β-receptor activity

- Clinical usage:
  - Treatment of hypotension

- Adverse effects:
  - Splanchnic vasoconstriction and ↓renal perfusion
  - ↑systolic blood pressure + ↑diastolic blood pressure = little/no change in pulse pressure
  - Reflexive decrease in heart rate

Direct sympathomimetics

Direct sympathomimetics

Isoproterenol	β_1 β_2 agonist. Treatment for AV conduction block. ↓diastolic BP (this effect induces a reflexive ↑heart rate)
Dopamine	D1 = D2 > β > α agonist. Inotropic and chronotropic. Treatment for shock, especially with heart failure
Dobutamine	β_1> β_2 agonist. Inotropic. Treatment of heart failure. Used in cardiac stress test
Ritodrine	β_2 agonist. Reduces premature uterine contractions
Metaproterenol **Albuterol** **Salmeterol** **Terbutaline**	Selective β_2 agonists (β_2>β_1). Treatment of asthma Acute: metaproterenol and albuterol Long-acting: salmeterol

• FA 2013: 235.1 • FA 2012: 266.3 • FA 2011: 240.1
• ME 3e: 193 • ME4e: 193

Indirect sympathomimetics

Indirect sympathomimetics

Amphetamine	Induces catecholamine release from terminals. Treatment for narcolepsy, obesity, and ADHD.
Ephedrine	Induces catecholamine release. Treatment for nasal congestion, urinary incontinence, hypotension.
Cocaine	Inhibits reuptake of catecholamines. Vasoconstriction, local anesthetic.
Tyramine	Similar mechanism to amphetamines, cleared by MAO (MAO inhibitors can cause hypertension, especially with tyramine-rich foods such as wine and cheese).

Sympathoplegics

Clonidine:

- Agonists of central α_2-adrenergic receptors which decreases sympathetic outflow

α-methyldopa:

- Used to treat hypertension by decreasing sympathetic tone

Alpha-blockers

Non-selective (α_1 and α_2)

Phenoxybenzamine (irreversible) **Phentolamine** (reversible)	Treatment of pheochromocytoma. Also used to treat Raynaud's syndrome

α_1-selective

Prazosin **Terazosin** **Doxazosin** (longest acting)	Treatment of hypertension, urinary retention (BPH). May cause orthostatic hypotension (usually taken at bedtime)

α_2-selective

Mirtazapine	Treatment of depression. Can cause sedation, increased serum cholesterol, and increased appetite

Beta-blockers

Non-selective (β_1 and β_2)

Propranolol (migraines)
Timolol (glaucoma)
Nadolol
Pindolol

β_1-selective

Metoprolol
Atenolol
Betaxolol
Esmolol (very short acting)

Mixed α and β blockers

Carvedilol
Labetalol

Partial β-agonists

Pindolol
Acebutolol

Beta-blockers

Treatments for:

- Hypertension ____ ↓CO, ↓renin production (β_1-blockade of JG cells)
- Angina ____ ↓HR, ↓inotropy, ↓myocardial O_2 consumption
- Myocardial infarction ____ ↓mortality
- Sinus ventricular tachycardia (SVT) ____ propranolol/esmolol to ↓AV conduction
- Heart failure (CHF) ____ slows progression of CHF (↓cardiac demand)

Side effects:

- Exacerbation of asthma
- Impotence
- Bradycardia
- AV blockade
- Sedation
- Decreased glucagon secretion

KAPLAN MEDICAL

Toxicology and Adverse Reactions

Matthew B. Wilkinson, PhD, M4
Mount Sinai School of Medicine

Antidotes

Drug	Antidote
Acetaminophen	N-acetylcysteine
Salicylates	Sodium bicarbonate to alkalinize urine, dialysis

Antidotes

Drug	Antidote
Anticholinesterases Organophosphates (insecticides)	Atropine, 2-PAM (pralidoxime)
Anticholinergics	Physostigmine

Antidotes

Drug	Antidote
β-blockers	Glucagon to increase inotropy and chronotropy of heart
Digitalis	Anti-digitalis Fab fragments. Normalize serum electrolytes, especially K^+, then lidocaine, magnesium

Antidotes

Drug	Antidote
Iron	Deferoxamine (de-Fe-roxamine)
Lead	Ca-EDTA (chelator), dimercaprol, succimer, penicillamine
Arsenic, mercury, gold	Dimercaprol, succimer
Copper, arsenic, gold	Penicillamine

Antidotes

Drug	Antidote
Cyanide	Nitrite, hydroxocobalamin, thiosulfate
Methemoglobin	Methylene blue, vitamin C
Carbon monoxide	100% O_2 (hyperbaric chamber)

Antidotes

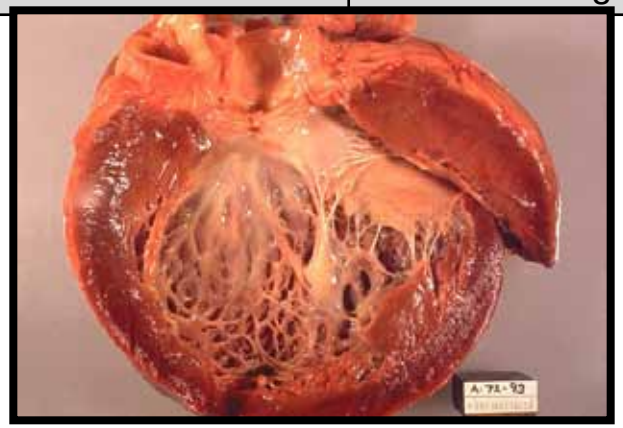
Drug	Antidote
Methanol, ethylene glycol	Ethanol, fomepizol
Opioids	Naloxone, naltrexone
Benzodiazepines	Flumazenil
Tricyclic antidepressants (TCAs**)**	$NaHCO_3$ (intravenous alkalinization), adjunctively treat for seizure, hyperthermia, and arrhythmia

Antidotes

Drug	Antidote
Heparin	Protamine
Warfarin (coumadin)	Vitamin K, fresh frozen plasma (restore factors II, VII, IX, X, and Proteins C, S)
tPA, streptokinase	Aminocaproic acid
Theophylline	β-blocker

Cardiovascular reactions

Side effect	Causal agent
Atropine-like (anti-cholinergic) symptoms	TCAs, anti-histamines
Dilated cardiomyopathy	Doxorubicin, daunorubicin
Coronary vasospasm	Cocaine, sumatriptan
Cutaneous flushing	**V**ancomycin, **A**denosine, **N**iacin, **C**a-channel blockers (**VANC**)
Torsades de pointes	Class III (sotalol) and Class IA (quinidine) antiarrythmics, cisapride (update: removed from the US market because of arrhythmias) Treat with magnesium



Dilated cardiomyopathy
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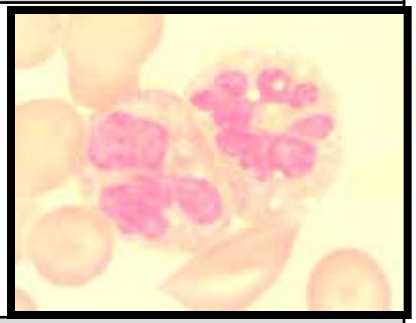
• FA 2013: 240.1 • FA 2012: 271.1 • FA 2011: 244.1
• ME 3e: 170 • ME4e: 170

Hematologic reactions

Side effect	Causal agent
Agranulocytosis	Clozapine, carbamazepine, colchicine, propylthiouracil, dapsone, methimazole
Aplastic anemia	Chloramphenicol, benzene, NSAIDs, felbamate
Hemolytic anemia (Coombs-positive)	Methyldopa
Gray baby syndrome	Chloramphenicol
G6PD-deficient hemolytic anemia	Isoniazid (INH), sulfa drugs, aspirin, ibuprofen, nitrofurantoin, primaquin
Megaloblastic anemia (hypersegmented neutrophils)	Methotrexate, sulfa drugs, phenytoin
Thrombosis	Oral contraceptives (higher risk with smoking)



Hypersegmented Neutrophils

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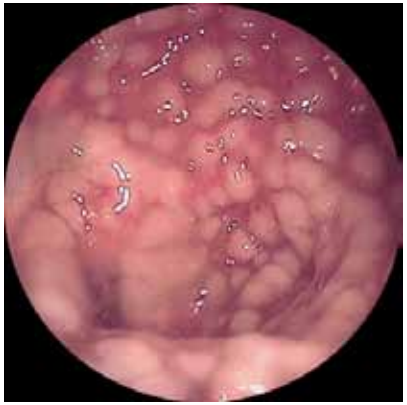
• FA 2013: 240.1 • FA 2012: 271.1 • FA 2011: 244.1
• ME 3e: 170 • ME4e: 170

Respiratory reactions

Side effect	Causal agent
Cough	ACE-inhibitors (use angiotensin-receptor blockers instead)
Pulmonary fibrosis	Bleomycin, amiodarone, busulfan

GI reactions

Side effect	Causal agent
Hepatitis	Isoniazid (INH)
Cholestatic hepatitis	Macrolide antibiotics (azithromycin, clarithromycin)
Hepatic necrosis	Halothane, valproic acid, acetaminophen, *Amanita phalloides* (mushroom)
Pseudomembranous colitis	Clindamycin, ampicillin, cephalosporins
Pancreatitis	Azathioprine, sulfonamides, valproic acid, methyldopa, furosemide, corticosteroids, sulindac, tetracycline, didanosine, estrogens, 6-mercaptopurine, pentamidine, 5-aminosalicyclic acid compounds, octreotide



Pseudomembranous colitis, endoscopy
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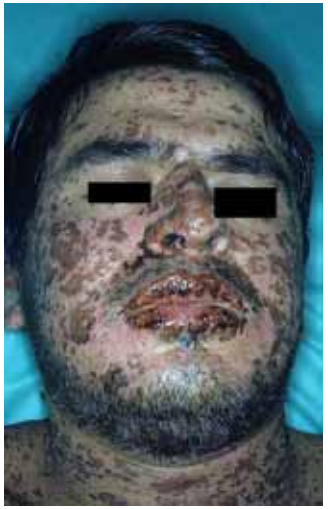
Reproductive/endocrine reactions

Side effect	Causal agent
Adrenocortical insufficiency	Glucocorticoid withdrawal, etomidate
Gynecomastia	Spironolactone, digitalis, cimetidine, alcohol, estrogens, ketoconazole
Hot flashes	Tamoxifen, clomiphene
Hypothyroidism	Lithium, amiodarone

Musculoskeletal/connective tissue reactions

Side effect	Causal agent
Gingival hyperplasia	Phenytoin
Gout	Furosemide, thiazides
Osteoporosis	Corticosteroids, heparin
Photosensitivity	Sulfonamides, Amiodarone, Tetracyclines, Fluoroquinolones
Rash (Stevens-Johnson syndrome)	Sulfa drugs, penicillin, carbamazepine, allopurinol
Lupus-like syndrome	Hydralazine, INH, procainamide, phenytoin
Tendon rupture	Fluoroquinolones



Stevens-Johnson syndrome
Dr. Thomas Habif, commons.wikimedia.org
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• FA 2013: 241.1 • FA 2012: 272.1 • FA 2011: 245.1
• ME 3e: 170 • ME4e: 170

Renal/GU reactions

Side effect	Causal agent
Fanconi's syndrome	Expired tetracycline
Interstitial nephritis	Methicillin, NSAIDs
Hemorrhagic cystitis	Cyclophosphamide

Neurologic reactions

Side effect	Causal agent
Cinchonism	Quinidine, quinine
Diabetes insipidus	Lithium, demeclocycline
Seizures	Bupropion, imipenem/cilastatin, INH
Parkinson-like syndrome	Haloperidol, chlorpromazine, reserpine, metoclopramide
Tardive dyskinesia	Typical antipsychotics

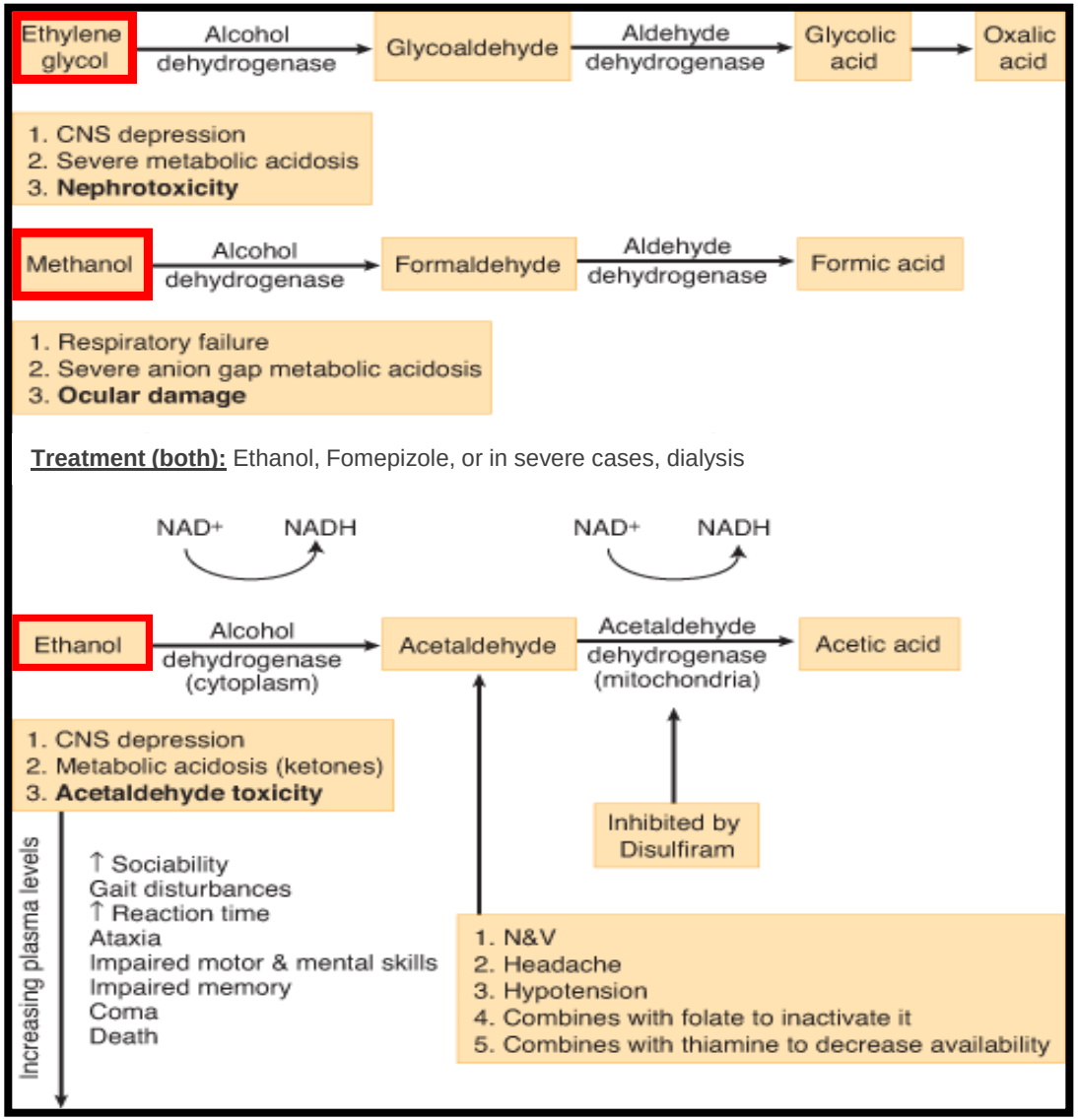
Multi-organ reactions

Side effect	Causal agent
Disulfiram-like reaction	Metronidazole, procarbazine, sulfonylureas, cephalosporins
Nephrotoxicity / neurotoxicity	Polymxyins
Nephrotoxicity / ototoxicity	Aminoglycosides, vancomycin, loop diuretics, cisplatin

Cytochrome P-450 interactions

Inducers	Inhibitors
Quinidine	HIV protease inhibitors
Barbiturates	Isoniazid (INH)
St. John's wort	Sulfonamides
Phenytoin	Cimetidine
Rifampin	Ketoconazole
Griseofulvin	Grapefruit juice
Carbamazepine	Omeprazole
Chronic alcohol use	Chloramphenicol
Glucocorticoids	Marcolides

Alcohol metabolism

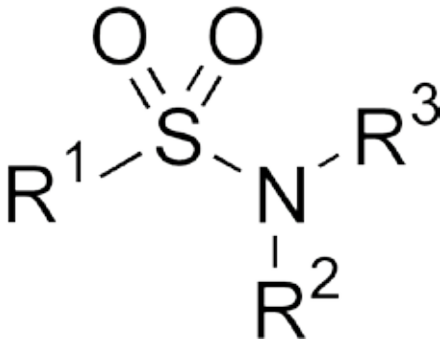


Kaplan Pharmacology 2011: Figure IV-2-1

- FA 2013: NA
- FA 2012: NA
- FA 2011: 246.1
- ME 3e: 13
- ME4e: 13

Sulfa drugs

- Any drugs that contain a sulfonamide group
- Allergies to these drugs are common



Sulfonamide group

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Drugs:

- Sulfonamide antibiotics
- TMP-SMX
- Acetazolamide
- Furosemide
- Thiazides
- Sulfasalazine
- Celecoxib
- Probenecid

Symptoms:

- Pruritic rash
- Fever
- Stevens-Johnson syndrome
- Hemolytic anemia
- Thrombocytopenia
- Agranulocytosis
- Urticaria (hives)

Common drug name endings

-afil	erectile dysfunction drugs
-ane	inhalational anesthetics
-azepam	benzodiazepines
-azine	phenothiazine
-azole	antifungals
-barbital	barbiturates
-caine	local anesthetics
-cillin	penicillins
-cycline	antibiotics, protein synthesis inhibitors
-etine	SSRIs
-ipramine	tricyclic antidepressants
-navir	protease inhibitors
-olol	β antagonist
-operidol	butyrophenone (neuroleptic)
-oxin	cardiac glycoside (inotropic)
-phylline	methylxanthines
-pril	ACE inhibitor
-terol	β_2 agonist
-tidine	H_2 antagonist
-triptan	5-$HT_{1B/1D}$ agonists (migraine)
-triptyline	TCAs
-tropin	pituitary hormone
-sartan	angiotensin receptor blockers
-zolam	benzodiazepine
-zosin	α_1 antagonist