BROUGHT TO YOU BY

MEDAIDPK

EMPOWERING YOU

WITH KNOWLEDGE!

MEDAIDPK.COM

1.1 Cholinomimetics: I'd Like to buy the world of Acetyl-cola

1. Called a cholinomimetic because they mimic the effects of acetylcholine, the primary NT pf parasympathetic nervous system
2. Acetyl-Cola: Acetylcholine receptor agonists
3. Mime drinking cola: cholinomimetics
4. Smoker: nicotinic acetylcholine receptor
5. Ganglia-like transformers near smoker: nicotinic acetylcholine receptors are found on autonomic ganglia
6. Outlet near smoker: nicotinic acetylcholine receptors are found on skeletal muscle motor end plates
7. Adrenal beanie on smoker: nicotinic acetylcholine receptors are found in the adrenal gland
8. Motorcycle parking spots: Muscarinic acetylcholine receptors (M1, M2, M3)
9. Ion channel news behind smoker: nicotinic receptors act as ion channels that will influx positive ions to polarize a muscle
10. QIQ store: M1, M2, and M3 are coupled to Gq, Gi, and Gq respectively
11. 3 "dags": M1 and M3 are coupled to Gq proteins which activate the IP3-DAG cascade leading to increased intracellular calcium
12. Packed up tent: M2 is coupled to a GI protein which decreases cAMP, notice the down arrows
13. Brain helmet: M1 receptors are found in nerves and the CNS
14. Top of heart with jewels: M2 receptors are found in the atria, the SA and AV node
15. Glandular sponge: M3 receptors are found on the glands,
16. Dilated Nitric Oxide exhaust: M3 receptor activation → nitric oxide release in vascular smooth muscles → increased cGMP and vasodilation
17. Constricted clogged ppe exhaust pipe: atherosclerosis → vascular epithelial damage → direct muscarinic receptor activation → vasoconstriction
18. In average patient muscarinics will cause a drop in blood pressure, all muscarinic can cross to work on other M receptors in high doses
19. Beth with cola: bethanechol (cholinomimetic)
20. Cement pouring from colon spout: muscarinic agonists (bethanechol) increase secretion and motor activity of the gut
21. [Do not obstruct] sign: bethanechol is used to treat non obstructive (non active) gastrointestinal dysmotility (post op ileus, neurogenic ileus)
22. Beth using bladder hose: bethanechol treats urinary retention (neurogenic bladder from spinal cord injury, post pregnancy)
23. Pile o' carp: pilocarpine (cholinomimetic)
24. Dripping carp mouths: pilocarpine increase salivation (sjogrens, radiation damage) dry mouth treatment
25. Round glass: muscarinic agonists (pilocarpine) cause accommodation of the lens, parallel fibers on net represent ciliary muscles
26. Smooth muscle crane with net zonules: pilocarpine contracts the ciliary muscle, increasing aqueous humor outflow (used to treat glaucoma)
27. Constricted hood: pilocarpine causes meiosis, activates the sphincter pupillae muscle to cause pupillary constriction (useful in acute angle glaucoma)
28. Constricted hood blocking carbon fumes: carbachol causes pupillary constriction (useful in acute angle glaucoma)
29. Carbon fumes from smoker: Carbachol is both a muscarinic and nicotinic agonist
30. Marathon challenge: methacholine (cholinomimetic) challenge
31. Challenge: methacholine challenge instigates asthma for pulmonary testing
32. Wheezing man: cholinomimetics (methacholine) contract bronchial smooth muscle which may exacerbate asthma or COPD, also all cholinomimetics can cause peptic ulcers
33. 1-800-Very-Clean: varenicline (nicotinic receptor partial agonist) is used for smoking cessation

1.2 Acetylcholinesterase Inhibitors: Stigmata gravis

1. Indirect view of Acetyl-cola mime: Indirect Cholinomimetics (inhibit acetylcholinesterase) bind either reversibly or irreversibly to acetylcholine to either raise acetylcholine, or increase the length of time acetylcholine is at the synapse
2. Dumpster of acetyl-cola bottles: acetylcholinesterase degrades acetylcholine (aCh)
3. Knocked over dumpster with acetyl-cola spilling out: acetylcholinesterase inhibitors increase synaptic concentrations of Ach
4. Anti-ESTablishment: anti-cholinesterase, AKA acetylcholinesterase inhibitor
5. STGMA: -"-Stigmine" drug suffix of acetylcholinesterase inhibitors
6. Skeletal muscle brick wall: acetylcholinesterase inhibits effects of Ach at the NMJ (increase activity of NICOTINIC Ach receptors) leading to increased strength of contractions
7. Electrical end plate: Motor end plate (at the NMJ)
8. GRAVIS graffiti: myasthenia gravis (MG) → antibodies against nicotinic Ach receptors at motor end plate (skeletal muscle NMJ)
9. Graffiti covering motor end plates: MG causes progressive muscle weakness, Ptosis, diplopia (inactivated nicotinic receptors at motor end plate)
10. **Community PRIDE: PYRIDOstigmine (acetylcholinesterase inhibitor used as long term treatment for MG**)
11. Removing graffiti on end plates: Acetylcholinesterase inhibitors increase Ach at NMJ endplate to outcompete MG antibodies
12. **Neon sign STIGMA: neostigmine (acetylcholinesterase inhibitor used to treat MG)**
13. **Phone Booth: edrophonium (acetylcholinesterase inhibitor that transiently reverses symptoms of MG)**
14. Quarters only: pyridostigmine, neostigmine and edrophonium are quaternary amines and do not penetrate into the CNS (only relives symptoms for 5-15 minutes)
15. Phone in working order: edrophonium REVERSES muscle weakness in undertreated MG patients (POSITIVE tensilon test)
16. Phone Wire tension: tensilon test → edrophonium reverses (positive) or fails to reverse (negative) muscle weakness
17. Phone out of order with anti-esterase graffiti: edrophonium FAILS to reverse muscle weakness during cholinergic crisis (NEGATIVE tensilon test)
18. CURARE crayons stuck in end plate: non-depolarizing neuromuscular blocking agents (tubucurarine, pancuronium, cisatracurium) inhibit nicotinic Ach receptors are NMJ endplate
19. Neon sign store owner kicking out CURARE crayon kid: acetylcholinesterase inhibitors (neostigmine) reverse non-depolarizing neuromuscular blockade
20. SUCKS: Succinylcholine is a depolarizing neuromuscular blocking agent (Nicotinic Ach receptor AGONIST), that overstimulates the NMJ, causing muscles to remain depolarizes and unable to respond to stimulus
21. PHASE-1 cleanup crew getting shocked: initial PHASE-1 of depolarizing blockade is IRREVERSIBLE (acetylcholinesterase inhibitors potentiate blockade)
22. Bladder hose: acetylcholinesterase inhibitors can be used to treat urinary retention (muscarinic activation)
23. PHYS ED center: PHYSostigmine (acetylcholinesterase inhibitor with CENTRAL effects)
24. Atropine in Wonderland: Atropine overdose → "mad as a hatter, Hot as a hare, Blind as a bat (reversed by physostigmine)
25. Deadly nightshade: belladonna flower is a naturally occurring form of atropine (overdose treated by physostigmine)
26. GYM Weeds: Jimson weed is a naturally occurring form of atropine (overdose reversed by physositgmine) "Gardeners mydriasis"
27. PHYS ED teacher reprimanding atropine "artist": physostigmine reverses atropine overdose (peripheral and central effects)
28. "your brain on drugs": physostigmine (and organophosphates) enters CNS to cause central cholinergic effects
29. DUMBBELS: acetylcholinesterase inhibitor toxicity (diarrhea, Urination, Miosis, Bronchospasm, Bradycardia, Lacrimation, salivation, sweating)
30. Weak nicotine kid: Acetylcholinesterase inhibitor toxicity includes flaccid paralysis (NMJ nicotinic Ach receptor over-activation)
31. THIOL spray: insecticides (parathion, maltion, echotiophate) are organophosphates, a type of acetylcholinesterase inhibitor (also includes nerve agents and herbicides)

32. Green fumes: organophosphates are a major cause of acute cholinergic toxicity (DUMBBELSS) 33. "your brain on drugs": physostigmine (and organophosphates) enters CNS to cause cholinergic effects 34. Closing LID on TOXIC spray: praLIDoxime reverses organophosphates toxicity (DUMBBELSS) by hydrolyzing the covalent bond 35. New toxic waste dumpsters: pralidoxime regenerates Acetylcholinesterase at muscarinic and nicotinic receptors (reverses cholinergic toxicity INCLUDING FLACCID PARALYSIS) 36. Atropine Alice on the side of the dumpster: Atropine reverses both peripheral and Central muscarinic toxicity from organophosphate poisoning (pralidoxime is peripheral only) 37. Old Pest control man: Aging of the organophosphate-cholinesterase complex leads to irreversible binding	38. Corroded dumpster: pralidoxime is ineffective once aging of organophosphatecholinesterase complex has occurred **39. Alzheimers GALA: galantime (acetylcholinesterase inhibitor used to treat Alzheimer's disease** **40. Reverse the Stigma: Rivastigmine (acetylcholinesterase inhibitor used to treat Alzheimer disease)** **41. Done with the Puzzle: Donepezil (acetylcholinesterase inhibitor used to treat Alzheimer's disease)** 42. Brain puzzle: galantine, rivastigmine, and donepezil penetrate the CNS

1.3 Anti-muscarinic Drugs: Atropine in Wonderland

1. Motorcycle parking spots: Muscarinic acetylcholine receptors (M1, M2, M3)
2. M3 spot: Reversing into motorcycle parking spot: muscarinic antagonists reversibly block muscarinic receptors
3. Blocked tweedle DUMBBELSS: antimuscarinics block the muscarinic effects of diarrhea, urination, miosis, bronchospasm, bradycardia, lacrimation, salivation
4. Blocked acetyl-cola bottle: anti-muscarinics block the action of acetylcholine at M receptors
5. **Alice: atropine (atropine) prototype**
6. Belladonna flower (deadly nightshade) a natural antimuscarininc flower
7. Jimson weed – natural antimuscarinic alkaloid
8. Large pupil gazing into the distance: antimuscarinics cause pupillary dilation (mydriasis) and cycloplegia (inability to accommodate the lens for near vision)
9. **Seasick sailor outfit: scopolamine is used to treat motion sickness (vestibular nausea) needs to be used prior to feeling sick**
10. Eyepatch: scopolamine transdermal patch is used to treat motion sickness
11. CNS Hat: antimuscarinics (scopolamine) cross the blood-brain barrier and inhibits central M1 receptors
12. Heart with jewel nodes: Antimuscarinics block parasympathetic activation of M2 receptors on the SA and AV nodes (increased HR, and Increased AV conduction)
13. Elevated heart watch: antimuscarinics (atropine) increase HR (useful in the treatment of bradycardia)
14. Heart shield: Heart block (AV block)
15. Falling heart shields: antimuscarinics (atropine) increase AV conduction (useful in the treatment of heart block)
16. **Cat-Ipa-Tio-Tropillar: iprarioprium and tiotropium (M3 muscarinic antagonists**
17. Puffing: ipratropium and tiotropium are inhaled antimuscarinic bronchodilators
18. Blue bloater with punk puffer: ipratropium and tiotropium are useful in the management of COPD (antagonize M3 receptors → bronchodilation, decreased secretions)
19. Long lasting TIO smoke rings: tiotropium dissociates more slowly from the M3 receptor (longer bronchodilator action)
20. **Ox butler: Oxybutynin (M3 muscarinic antagonist) used to relieve bladder spasm after urologic surgery**
21. **Turtle butler: Tolterodine (M3 muscarinic antagonist) used in adult urinary incontinence**
22. Turning off bladder: oxybutynin and tolterodine treat incontinence (antagonize M3 receptors → relax smooth muscle in ureters and bladder wall
23. CENTER over M1: M1 muscarinic receptors are found in the CNS
24. PARKING over M1: M1 receptor antagonists can reduce tremors and rigidity in Parkinson's disease
25. **BENZ parked in M1: Benztropine (centrally acting M1 muscarinic antagonist)**
26. **Tri-Hex car parked in M1: trihexyphenidyl (centrally acting M1 muscarininc antagonist)**
27. Shaking antennae: centrally acting antimuscarinics (benztropine, trihyxyphenidyl) treat tremor and rigidity in Parkinson's (block excess cholinergic activity)
28. Cogwheel: excessive M1 activation is associated with cogwheel rigidity in Parkinson's disease
29. Falling "esxtra parking" cone: antimuscarinics treat extrapyramidal; side effects caused by antipsychotics e.g. dystonia, akathisia, parkinsonism (re-establish dopaminergic-cholinergic balance)
30. Side Effects of Antimuscarinics / anticholinergics
31. Heart with jewel nodes: Antimuscarinics block parasympathetic activation of M2 receptors on the SA and AV nodes (increased HR, and Increased AV conduction)
32. Elevated heart watch: antimuscarinics (atropine) increase HR
33. Hot as a Hare: antimuscarinics inhibit M3 receptors; sweat glands → decreased sweating → hyperthermia
34. Dry as a cracker: antimuscarinics decrease salivation and lacrimation → dry mouth and eyes
35. Blind as a bat: antimuscarinics cause mydriases and cycloplegia → blurred vision
36. High pressure as a kettle: antimuscarinics cause mydriasis → decreased outflow of aequeous humor → acute angle closure glaucoma
37. Mad as a Hatter: antimuscarinics cross BBB and antagonize central M1 receptor → sedation, agitation, hallucination, coma (especially in elderly patients)

2.1 Sympathomimetics: Drugs that mimic the effects of Epinephrine and Norepinephrine

1. Sympathetic Mime: Sympathomimetic Drugs
2. QISS: alpha1, alpha2, beta1, beta2 receptors are coupled to Gq, Gi, Gs, Gs, respectively
3. Alpha scouts: alpha receptor agonists
4. **Single lit candle: alpha 1 agonist**
5. 3 dags: alpha1 receptor coupled to Gq → IP3-DAG cascade
6. "Dag" with bone: IP3-DAG cascade → increased intracellular calcium (smooth muscle cell)
7. Alpha1 scout pulling Red leashes alpha1 activation increases peripheral arterial resistance (vasoconstriction at small arteries, arterioles, precapillary sphincters)
8. Alpha1 scout elevating MAP: alpha1 activation increases mean arterial pressure (MAP)
9. Alpha1 scout pulling blue leashes: alpha1 activation increases venous return (venoconstriction)
10. Alpha 1 scout binoculars: alpha1 activates pupillary dilator muscle causes mydriases (dilation)
11. Alpha1 scout pulling drawstring: alpha 1 activation causes urethral sphincter and prostatic smooth muscle contraction
12. Full bladder canteen: alpha1acticvation causes urinary retention
13. **Two lit alpha candles: alpha2**
14. "No sympathy": alpha2 agonists are sympatholytics (act centrally to decrease sympathetic tone)
15. Packed up alpha2 camp tent: alpha2 receptor coupled to Gi → IP3-DAG cascade leading to decreased cAMP
16. Alpha2 scout packing up presynaptic wire: presynaptic alpha2 receptors cause inhibition of neurotransmitter release
17. Welcome inside mat: Insulin
18. Rolled up welcome inside mat: alpha2 activation at pancreatic islet cells decreases insulin release
19. Alpha2 scout dousing roasting pig: alpha2 activation inhibits lipolysis and release of fatty acids
20. Alpha2 scout emptying water from eyeball hat: activation of alpha2 at ciliary body decreases aqueous humor production
21. Brim of eyeball hat: Brimonidine is an alpha 2 agonist used to treat chronic open angle glaucoma (decreases aqueous humor production)
22. Band cAMP: beta receptor agonists against increase cyclic AMP (cAMP)
23. **Beta1 bugle: beta1 agonist**
24. I <3 Band cAMP shirt: beta1 receptors are found on cardiac myocytes (including SA and AV nodes) causes increase cyclic AMP → increased intracellular calcium which increases contractility and accelerates the heart
25. Elevated heart clock: beta1 activation increases heart rate (SA node)
26. Buff contracted bicep: beta1 activation increases cardiac contractility (cardiac myocytes)
27. Heart hydrant: beta1 activation results in increased cardiac output
28. Open rain umbrella: beta1 activation increases renin release (JGA cells) renin = rainin
29. **Beta2 tuba: beta2 activity**
30. Beta2 camper taking big breath: beta2 activation leads to bronchoDILATION (increased cyclic AMP → activates PKA)
31. Beta2 camper with dilated sleeves: beta2 activation causes coronary and skeletal muscle vasoDILATION → decreases systemic vascular resistance (SVR)
32. Beta2 camper with dangling DIAmond earrings: beta2 activation decreases diastolic blood pressure
33. Beta2 camper roasting pig: beta 2 activation Expressed on human fat cells stimulates lipolysis and release of free fatty acids
34. Beta2 camper producing marshmallows from liver shaped bag: beta2 receptor activation at the liver promotes gluconeogenesis
35. Welcome INSIDE mat: insulin increased, beta2 activation at pancreatic islet cells will cause an increase of insulin release
36. Banana peels: beta2 activation can cause hypokalemia (due to increased insulin activity)
37. Beta2 camper filling eyeball balloon: beta2 activation at ciliary body increases aqueous humor production.

2.1 Sympathomimetics: the drugs

1. **Flannel friends: phenylephrine (alpha1 agonist)**
2. Flannel friend holding single burning candle: phenylephrine is an alpha1 agonist, smooth muscle activation
3. Flannel friend's nasal spray: phenylephrine treats nasal congestion (alpha1 mediated vasoconstriction) reduces edema of nasal mucosa
4. Flannel friends binoculars: phenylephrine causes mydriasis (activates pupillary dilator muscle)
5. Map: Phenylephrine increases MAP (alpha1 increases SVR), increases systolic pressure (alpha1 arteriolar constriction), increases diastolic pressure (alpha1 venous constriction)
6. Flannel friends low dangling heart watch: phenylephrine causes reflex bradycardia (response to alpha1 increase in MAP), this is a baroreceptor mediated mechanism
7. **North compass scout leader: NORepinephrine (alpha>beta1 agonist**
8. North scout blowing beta1 bugle: norepinephrine has some beta1 activity (primarily an ALPHA AGONIST)
9. Norepinephrine increases MAP (alpha1 increase in SVR), increases systolic pressure (alpha1 arteriolar constriction), increases diastolic pressure (alpha1 venous constriction
10. North scouts low dangling heart watch: norepinephrine causes reflex bradycardia (response to alpha1 increase in MAP)
11. North scouts buff contracted bicep: norepinephrine increases cardiac contractility (activates Beta-1)
12. Septic Tank: septic shock (phenylephrine and norepinephrine increase SVR and venous return to treat distributive/hypovolemic shock)
13. Norepinephrine increases PULSE PRESSURE difference between systolic and diastolic (beta1 increase in contractility)
14. "ROL" call sheet held by beta2 tuba player: beta 2 agonists used for bronchodilation have –rol suffix (albuterol, formoterol, salmeterol)
15. **EPIC kiss between alpha and beta camps: EPInephrine (beta>alpha agonist) it's an effective dose dependent vasoconstrictor and cardiac stimulator**
16. Low side of EPIC raft: at LOW doses, epinephrine's BETA Agonist effects predominate
17. Beta2 tuba girls EPIC inhaler: epinephrine caused bronchodilation (beta2 effects)
18. EPIC DIAmond falling off LOW side of raft: at LOW doses, epinephrine decreases DIAstolic pressure (beta-2 vasodilation and decreased SVR)
19. EPIC elevated heart watch and Buff contracted bicep: epinephrine increased heart rate and cardiac contractility (beta1 effects)
20. High side of EPIC raft: at high doses epinephrine's ALPHA AGONIST effects predominate, Vasoconstriction, increased SVR
21. MAP in front of EPIC kiss: Epinephrine increases systolic pressure and decreases diastolic pressure causing an INCREASE IN PULSE PRESSURE, but get an increase in MAP (alpha 1 increase in SVR)
22. Ana + Phil on raft: For anaphylactic shock epinephrine is preferred because alpha 1 counteracts vasodilation, Beta 1 improves blood flow to tissues, and beta 2 opens up the airways
23. **"Just DO Bugling": DOBUtamine (beta1>beta2 agonist)**
24. Beta1 Bugle: dobutamine is primarily a beta 1 agonist "do beta 1 = do but amine"
25. "just do bugling" winding up heart flashlight: dobutamine increases heart rate, contractility, and cardiac output (beta1 effects) to treat refractory heart failure
26. "Just DO Bugling" friend's Beta2 tuba: dobutamine has some beta2 activity (primarily a BETA 1 AGONIST)
27. Map being held by dobutamine character: Dobutamine increases PULSE PRESSURE, difference between systolic and diastolic (beta1 increase in contractility), increases systolic pressure (beta1 increase in CO, decrease diastolic pressure (beta2 arteriolar dilation)
28. Batteries fallen out of heart flashlight: dobutamine can be used in cardiogenic shock
29. Dead heart batteries: cardiogenic shock (dobutamine increases contractility and CO to treat cardiogenic shock)
30. Dobutamine will also be used to induce a heart stress test in people who are unable to physically, this will help to identify areas of ischemia.
31. **"iso-pro-tunnel" between beta1 and beta2 camps: Isoproterenol (beta1 = beta2 agonist)**
32. Tunnel camper's elevated heart watch and contracted bicep: Isoproterenol increases heart rate and contractility (beta-1 effects)
33. Tunnel campers dilated sleeves: isoproterenol causes vasodilation → decreases SVR (beta2 effects)
34. Tunnel Campers Dangling DIAmond earrings: isoproterenol decreases DIAstolic pressure (beta 2 activation and decrease SVR)
35. Tunnel with decreasing lines: Isoproterenol decreases MAP (beta2 decrease in SVR), decreases DIAstolic pressure (beta2 arteriolar dilation), since it has potent beta1 activity it will increase PULSE PRESSURE, difference between systolic and diastolic,
36. Sleeping beta2 camp counselor: beta2 agonists relax uterine smooth muscle tone
37. **"Do not disturb" TERButaline prevents premature labor (beta2 relaxes the uterus)**
38. **"I DREAM of band camp": ritoDRINE prevents premature labor (beta2 relaxes the uterus)**

2.2 Indirect Sympathomimetic: Catecholamine catch and release

1. Indirect view of sympathetic mime: indirect sympathomimetic
2. Catfish: catecholamine's (epinephrine, norepinephrine, dopamine) sympathomimetic will increase the activity of these substances
3. Dock: adrenergic nerve terminal (site of action of indirect sympathomimetics)
4. Retrieving TIRE: tyrosine (the amino acid precursor to catecholamine's) is transported to the nerve terminal
5. L-shaped rope handle: tyrosine is converted to L-DOPA
6. Dope rope: L-DOPA is converted to Dopamine
7. Camp counselor Mitch yelling "My TIRE!": metyrosine (a tyrosine analog) prevents conversion of tyrosine to L-DOPA
8. Sea Vessel: vesicle containing neurotransmitters in the presynaptic neuron
9. North-facing compass on sea vessel: dopamine is converted to norepinephrine in the vesicle, by using dopamine beta hydroxylase.
10. Hauled in catfish NET: norepinephrine transporter (NET) transports norepinephrine (and dopamine) back into the presynaptic neuron
11. NET DAT catfish: dopamine transporter (DAT) transports dopamine back to the presynaptic neuron, NET and DAT are targets for many antidepressant drugs and also cocaine
12. Hot cocoa: Cocaine
13. Hot cocoa scout ignoring catfish net: cocaine inhibits the norepinephrine transporter (NET), Peripheral NET inhibition leads to sympathetic stimulation which can manifest as hypertension, tachycardia, and mydriases. Central dopamine transporter (DAT) inhibition leads to increasing concentrations in the CNS contributing to arousal, addiction, and the development of seizures.
14. Stimulated hot cocoa scout: cocaine can cause agitation, mydriasis, hypertension and tachycardia.
15. Bloody nose: cocaine can cause nasal mucosal atrophy or septal perforation due to vasoconstriction
16. Constricted red crown: cocaine can cause coronary vasospasm and myocardial ischemia
17. Constricted net on anvil: cocaine induced coronary vasospasm can cause angina, look at the tethers that simulate tight constricted arteries.
18. High pressure blocked bugle: beta blockers can cause sever hypertension in cocaine intoxication (unopposed alpha 1 stimulation)
19. **Atom next to empty net: Atomoxetine (NET inhibitor)**
20. Scout distracted watching HD TV: atomoxetine treats attention deficit and hyperactive disorder (ADHD)
21. "V"mat: vesicular monoamine transporter (VMAT)
22. Catfish transported to sea vessel: catecholamine's are transported by VMAT into presynaptic vesicle
23. **Serpent blocking V mat: reserpine and tetrabenazine inhibits VMAT, depleting neurotransmitter stores, SE: DEPRESSION**
24. A FRIEND of MINE releasing catfish: amphetamines displace catecholamine's (Norepi, dopamine) into synapse
25. Distracted by HDTV while catfish are released: amphetamines can be used to treat ADHD
26. **Friend Date on HDTV: methylphenidate (an amphetamine derivative) treats ADHD**
27. **Sleeping scout hitting "sleep mode": modanifil is a stimulant used to treat narcolepsy**
28. Untouched dinner: stimulants (amphetamines, methylphenidate, modafinil) suppress appetite
29. Dope Rope **Sw**I**n**g: D1 and D2 are coupled to Gs and Gi respectively. At low doses dopamine stimulates D1 receptors in the renal vasculature thereby increasing renal blood flow, GFR, and sodium excretion.
30. **Single rope swing: D1 receptor**
31. Low kidney tied to single rope: low doses of dopamine act on D1 receptors to increase RBF
32. Beta Bugler in the middle: medium doses of dopamine activate beta1 receptors (cardiac activation)
33. Alpha1 scout w/ single candle up high: high doses of dopamine activate alpha1 receptors (pressor effects)
34. This is why it can be used as a pressor in heart failure or in shock that has failed treatment with norepinephrine
35. **Double rope swing: D2 receptor**
36. Brain helmet on double rope swing: D2 receptors are found in the CNS

2.3 – Alpha Drugs

1. **Raul with the "law weapon Claw": Clonidine (alpha-2 agonist)**
2. 2 lit alpha candles: alpa-2 receptor agonist
3. Brain –shaped platform: alpha-2 agonists affect the CNS (inhibition of sympathetic tone → reducing blood pressure)
4. Crossed out "sympathy": alpha2 agonists (clonidine) are sympatholytic in txt of HTN
5. High pressure pipes: clonidine treats HTN (reduced sympathetic tone) reducing CO
6. Urgent pressure: clonidine is useful in HTN urgency
7. Distracting mirror: clonidine can be used to treat ADHD
8. Tourette's marionette: alpha2 agonists(clonidine) are useful in the management of Tourette's syndrome
9. **Alpha-shaped rope: alpha methyldopa (alpha2 agonist) methylRopa**
10. 2 lit alpha candles: alpha 2 receptor agonists
11. Brain shaped platform: alpha 2 agonists affect the cns (inhibition of sympathetic tone → reduced BP)
12. High pressure pipes: Alpha methyldopa treats HTN
13. Pregnant: alpha methyldopa is primarily used to treat gestational HTN
14. Lupus wolf: alpha methyldopa can cause a lupus like syndrome
15. **To X-tine: tizanidine (alpha-2 agonist)**
16. 2 alpha candles next to chailr: alpha 2 receptor agonist
17. Relaxing chair: tizanidine (alpha 2 agonist) is a central acting muscle relaxant
18. Extinguished candles: antagonists
19. **Phantom: phentolamine (reversible alpha-1 and alpha-2 receptor antagonist**
20. Extinguished single and double alpha candles: alpha 1 and alpha 2 receptor antagonist
21. Dilated sleeves: phentolamine causes vasodilation (alpha 1 antagonist effect)
22. **Irreversible phoenix tattoo: phenosybenzamine (irreversible alpha 1 and alpha 2 receptor antagonist)**
23.
24. Hot Cocoa: alpha antagonists (phentolamine) can be used to treat cocaine toxicity (avoid beta blockers due to unopposed alpha vasoconstriction
25. Wine and aged cheese contain the sympathomimetic tyramine (metabolized by MOA-A)
26. Mousetrap protecting wine and cheese: MAO inhibitors can prevent the metabolism of tyramine → HTN crisis (treat with alpha blockers, phentolamine)
27. Frozen colorful dessert: pheochromocytoma (catchecholamine secreting tumor of the adrenal medulla)
28. Brain Freeze: catecholamine excess in pheochromocytoma causes headaches, hypertension, palpitation, sweating, use alpha blockers (phentolamine) preoperatively and interoperatively to control blood pressure, Phenoxynenzamine will be given days in advance
29. Tilt table: alpha receptor antagonism can cause orthostatic hypotension
30. Heart reflex reflex hammer: alpha blocker induced hypotension causes reflex tachycardia
31. **Opera singer: "osin" suffix of alpha 1 selective antagonists (prazosin, terazosin, doxazosin, tamsulosin)**
32. Extinguished single alpha candle: alpha 1 receptor antagonist
33. Banister compressing prostate: alpha 1 antagonists (terazosin) treat BPH (relax smooth muscle in the urethra and prostate)
34. Dilated sleeves: alpha 1 antagonists "-osins" cause vasodilation
35. Praying opera singer: Prazosin (alpha 1 antagonist)
36. PTSD dog tags: prazosin can be used to treat PTSD
37. Tilt Table: increased risk of orthostatic hypotension
38. **Mirth and misery: mirtazapine (atypical antidepressant with antagonist effects at alpha-2 and other receptors)**
39. 2 extinguished alpha candles: alpha 2 antagonist
40. Happy face/ frowning mask: mirtazpine enhances serotonin release and treats depression

2.4 Beta Blockers

1. Muted Beta 1 bugle and beta 2 tuba: beta adrenergic receptor antagonists (beta blockers)
2. Brahm's LOLlaby: "-LOL" suffix of beta blockers (propranolol, metoprolol, atenolol.
3. Weak Arm: beta blockers decrease cardiac contractility (by antagonizing effects on beta 1 receptors throughout the myocardium)
4. Music notes: beta blockers suppress at the SA and AV nodes of the heart
5. Low dangling heart watch: inhibition of SA node activity can cause bradycardia
6. Remain un-Blocked – Beta blockers can cause or exacerbate heart block (due to excessive suppression of AV node conduction)
7. Angina anvil: beta blockers are useful in the management of chronic stable angina by slowing the heart rate increasing diastolic filling and then increasing contractility decreasing cardiac oxygen consumption
8. Discarded oxygen line: beta blockers treat angina by reducing myocardial oxygen demand
9. **A-BEAM spotlight on beta 1 bugler: beta 1 selective antagonists (atenolol, betaxolol, esmolol, acebutolol, metoprolol)**
10. A-BEAM spotlight on heart: the beta 1 selective antagonists primarily suppress adrenergic stimulation of the heart (cardioselective)
11. Broken heart strings under A-BEAM spotlight: cardioselective beta blockers are useful in the acute treatment of MI and other acute coronary syndromes (ACS)
12. Failing heart balloon in the A-BEAM spotlight: cardioselective beta blockers are useful in the management of chronic heart failure to reduce excessive tachycardia and high catecholamine levels on the heart
13. **CARVED candleholder next to failing heart: carvedilol (in addition to cardioselective beta blockers) is useful in the management of chronic heart failure.**
14. Extinguished alpha candle on CARVED candleholder: carvedilol is a nonselective beta blocker and alpha 1 blocker
15. Angel: beta blockers reduce mortality in chronic heart failure and post-MI
16. Remodeling: beta blockers reduce cardiac remodeling by protecting the heart from excess circulating catecholamine's
17. High pressure pipes: beta blockers are useful in the treatment of HTN (especially in patients post MI)
18. Closed rain umbrella with blocked beta 1 bugle: beta blockers inhibit production of renin (antagonize beta 1 receptors at the JGA)
19. **Alpha and beta organ stops with extinguished alpha candle: Labetalol is a nonselective beta blocker and alpha 1 blocker**
20. Dilated sleeves: labetalol antagonizes alpha 1 receptors leading to peripheral dilation
21. Pregnant organist: labetalol treats HTN in pregnancy
22. Emergency stop: labetalol is useful intravenously for hypertensive emergency (due to combined alpha and beta effects)
23. Ivy: Used intravenously
24. Dissected organ pipe with IVY: IV beta blockers are useful in acute aortic dissection
25. Big obstructed heart bag: beta blockers are useful in the management of hypertrophic obstructive cardiomyopathy
26. Ponding head bell: beta blockers can be used for migraine prophylaxis for episodic migraines
27. Big stormy bowtie: beta blockers are useful for the sympathomimetic treatment of thyroid storm (blocks catecholamine surge) treat with 3 p's propranolol, prednisone, and propothyrouracil
28. Shaking Baton: beta blockers treat essential tremor
29. Rhythm inducing record: beta blockers have antiarrhythmic properties
30. Wheezing beta 2 tuba player: nonselective beta blockers can exacerbate asthma and COPD (antagonize beta 2 mediated bronchodilation)
31. Draining the muted beta 2 tuba: topical nonselective beta blockers (timolol) treat glaucoma (antagonize beta 2 receptors on the ciliary epithelium → decreasing aqueous humor production)
32. Droopy Tromboner: beta blockers can cause impotence in men
33. Antagonizing plastic bugle: acebutolol (a selective beta 1 antagonist with partial agonist activity)
34. Agonizing pin: pindolol (a nonselective beta blocker with partial agonist activity)
35. Young: not full agonists
36. Popping failing heart: beta blocker with partial agonist activity (pindolol, acebutolol) should be avoided in patients with heart failure or a history of MI)
37. Glucagon packets: glucagon treats beta blocker toxicity (stimulates heart via glucagon receptors)

Digoxin, milirinone, nesiritide

1. **DJ Foxglove: Digoxin – Derived from the foxglove plant**
2. Knocked over banana vending machine: inhibition NA+/K+ ATPase
3. Obstruction salty sodium peanuts: increased intracellular sodium as a result of Na+/K+ ATPase inhibition
4. Salty peanuts sneaking in the calci-yum ice cream: increased intracellular sodium promotes calcium influx at the NA+/Ca2+ exchanger
5. Flexed arm: increased cardiac contractility due the the positive ionotropic effects
6. Deflated heart balloon: symptomatic treatment of chronic systolic heart failure. Only used for symptomatic relief, does not decrease mortality
7. Las Vegas: direct stimulation of the vagus nerve allows for treatment of Atrial arrhythmias
8. Rhythm-inducing record: antiarrhythmics
9. Patients presenting will have HF and A.Fib, labs show elevated in K+

Adverse effects

10. Pile of bananas: Hyperkalemia with acute digoxin toxicity
11. Various dances on the heart shaped dance floor: digoxin may induce various arrhythmias
12. TaSTy scoop: chronic digoxin use may cause scooped concave ST segments on EKG
13. SA music note: side effect of bradycardia due to parasympathetic activity of SA node
14. Dangling heart watch: side effect of bradycardia
15. Av MUSIC NOTE: SIDE EFFECT OF HEART BLOCk DUE TO DIGOXIN TOXICITY
16. Remain Unblocked: Digoxin is contraindicated in SA node heart block, or in use with caution in Beta Blockers
17. GI side effects include nausea, vomiting ,and abdominal pain
18. Yellow spotlight: side effect of Xanthopia (objects appear yellow)
19. Kid stuffed inside banana depleted vending machine: Hypokalemia will exacerbate digoxin toxicity
20. Loop diuretics can cause hypokalemia, along with diarrhea or vomiting may also occur
21. Kidney jukebox with long tapering flag on cracked kidney: Renal insufficiency can make digoxin toxicity worse and will precipitate digoxin rise, the long flag indicates the long ½ life of digoxin, and increasing susceptibility to toxicity
22. Records in kidney jukebox: many arrhythmics inhibit renal clearance of digoxin, increasing susceptibility to toxicity
23. Fabulous: digoxin immune fab is used to reverse toxicity
24. **One in a million: Milrinone**
25. Don't phoster disinterest: milrinone inhibits phosphodiesterase
26. CAMPaign: milirinone decreases CAMP breakdown
27. Flexing arms: milrinone increases cardiac contractility
28. Dilated red donkey ears: milirinon causes arteriolar dilation in HF, but watch for hypotension
29. **Turn the tide: nesiritide**
30. BuMP: BNP analog that increases cGMP
31. Dilated red ears and blue legs: nesiritide causes arteriolar and venous dilation, reducing afterload and preload
32. Salty peanut stream: nesiritide causes natuiresis

ACE inhibitors, ARB's, Aliskiren

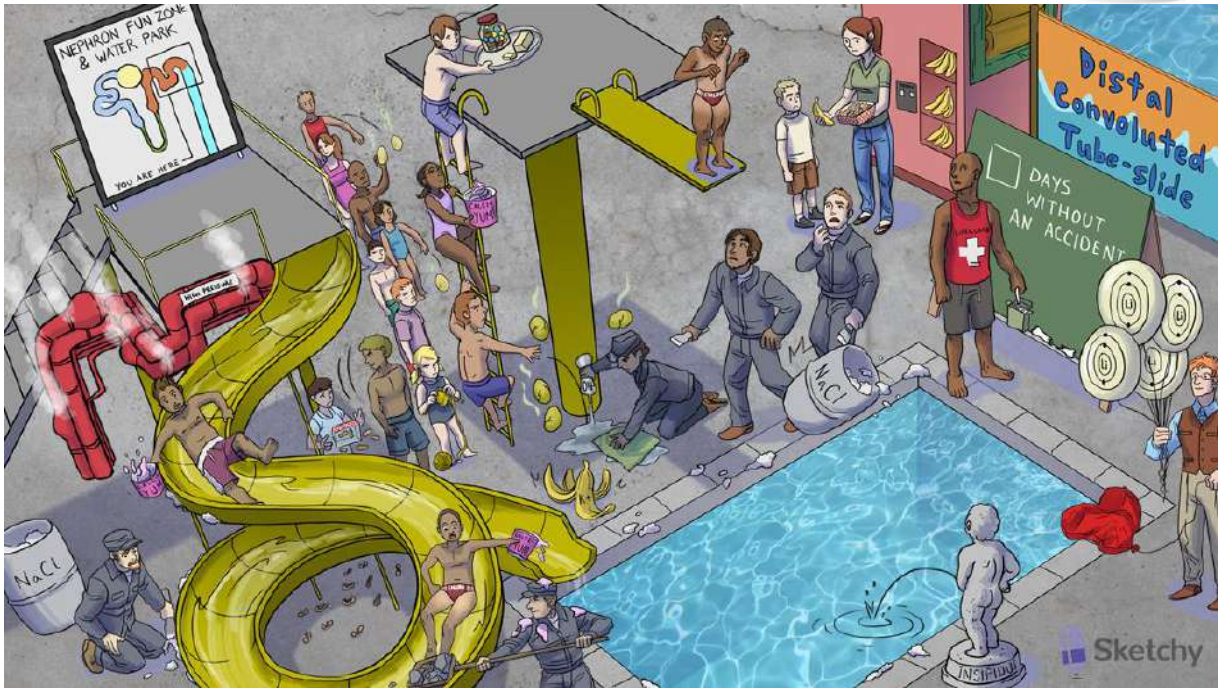
1. Rain umbrella: Renin
2. JGA: is the site of synthesis, storage, and release of Renin by direct sympathetic beta 1 receptors, or decrease in serum Na+, or dec GFR
3. Loose red tie guy circulating from machine to machine: angiotensinogen is cleaved by renin
4. Tense red tie: renin converts angiotensinogen into angiotensin I
5. Lung Vest: ACE is located in the vascular endothelium of the lungs
6. Two tense red suspenders with the wining ACE: angiotensin II is converted from angiotensin I by ACE in the lungs
7. Tense red suspenders: Angiotensin II causes vasoconstriction.
8. Grounds filtration rate increased: increased angiotensin II increases GFR
9. Pinched efferent end of straw: angiotensin II constricts the efferent arteriole
10. When GFR plummets ATII preserves GFR
11. Salty sodium peanuts at the pro cart track: angiotensin II acts at the proximal tubule to increase sodium absorption
12. Suspenders at the mineral bar: ATII increases aldosterone release from the adrenal cortex,
13. Banana peels at the mineral Bar: the mineralocorticoid aldosterone acts on the collecting ducts to increase Na+ and fluid retention at the expense of K+
14. **Ace on table: ACE inhibitors**
15. APRIL showers: -pril suffix common to all ACE inhibitors
16. Suspenders with the losing hand: ACE inhibitors prevent ATI to ATII
17. Floppy Red suspenders: ACE inhib counteract the presser effects of ATII
18. Ace inhibitors and arbs decrease GFR, dilate the efferent arteriole, decrease sodium-bicarb reabsorption in the PTC, and decrease aldosterone release
19. Credit card: ACE inhibitors can cause an expected bump in creatinine
20. Fainting: ACE inhibitors can cause significant hypotension and syncope in patients with high renin levels (in heart failure)
21. Cheering single tense neck tie: ACE inhibitors increase levels of ATI and renin
22. Raised banana daiquiri: ACE inhibitors can cause hyperkalemia due to decreased aldosterone levels
23. Failing heart balloon: ACE inhibitors are first line agents for the treatment of chronic heart failure
24. Angel: Ace inhibitors reduce mortality in heart failure and MI
25. Remodeling: ACE inhibitors decrease ATII mediated cardiac remodeling
26. Broken heart strings: ACE inhibitors are used in myocardial infarction
27. High pressure pipes: ACE inhibitors are the first line agents used for HTN
28. Candy shop: ACE inhibitors slow the progression of diabetic nephropathy
29. Album: patients with albuminuria and blood pressure greater than 130/80 are started on and ACE inhibitor
30. **Adverse effects**
31. Coughing dealer: ACE inhibitors can cause a dry cough due to an increase of bradykinin
32. Braids: ACE inhibitors can increased bradykinins and substance P causing lung irritation and inflammation
33. "C" shaped ring on fat lip: ACE inhibitors are contraindicated in hereditary angioedema (due to C1 esterase deficiency)
34. Tarantula: ACE increases the risk of fetal hypotension
35. Fire extinguisher in cracked kidney glass: co-administration of ACE inhibitors with NSAIDS can precipitate acute kidney injury due to afferent renal constriction leading to decreased GFR
36. Contraindicated kidney purse straps: ACE inhibitors are contraindicated in bilateral renal artery stenosis because the ATII needs to vasoconstriction
37. Credit card: ACE inhibitors can precipitate acute renal failure in bilateral renal artery stenosis indicated by a persistent increase in creatinine
38. **SoRry Taken: -sartan suffix common to all ARB's (angiotensin receptor blocker)**
39. Braids: ACE inhibitors can increase bradykinins, this can be avoided by using ARB's
40. Raised banana daiquiri: ARB's can increase K+ retention causing hyperkalemia due to decreased aldosterone levels
41. **High Risk: aloskerin – a direct renin inhibitor**
42. Losing neck tie gambler: aliskaren prevents renin from being released preventing ATI from being converted to ATII
43. Bananas: aliskiren can increase K+ retention causing hyperkalemia due to decreased aldosterone levels

Acetazolamide, Mannitol

1. WHERE EVER SODIUM GOES, WATER WILL FOLLOW
2. Pro cart track: proximal convoluted tubule
3. Proximal convoluted tubule: site of action of acetazolamide and mannitol; sodium, Cl-, K+, glucose and amino acids will be absorbed here. Bicarb 85% is reabsorbed here
4. Banana vending machines: Na+/K+ ATPase on the basolateral membrane
5. Three P batteries: ATPase
6. Yellow track: lumen of tubule
7. Grey track: intracellular compartment
8. Wall is the basolateral membrane
9. Track worker distributing peanuts inside and letting H+ helmets out. Na+/H+ exchanger located on the apical membrane
10. biCARb race car: Bicarb in the lumen in the PCT
11. Rider with H+ helmet sitting in biCARb secreted H+ combines with the bicarb in the tubular lumen to form carbonic acid H2CO3
12. Car battery anhydrase on the inside track: lumen carbonic anhydrase (CA)
13. Battery powered car producing H2O and CO2 exhaust: Luminal CA converts carbonic acid to H2O and CO2
14. H2O and CO2 exhaust on the outside track: H2O and CO2 enters the intracellular space via diffusion
15. Water is sprayed over the wall: water is reabsorbed with solutes at the PCT (High Permeability)
16. Car battery anhydrase on the outside track: intracellular CA converts H2O and CO2 back into carbonic acid (H2CO3)
17. H+ helmet leaving the biCARb: intracellular carbonic acid disassociated back into H+ and Bicarb
18. Recycled H+ helmet: H+ transported back into the lumen by the Na+/H+ exchanger
19. biCARb taken away: intracellular bicarb is absorbed vis basolateral transporter
20. Battery acid breaking car battery: Acetazolamide inhibits carbonic anhydrase (preventing reabsorption of bicarb)
21. Spilled alkaline substance on inside track: CA inhibitors (acetazolamide) cause bicarb to stay in the tubular lumen leading to urine alkalization
22. Dropping salty peanuts on the inside of track: CA inhibitors prevent the reabsorption of sodium (with bicarb) causing naturiesis
23. biCARb taken away: CA inhibitors cause excretion of bicarb
24. Close the gap #2!: CA inhibitors cause a normal anion gap metabolic acidosis leading to a hyperchloremic state
25. Spilled eyeball cups: CA inhibitors (acetazolamide) decreased production of aqueous humor (useful in the management of glaucoma) very common to be used
26. High pressure head balloon: CA inhibitors decrease production of CSF (useful in the management of idiopathic intracranial HTN, pseudo tumor cerebri)
27. High elevation: CA inhibitors are useful in the treatment and prevention of mountain sickness, allowing the increasing ventilation decreasing hypoxia
28. Buildup of bicarb in the tubule will increase the pH of the urine, leading to prevention of uric acid kidney stone, promoting ca++ ston
29. Banana peel: CA inhibitors can cause hypokalemia (potassium wasting)
30. Two tubes of acid: CA inhibitors cause a type 2 renal tubular acidosis (defect in proximal bicarb reabsorption)
31. Rocks on the inside track: CA inhibitors promote the formation for calcium phosphate stones (insoluble at high pH)
32. Rotten sulfur eggs: CA inhibitors are sulfa drugs
33. **Tall Man: mannitol** (osmotic diuretic) acts at the PCT and descending limb of the loop of Henle, pulls water out to be excreted
34. High pressure head balloon: mannitol draws free water out of the CNS (useful in the treatment of elevated intracranial pressure) can be used urgently
35. Spilled eyeball cups: Draws free water out of the eye, (decreases intraocular pressure)
36. Tall man causing wet lungs: mannitol induced expanded extracellular volume can cause pulmonary edema and hyponatremia
37. Tall man dousing failing heart balloon: mannitol induced expanded extracellular volume can exacerbate heart failure.
38. Elevated salty peanuts: mannitol induced water depletion can cause hypernatremia
39. Spilled salty peanuts: mannitol induced expanded extracellular volume can cause hyponatremia

Loop Diuretics

1. Loop de Loop of Henle: Loop of Henle
2. Thick ascending Limb of the loop of Henle: site of action of most loop diuretics. Most relevant is sodium chloride blocks
3. Banana vending machine: Na+/K+ ATPase on the basolateral membrane, that will pump sodium into the interstitium
4. Three P batteries: ATPase
5. Yellow track: lumen of the renal tubule
6. Platform: intracellular compartment
7. Background wall is the interstitium
8. Track worker taking peanuts, bananas, and 2 chloride packets: Na+/K+/2Cl cotransporter (NKCC) reabsorbs these ions at the luminal membrane of the TAL thick ascending limb
9. Water secured in car: the TAL is impermeable to water (diluting segment)
10. **Furious kid: furosemide (loop diuretics)**
11. Furious kid clinging to food: furosemide selectively blocks the NKCC transporter on the luminal membrane of the TAL, keeping sodium in the lumen in the tubule representing furosemides ability to reduce reabsorption of NaCL causing naturesis.
12. Loop diuretics are the most efficacious currently
13. **Ethics: ethacrynic acid (loop diuretic)**
14. Furious kid clinging to magnets and calci-yum ice cream: by blocking the NKCC, Loop diuretics reduce the lumen positive potential, promoting the excretion of Mg2+ and Ca2+
15. Falling magnets: prolonged use of loop diuretics can cause hypomagenesmia, especially in diet deficient patients
16. Falling calci-yum ice cream: Loop diuretics can cause hypocalcemia (rare)
17. **Pro-slugger: prostaglandins**
18. Furious kid wielding pro-slugger: loop diuretics induce the expression of COX-2, synthesizing prostaglandins that enhance salt excretion and dilate the afferent arteriole
19. Kid opening a path to afferent line of coaster: Prostaglandins will increase RBF in the afferent arteriole of the glomerulus. Thus enhancing diuretic action
20. Fire extinguisher inhibiting the pro-slugger: NSAIDs decrease prostaglandin synthesis, interfering with the actions of loop diuretics
21. Failing heart balloon: loop diuretics are 1st line for the symptomatic treatment of acute decompensated heart failure with fluid overload, reduction for peripheral or pulmonary edema
22. Wet lungs: Loop diuretics cause maximal amount of diuresis in the shortest amount of time. Used 1st line in acute heart failure with orthopnea that has crackles in the lungs and JVD. Loops will help with PRELOAD function. This will not help prolong the life of the heart.
23. Yellow inner tube: loop diuretics treat ascites in liver failure
24. High pressure pipes: loop diuretics can be useful in the treatment of HTN
25. Diuretics lower blood pressure by decreasing body sodium stores
26. Banana peel: loop diuretics are potassium wasting causing hypokalemia, hypokalemia can exacerbate any underlying arrhythmias in heart failure
27. Loud gong: loop diuretics can cause dose related hearing loss
28. Stinky sulfur eggs: most loop diuretics are sulfur drugs
29. Sulfa-less ethics: Ethacrynic acid is not a sulfa drug
30. Kidney filled with blue tickets: Interstitial nephritis can be caused by loop diuretics
31. Knitting needles: loop diuretics can cause hyperuricemia, may lead to gouty arthritis
32. Park employee cleaning the floor with contracted bleach bottle: loop diuretics can cause contraction alkalosis, causing dehydration and metabolic alkalosis by many mechanisms.



Thiazides - Distal Convoluted Tube-Slide

1. Distal convoluted tube slide: Distal convoluted tubule
2. Distal convoluted tubule: site of action for thiazide diuretics
3. Banana vending machine: Na+/K+ ATPase on the basolateral membrane
4. Three P batteries: ATPase
5. Yellow tube slide: tubular lumen
6. Area outside slide: intracellular compartment
7. Sodium chloride salt scraper: NaCl cotransporter reabsorbs these ion at the apical membrane of the DCT
8. Active slider dropping the calci-yum ice cream: calcium is actively reabsorbed at the DCT (regulated by PTH)
9. **Chloro-thighs, thiodore Roosevelt on high dive: Hydrochloriathiazide and chlorothalidone (thiazide diuretics)**
10. Sodium chloride dumping into pool: thiazides inhibit NaCl reabsorption by blocking the NaCl cotransporter on the apical membrane (causing natiuresis)
11. Chloro-thighs kid dropping calci-yum: thiazide diuretic enhance calcium reabsorption, may be result at proximal and distal tubule. At the proximal tubule thiazide induced volume depletion leads to enhanced sodium and passive calcium reabsorption. At the distal tubule thiazides block sodium entry into the epithelial cell. This decrease of sodium entry enhances sodium calcium exchange at the basolateral membrane leading to the enhanced absorption of calcium
12. High pressure pipes: thiazide diuretics are one of the first line treatments for mild or moderate HTN
13. Loop diuretics are first line for acute, not thiazide
14. Floppy failing heart balloon: use of thiazides can be useful in the symptomatic treatment of heart fauilure (loop diuretics are first line)
15. Insipidus fountain: thiazide diuretics treat nephrogenic diabetes insipidus, thiazide diuretics can reduce polyuria and polydipsia in nephrogenic DI, and this paradoxical association is due to a hypovolemia induced increase in Na and H2O reabsorption in more proximal segments of the nephron where ADH is not working in the distal tubule. Thus allowing for more electrolytes to be retained.
16. Removing tube slide stones: thiazide diuretics can be used to prevent calcium stones (increased calcium reabsorption causes hypocalciurea) found in hyperparathyroidism, sarcoidosis,
17. New calcium chalk: thiazide diuretics may benefit patients with osteoporosis
18. Elevated calci-yum ice cream: thiazide diuretics can cause hypercalcemia
19. Elevated Candy jar and stick of butter: Thiazide diuretics can promote Hyperglycemia and also hyperlipidemia.
20. HIGHdroclorothiazide and the HIGH dive raises a lot of lab values
21. Yellow knitting needles: thiazide diuretic can cause hyperuricemia (can precipitate gout) due to hypovolemia and hyper absorption of urea
22. "Lift"ium balloons: thiazide diuretics decrease the amount of lithium cleared, therefore there will be increased serum lithium levels
23. Grey kid pissing in the pool: Lithium is a common cause of nephrogenic diabetes insipidus
24. Potassium depleted banana peel: Thiazide diuretics block the Na+/Cl+ cotransporter in the distal convoluted tubule, increasing sodium delivery to the collecting duct. This leads to increasing potassium secretion by the collecting duct in exchange for Na+ reabsorption leading to hypokalemia
25. Spilled peanut shells: thiazides diuretics can cause hyponatremia
26. Rotten eggs being tossed: Thiazides are sulfa drugs
27. Contracted bleach bottle: thiazides can cause contraction alkalosis, metabolic acidosis by hypovolemia induced renin production by the kidneys. Increasing aldosterone which causes increased H+ excretion at the collecting duct and more ATII leading to increased sodium bicarb reabsorption at the proximal convoluted tubule

K+ sparing Diuretics – Pt 1

1. Central gutter: work in the collecting duct
2. Collecting duct (site of action of the K+ sparing diuretics)
3. Mineral-O-Food court: mineralocorticoids site of action (aldosterone) in the collecting duct
4. Principal court: principle cell of the collecting duct (major site of Na+/K+/H2O transport
5. Banana vending machine: Na+/K+ ATPases on the basolateral membrane, help pump reabsorbed sodium into interstitium
6. Three P batteries: ATPase
7. Food court ground: intracellular compartment
8. Salt-E sNaC cart: epithelial Na+ channels (ENaC) reabsorb Na+ across the luminal membrane of the collecting duct and distribute to the interstitium
9. Water in gutter: tubular lumen
10. Banana stand dumping bananas: K+ channels allow the excretion of K+ across the luminal membrane of the collecting duct
11. Salt-E sNaC care toppling banana stand: reabsorption of Na+ creates a negative luminal potential that facilitates K+ excretion, this is due to the negative electrical potential caused by the absorption of sodium into the interstitium that will draw the potassium into the tubular lumen
12. Alpha intercontinental food truck: alpha intercalated cell of the collecting duct (major site of H+ excretion)
13. Batter powered acid pump: H+ATPase on the apical membrane of the alpha intercalated pumps H+ into the lumen
14. Three P batteries: ATPase
15. Mineral court services: intracellular mineralcorticoids (aldosterone) receptor
16. Mineral key: aldosterone binds to the salt-E sNaCk upregulating ENaCs on the apical membrane, increasing Na+ reabsorption
17. Mineral Key activating the banana vending machine: aldosterone upregulates Na+/K+ ATPse on the basolateral membrane
18. Mineral key activating the banana stand: aldosterone upregulates K+ channels on the apical membrane, increasing K+ excretion
19. Loops and thiazides activate renin (and aldosterone) due to hypovolemia and cause a hypokalemia because they leave all of the sodium in the tubular lumen until it gets to the collecting duct. Then there is an attempt by the ENAC to retain all of the sodium at the expense of potassium, and facilitate H+ secretion causing a metabolic alkalosis.
20. **Tangerines: triamterene (K+ sparing diuretic)**
21. Tangerines blocking the salt-E sNaCk cart: triamterene inhibits Na+ reabsorption through ENAC
22. **Almonds: amiloride (K+ sparing diuretic)**
23. Almonds blocking the Salt-E sNaC cart: amiloride inhibits Na+ reabsorption through ENaC
24. Salty sodium peanuts falling into the duct: K+ sparing diuretics inhibit Na+ reabsorption at the collecting duct, promoting natiuresis
25. **Apple with the teacher: eplerenone (K+ sparing diuretic)**
26. Teacher with apple antagonizing the mineral court services man: eplerenone antagonizes the mineralocorticoid receptor
27. **Health inspector with Spiral bound notebook: spironolactone (a K+ sparing diuretic)**
28. Health inspector antagonizing the mineral court services man: spironolactone antagonizes the mineral corticoid receptor
29. Crumbling mineral mountain: K+ diuretics (spironolactone, eplerenone) are useful in the treatment of 1 and 2 hyperaldosteronism, conn syndrome, ACTH etc…
30. Failing heart balloon: K+ diuretics (spironolactone, eplerenone) are useful in the treatment of heart failure to prevent K+ wasting
31. Remodeling: mineralocorticoid antagonists (spironolactone, eplerenone) prevent myocardial remodeling induced by high level of aldosterone
32. Angel: mineralocorticoid antagonists decrease mortality in heart failure
33. Insipidus fountain: amiloride is useful in the treatment of Li+ induced nephrogenic diabetes insipidus, this will block lithium entry into collecting duct cells increasing clearance of lithium

K+ Sparing Diuretics - CONT

34. Little gnome blocked by almonds and tangerines: amiloride and triamterene are useful in the treatment of Liddles syndrome (overactive ENaCs)
35. Elevated banana's: K+ sparing diuretics can cause mild or even dangerous hyperkalemia, seen in renal disease when there is a decreased excretion of potassium and with drugs that decrease renin and angiotensin activity such as Beta blockers and ACE inhibitors. Use a potassium wasting diuretic with these pts
36. Acid spill: K+ sparing diuretics cause a normal anion gam metabolic acidosis (by decreasing the function of the H+ATPase) by inhibition of aldosterone's effects at the collecting duct
37. Worker holding 4 acid tubes: K+ sparing diuretics inhibit the effects of aldosterone in the collecting duct causing a type 4 renal tubular acidosis
38. Big K: type 4 RTA is associated with hyperkalemia: this is the only one associated with hyperkalemia.
39. Spironolactone is much less selective with the aldosterone receptor, spironolactone is a synthetic steroid that can bind to other steroid receptors and processing enzymes. This has anti androgenic side effects and can block testosterone synthesis.
40. Fried male symbol: testosterone produced from cholesterol
41. Health inspector inhibiting 17 aplha "fry"droxylase: spironolactone inhibits 17alpha-hydroxylase. Important in the adrenal cortex and testes
42. Bubbling ovary shaped vats: spironolactone treats the symptoms of androgen excess in polycystic ovarian syndrome, used after a trial of birth control
43. Bushy beard: symptoms of androgen excess (hirsutism) in PCOS are treated with spironolactone
44. Preventing boy from receiving onion ring: spironolactone directly antagonizes the androgen receptor
45. Lids on chest: Gynecomastia caused by spironolactone
46. Droopy churro: Spironolactone can cause impotence and decreased libido

Calcium Channel Blockers

1. L-Shaped handle: calcium channel blockers target voltage gated L Type calcium channels specifically
2. Smooth muscle tile: Dihydropyridines block L-Type calcium channels in smooth muscle
3. Cardiac muscle tile: non-dihydropyridines block L-Type calcium channels in cardiac muscle
4. **Dairy: dihydropyridines**
5. **Non-dairy: non dihydropyridines**
6. Dilated dairy nozzle: dihydripyridines cause vasodilation
7. Dippin station: -dipine suffix of dihydropyridines (nifedipine, amlodipine, nicardipine)
8. **Very vanilla: verapamil (a non dihydropyridine)**
9. Small sized nozzle: Verapimil has very minimal dilatory activity
10. **Delicious dark chocolate: diltiazem (a non-dihydropyridine)**
11. Medium sized muscle: Diltiazem has some vasodilatory activity
12. Weak kid at the non-dairy: non-dihydropyridines decrease cardiac contractility
13. Music notes on non-dairy sign: non-dihydropyridines decrease activity at the SA and AV nodes
14. Low dangling heart pocket watch: Bradycardia with SA node inhibition
15. High pressure pipes: CCB's treat hypertension
16. Emergency shut off: an IV dihydropyridine (clevidipine, nicardipine) can treat hypertensive emergency
17. **Large knife: nifedipine (a dihydropyridine)**
18. Pregnant knife lady: nifedipine is used to treat hypertension in pregnancy or post-partum
19. Angina anvil: CCB's treat stable angina
20. Dilated coronary crown: dihydropyridines vasodilate coronary arteries. Reduce coronary resistance, increase coronary blood flow and may enhance development of collaterals
21. Reduced anvil load: dihydropyridines reduce afterload by causing increased peripheral vasodilation. Reducing myocardial oxygen demand
22. Discaarded oxygen line: non-dihydropyradines decrease myocardial oxygen demand by acting as a negative ionotrope and chronotrope and by lowering systemic blood pressure
23. Anvil medal: CCB's treat prinzmetal angina, varying form of angina attributed to vasocoronary spasm. Episodes are predominantly at rest and occur at night.
24. Blue fingertips: dihydropyridines treat raynaud's syndrome, "an exaggerated response to cold temperature or stress" nifedipine and amlodipine can treat
25. Brain shaped ice cream with berries: Dihydropyridines can be used to treat subarachnoid hemorrhages commonly associated with berry aneurysms. May have a history of polycystic kidney disease
26. Need Mo'dippin with berry brain ice cream: nimodipine prevents vasospasms after a subarachnoid hemorrhage, vasodilates cerebral vessels
27. Pounding head bell: migraine prophylaxis with verapamil
28. Jukebox: Non-dihydropyridines have antiarrhythmic properties, this will help with A.Fib and A.Flutter
29. Adverse effects
30. Lightheaded patron: Dihydropyridines can cause lightheadedness, Headache, flushing,
31. Baggy pants: peripheral edema from dihydropyridines due to preferential dilation from precapillary vessels from the arterioles increased capillary hydrostatic pressure
32. Heart reflex hammer: dihydropyridines can cause reflex tachycardia, especially with nifedopine
33. Knife cutting heart: Short acting nifedipine has a high chance of side effects because of how active it is. Nifedipine can exacerbate myocardial ischemia due to reflex tachycardia – avoid in patients with unstable angina or MI
34. Clogged toilet: verapamil can cause constipation
35. Expanding gum: verapamil can cause gingival hypertrophy
36. Remain unblocked: verapamil and diltiazem care relatively contraindicated in patients with heart block
37. Verapamil or diltiazem combined with a beta blockers may produce excessive AV block
38. Failing heart balloon locked out of store: CCB'sc an worsen heart failure due to hypotension, and can increase sympathetic activity

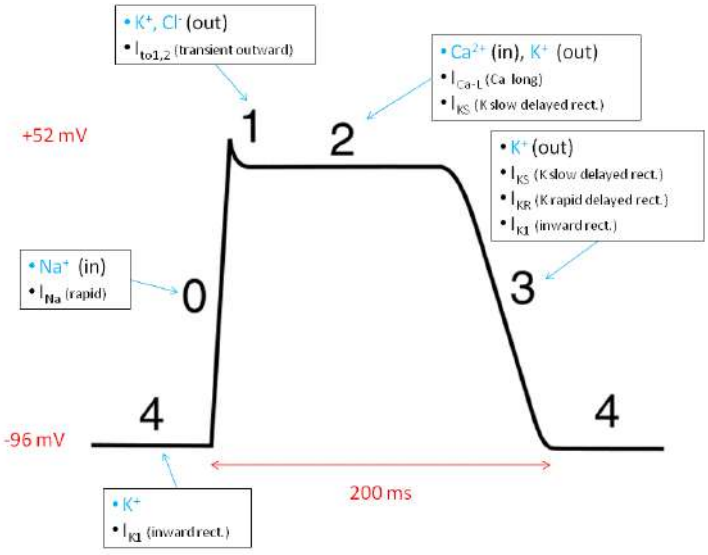
Primary hypertension and Hypertensive emergency

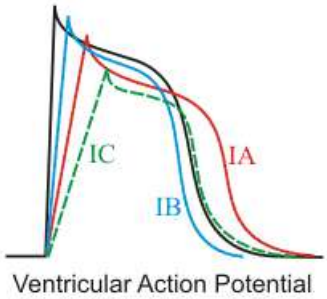
1. High pressure pipes: antihypertensives
2. Primary deck: primary (essential) hypertension treatment
3. Two life preservers if >20 LBS: two antihypertensives for BP >20/10 mmHg above goal
4. Main TXT is thiazide diuretics, Long acting CCB's, ACE inhibitors or ARBS
5. **Chloro-thighs: hydrochlorothiazide is a first line agent for treating primary HTN, chlorthalodone**
6. Elderly black man with Calci-YUM ice cream: Black and elderly patients respond well to a CCB for txt of primary HTN
7. **Dippin' pool: long acting dihydropyridines (-dippin suffix) treat primary HTN**
8. Cloro-thighs: Black and elderly patients respond well to hydrochlorothiazide for treatment of primary HTN
9. **ACE-stealing dealer: ACE inhibitors treat primary HTN**
10. Ace inhibitors are first line treatment for hypertension in patients with heart failure (failing heart balloon), MI (broken heart strings), and diabetes (candy jar)
11. Emergency shut off switch: treatment for hypertensive emergency (blurry vision, lung crackles, headache)
12. 180 protractor over 12 inch ruler: hypertensive emergency (SBP>180 or DBP>120)
13. Hole in the titanic: hypertensive emergency is defined by end organ damage plus elevated BP (SBP>180 or DBP>120)
14. Muted beta bugles: Beta-1 antagonists (esmolol and metropolol) can be used for hypertensive emergencies
15. Ivy: IV beta blockers administration treats hypertensive emergency
16. Alpha and beta organ stops: Labetalol (alpha and beta antagonist) can be used in hypertensive emergency
17. Dilated red smoke stack: many agents used in hypertensive emergencies are potent vasodilators, which may result in a rebound hypotension and tachycardia, and sodium and fluid retention from renin increase
18. Heart shaped reflex hammer and rain umbrella: hypotension leads to reflex tachycardia and increased renin levels
19. Unloaded scale: vasodilation reduces afterload
20. Calci-yum ice cream lady with red floppy sleeves: IV calcium channel blockers (nicardipine, clevidipine) can be used in hypertensive emergency and to vasodilate
21. **Nice card: nicardipine (dihydropyridine CCB)**
22. **Clover Clevitipine (dihydropyridine CCB)**
23. Dilated red sleeves: dihydropine CCB's can cause arteriolar dilation to reduce systemic dilation
24. **Hydro-Boat: hydralazine treats hypertensive emergency**
25. Dilated red hose: hydralazine is a direct arteriolar vasodilator
26. Pregnant woman boarding hydro-boat: hydralazine is safe in pregnancy
27. Fainting: hydralazine can cause hypotension
28. Anvil anchoring hydro boat: hydralazine induced reflex tachycardia can worsen angina
29. Beta-1 bugler leaving to get on hydro boat: administration beta-blocker with hydralazine to prevent reflex tachycardia
30. Muted beta 1 bugler deflecting reflex hammer and rain umbrella: beta blockers minimize the reflexive sympathetic activation
31. Dynamite: nitrate (nitroglycerine)
32. Failing heart balloon: Hydralazine combined with a nitrate (nitroglycerine) treats heart failure, especially in left ventricular systolic dysfunction
33. Guardian angel: hydralazine (arteriolar vasodilator) combined with a nitrate (veinodilator) provides a mortality benefit for certain patients in heart failure
34. Lupus wolf: hydralazine can cause a drug induced lupus syndrome
35. **Nitro-prusside speedboat: nitroprusside can be used in hypertensive emergency**
36. Nitric oxide exhaust: nitroprusside causes vasodilation via nitric oxide
37. Grump: nitric oxide promotes smooth muscle relaxation by increasing cyclic GMP, causing decreased myosin activity and dephosphorylation
38. Sailor with dilated red sleeves and blue pants: nitroprusside causes arteriolar and venous dilation
39. Blue Cyanide exhaust pipe gas: Cyanide poisoning is a side effect of nitroprusside **Old lady Pam: fenoldopam treats hypertensive emergency**
40. Single rope: fenoldopam is a selective dopamine 1 receptor agonist, with no effect on alpha or beta receptors
41. Camping tent: fenoldopam (D1 agonist) increases cAMP, causes vasodilation in most arteriolar beds leading to reduced systemic resistance
42. Dilated red crown: fenoldopam causes coronary vasodilation
43. Rope connected to kidney: fenoldopam dilates renal arteries increasing renal perfusion while lowering blood pressure,
44. Salty peanuts in the water: fenoldopam (D1 Agonist) is a natriuretic, leading to increased Na+ and H20 excretion

Antiarrhythmic Class I A-C (rhythm control): **No (Class I sodium)** Bad Boy (Beta Blockers) Keeps (Potassium) Clean (calcium)

1. Soloist: class I antiarrhythmics
2. Microphone stand Phase 0: of the AP upstroke dictated by Na+
3. Wire off the microphone is Phase 2: plateau dictated by Ca2+
4. Phase 3 downslope: repolarization dictated by K+
5. Soloist holding peanut jar: Class I antiarrhythmic block sodium channels
6. Soloist tipping mic stand: class I antiarrhythmics decrease the slope of phase 0 upstroke (slows conduction of the cardiac AP) AP will almost look tipped over with a decreased slope
7. Inactivating spoon in open peanut butter jar: Class I antiarrhythmics bind to open or inactivated Na+ channels.
8. Heart tipping mic stand: "use dependence" – class I antiarrhythmics have a greater effect on rapidly depolarizing tissues (increased heart rate causes slower phase 0 upstroke)
9. Potassium banana curtain: K+ current present during Phase 2 (plateau) and phase 3 (repolarization) of the cardiac action potential
10. Illuminated atria, ventricles, and His-perkinje system: class I antiarrhythmics affect the Na+ dependent cardiac action potential (no action at the SA and AV nodes)
11. Wide QRS shaped crack: class I antiarrhythmis widen the QRS complex on the ECG (decreased AP conduction velocity) this will happen when the HR increases because that will increase the effect of the drug
12. **Class IA antiarrhythmics: quinidine, procainiminde, dysopyramide "Double, Quarter, Pounder"**
13. **Dining prom queen: quinidine (class IA antiarrhythmic)**
14. **Prom King: procainamide (class IA antiarrhythmic)**
15. **"Disapears!" disopyramide (class IA antiarrhythmic)**
16. Binding strength: IC>IA>IB
17. Prom queen lightly holding peanut butter jar: class IA antiarrhythmics have an intermediate binding affinity to the Na+ channel (intermediate use dependence, moderate slowing of phase 0 upstroke) <u>increased AP duration</u>
18. Pushing away the curtain: class IA antiarrhythmics also block K+ channels prolonging phase 2 and 3 of the cardiac action potential → prolonged refractory period
19. Illuminated top and bottom of IA heart: class IA antiarrhythmics treat supraventricular and ventricular arrhythmias
20. White wolf pack: class IA antiarrhythmics treat WPW syndrome (a type of SVT involving extra signals in a accessory pathway)
21. Tin cans: quinidine toxicity can cause cinchonism (syndrome of tinnitus, headache, dizziness)
22. Broken plates: quinidine can cause thrombocytopenia
23. Prom kings lupus wolf: procainamide can cause a lupus – like syndrome raising an ANA titer
24. Darts in failing heart balloon: dysopyramide can exacerbate heart failure (negative ionotrophy)
25. Twisted torsades streamer: Class IA antiarrhythmics can cause Q-T interval prolongation (Precipitates torsades)
26. Whenever the potassium current is prolonged and thrown aside it can cause torsades de pointes (prolonged QT intervarl)
27. **Class IB antiarrhythmics "Lettuce, Tomato, Mayo"**
28. **Lied: lidocaine (class IB antiarrhythmic)**
29. **Friendly towing: Phenytoin (an anti-epileptic) that shows some type IB properties**
30. **Mexican flag: mexilitine (class IB antiarrhythmic)**
31. Dropped peanut butter jar: Class IB antiarrhythmic have a low binding affinity for the Na+ channel (low use dependence, modest slowing of the phase 0 upstroke) <u>Decreased AP duration</u>
32. Pulling the curtain: class IB antiarrhythmics shorten phase 2 and 3 of the cardiac action potential → shortened refractory period so no chance for torsades de pointes
33. Illuminated and cracked bottom of heart: Class IB antiarrhythmics treat ventricular arrhythmias (especially in ischemic tissues) in sodium channels spending more time in the open and resting state because of the longer action potential
34. Broken illuminated IB heart: has a greater tendency to work with ischemic heart because of the reduced resting membrane potential delays sodium channel transition from inactive back into resting state resulting in increased drug binding
35. "DEAD": class IB antiarrhythmics treat ischemia induced ventricular arrhythmias one of the most common causes of death in the acute period following an MI
36. Brain trucker hat: class IB antiarrhythmics cause neurological problems (parasthesias, tremor, convulsions)

37. **Class IC antiarrhythmics Heart floor: propafenone, flecaoinide "Fries Please"**
38. **Flakes: Flecainide (class IC antiarrhythmic)**
39. **Purple phone: propafenone (class IC antiarrhythmic)**
40. Tightly held peanut butter jar: Class IC have a atrong binding affinity for the Na+ channel (strong use dependence, drastic slowing of the phase 0 upstroke) dramatic effect on QRS duration, prolongs ERP in AV node, no change in AP Duration
41. Untouched potassium curtain: class IC antiarrhythmic do not affect the cardiac action potential duration
42. Illuminated top and bottom of heart: class IC antiarrhythmics treat supraventricular (A.Fib) and ventricular arrhythmias
43. Irregularly Irregular signal: Class IC antiarrhythmics treat atrial fibrillation (and flutter)
44. Converting the signal: class IC antiarrhythmics can restore and maintain normal sinus rhythm in A. Fib and Flutter
45. "Healthy Hearts Only"!: class IC antiarrhythmics are contraindicated in patients with history of structural or ischemic heart disease (proarrhythmic effects)



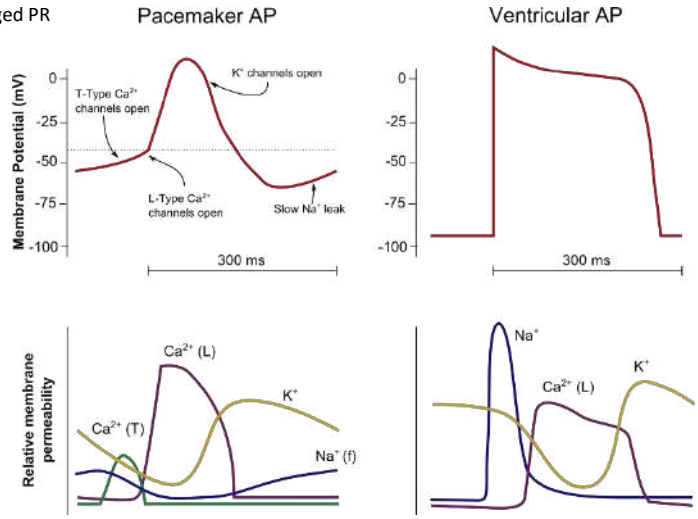


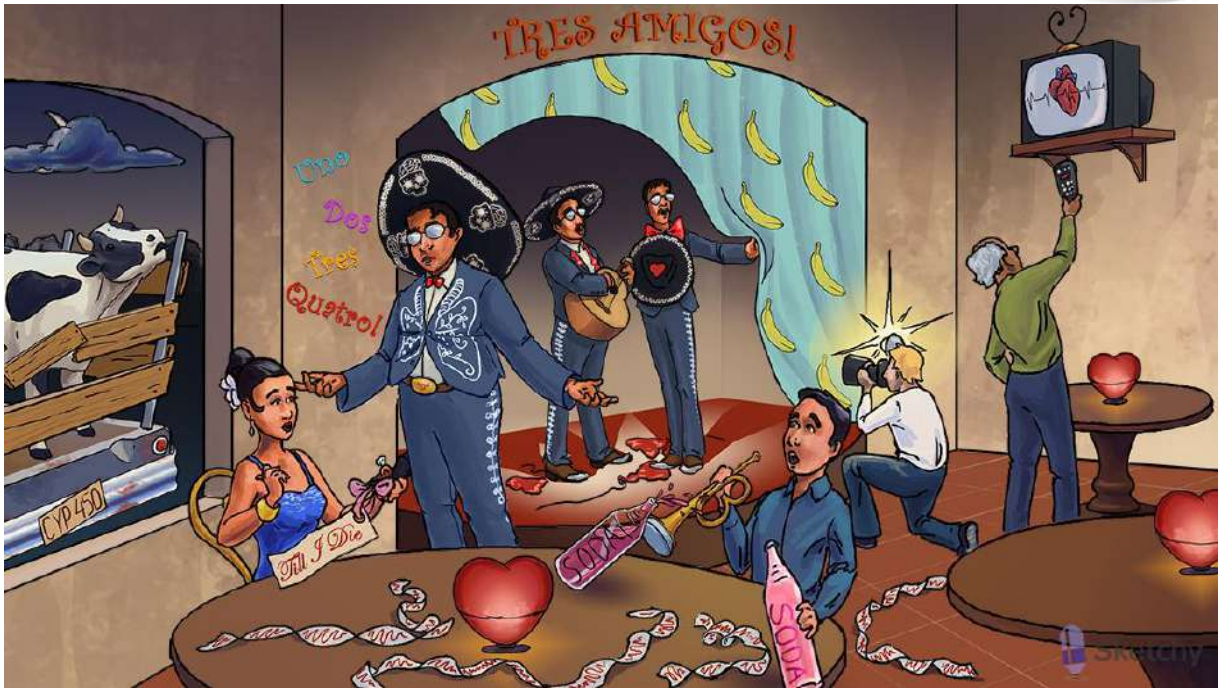
Ventricular Action Potential

- Class IA: e.g., quinidine
  - Moderate Na+-channel blockade
  - ↑ ERP
- Class IB: e.g., lidocaine
  - Weak Na+-channel blockade
  - ↓ ERP
- Class IC: e.g., flecainide
  - Strong Na+-channel blockade
  - → ERP

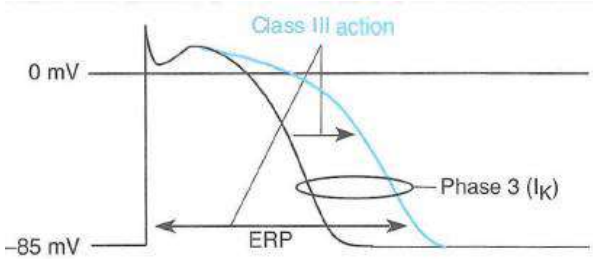
Class II (rate control) : Beta Blockers - No (Class I sodium) **Bad Boy (Beta Blockers**) Keeps (Potassium) Clean (calcium)

1. Duet: class II antiarrhythmics
2. Muted beta bugle: beta blockers (class II antiarrhythmics)
3. Notes: beta blockers treat arrhythmias by blocking sympathetic input to SA and AV nodes
4. Torn Band Camp: beta blockers decrease cAMP
5. Crushed calci-yum ice cream cartons: decreased cAMP leads to closure of membrane calcium channels, preventing the upstroke of AV nodal action potential
6. Phase 4: pacemaker current dictated by Na+ (funny current) and other ion. Depolarization is from Ca++
7. Phase 0: upstroke dictated bt Ca2+
8. Phase 3 repolarization dictated by K+
9. Sliding up the keys: beta blockers prolong phase 4 of the nodal action potential decreased pacemaker activity, prolonged conduction time and refractory period
10. Disconnected bottom of light: beta blockers decrease atrioventricular conduction
11. Heart light Lit up top: beta blockers treat supraventricular arrhythmias (Afib and RVR)
12. IVY: IV beta blockers (esmolol) can be used for acute supraventricular arrhythmias
13. Hat shielding heart: beta blockers can cause heart block
14. Public relations: heart block manifests as a prolonged PR interval on EKG
15. Irregularly irregular static signal: beta blockers are useful in atrial fibrillation (and flutter)
16. Metronome: beta blockers prevent rapid ventricular response in atrial fibrillation and flutter “rate control” but does not fix the atrial fibrillation





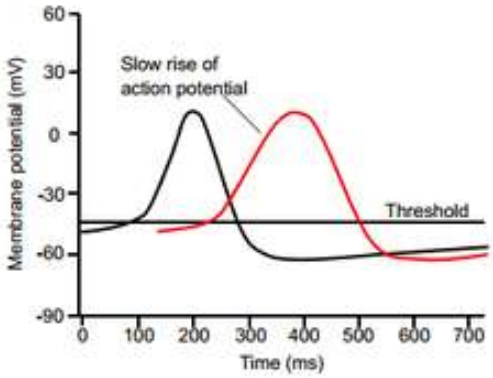
Class III (rhythm control): No (Class I sodium) Bad Boy (Beta Blockers) **Keeps (Potassium)** Clean (calcium)



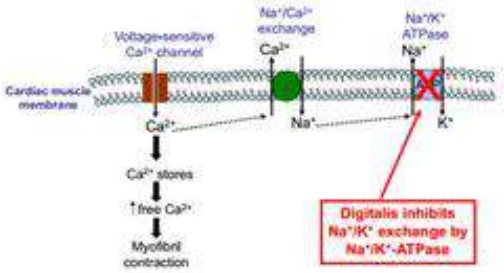
1. Phase 2: plateau dictated by Ca2+
2. Phase 3: repolarization dictated by K+
3. Potassium banana theme curtain: K+ current present during Phase 2 (plateay) and Phase 3 (repolarization) of the cardiac action potential
4. Singer pushing away the curtain: class III antiarrhythmics block K+ channels prolonging phase 2 and 3 of the cardiac action potential → prolonged refractory period
5. **"uno, dos, tres, quattro": Amiodarone shares properties of class I, II, III, and IV antiarrhythmics.**
6. **"till I die": –tilide suffix shared by dofetilide and ibutilide (class III antiarrhythmics)**
7. **Soda: sotolol**
8. Muted bugle and soda bottles: sotalol is also a beta blocker (lol suffix)
9. Heart illuminated on top and bottom: class III antiarrhythmics treat both supraventricular arrhythmias and also ventricular arrhythmias
10. Irregularly irregular signal: class III antiarrhythmics treat atrial fibrillation and flutter
11. Converting the signal: class III antiarrhythmics can restore and maintain normal sinus rhythm in atrial fibrillation and flutter
12. **Adverse effects**
13. Skull brains: amiodarone has many neurologic side effects (tremor, ataxia, peripheral neuropathy, sleep disturbances)
14. Gray sunglasses: amiodarone can cause grey corneal deposits
15. Bog and small bowties: amiodarone can cause hyper or hypothyroidism, always evaluate thyroid prior to use and monitor during
16. Fibrotic lung embroidery: amiodarone can cause pulmonary fibrosis
17. Tight button: amiodarone induced lung fibrosis causes restrictive lung diseases
18. Trampled failing heart balloon: amiodarone can induce heart failure
19. Liver spot: amiodarone can cause hypersensitivity hepatitis (always monitor LFT's)
20. Grey blue outfits: amiodarone can cause gray blue skin discoloration
21. Flash photo: amiodarone can cause photo dermatitis
22. Broken chrome bumper: amiodarone inhibits the cytochrome P450 inhibition
23. Twisted streamer: sotolol, dofetilide, and ibutilide can induce dose related torsade's (although all type III antiarrhythmics can widen the QT interval)

Class IV antiarrhythmics (rate control)- No (Class I sodium) Bad Boy (Beta Blockers) Keeps (Potassium) **Clean (calcium)**

1. 4 singers quartet: Class IV (rate control at SA and AV nodes) Non dihydropyridine calcium channel blockers
2. L shaped nozzles on wall: Block L type calcium channels in the heart
3. Nondairy: non-dihydroppyridine calcium channel blockers (class IV antiarrhythmics)
4. Delicious dark chocolate: Diltiazem (non-dihydropyridine CCB)
5. Very Vanilla: verapamil (non-dihydropyridine CCB)
6. Notes on music sheet: Exert a greater effect on tissues that fire more frequently that use a calcium current, non-dihydropyridines treat arrhythmias by blocking Ca2+ current in the SA and AV nodes
7. Keys leading up the piano as the gradual phase 4: pacemaker dictated by Na+ and other ions
8. Phase 0: upstroke dictated by ca2+
9. Phase 3: repolarization dictated by K+
10. Sliding up the keys: non-dihydropyridine CCB's prolong phase 4 of the nodal action potential → decreased pacemake activity, prolonged conduction time and refractory period
11. Disconnected bottom: non-dihydropyridine CCB's decrease atrioventricular conduction
12. Illuminated top: non-dihydropyridine CCB's treat supraventricular arrhythmias (A.FIB with RVR)
13. Public relations: non-dihydropyridine CCB's will prolong the PR interval
14. Hat shielding heart: Non-dihydropyridine CCB's can cause heart block, be careful when combining with other drugs that cause AV nodal blocking like digoxin
15. Irregularly irregular signal: non-dihydroopyridine CCB's are useful in atrial fibrillation and flutter
16. Metronome: non-dihydropyridine prevents rapid ventricular response in A Fib and Flutter



Class V: Rate control

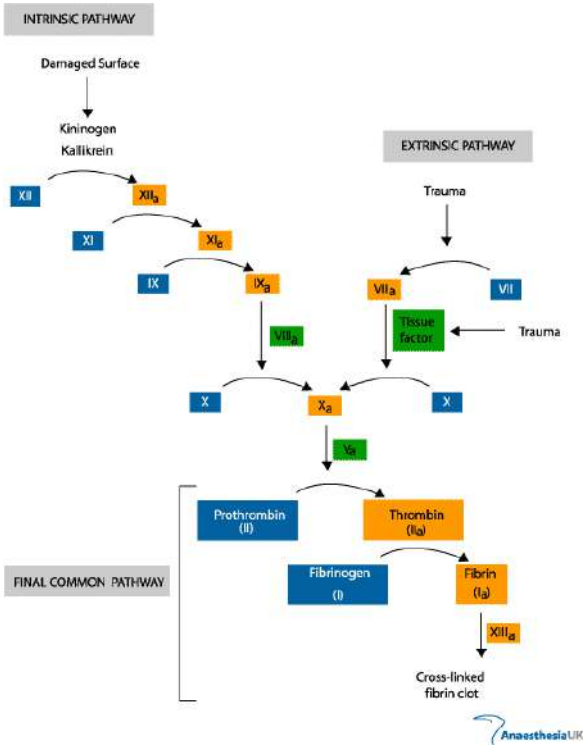


1. **DJ Foxglove: Digoxin has antiarrhythmic properties**
2. Vegas: digoxin exerts direct parasympathomimetic effects via direct stimulation of the vagus nerve → AV nodal inhibition
3. Irregularly irregulars signal: digoxin is useful in atrial fibrillation and flutter, not first line
4. Metronome: digoxin prevents rapid ventricular response in atrial fibrillation and flutter (rate control)
5. **Magnets: magnesium** is useful for the treatment of certain arrhythmias (torsades)
6. Torn twisted torsades streamers: magnesium treats torsades de pointes
7. Banana dancer pointing up: hyperkalemia can induce arrhythmia
8. Peaked streamer: hyperkalemia can cause peaked T waves (with shortened QT intervals) on ECG
9. Banana dancer pointing down: hypokalemia can induce arrhythmias, sever muscle weakness, and glucose abnormalities
10. Streamer with extra bump: hypokalemia can induce U waves at the end of the T wave on EKG
11. **Swing dancing: adenosine (a purine nucleoside with antiarrhythmic properties)**
12. Purine shaped gate: adenosine is a purine nucleoside
13. A1 swing: adenosine activated inhibitory AI receptors on the myocardium and at the SA and AV nodes
14. Banana flying out of the cup: activation of A1 receptors increases outward K+ current (hyperpolarizes, suppressed, Ca2+ dependent AP)
15. Falling calci-YUM ice cream: activation of A1 receptors suppress inward Ca2+ current
16. Note shaped dance floor: Adenosine inhibits AV nodes (decreased AV conduction, prolonged AV refractory period)
17. Hat blocking heart: Adenosine causes transient high grade heart block (direct av node inhibition for about 10s)
18. Disconnected bottom of heart: adenosine decreases atrioventricular conduction
19. Illuminated top of heart: adenosine is a first line agent for acute treatment of supraventricular arrhythmias (PVST)
20. Dilated coronary crown: adenosine causes coronary dilation (mediated by A2 receptors)
21. **Adverse Effects**
22. Flushed dancer: adenosine can cause cutaneous flushing
23. Dancer clutching chest: adenosine can cause shortness of breath, chest pain, and impending sense of doom
24. Fainting dancer: adenosine can cause fainting, headache, and hypotension
25. Energy drink blocking A1 gate: the actions of adenosine are inhibited by caffeine and theophylline (methylxanthines)

Heparin, LMWH, Fondaparinux, Direct thrombin inhibitors, Xa inhibitors

1. Beaver dam: fibrin clot
2. Throm-beaver: thrombin
3. Throm-beaver preparing stick: thrombin transforms fibrinogen into fibrin, these fibrin monomers will crosslink with calcium, a phospholipid surface and factor XIII to make a strong mesh
4. Throm-beaver II shaped teeth: factor II (thrombin)
5. FoX: factor X and Xa catalizes the conversion of pro-thrombin into thrombin (factor 2 into 2a)
6. FoX waking up throm-beaver: factor Xa converts prothrombin into thrombin.
7. **Heppy hunting: heparin**
8. Heppy hunting father: unfractionated heparin
9. Trap with III shaped bars: unfractionated heparin binds with antithrombin III
10. Trapped throm-beaver and foX: the unfractionated heparin-antithrombin III complex irreversible inactivates thrombin and Factor Xa
11. Birdwatching father: monitor APTT (activated partial thromboplastin time) to assess unfractionated heparin levels
12. Woodpecker inside tree trunk: PTT measures the function of the intrinsic pathway of the coagulation cascade
13. Heparin is not a clot buster, it will prevent the fibrin clots from forming
14. Hunting at the iliofemorial river: heparin can be used for deep vein thrombosis prophylaxis
15. Beaver dam ion the iliofemoral river: heparin can be used for acute treatment of deep vein thrombosis
16. Lung shaped tree: pulmonary arterial tree
17. Birds nest on ischemic branch: heparin can be used for prophylaxis and acute treatment of pulmonary embolism (PE)
18. Branched distal is ischemic and leafless
19. Continuous heparin drip can help reduce the development of the PE
20. Broken heart strings: Heparin is used in the setting of an acute MI, heparin is used to prevent clot extension and also formation
21. Ivy: administration IV heparin in the setting of acute DVT, PE, and MI
22. **Adverse effects of heparin**
23. Bleeding, need to keep close monitoring PTT
24. Shooting four clay plates: Heparin induced thrombocytopenia, (ex. in a 50 y/o pt receiving heparin prophylaxis for a few days then gets a swollen foot) This occurs when antibodies are made against heparin complex to platelet factor 4
25. Broken plates: heparin can cause thrombocytopenia
26. Throm-beaver dam around broken plates: HIT results in paradoxical thrombosis in the setting of thrombocytopenia
27. Depleted mineral mine: heparin can cause hyperaldosteronism (a mineralocorticoid) even in low doses heparin causes this
28. Big K: heparin induced hypoaldosteronism (type 4 RTA) causes hyperkalemia
29. Porous termite damage: heparin can cause osteoporosis
30. Protected area deterring the hunter: protamine sulfate reverses the anticoagulant effect of the unfractionated heparin (less effective foe LMWH and fondaparinux)
31. Protamine sulfate is a positively charged peptide that binds to unfractionated heparin (negatively charged)
32. **Heppy hunter daughter: low molecular weight heparin (LMWH)**
33. Trap with III: LMWH binds antithrombin III: Similar MOA as Unfractionated heparin,
34. FoX in small trap: the LMWH-antithrombin complex inhibits factor Xa with less of an effect on thrombin
35. Protected area deterring the hunter: protamine sulfate reverses the anticoagulant effect of unfractionated heparin (less effective against LMWH and fondaparinux)
36. Long tapering flag: LMWH has a prolonged half-life
37. Does not require PTT monitoring

38. Decay flag breaking a kidney shaped rock: LMWH is eliminated renally and can stay in the system if there is renal insufficiency
39. Heppy pregnant hunter: heparin is safe during pregnancy. “keep that baby heppy with heparin”
40. Intact clay pigeons: LMWH is less likely to induce HIT
41. ALL TYPES OF HEPARIN CAN CAUSE HIT, Just less likely
42. **Fido with a pair of FoXes: fondaparinux**
43. Protected area deterring the hunter: protamine sulfate reverses the anticoagulant effect of the unfractionated heparin (less effective foe LMWH and fondaparinux)
44. Fido with two cages: Fondaparinux binds antithrombin III with higher specificity that LMWH
45. FoX in small trap: the fondaparinux-antithrombin complex inhibits factor Xa with less of an effect on thrombin
46. Fido with no broken plates: Lowest risk of HIT
47. **NO intruding: bivaliRUDIN is a direct thrombin inhibitor**
48. **Big GATOR: arGATROban and dabigatran are direct thrombin inhibitors**
49. Intruding gator directly eating the throm-beaver: use direct thrombin inhibitors (argatroban, dabigatran, bivalirudin) in HIT
50. **Banned foXes: direct factor Xa inhibitors rivaroxaban and apiXaBAN**
51. Directly grabbing foX: factor Xa inhibitors bind directly
52. Open mouth: factor Xa inhibitors are oral medications, Afib
53. Irregularly irregular tv signal: direct Xa inhibitors are used for long term anticoagulation in atrial fibrillation



Warfarin

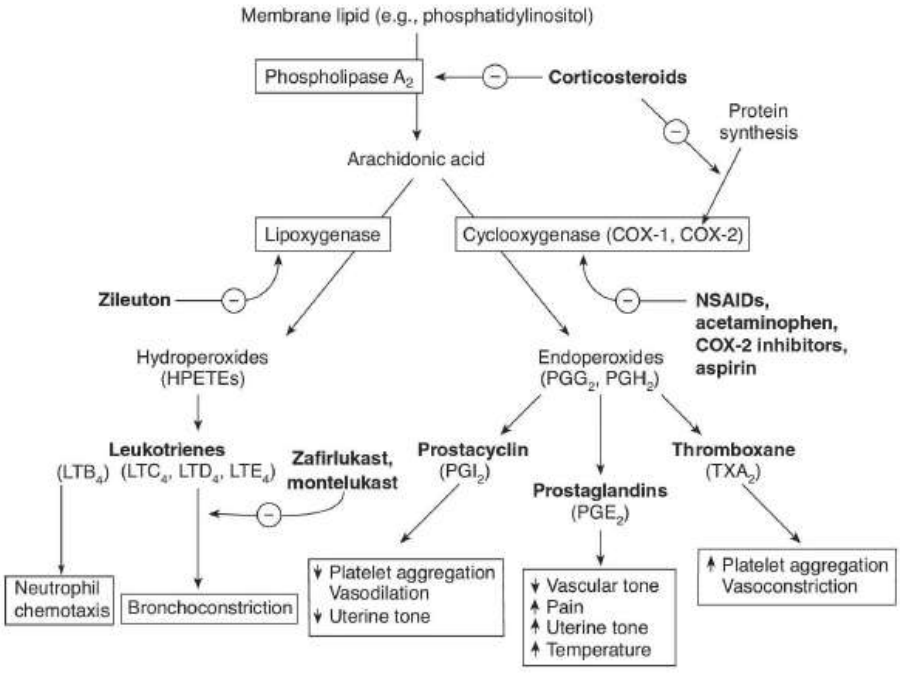
1. Vitamin K medic stopping the bleeding: vitamin K is a cofactor for the enzymatic activation of clotting factors
2. Blocks vitamin K epoxide reductase, this is required for activation of Vitamin K preventing clotting factors 2,7,9,10 from being produced, and proteins C and S
3. Vit K medic applies gamma shaped bandage: vitamin K promotes gamma carboxylation of coagulation factors II, VII, IX, and X
4. Throm-beaver with II shaped teeth: factor II (thrombin)
5. Seven deadly sins: Factor VII
6. Nine lives cat: factor IX
7. FoX: factor X
8. GL: gamma carboxylation occurs at the glutamic acid residue on factor II, XII, IX, and X
9. V-KOR supply boat: vitamin K epoxide reductase (VKOR) converts vitamin K epoxide (inactive) into vitamin K (Active)
10. Corporal: vitamin K promotes gamma carboxylation of proteins C
11. Sergeant: vitamin K promotes gamma carboxylation of protein S
12. Corporal and sergeant hold their troops back: proteins C and S are anticoagulant factors
13. Remember: vitamin K contributes to coagulant and anticoagulant forces
14. Warhead destroying V-KOR supply ship: Warfarin inhibits vitamin K epoxide reductase (VKOR)
15. Incapacitated Vik K medic: inhibition of VKOR prevents activation of Vit K
16. Onset of action is not immediate, not for acute thrombotic events
17. Wounded VIII soldier: factor VIII is the first clotting factor to be reduced when starting warfarin
18. Delayed warhead detonation: warfarin onset of action is 8-12 hours, full clinical effect takes 3 days
19. Soldier with open mouth leaning on warfarin bomb: oral administration
20. Long tapering flag: Long half life
21. Para trooping soldier: Monitor warfarin using PT time, this is an extrinsic factor, like the paratrooper landing extrinsically
22. INtercom Radio worn by paratrooper: the international normalized ration (INR) is also used to measure warfarin activity
23. Goal INR 2-3 for prevention and treatment of thrombosis
24. Irregularly irregular heart signal: warfarin is used for long term anticoagulation in atrial fibrillation
25. Warfarin patrolling Iliofemoral river: used as DVT prophylaxis
26. Acute txt for DVT is IV heparin, warfarin is delayed onset
27. **Adverse effects**
28. Tarantula: warfarin can cross the placental barrier and can cause a hemorrhagic disorder or prevent carboxylation reactions in bone.
29. Soldiers charging past the injured corporal: the anticoagulation protein C is reduced early in warfarin therapy, resulting in a hypercoagulable state initially
30. Black soot on corporal: warfarin induced skin necrosis due to early hypercoagulable state
31. Heparin hunters patrolling the bridge: coadministration of heparin when starting warfarin therapy prevents the early hypercoagulable state (heparin bridge)
32. Skin necrosis risk is increased with a hereditary protein C deficiency
33. Distant Vit K medic reinforcements: warfarin anticoagulation can be reversed with vitamin K (delayed effect)
34. FFP fighter pilot: fresh frozen plasma (FFP) provides coagulation factors for immediate reversal of warfarin anticoagulation
35. CYP-450 chrome tank crushing warhead: warfarin is a substrate of cytochrome P-450 (increase P450 rifampin, phenobarbital, phenytoin, decrease effects) (decrease P450, antibiotics, antifungals, SSRI's, increase effects)
36.

Aspirin, ADP receptor inhibitors, GP IIb/IIIa, cilostazol, dipyridamole

1. Peeling von Willie brand field: damaged vascular epithelium exposes collagen and von willebrand factor platelets will adhere to this and activate.
2. Holding 1b bat: binding of Von willebrand factor to GP1b receptors activate platelets
3. Home plate: activated plate degranulation
4. Aggregated players: platelet degranulation releases ADP, 5-HT, and TXA2, stimulating platelet aggregation
5. "ADP" aggregate Da players! Play youth ball 2-12y: adenosine di phosphate binds to the P2-Y12 receptor on platelets causing aggregation
6. Thrown happy face helmet: platelet degranulation releases serotonin (5-HT3) causing platelet aggregation and vasoconstriction
7. Batter's box: platelet degranulation releases thromboxane A2 (TXA2) causing aggregation and activation
8. **Thromboxane synthesis**
9. Head coach cox: Cyclooxygenase 1 (COX1) synthesizes prostaglandins (prostaglandins, TXA2) within platelets
10. Sleeping assistant coach: COX-2 expression induced during inflammation, so he is inactive until some inflammatory event
11. AA minor league dugout: COX-1 synthesizes TXA-2 from the precursor molecule arachidonic acid (AA)
12. Coach Cox twisting hat: TXA2 (synthesized by COX-1) causes vasoconstriction
13. **ASA umpire: Aspirin (ASA) antagonizing Coach Cox (COX-1)**
14. Acetyl-whistle: aspirin irreversibly acetylates COX-1 and COX2
15. ASA umpire ejecting the coaches: aspirin irreversible inhibits COX-1 and COX-2 reducing platelet activation and aggregation
16. Swollen ASA uppire: aspirin "pseudo-allergy" due to excess leukotriene synthesis, seen in asthma or nasal polyposis pts. Involves excessive leukotriene synthesis with cox inhibition. Use an ADP inhibitor, like clopidigrel if this occurs
17. **Hot dog grill: thienopyridines with –grel suffix (clopidogrel, ticagrelor, prasugrel) are surface ADP P2Y12 receptor inhibitors**
18. This inhibition is irreversible
19. "ADP" aggregate Da players! Play youth ball 2-12y: adenosine di phosphate binds to the P2-Y12 receptor on platelets causing aggregation, this is inhibited by thienopyidines
20. Greasy grill pipe: antiplatelet agents (aspirin, ADP receptor inhibitors) reduce cardiovascular events in patients with peripheral artery disease, they do not reduce the symptoms of peripheral artery disease such as atypical pain and claudication in the effected extremity
21. Angina anvil: antiplatelet agents (aspirin, ADP receptor inhibitors) reduce cardiovascular events in patients with coronary artery disease
22. Broken heart strings: use antiplatelet therapy (aspirin, ADP receptor inhibitors) in the setting of MI and other acute coronary syndromes, give as soon as possible to a patient with a STEMI
23. ASA umpire chewing tablets: give chewable aspirin tablets initially in an acute MI for immediate effect
24. Corked bat: dual antiplatelet therapy (aspirin and ADP receptor inhibitors) prevent coronary stent thrombosis
25. Black paint stroke: antiplatelet therapy (aspirin and ADP receptor inhibitors) prevents ischemic stroke in patients with atherosclerosis and known cerebrovascular disease
26. **Ty Cobb: ticlodapine** (an ADP inhibitor) causes neutropenia in 2% of patients
27. Falling granules: ticlodapine can cause granulocytopenia, you must obtain white cell and rbc count when starting therapy
28. **Fries: fibrinogen**
29. Crowd of spectators from seats 2b-3a: platelet surface receptors GP IIb/IIIa binds to fibrinogen to promote platelet aggregation
30. Seats 2b/3a: platelet surface receptor GP IIb/IIIa binds fibrinogen
31. **ABC sportscaster grabbing fries: abciximab blocks the GP IIb/IIIa receptor preventing platelet aggregation**
32. Antibody shaped microphones: abciximab is a monoclonal IgG antibody
33. **Tied game: eptifibatide and tirofiban block the GP IIb/IIIa receptor to prevent aggregation, must be given IV continuously**
34. Broken plates: GP IIb/IIIa inhibitors cause thrombocytopenia
35. Ketchup time: antiplatelet therapy increases bleeding time (a measure of platelet function)
36. **Don't phoster disinterest: Phosphodiesterase inhibitors (dipyridamole, cilostazol)**
37. Sign "up" for cAMP: phosphodiesterase inhibitors increase cAMP impairing platelet function
38. **Two pyramids: dipyramidole (an antiplatelet phosphodiesterase inhibitor)**

39. Player that Lost the ball: cilostazol

40. Dilated red sleeves: cilostazol causes arterial vasodilation
41. Dirt clods hitting leg: cilostazole treats symptoms of claudication due to peripheral artery disease
42. Stolen heart base: cilostazole can cause coronary steal, this will dilate all of the other coronary arteries preventing blood flow to the ischemic areas exacerbating ischemia
43. Dilated red crown: cilostazol causes coronary artery dilation



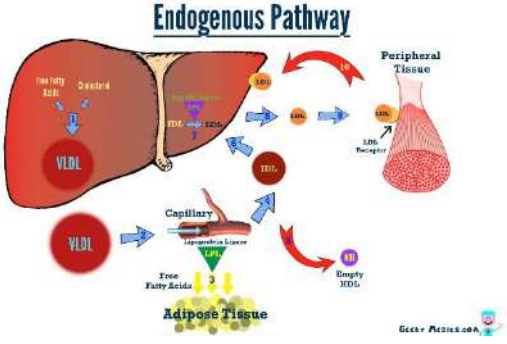
Fibrinolytic's: TPA'se: Alteplase, reteplase, tenecteplase, Streptokinase, Aminocaproic acid

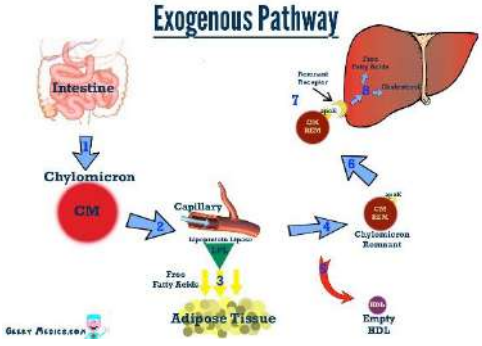
1. Mesh of sticks: fibrin clot
2. **Toy PlAyset: tissue plasminogen activator (tPA)**
3. **Strepto-kinectors: streptokinase (a fibrinolytic)**
4. Purple sphere chain: streptokinase is synthesized by streptococci
5. Plasma general: plasminogen
6. Plasma general activation: plasminogen Is converted to plasmin by TPA and streptokinase
7. Plasma beams destroying wall: plasmin degrades fibrin clots
8. Paratrooper and PTTT Birdwatcher: Fibrinolytics prolong PT and PTT
9. D-shaped twigs: D-Dimer is a fibrin degradation product formed from clot lysis
10. Black paint stroke: IV fibrinolytics may be used in the setting of ischemic stroke
11. After school painting session 3:00-4:30: Administer IV fibrinolytics within 3-4.5 hours of ischemic stroke symptoms
12. Birds nest on ischemic branch: IV fibrinolytics can be used for acute treatment of sever DVT and PE
13. Broken heart strings: fibronolytics may be used in the acute management of MI
14. Corked Bat: percutaneous coronary intervention is the preferred reperfusion option in ACUTE STEMI
15. **Contraindications**
16. Calling for 2: perform PCI ideally within 2 hours of acute STEMI
17. Red pain stroke on painting: hemorrhagic stroke is a side effect of fibrinolytic therapy
18. Traumatic plasma beam: Recent head trauma is a contraindication for fibrinolytic therapy
19. Red palette knife: recent intracranial surgery is a contraindication for fibrinolytic therapy
20. White area on CT indicates cerebral hemorrhage – a contraindication for fibrinolytic therapy
21. High pressure paint tube: severe hypertension is a contraindication for fibrinolytic therapy
22. Choking hazard: Streptokinase only can cause allergic reaction and even prophylaxis
23. **Reverse fibrinolysis**
24. **Cap on paint tube: aminocaproic acid can be used to reverse fibrinolysis**
25. Plasma general tucked under arm: aminocaproic acid competitively inhibits plasminogen activation
26. **Exams: transexamic acid canbe used to reverse TPA**
27. **FFP Pilot: FFP can be used to reverse coagulopathy**
28. **Cryo ice pack: cryoprecipitate can be used to reverse coagulopathies**

Statins – HMG-CoA reductase inhibitors

1. Liver station: import and export of lipoprotein transporters
2. Intestinal airbase: lumen of the small intestine (site of free fatty acid and cholesterol absorption), flags resemble the microvilli of the brush border, 1st packaging and shipping center of endogenous lipids
3. Gold Bars: cholesterol
4. **Hot air balloon: chylomicron**
5. Chest: cholesterol ester, allows more to be packaged into the interior of the chylomicron
6. Moving chest into the hot air balloon: Cholesterol esters are packaged into the interior of the chylomicrons (intestinal cell)
7. Tridents: triglycerides, the main components of chylomicrons
8. Trident passengers: triglycerides make up most of the chylomicron
9. E-shaped flag: chylomicrons contain surface apolipoproteins A, B, C, and E, apo E plays an important role in being taken into the liver
10. Chylomicrons deliver triglycerides from the intestines to peripheral tissues
11. **Lipo-port lighthouse: Lipoprotein Lipase (LPL)**
12. Trident passengers disembarking at lipo-port lighthouse: triglycerides in chylomicrons are hydrolyzed by LPL releasing free fatty acids
13. Muscle shells: free fatty acids can be used for energy by heart and skeletal muscle
14. Adipocyte sea foam: free fatty acids can be converted back to triglycerides and stored in adipose tissue
15. Once depleted of nutrients, these chylomicrons return to the live where they are returned to the circulation
16. LoaD L receptor: LDL receptor
17. Pulling in E-Shaped flag: LDL receptor binds to ApoE and transports chylomicron remnant into liver via endocytosis
18. Cholesterol from chylomicron remnants are used by the liver
19. HMG crude ore reducer: HMG CoA reductase synthesizes cholesterol in the liver
20.
21. Evaluator: first intermediate in cholesterol synthesis is mevalonic acid
22. **Very low density airship: VLDL Very low density lipoproteins**
23. Cholesterol esters are packaged into the interior of VLDL's (hepatocyte)
24. Trident passengers: triglycerides make up most (60%) of the VLDL
25. B shaped anchor: apolipoprotein B100 is found on "bad cholesterol" (LDL and VLDL)
26. VLDL's deliver triglycerides from the liver to the peripheral tissues
27. Trident passengers disembarking at lipo-port lighthouse: triglycerides in VLDL's are hydrolyzed by LPL, releasing Free Fatty Acids
28. **Low density ship: low density lipoprotein** (LDL formed as VLDL's lose triglycerides via LPL and hepatic lipase)
29. Chest cargo: LDL's contain a core of cholesterol esters
30. LDL's deliver cholesterol to peripheral tissues expressing LDL receptors (like adrenal cells)
31. LoaD L receptor: LDL receptor
32. Pulling in B shaped anchor: LDL receptor binds ApoB and transports LDL particle into liver via receptor mediated endocytosis
33. B shaped anchor: apolipoprotein B100 is found on "Bad cholesterol" LDL and VLDL
34. **High-density submarine: High density Lipoprotein (HDL)** Nascent HDL is secreted by the liver and intestine
35. Deep sea diver collecting gold bars: HDL extracts cholesterol from membranes of peripheral tissues
36. Load Catch platform: lecithin: Cholesterol acyltransferase (LCAT) converts free cholesterol into cholesterol esters for transport by HDL
37. Loaded submarine: mature HDL particle contains LCAT generated cholesterol esters. HDL is critical for reverse cholesterol transport

38. Chest transform platform: HDL transfers cholesterol esters to LDL's and VLDL's to be transported back to the liver
39. Scavenger-1 dock: HDL Delivers cholesterol esters directly to the liver via scavenger 1 receptor.
40. **Steampunk pirate: Statins (simvastatin, avorastatin, rosuvastatin) extensive 1st pass metabolism**
41. Knocking over HMG crude ore reducer: statins inhibit HMG CoA reductase, reducing valinate and endogenous cholesterol production
42. Statin-punk threatening workers to pull in LDL ship: statins cause increased LDL receptor expression on hepatocytes, clearing LDL's from circulation
43. Sinking LDL ship: statins are most effective drugs for lowering LDL's (30-60%)
44. Statin-punk pirate kicking off trident passenger: statins can lower triglycerides (mild effect)
45. Raised HDL submarine: statins can increase HDL (mild effect)
46. Gold bar plunder: Hypercholesterolemia (LDL) treated with lifestyle modification and statins
47. **Guardian angel: Statins are the most effective lipid lowering medication for preventing future cardiovascular events**
48. Yellow filled coronary crown: statins are the only lipid lowering drug consistently proven to reduce risk of atherosclerotic heart disease
49. Statin therapy initiated in setting of MI and other acute coronary syndromes (ACS)
50. Candy jar: statins reduce risk of cardiovascular events and mortality in high risk diabetics
51. Clogged pipe: statins reduce risk of cardiovascular events and mortality in patients with peripheral artery disease
52. Black paint stroke: statins reduce risk of future vascular events in patients with history of TIA or stroke
53. Tarantula: statins may be teratogenic
54. Bite out of crispy chicken: statins can cause myopathy weeks to months after starting therapy (proximal muscle weakness/soreness), difficulty raising arms above head
55. Crispy chicken bucket: statins can cause elevations in serum CK (myopathy)
56. Raised LFT flag: mild elevations in liver function tests (LFT's) are common (reversible with discontinuation of statin)
57. Chrome tank with CYP bumper: all statins except pravastatin are metabolized by the cytochrome p450 (CYP-450) in the liver leading to an increased risk of developing myopathy



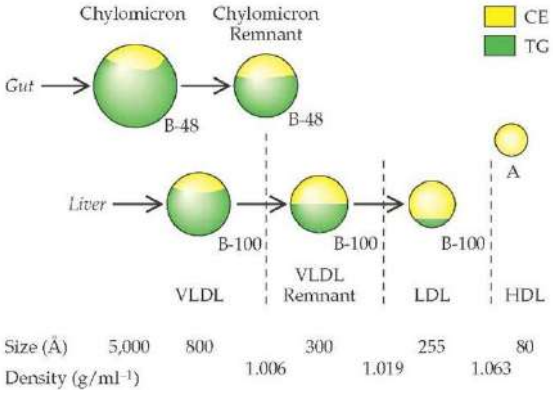


Cholestyramine, ezetimibe

1. Liver station: import and export of lipoprotein transporters
2. Intestinal airbase: lumen of small intestine site of cholesterol and bile acid absorption
3. Sea "gall": bile acids (derived from cholesterol) are released into the intestinal lumen
4. Liver station worker unloading sea "galls": the liver metabolizes cholesterol into bile acids (conjugated to become water soluble)
5. Sea galls exiting liver station: bile acids (derived from cholesterol) are secreted from the liver into the biliary tract and reabsorbed in the terminal ileum
6. Sea Gall droppings swept back to liver station: normally 95% of bile acids in the ileum are recycled back to the liver through enterohepatic circulation (hepatic vein)
7. Disabled sea gall droppings sweeper: bile acid resins prevent recycling of bile acids to the liver
8. **Cho"lobetser"amine: bile acid binding resins prevent bile acids from returning to the liver (cholestyramine, colestipol, colesevam)**
9. Empty gold stores: resins interrupt bile acid recycling and promote synthesis of new bile acids, depleting cholesterol stores
10. HMG crude or reducer: HMG CoA reductase
11. Activating HMG crude ore reducer: resins interrupt bile acid recycling, causing HMG CoA reductase to synthesis more cholesterol
12. Activating LoaD L receptor: resins interrupt bile acid recycling, causing upregulation of LDL receptor and uptake of circulating LDL
13. Low-Density ship: Low Density Lipoprotein (LDL)
14. Used in ots that have primary hypercholesteremia
15. **Adverse effects**
16. Very-low-density airship: Very Low Density lipoprotein (VLDL) exit liver
17. Trident passengers: triglycerides carried on VLDL's
18. Cho"lobster"amine scaring airship away: bile acid resins (cholestyramine, colestipol, colesevelam) cause hypertryglycemia (increased VLDL's)
19. Because of this do not use this in hypocholesteremia with concomitant hypertriglycemia
20. Sea"gall" stones: bile acid resins (cholesryamine, Colestipol, Colesevelem) can cause cholesterol gall stones
21. Cho"lobster"mine clamping pipe: bile acid resins can cause constipation and bloating. So not use in pts with diverticulitis, or preexisting bowel disease
22. DEcK-A: bile acid resins impair absorption of fat soluble vitamins A, D, E, K
23. Cho"lobster"amin clashing with statin punk: bile acid resins decrease statin absorption (administer 4 hours apart)
24. **Z shaped Eel: eczetimibe**
25. Z shaped eel blocking gold delivery at intestinal airbase: ezetimibe blocks intestinal absorption of cholesterol
26. Hot air balloon: chylomicron
27. Z shaped eel: ezetimibe: will prevent intestinal absorption of cholesterol decreasing chylomicron carrier
28. Empty chest delivery: ezetimibe restricts liver's access to exogenous cholesterol
29. Activating HMG crude ore reducer: ezetimibe blocks intestinal cholesterol absorption, causing HMG CoA reductase to synthesize more cholesterol
30. Sunken LDL ship: ezetimibe blocks intestinal cholesterol absorption, causing upregulation of LDL receptors and uptake of circulating LDL
31. STATINS ARE LIPID LOWERING DRUGS OF CHOICE FOR CARDIOVASCULAR DISEASE, USED IN CONJUNCTION WITH STATIN THERAPY
32. Ezetamibe does not cause gallstones or hypertrigylcemia
33. Raised LFT flag: ezetimibe may cause increased liver function tests (LFT's)
34. **Steam-ctopus man: evolocamab is a PCSK9 inhibitor**
35. Pesky "9" crabs inhibiting LoaD L receptor workers: PCSK9 normally causes degradation of LDL receptors
36. Octopus antibody-shaped claws: Many PCSK9 inhibitors (evolcumab) are antibodies
37. Steam-octopus man removing pesky crabs: evolcumab binds PCSK9 and prevents degradation of LDL receptors, increasing uptake of circulating LDL

Loch Niacin

1. LIPO-Port Light house: Lipoprotein Lipase (LPL)
2. Trident passengers disembarking at Lipo-Port light house: triglycerides in VLDL's are hydrolyzed by LPL, releasing free fatty acids
3. Muscle shells: free fatty acids can be used for energy by heart and skeletal muscle
4. Adipocyte sea foam: free fatty acids can be converted back into triglycerides and stored in adipose tissue
5. **Gem-fibrozil jellyfish: fibrates (gemfibrozil and fenofibrate)**
6. News PPAR: PPAR-alpha
7. Lighthouse keeper lighting newsPPAR signal: fibrates activate PPAR-alpha to upregulate LPL
8. Trident passengers escape airship: fibrates decrease serum triglycerides (increase hydrolysis of VLDL and chylomicron triglycerides via LPL)
9. Gem-Fibozil jellyfish takes down airship: fibrates decrease serum VLDL 35-50% (stimulate LPL and reduce hepatic VLDL secretion)
10. Gem-fibrozil jellyfish sinks ship: fibrates decrease serum LDL (mild effect) by reducing VLDL
11. Statins are LDL lowering drugs of choice
12. Elevates High density submarine: fibrates increase serum HDL (mild effect) by activation of apolipoproteins A1 and A2 that will create nascent HDL's
13. **Adverse effects**
14. Elevated statin-punk eating crispy chicken: Fibrates combines with statins increases risk of myopathy
15. Sea"gall" stones: fibrates can cause cholesterol gall stones
16. **Loch Niacin monster: niacin (vitamin B3)**
17. Elevate High Density submarine: niacin is MOST EFFECTIVE drug for increasing serum HDL (~30%)
18. Trident passengers escape airship: niacin decreases serum triglyceride (reduces hepatic VLDL secretion)
19. Loch Niacin monster takes down airship: niacin decreases serum VLDL (reduces hepatic secretion)
20. Loch Niacin monster sinks ship: Niacin decreases serum LDL (mild effect) by lowering VLDL
21. Red fiery furnace: niacin can cause cutaneous flushing and warmth
22. Pro slugger bat: prostaglandins (cause flushing) is a mediator of vasodilation and inflammation
23. Fire extinguisher: NSAIDs (including aspirin) can be used to prevent flushing from niacin
24. Elevated candy: niacin can cause hyperglycemia
25. Yellow knitting needles: niacin can cause hyperuricemia (can precipitate gout)
26. Raised LFT Flag: niacin can cause elevated liver function tests (LFT's) leading to severe hepatotoxicity, requires monitoring
27. Omega fish leaking oil: fish oils are high in omega 3 fatty acids
28. Sunken tridents: fish oil can lower serum triglycerides (by decreasing VLDL and apoB production)



NSAID's, selective COX inhibitors

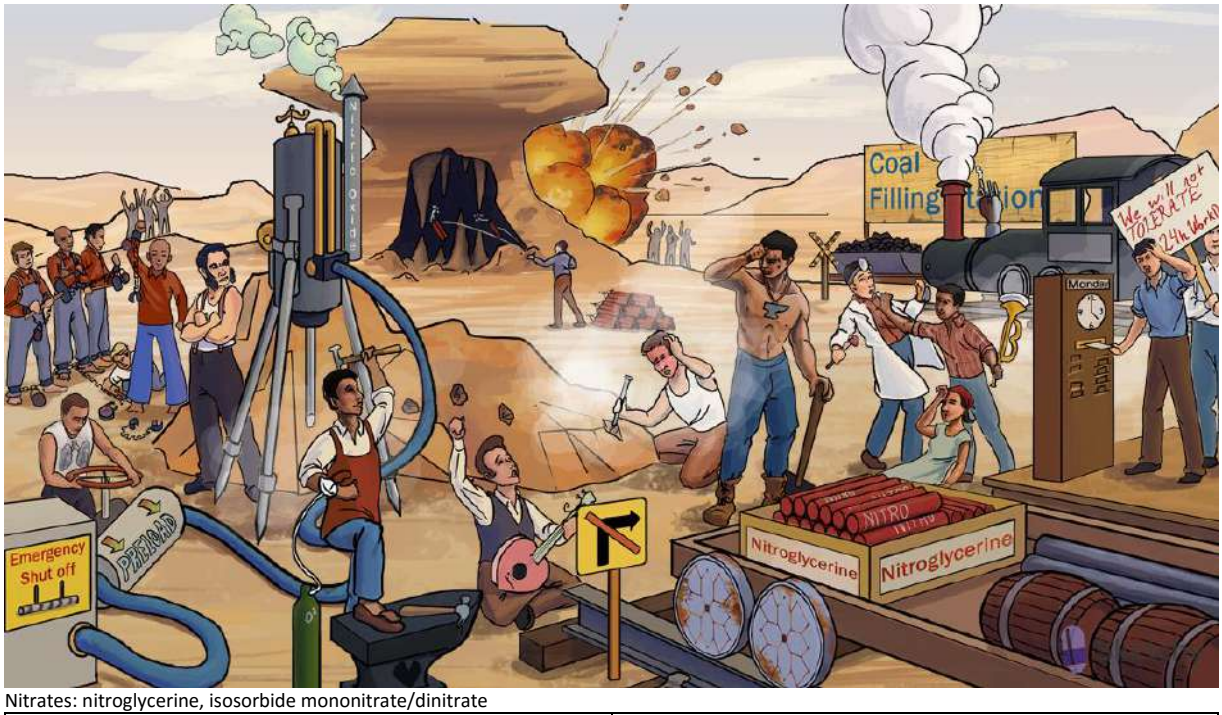
1. **AA League: Arachidonic Acid** (precursor molecules to prostanoids and Leukotrienes) a poly unsaturated fatty acid in almost every cell membrane
2. Pla2y ball: phospholipase A2 (PLA2) hydrolyzes arachidonic acid from the cell membrane
3. Head coach cox: cyclooxygenase-1 (COX-1) is constitutively expressed and active in most cells
4. Assistant coach: COX-2 expression is induced by inflammation
5. Batter's box: thromboxane A2 (TXA2) is synthesized by COX-1, just like how the batter needs to step inside the box and now the plate is activated
6. Twisted red hat: TXA2(from COX-1) causes vasoconstriction
7. **Pro-slugger bat: prostaglandins, made by COX-1**
8. Pro-slugger protecting catcher with gastrointestinal pads: COX-1 synthesizes gastric cytoprotective prostaglandins
9. Assistant coach in endothelial dugout: COX-2 is expressed in vascular endothelial and smooth muscle cells and mediates vascular smooth muscle effects
10. Pro-cycle pitching machine: prostacyclin (PGI2) is synthesized by COX-2
11. Pro-cyclers dilated red barrel: PGI2 causes vasodilation
12. Pro cycler dispersing the plates in the audience: PGI2 inhibits platelet aggregation
13. Pro-sluggers at the afferent tunnel: COX-1 and COX-2 synthesize prostaglandins that dilate the afferent arteriole
14. Pro-slugger activating the sprinkler: COX-2 synthesizes prostaglandins that increase vascular permeability
15. Pro-Slugger in pain: COX-2 synthesizes prostaglandins that increase pain sensitivity
16. Pro-slugger with flaming head: COX-2 synthesizes prostaglandins that induce fever
17. Right dugout Head Coach Cox: Cyclooxygenase -1 is constitutively expressed
18. Right dugout Assistant coach: cyclooxygenase-2 (COX-2) expression is induced by inflammation
19. Anti-inflammatory Fire extinguisher: NSAID's
20. Head coach and assistant couch doused by fire extinguisher: NSAID's reversible inhibit both COX-1 and COX-2
21. **BLAC sox: diclofenac and ketorolac (NSAID's)**
22. **INDIGO sox: Indomethacin (NSAID) closure of ductus arteriosus**
23. **SOX CAM: meloxicam and piroxicam (NSAID's)**
24. **Approximately 110 Mph: Naproxen (NSAID)**
25. **Adverse effects**
26. Burned hole in the gastrointestinal pads: Inhibition of COX-1 by NSAID's can cause gastric inflammation, erosions, and ulceration
27. Ketchup on the gastrointestinal pads: inhibition of COX-1 by NSAID's can cause GI bleeding
28. Ketchup on clock: inhibition of COX-1 by NSAIDs can prolong bleeding time
29. Bursting from high pressure: NSAIDs can increase blood pressure due to COX inhibition in the kidney, decreasing sodium excretion
30. Baseball-filled kidney containers: NSAIDs can cause acute interstitial nephritis
31. Contracted proximal end of fire extinguisher hose: NSAID's cause afferent arteriole vasoconstriction, decreasing GFR. ACE inhibitors will effect GFR greatly when used with NSAIDS due to the great decrease of GFR, this can lead to …
32. Sloughing of cleat spikes: NSAIDs can cause renal papillary necrosis (sloughing of renal papillae)
33. Elevated "lift-ium" balloons: NSAIDs can increase serum lithium concentrations
34. Plastic bone-shaped balloon: NSAIDs (indomethacin generally) can cause aplastic anemia
35. Depleted mineral mine: NSAIDs will cause Impaired renin secretion leading to hyperaldosteronism (decreased mineralcorticoids) that will lead to hyperkalemia, type IV RTA
36. Big K: NSAID induced hyperaldosteronism can cause hyperkalemia
37.

38. ASA umpire: aspirin
39. ASA umpire ejecting the coaches: aspirin **irreversible** inhibits COX-1 and COX-2
40. Acetylation whistle: aspirin acetylates COX-1 and COX-2 resulting in irreversible inhibition
41. Child in Kawasaki's ATV: aspirin is useful in Kawasaki's disease (the most common vasculitis in children) manifests as fever, conjunctivitis, erythema of lips and oral mucosa, rash, and cervical lymphadenopathy
42. Tissue box: Reye's syndrome occurs when a child is given aspirin in the setting of a viral illness. Consists of rapidly progressive encephalopathy with hepatic dysfunction after apparent recovery of a viral illness
43. Rays shirt pattern: aspirin use in children can lead to development of Reye's syndrome
44. Cerebral baseball cap: Reye's syndrome encephalopathy (confusion, seizure, coma)
45. Fat liver spot on cow: Reye's syndrome hepatic dysfunction (hepatic steatosis, hepatomegaly)
46. Mudpile: aspirin toxicity can cause an anion gap metabolic acidosis
47. Blowing "OH-" bubbles: aspirin causes respiratory alkalosis prior to metabolic acidosis
48. Tin Cans: aspirin can cause tinnitus
49. Charcoal lines: activated charcoal can be used to control aspirin in the setting of acute toxicity, alkanlinization of the serum allows you to pull aspirin out of the CNS
50. Bases loaded hose: alkalinization of the serum and urine with a basic solution (sodium bicarb) increases the renal excretion of aspirin
51. Fire extinguisher behind cracked kidney-shaped glass: minimize NSAID use in patients of risk for acute kidney injury, because it can exacerbate renal insufficiency, same with MI, or any other issue that may decrease renal perfusion
52. Exiting pregnant lady: avoid NSAIDs in 3rd trimester due to risk of premature closure of ductus arteriosus (highest risk with indomethacin and ibuprofen)

53. Celebrating catcher in the dugout drenching the assistant coach: celecoxib is a selective COX-2 inhibitor
54. Clean gastrointestinal pads: celecoxib has reduced ulcer and bleeding risk by avoiding COX-1 inhibition
55. Thrombus ice cubes: celecoxib may increase the risk of ischemic cardiovascular disease, avoid in acute MI and stable angina
56. Rotten sulfa eggs: celecoxib is a sulfa drug
57. **Icy-medicine spray on assistant coach: acetaminophen** inhibits COX-2, acting as an antipyretic and analgesic (NOT anti-inflammatory) used for mild to moderate pain, osteoarthritis and some Rheumatoid arthritis
58. Goat scared by the icy medicine: toxic levels of acetaminophen deplete glutathione in the liver (glutathione will inactivate the toxic metabolite NAPQI) goat:glutathione
59. Liver spot on goat: acetaminophen causes hepatotoxicity (via the toxic metabolite: NAPQI)
60. Charcoal lines on the fan above acetaminophen spray: activated charcoal can be used to absorb acetaminophen in setting of acute toxicity
61. N Flower seeds: n-acetylcysteine (antidote for acetaminophen overdose)
62. Goat attracted to N-Flower seeds: N-acetylcysteine restores hepatic glutathione stores to treat acetaminophen hepatoxicity

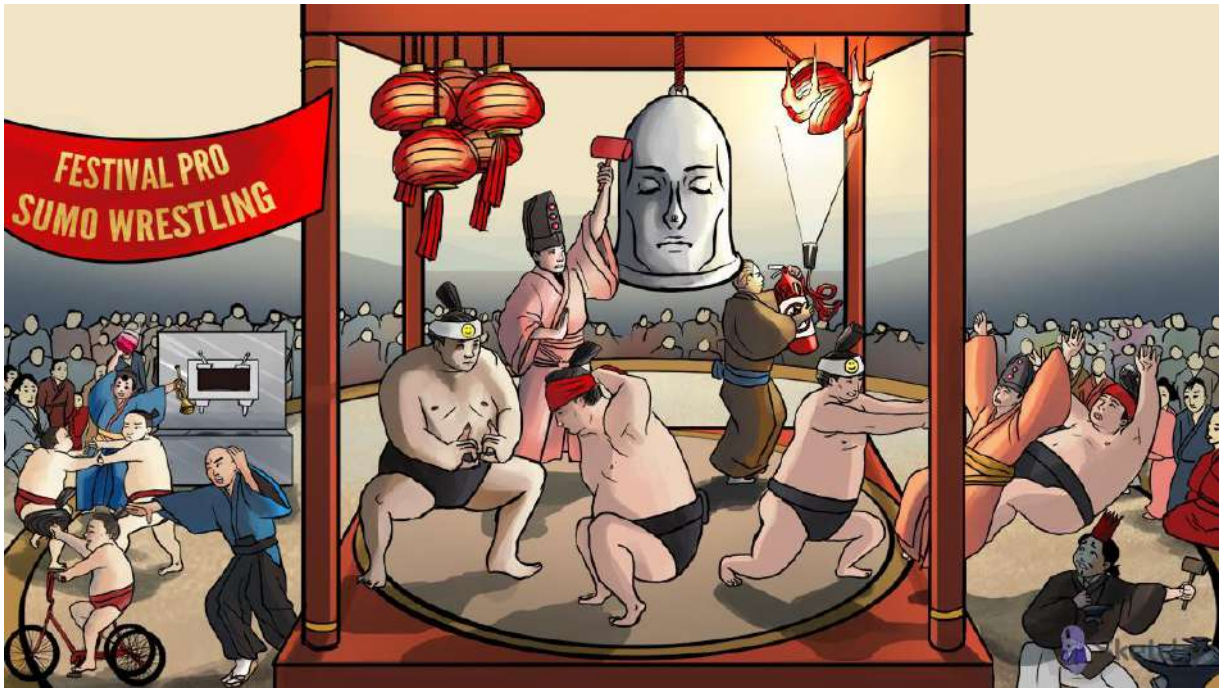
Gout Drugs

1. Knitting needles: uric acid crystals
2. Yellow center aisle: renal tubule
3. Uric acid yarn in the center aisle: uric acid excretion by kidney
4. Purine shaped collection plate: purines (purine metabolism produces uric acid)
5. Small kid passing XO note: hypoxanthine (purines are converted to hypoxanthine)
6. XO love letter: Xanthine oxidase (converts hypoxanthine to xanthine)
7. Larger kid passing XO note: Xanthine
8. XO love Letter: Xanthine Oxidase converts Xanthine to Uric acid
9. Tripping over Yarn and foot on fire: acute gout, will commonly manifest in the 1st metatarsal
10. **Fire extinguisher: NSAIDs**, 1st line treatment in acute gout (indomethacin)
11. **Moon Face: glucocorticoids** (prednisone) treat acute gout
12. **Choir sing: colchicine** treats acute gout, taken orally 12-24 hours
13. Spindly palm fronds: spindle apparatus microtubules
14. Binding palm fronds: colchicine binds intracellular tubulin preventing polymerization of microtubules
15. First responders blocked by choir: colchicine disrupts the cytoskeleton of neutrophils thereby inhibiting neutrophil migration, phagocytosis, and degranulation
16. Muddy floor: colchicine can cause diarrhea
17. Lying: pseudogout (acute treatment is similar to acute gout – NSAIDs, glucocorticoids, colchicine)
18. Blue rhomboid incense holder: Pseudogout is positively birefringent (blue as polarized light) and forms rhomboid shaped crystals)
19. **Pure nun: allopurinol manages chronic gout**
20. Nun grabbing XO notes: allopurinol inhibits xanthine oxidase
21. Stopped XO note in nun pocket: febuxostat inhibits xanthine oxidase (chronic gout)
22. Shattered cancer crab glass: uric acid crystals can form in tumor lysis syndrome after starting cytotoxic chemotherapy
23. White T Cell crusaders: tumor lysis syndrome is most common with treatment of lymphoma and acute lymphoblastic leukemia
24. Nun sweeping crystals: allopurinol prevent uric acid deposition in setting of tumor lysis syndrome
25. Needle in flesh and biting of finger of kid by stained glass window: Lesch-Nyhan syndrome (associated with hyperuricemia is managed with allopurinol. Will see picking of the skin or biting of the lips in a child where uric acid is causing pain
26. Concentrated purine beads on nuns: allopurinol inhibits breakdown of purine analogs (6 mercaptopurine and azathioprine increasing risk of toxicity) and may cause a mild rash
27. Sloughed off red mask: allopurinol can cause Stevens-Johnsons syndrome
28. Eo-slingshot granules: eosinophilia
29. Eosinophilic Dress: allopurinol can cause drug reaction with eosinophilia and systemic symptoms (DRESS syndrome)
30. Probation officer Cid: Probenacid (a uricosuric agent) manages chronic gout
31. Preventing punk from grabbing yarn: probenecid decreases renal tubular reabsorption of uric acid
32. Accumulating yarn and needles: probenecid may increase the risk of forming renal stones due to increased uric acid excretion.
33. "Drugs" tattoo: probenecid can inhibit the excretion of many drugs
34. Cid's purple pencil: probenecid prevents excretion of penicillin
35. Uricosyurics are only for under excretors and only for chronic gout.
36. Rotten sulfas eggs: probenecid is a sulfa drug
37. ASA umpire: aspirin
38. Preventing son from grabbing yarn: aspirin at high doses can prevent tubular reabsorption of uric acid
39. Little ASA umpire yarn: aspirin at low doses inhibits uric acid excretion
40. Holy water just in case!: pegloticase converts uric acid into water soluble allantoin
41. "Just in case" plegoticase (recombinant uricase) can be used in chronic gout management
42. Watermelon with bite: pegloticase can cause hemolysis in G6PD deficiency (bite cells)
43. Choking Kid: pegloticase can cause anaphylaxis
44. Ivy: pegloticase is administered IV



Nitrates: nitroglycerine, isosorbide mononitrate/dinitrate

1. **Dynamite: nitrates (nitroglycerine)**
2. Anvil: antianginal therapy
3. Nitric oxide exhaust: nitrates are metabolized and release nitric oxide
4. Grump: nitric oxide causes and increase in cGMP in vascular smooth muscle
5. Cut P lock off chain: increased cGMP causes myosin light chain dephosphorization, preventing its interaction with actin
6. Dilated blue pants: nitrates cause venous dilation and increased venous capacitance
7. Modest dilated red sleeves: nitrates cause some vasodilation of large arteries, but minimal dilation of arterioles
8. Turning the nozzle down on the preload: Nitrates decrease preload, venous return and filling of the heart, and decreasing the wall stress
9. Angina anvil: nitrates treat chronic stable angina
10. Discarded oxygen mask: nitrates reduce myocardial oxygen requirements
11. Folded tongue: sublingual administration of nitroglycerine avoids first pass metabolism (for acute symptom relief)
12. Mouth cave: oral nitrate preparations have a longer duration of action
13. **Single nitro stick in cave: isosorbide mononitrate**
14. **Double nitro stick in cave: isosorbide dinitrate**
15. Big pile of dynamite: oral nitrate preparations require larger doses due to first pass metabolism
16. Anvil medal: nitrates prinzmetal angina
17. Brocken heart strings: nitrates are useful in acute coronary syndrome
18. No right turn: nitrates should be avoided in right sided MI, should give IV fluids to increase preload
19. Emergency shut off: IV nitroglycerine can be used in hypertensive emergency
20. Wet lung spots: nitroglycerine is an acute treatment for pulmonary edema
21. Fainting woman: nitrates can cause hypotension
22. Doctor with Heart reflex hammer: nitrate induced hypotension activates baroreceptors that cause reflex tachycardia
23. Muted beta bugle stopping doctor: beta blockers help prevent reflex sympathetic activation
24. Guy holding the nails for john angina with a red face: Nitrates can cause throbbing headaches and flushing
25. Oxidized iron wheels: nitrates can cause methemoglobinemia
26. NO tolerance for 24 hour workday: avoid tolerance with daily nitrate free intervals, if not done this may lead to tachyphalaxis and decreased metabolism of the drug
27. Monday disease: with workplace exposure, tolerance disappears over weekend causing headache and dizziness to recur on Monday. This can happen in the chemical industry, called Monday disease
28. Fill station on blocked track: patients on PDE-5 inhibitors (sildenafil) should avoid nitrate therapy for 24 hours (give you severe hypotension)
29. Obstructed heart smokestack: nitrates are contraindicated with hypertrophic obstructive cardiomyopathy



Sumitriptans and Migraine

1. Pounding head shaped bell: Migraine therapy
2. Three gems on hat: migraine pain due to activation of trigeminal nerve afferents in the meninges
3. Dilated sleeves: trigeminal afferents release vasoactive peptides (CGRP, substance P, neurokinin A) onto meningeal vessels → vasodilation and protein extravasation
4. **Sumowrestler: triptans (sumitriptan)** are an acute treatment for migraines, selective agonists of the 5-HT1b and 5-HT1d receptors found on the meningeal vessels, trigeminal nerve, and brainstem
5. "b" and "d" shaped fingers: triptans are 5-HT1b and 5-HT1d receptor agonists
6. Smiley face on headband: 5-HT1b and 5-HT1d receptors are located on the meningeal vessels, this may induce vasoconstriction and attenuates inflammation and decreases stretch at pain receptors
7. Sumo taking out 3 gems: triptans also activate 5-HT1b and 5-HT1d on the trigeminal nerve, preventing release of vasoactive peptides
8. Hair stem: triptans also activate 5-HT1b and 5-HT1d receptors in the brainstem, inhibiting pain pathways
9. **Adverse effects**
10. Constricted coronary crown: triptans cause coronary vasospasm
11. Anvil in the sumo's shadow: triptans are contraindicated in patients with angina
12. Anvil medals in the sumo's shadow: triptans are a known trigger of Prinzmetal angina
13. Lantern cluster: triptans (and inhaled oxygen) are also an acute treatment of acute cluster headache
14. Fire extinguisher: NSAID's are an acute treatment for migraine
15. **Long term prophylaxis**
16. **Calci-yum ice cream nozzles: CCB's are widely used for migraine prophylaxis**
17. **Muted beta bugle: beta blockers can be used for migraine prophylaxis**
18. **Festival PRO: valPROic acid (an antiepileptic) can be used for migraine prophylaxis**
19. **Toupee: topiramate (an antiepileptic) can be used in migraine prophylaxis**
20. **Tricycle: tricyclic anti-depressents (amitryptaline) can be used for migraine prophylaxis**
21.

Prostaglandins, prostacyclin, bosentan, PDE5 inhibitors

1. Head and assistant coaches: COX-1 and COX-2 produce prostanoids (prostaglandins)
2. Pro slugger bat: prostaglandins
3. E in extreme sports: PGE1 and PGE2
4. **Dill pickle theme board: alprostadil (PGE1) and erectile dysfunction therapy**
5. Erect bat: alprostadil treats erectile dysfunction
6. Dilated red sleeves on skateboarder: alprostadil is a vasodilator
7. Opening air duct: alprostadil maintains patent ductus arteriosus
8. Fire extinguisher and closing the air duct: NSAID's (indomethacin) promote the closure of PDA
9. **Missed swing: misoprostol (PGE1)**
10. Gastric protective equipment: misoprostol promotes protective mucus secretion by gastric mucosa
11. Missed swing hitting fire extinguisher: misoprostol can prevent NSAID-induced peptic ulcer
12. Opening uterus bag: misoprostol can facilitate labor or terminate pregnancy
13. Flooded bathroom: misoprostal can cause diarrhea
14. **Dino helmet: dinoprostone (PGE2)**
15. Opening uterus bag: dinoprostone promotes uterine contraction and ripens the cervix to facilitate labor or terminate pregnancy
16. **F in Foot wear: PGF2a**
17. Cardboard box: carboprost (PGF2a)
18. Opening uterus bag: carboprost promotes uterine contraction to control postpartum hemorrhage or terminate pregnancy
19. **LA tan sandals: LAtanoprost (PGF2a)**
20. **World traveler boots: Travoprost (PGF2a)**
21. Leaking eyeballs: latanoprost and travoprost treat glaucoma by increasing aqueous humor outflow
22. Brown sunglasses: latanoprost and travoprost can produce brown pigmentation in the iris
23. High tension pulmonary rackets: pulmonary hypertension, usually manifests as dyspnea and exercise intolerance in women aged 20-40
24. Dilated pro-cycler: prostacyclin analogs cause vasodilation (ilioprost, epoprostenol)
25. iLow –ePRO: iloprost and epoprostenol (prostacyclin analogs) treat pulmonary HTN. Epoprostanol when delivered by IV can be used first line will improve symptoms, prolong survival and delay lung transplants
26. Fainting customer: Adverse effects: Flushing headache, and hypotension
27. **Fill: -fill suffix of phosphodiesterase isoform 5, (PDE-5) inhibitors (sildenafil, tadalafil)**
28. Don't phoster disinterest: phosphodiesterase isoform 5 (PDE-5) inhibitors (sildenafil, tadalafil)
29. Grump: PDE-5 inhibitors increase cGMP
30. increased cGMP causes myosin light chain dephosphorization, preventing its interaction with actin
31. Erect bat: PDE-5 inhibitors (sildenafil, tadalafil) treat pulmonary hypertension and erectile dysfunction
32. **Boss man stan: bosentan treats pulmonary HTN**
33. End o' the line: bosentan is an endothelin inhibitor
34. Dilated red sleeves: bosentan (an endothelin inhibitor) causes vasodilation
35. Liver spot on shirt: bosentan is associated with fatal hepatotoxicity

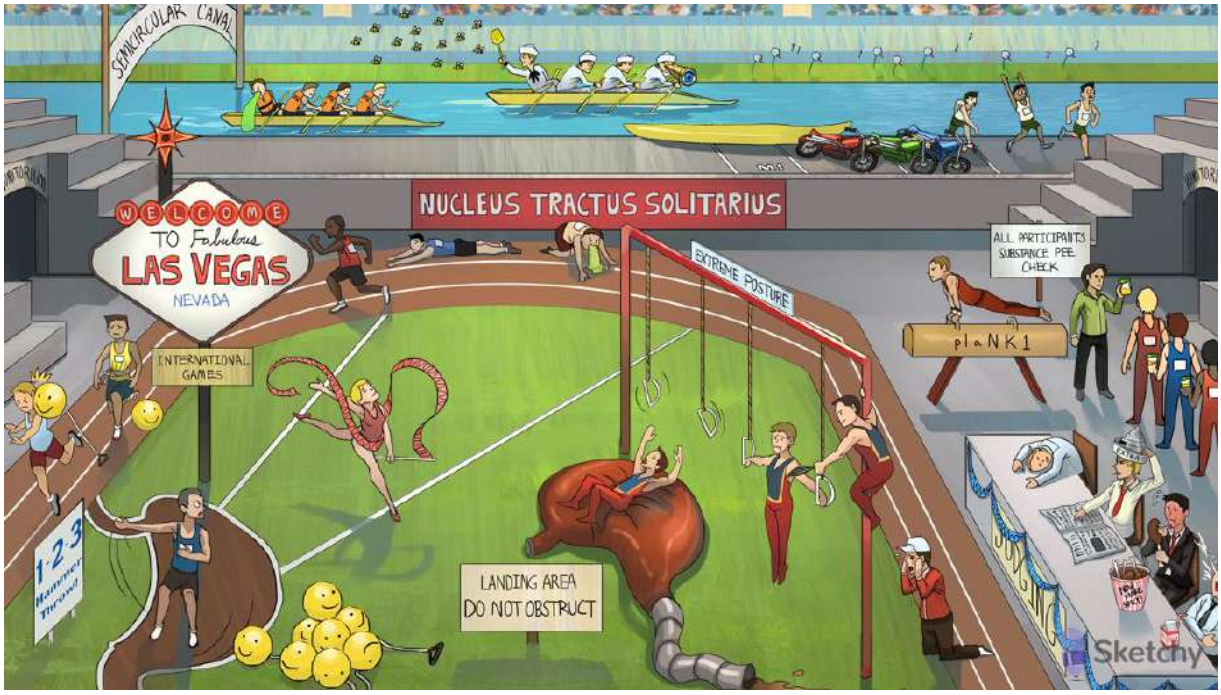
Antihistamines: H1 receptor antagonists

1. Beehive: histamine sequestered inside the granules of mast cells
2. "Q" dandelion: H1 histamine is coupled to the Gq protein (mediates allergic inflammation)
3. Honeypot with 2"S" handles: H2 histamine receptors is coupled to Gs protein
4. Golden gastric honey: H2 histamine receptor mediates gastric acid secretion
5. Dripping nose sap: histamine increases nasal and bronchial mucus production (H1 receptor activation)
6. Dripping vesicular sap: histamine increases vascular receptor permeability (H1 receptor agonist)
7. Constricted lung branch: histamine causes constriction of bronchial smooth muscle (H1 receptor activation)
8. Brain tree: histamine functions as a neurotransmitter (H1 receptor regulates sleep and arousal)
9. **Bee swatter: H1 receptor blocker (antihistamine) treats allergy**
10. **Dragonfly fairy: diphenhydramine and dimenhydranate are 1st generation H1 Blockers**
11. **Color fairy: chlorphenramine (1st gen H1 blocker)**
12. **fairy cuiSINE: hydroxyZINE, mecliZINE, promethaZINE, (1st generation H1 receptor blockers)**
13. Fairy dust and dander: histamine mediates type-1 allergic reaction → hives, allergic rhinitis, (H1 receptor blockers are 1st line therapy)
14. Seasick fairy sailors: 1st generation H1 blockers treat vestibular nausea or motion sickness (lipophilic → enter CNS → act on vestibular system and brainstem)
15. Sleeping under brain tree: 1st generation H1 blockers cause drowsiness (lipophilic → cross BBB → central effects)
16. Anti-muscarinic tea party: 1st generation H1 blockers antagonize –peripheral and central muscarinic receptors (pupillary dilation, dry mouth, urinary retention, constipation, exacerbation of glaucoma, and delirium)
17. adrenergic properties)
18. Falling "extra parking cone: 1st generation H1 blockers treat extrapyramidal side effects caused by antipsychotics (acute dystonia) (antimuscarinic effects re-establish dopaminergic-cholinergic balance)
19. Stuffed fairy: 1st generation H1 blockers stimulate appetite and weight gain (anti-serotonergic effects)
20. Cut smiley face cake: 1st generation H1 blockers antagonize serotonin receptors in the CNS
21. Extinguished single alpha candle: 1st generation H1 blockers antagonize alpha-1 receptors → dizziness and hypotension
22. Fainted fairy: 1st generation H1 blockers cause dizziness and hypotension (anti alpha-adrenergic effects)
23. Delirious elderly man: 1st gen H1 blockers cause cognitive impairment in the elderly (central antihistamine and antimuscarinic effects)
24. **Fox, satyr, and rat: 2nd generation H1 blockers, Fexofenadine, cetirizine, loratidine**
25. Fox, satyr, and rat stand outside the brain tree: 2nd generation H1 blockers are less lipophilic → do not cross BBB → less sedating (also less antimuscarinic, antiserotonergic, or anti-alpha

Asthma: Beta 2 selective agonists, Cromolyn, Leukotriene inhibitors, sulfate, olmalizumab, methylxanthanes

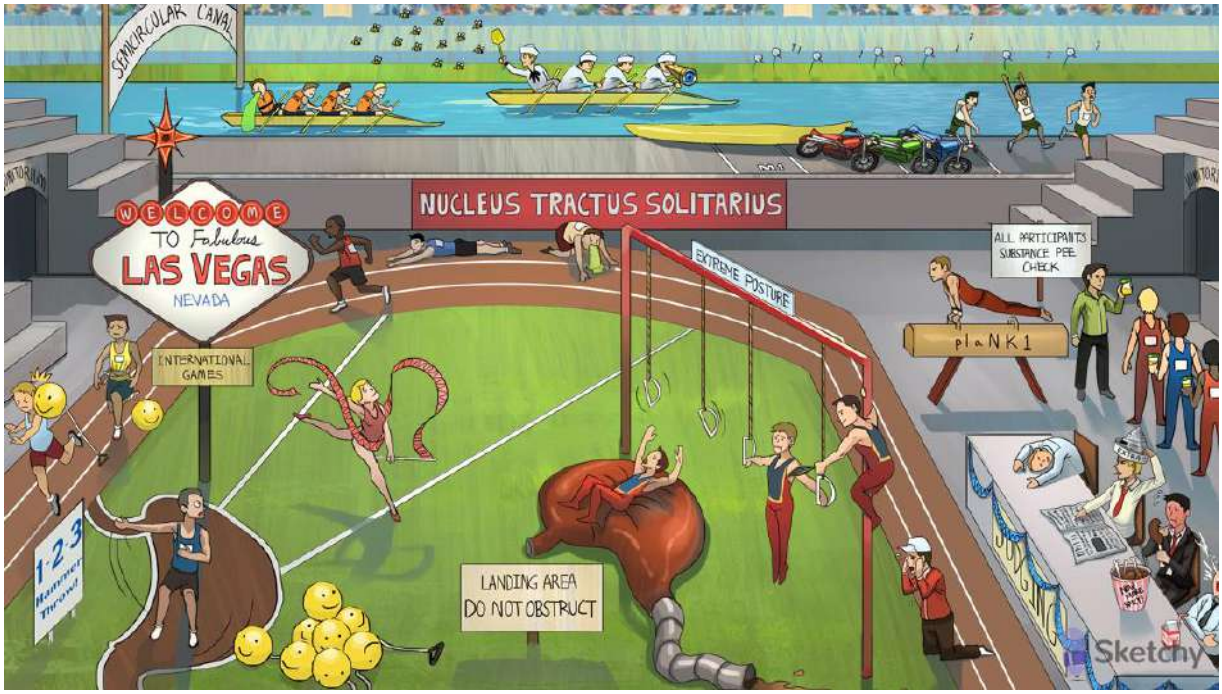
1. Dilated beta 2 tuba: selective beta-2 agonists (albuterol) treat bronchoconstriction in asthma
2. **ROL call: -"rol" suffix of the selective beta-2 agonists (albuterol, pirbuterol)**
3. "do not disturb": terbutaline (a selective beta 2 agonist) treats bronchoconstriction in asthma
4. Inhaler: selective beta 2 agonists (albuterol) are available as metered dose inhalers for acute symptom relief
5. **Moon face: inhaled corticosteroids** (beclomethasone, budesonide, fluticasone) can be added as daily maintenance therapy for persistent symptoms
6. Moon eclipsing inflammatory sun: corticosteroids treat asthma by blocking inflammation and cellular inflammation
7. Canadian snow cones: candida albicans,
8. Snow cone tongue: inhaled corticosteroids (beclemthasone, budesonide, fluticasone) can cause oropharyngeal candidiasis. Treated with tropical clopiprazole
9. AA league: arachidonic acid is the precursor of leukotrienes (and prostanil) synthesis
10. Lacrosse coach Lox: lipoxygenase (LOX) converts AA into leukotrienes
11. Lacrosse players: leukotrienes LTB4, C4, D4, and #4, are important regulators of inflammation
12. B4 attractant first responders: LTB4 is a chemoattractant for inflammatory cells (neutrophils)
13. First responders: neutrophils
14. Constricted lacrosse stick bronchi: LTC4, D4, andE4, increase airway vascular permeability, mucus production, and bronchoconstriction
15. Lacrosse goal CysLT1: receptor for LTD4 (most potent bronchoconstrictor)
16. Monte the broadcaster: "-Kast" suffix of LTD4-receptor antagonists (montelukast, zafirlukast)
17. Blocked D4 shot: LTD4-receptor antagonists (montelukast, zafirlukast) are an alternative therapy for mild persistent asthma
18. Dilated scarf: LTD4-receptor antagonists cause bronchodilation
19. Open mouth: LTD4-receptor antagonists are taken orally
20. **Godzilla falling on coach LOX: zileuton** (a direct lipoxygenase inhibitor) is an alternative therapy for mild persistent asthma
21. Liver spot: zileuton has a risk of hepatoxicity
22. ASA umpire grabbing coach COX: inhibition of COX shifts the AA metabolism to the LOX leukotriene pathway (exaggerated in aspirin-induced asthma)
23. Salute formation: salmeterol and formoterol (long acting beta 2 agonists) treat moderate or severe persistent asthma
24. Long tapering flag: salmeterol and formoterol (beta 2 agonists) have a long duration of action
25. Inhaler: Long acting beta 2 agonists (salmeterol, formoterol) are administered as a daily controller inhaler
26. Higher glucocorticoid moon face: an increased dose of inhaled corticosteroid treats moderate or severe persistent asthma
27. Xanthine energy drink: methylxanthines (theophylline) are an alternative therapy for mild to severe persistent asthma
28. **"flyin": theophylline (a methylxanthine)**
29. Caffeine: methylxanthines are related to caffeine
30. Don't phoster disinterest: methylxanthines (theophylline) are phosphodiesterase inhibitors
31. "Camping": methylxanthines increase cAMP
32. Open mouth: theophylline is administered orally
33. <u>Adverse effects</u>
34. Shaking kid: methylxanthies (theophylline) have CNS side effects including nervousness and tremor
35. Holding up heart watch: methylxanthines (theophylline) can cause tachycardia
36. Chrome bumper hitting energy drinks: methylxanthines (theophylline) are metabolized by the cytochrome P-450 system
37. Bee hive: mast cell degranulation is important to the pathogenesis of asthma
38. IgE gun shooting hive: antigen binding to Fc portion of IgE on mast cells causes degranulation and release of inflammatory mediators (histamines)
39.

40. **Limousine: omalizumabe** (an anti-IgE monoclonal antibody) is an adjunctive therapy for moderate or severe persistent asthma
41. grabbing end of IgE gun Omalizumab is a monoclonal antibody directed against the Fc portion of IgE, preventing mast cell sensitization
42. **Lynn's bee control: chromolyn sodium**
43. Bee sedating smoke: cromolyn sulfate inhibits mast cell degranulation (preventing release of histamine)
44. **IN THE EMERGENT SITUATION**
45. Beta 2 tuba: inhaled short-short acting beta 2 agonists (albuterol) treat an acute severe asthma exacerbation
46. Floating moon face caterpillar:" Systemic corticosteroids treat acute severe asthma exacerbation
47. Ivy: corticosteroids are administered IV or orally during acute severe asthma exacerbation
48. Cat-IPRA-pilar: nebulized IPRAtroprium bromide (antichlinergic) can be added to treat an acute severe asthma exacerbation
49. Epic: subcutaneous or intramuscular epinephrine can be used to treat an acute severe asthma exacerbation

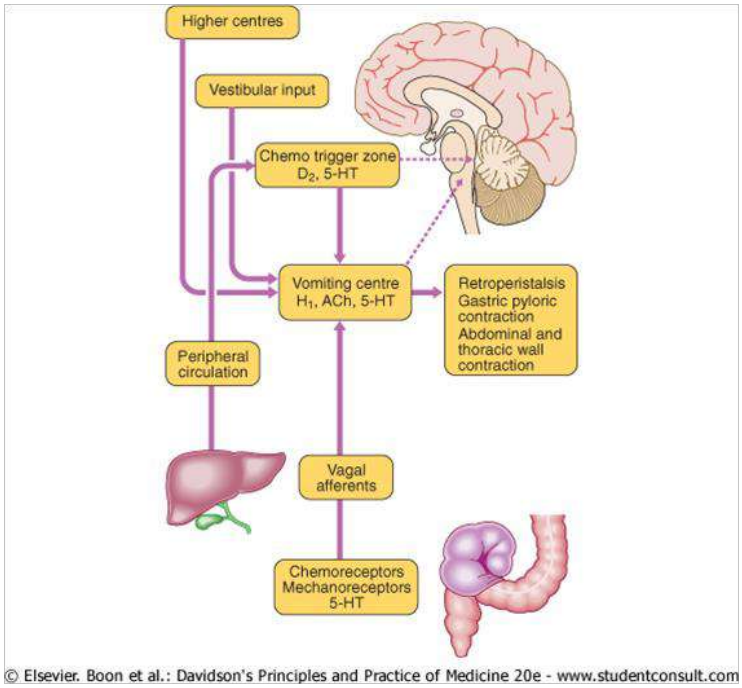


Antiemetic agents: Odansetron, metoclopramide, H1 receptor agonists, Scopolamine, aprepitant

1. Solitary track runner: the nucleus tractus solitaries (NTS, or vomiting center) located in the medulla, receives inputs from the GI tract, vestibular system, and area postremia
2. Vomiting on track: the NTS projects neurons to other medullary nuclei to coordinate the vomiting response
3. Stomach hammer throw area: The GI tract blood barrier (bb) directly with the NTS (via CN X)
4. Vegas sign at the stomach area: vagal afferents from the GI tract communicate with the NTS
5. Smiley hammer at the stomach area: GI irritation (due to infection, chemotherapy, distension) causes mucosal serotonin release
6. "1-2-3" Hammer Throw!": serotonin activates 5HT-3 receptors on the vagal afferents
7. Semicircular canal: the vestibular system communicates directly with the NTS (via CN III)
8. Vests at the semicircular canal: the vestibulocochlear nerve (CN III) from the vestibular system communicates with the NTS
9. Seasick at the canal: the vestibular system is responsible or vertigo and motion sickness (vestibular nausea)
10. Extreme postures on the pommelhorse next to the track: the area postrema (chemoreceptor trigger zone) is located adjacent to the NTS (outside the BBB in the 4th ventricle) and responds to emetogenic substances (chemotherapeutic agents)
11. **Ribbon dancer blocking the hammer throw: Ondansetron** antagonizes 5-HT3 receptor on vagal afferents in the GI tract (treats chemo-induced or post-op vomiting)
12. Hammer tightening gut: ondansetron can cause constipation
13. Hammer hitting head: Ondansetron can cause headache and dizziness
14. Twisted torsade's streamer: ondansetron can prolong the QT interval and induce torsade's
15. Pile of smiley faces: Ondansetron can cause serotonin syndrome (symptoms include rigidity, tremor, hyperthermia, confusion)
16. Allergy inducing, Q shaped dandelions: the vestibular system contains H1 histamine receptors (coupled to Gq)
17. **Bee swatters: 1st generation H1 receptor blockers** (diphenhydramine, Meclizine) treat vestibular nausea (motion sickness)
18. M1 motorcycle parking: the vestibular system contains M1 muscarinic receptors
19. **Telescope: scopolamine** (muscarinic agonist) treats vestibular nausea (motion sickness)
20. Seasick Sailor outfits: motion sickness (vestibular nausea) is treated with 1st generation H1 antagonists (diphenhydramine) and scopolamine
21. Extreme posture 2 D-Ring ropes: the area postrema contains D2 receptors
22. **Tickler blocking the D-rings: metoclopramide** antagonizes D2 receptors in the area postrema (treats chemotherapy induced vomiting)
23. Contracted stomach: metoclopramide has upper GI prokinetic effects (increased esophageal peristalsis, decreased lower esophagus sphincter pressure, and enhanced gastric emptying) (useful for treatment of delayed gastric emptying due to post-surgical disorders and diabetic gastroparesis)
24. "Do not obstruct": metoclopramide (D2 Antagonist) is contraindicated in small bowel obstruction
25. Adverse effects
26. Mud puddle: metoclopramide can cause diarrhea (prokinetic effects)
27. Sleeping judge: Metoclopramide can cause drowsiness, especially in the elderly
28. Crying coach: metoclopramide can cause depression (central D2 blockade)
29. EXTRA pyramidal newspaper hat: metoclopramide can cause extrapyramidal effects due to central D2 blockade (dystonia, akathisia, parkinsonian features)
30. Sticking out tongue: metoclopramide can cause tardive dyskinesia with chronic use (central D2 blockade), especially in the elderly
31.



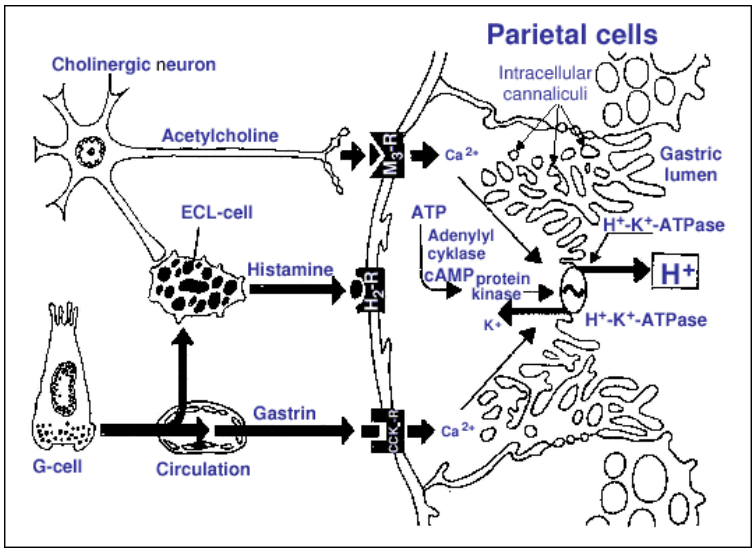
32. **N**ow **M**ore **S**picy chicken: metoclopramide (D2 agonist) can cause **neuroleptic malignant syndrome** (symptoms include fever, rigidity, mental status changes, autonomic instability, rhabdomyolysis)
33. Elevated milk release: metoclopramide can cause elevated prolactin levels (central D2 blockade), leading to gynecomastia, amenorrhea, and decreased sexual drive
34. Twisted torsade's streamer: metoclopramide can cause QT prolongation and induce torsade's
35. plaNK1 pommel horse: the area postrema contains neurokinin 1 (NK1) receptors (activated by substance P)
36. Substance Pee check: substance P binds to the NK1 receptors in the area postrema
37. "participants": aprepitant antagonizes the NK1 receptors in the area postrema (treats chemotherapy induced vomiting), the "a preppy aunt" is a better mnemonic

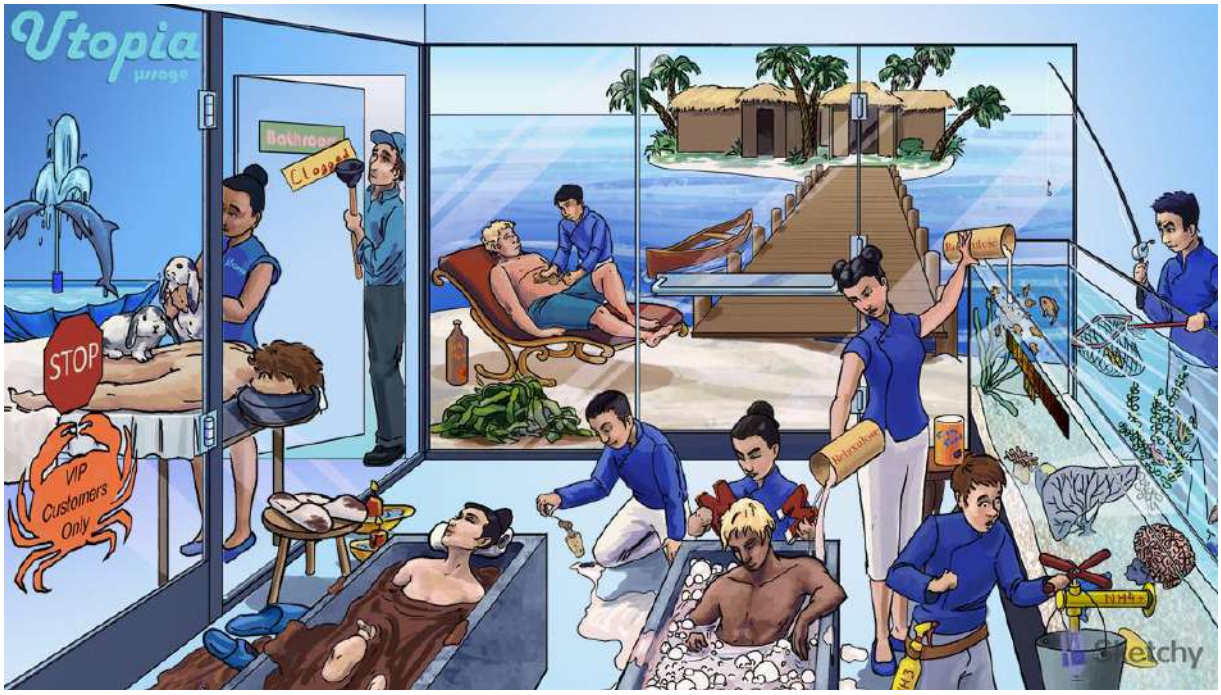


H2 Receptors: PPI's

1. "pour it all": parietal cells in the gastric mucosa are responsible for acid secretion
2. Battery powered puree pump: H+/K+ ATPase (proton pump) on the luminal membrane pumps H+ into the lumen
3. Banana into the pump, lemons out: the H+/K+ ATPase exchanges one K+ for one H+ at the luminal membrane
4. Sidewalk: lumen of the stomach
5. Three P batters: ATPase driven process
6. Bees swarming honey pot: histamine (released by the ECL cell) activates H2 receptors on the parietal cell
7. Honey pot with 2 "S" handles: H2 histamine receptors (coupled to Gs to increase cAMP) on the basolateral membrane
8. Honey pot kid knocking over acid pitcher: activation of H2 receptors upregulates the H+/K+ ATPase → increased acid secretion
9. Enter CarefuLly: enterochromaffin –like (ECL) cells
10. Bees released from ECL tree: the ECL cell releases histamine (activates the parietal cells)
11. Gas Powered blower releasing bees from ECL tree: gastrin (released by G cells) stimulates the ECL Cell to release histamine
12. Gas truck releasing gas tanks: G cells release gastrin (Which stimulates ECL and parietal cells)
13. Gas powered acid pump: gastrin (released by G cells) stimulates the parietal cell to secrete H+ (minor effect) gastrin's major effect is release of Histamine from ECL cells
14. Motorcycle attached to stand in M3: M3 acetylcholine receptors are located on the parietal cell
15. Vegas sticker: vagal stimulation stimulates the parietal by the vagus nerve (M3 receptor)
16. Vegas Sticker: vagal stimulation stimulates the G cell to release gastrin (VIA GRP)
17. Gate release pull: gastrin releasing peptide (GRP) from the vagus nerve activates G Cells
18. **2 bee swatters: H2 histamine receptor antagonists** (ranitidine, cimetidine) inhibit acid secretion by parietal cells
19.
20. Tie dye t shirt: "-tidine" suffix of H2 receptor antagonists (ranitidine, cimetidine, famotidine, nizatidine) @ antagonists reduce the acid secretion that is mediated by histamine, this comes from the enterocrhomaffin like cell, this cell is initially by gastrin by the G cell, which is brought on by vagal stimulation. So H2 blockers work with Histamine, gastrin, and Vagal stimulation. But Vagal stimulation will also stimulate the parietal cell directly to secrete acid. H2 blockers are used at night to prevent nocturnal secretion of acid that is largely dependent on histamine, but only a modest effect on meal stimulation because vagus nerve will stimulate Parietal cells directly
21. Gargling: H2 blockers (ranitidine, cimetidine) treat GERD (PPI's are first line)
22. Ulcerated sidewalk: H2 blockers (ranitidine, cimetidine) treat duodenal ulcers (PPI's are first line)
23. **Tie dye kid on the cement: cimetidine** (H2 blocker with antiandrogenic side effects)
24. Dented chrome bumper: Cimetidine inhibits cytochrome P-450
25. Pot lids on chest: cimetidine can cause gynecomastia when used long term or in high doses
26. Droopy honey wand: cimetidine can cause impotence
27. Milk shooting from nose: cimetidine can cause elevated serum prolactin levels
28. **Girl scout blocking puree pump: Proton Pump Inhibitors** (PPI's) irreversibly inhibit the H+/K+ ATPase (the final common pathway for H+ secretion)
29. PRIZE: "-prazole" suffix of PPI's (omeprazole, lansoprazole, rabeprazole)
30. Gargling: H2 blockerrs (ranitidine, cimetidine) treat GERD but PPI's are the first line
31. Ulcerated sidewalk: PPI's provide faster symptom relief for gastric and duodenal ulcers
32. Jumbo gas tank on mower with crab logo: gastrinoma causing hypersecretion of gastric acid (Zollinger-Ellison syndrome – treat with PPI's)
33.

34. Swarm of bees over lawn mower: extra gastrin will stimulate parietal cell directly with increasing Histamine, PPI's are the best medical treatment
35. Helicopter hat: PPI's treat H.Pylori infection, with clarithromycin or amoxicillin/metronidazole
36. Adverse effects
37. Chocolate fondue fountain: PPI's increase the risk for C.Diff infection
38. Dirty lung spots: PPI's increase the risk for respiratory infections (pneumonia)
39. Medals bound to wagon: PPI's decrease the absorption of Ca2+, Mg2+, and Fe2+ (requires acidic environment)
40. Fractured Axel: PPI's increase the risk of osteoporotic hip fractures (due to decreased Ca2+ absorption)
41. Porous wood: PPI's may worsen osteoporosis (due to decreased Ca2+ absorption)
42. Falling magnets on girl scout: PPI's can cause hypomagnesia
43. **Stop sign: Somatostatin** inhibits release of histamine by ECL cells
44. Stop sign: Somatostatin (SST) inhibits the release of gastrin by G cells (and SST receptor positive gastrinomas)
45. **Octagon shape of stop sign: octreotide** (a long acting SST analog) inhibits ECL production
46. Octagon: octreotide (a long acting SST analog) inhibits G cells (useful in the treatment of gastrinoma/Zollinger Ellison syndrome





Laxatives and anti-diarrheal agents

1. Spa water: osmotic laxatives (magnesium compounds, lactulose, polyethylene glycol) are non-absorbable substances that draw water into the intestinal lumen → distension → peristalsis
2. Magnets: magnesium compounds (magnesium hydroxide (milk of magnesia), magnesium citrate) are osmotic laxatives
3. PEG drain cover: polyethylene glycol (PEG) is an osmotic laxative (non absorbable sugar), commonly is iso electrolytic so not to draw electrolytes into the lumen
4. Relaxulose: lactulose is an osmotic laxative (non absorbable sugar) sever flatus and cramps may be AE's
5. Relaxulose into the liver and brain coral tank: lactulose is useful in the treatment of hepatic encephalopathy
6. Cirrhotic liver and brain coral: hepatic encephalopathy (a neurologic complication of cirrhosis due to the buildup of ammonia and other toxins) as ammonia gets shunted past the liver and ends up in the brain, leads to the rhythmic flapping of hands (asterixs)
7. Fish eating lactulose: intestinal bacteria metabolize lactulose into acidic metabolites
8. Acidic pH meter: acidic metabolites decrease the pH of the intestinal lumen
9. Worker on the NH4+ release valve carrying the ammonia bottle: ammonia (NH3) is trapped as ammonium (NH4+) in the acidic lumen and excreted
10. **Fisherman removing fish: rifaximin** (a poorly absorbed antibiotic) eradicates ammonia producing intestinal bacteria (treats hepatic encephalopathy)
11. Spoiling mud bath: laxatives can cause diarrhea and dehydration
12. **Bulky seaweed outside of the shop:** psyllium is a bulk forming laxative (indigestible hydrophilic colloid → absorbs water → distension → peristalsis)
13. **Water penetrating a canoe at the DOCK: docusate** is a stool softener (surfactant agent that facilitates penetration pf stool by water and lipids)
14. Stimulating suntan lotion: senna is a stimulant laxative a.k.a cathartic (stimulation of enteric nervous system and colonic secretions)
15. Brown gut: chronic use of senna causes melanosis coli (brown pigmentation of the colon)
16. Muddy slippers left outside: antidiarrheal agents (featured in massage room)
17. Utopia: Opiate agonists (diphenoxylate, loperamide) treat diarrhea
18. MUssage: opioids treat diarrhea by activating mu-opioid receptors in the GI tract
19. **Lop-eared rabbit: Loperamide** treats diarrhea (mu-opioid agonist that does not cross the BBB → no analgesia or potential for addiction)
20. Lop eared rabbit hopping back and forth: opioid agonists (loperamide) increase colonic phasic segmenting activity → increased colonic transit time
21. **Dolphins: Diphenoxylate** treats diarrhea (mu-opioid agonist with some ability to cross the BBB → combines with atropine to prevent abuse)
22. Red stool and inflammatory candles outside door: antidiarrheal agents are contraindicated in patients with bloody diarrhea or fever (treat the underlying cause)
23. Clogged: opioids can cause constipation
24. VIP CUSTOMERS only crab: VIPoma and carcinoid tumor cause secretory diarrhea, pancreatic endocrine tumor secreting VIP
25. STOP sign: Octreotide treats the symptoms of VIPoma and carcinoid syndrome (secretory diarrhea)

Diabetes: insulin, sulfonylureas, meglitinides, GLP-1 agonists, DPP-4 inhibitors (type I on this page)

1. Welcome inside mat: insulin (the storage and anabolic hormone of the body)
2. LangerHansel: islets of Langerhans in the pancreas (the site of beta cells in the pancreas)
3. Beta 2 tuba: pancreatic beta cells produce insulin (stimulated by many factors including glucose and sympathetic activation of beta 2 receptors)
4. Langerhansel candy: glucose – the most potent stimulant of glucose secretion
5. Closed gate around banana candy flowers: glucose increases ATP levels in the beta cell → ATP dependent K+ → channels close
6. Gretel rushing in on the calci-yum ice cream flower: closing the ATP dependent K+ channels causes the beta cell to depolarize → voltage gated Ca2+ channels open → Ca2+ INFLUX → insulin secretion
7. Candy wrapper on the ground: C-Peptide (cleaved from proinsulin in the secretory granule) is released with endogenous secretion of insulin
8. Tyrosine tire swing: the insulin receptor contains an intracellular tyrosine kinase domain, this sets off a cascade of phosphorylation events eventually leading to glucose transporters being added to the cell membrane
9. 4 on the open door: insulin inserts glucose transporter type 4 (GLUT4) into the membrane of peripheral tissues (adipose and muscle)
10. Full liver candy jar: insulin increase hepatic glycogen stores (increased glycogenesis, decreased glycogenolysis)
11. Glycogen glazed ham: insulin increases glycogen storage and protein synthesis in muscle
12. Full fatty donut jar: increases triglyceride storage in adipocytes
13. Old lady Eating banana candy: insulin decreases serum K+ (increased Na+/K+ ATPaase in skeletal muscle drives K+ into the cells)
14. **Girls and Lads**: Insulin Glusine, Aspart, Lispro (rapid acting, short duration) these do not polymerize into hexamers so they are absorbed rapidly
15. Tall immediate peak on "girls and Lads": Insulin glusine, aspart, and Lispro have rapid onset and short duration of action, mimicking post prandial response.
16. Birds nibbling the peak: insulin glusine, aspart, and lispro control the postprandial glucose spike
17. **Rest Now: regular insulin and NPH** (neutral protamine Hagedorn) Intermediate acting
18. Delayed peak on the house: regular and NPH insulin have a delayed onset and intermediate duration of action (NPH is more delayed) this is due to the formation of dimers and hexamers, taking time to breakdown
19. Ivy under "R": Regular insulin is only one to be administered IV
20. Candy Cane Key: Diabetic Keto Acidosis (DKA – Presents with vomiting, Fatigue, Polyuria)
21. Ivy next to candy key: IV regular insulin is useful in the management of DKA (watch K+ levels)
22. Ivy next to eaten banana: IV regular insulin is useful in the management of hyperkalemia (administer with glucose!)
23. **Rest Now: regular insulin and NPH** (neutral protamine Hagedorn) Intermediate acting
24. Delayed Peak: : regular and NPH insulin have a delayed onset and intermediate duration of action (NPH is more delayed) this is due to the formation of dimers and hexamers, taking time to breakdown, NPH is not used much clinically
25. **Don't Go: insulin Detemir, Glargine (long acting)**
26. Roof on hat is long and flat: Insulin detemir and glargine have long durations of action and provide a steady background level of insulin (glargine has no peak)
27. Falling candy: insulin therapy can cause hypoglycemia (presents with tachycardia, palpitations, sweating, nausea)
28. Glucagone for when your glucose is gone!

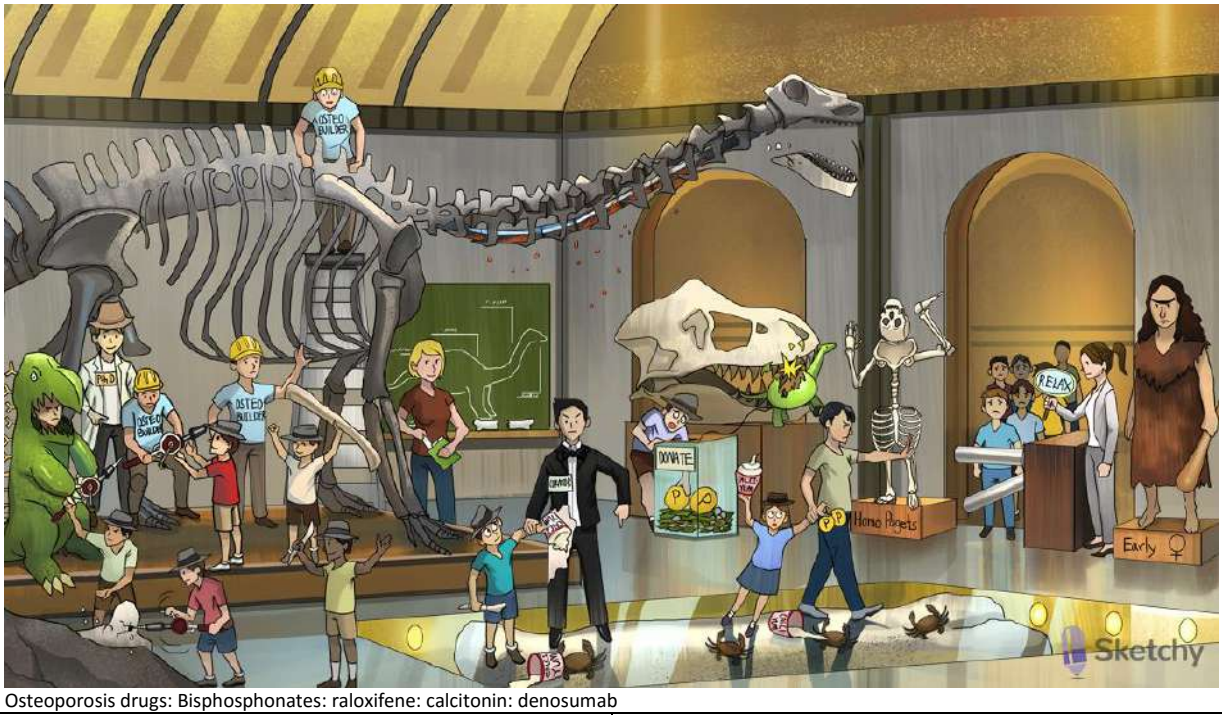
Type II diabetics

1. **Sulfa egg laying swan: sulfonylureas (glyburide, glipizide)** are sulfa drugs that stimulate endogenous insulin release from beta cells
2. Sulfa swan lake behind closed banana gate: sulfonureas bind the ATP-dependent K+ channels on beta cells → leading to depolarization of beta cells → calcium influx → release of endogenous insulin
3. **Mother swan in a maid outfit: "-amide"** suffix of first generation sulfonureas **(tolbutamide, chloropropramide)** long duration of action, rarely used)
4. **Goslings riding on the mother swan's back: "-ride" suffix** of second generation sulfonureas **(glyburide, glimepiride)** smaller dosing, long duration of action
5. **Short zig-zagging gosling: glipizide (2nd generation sulfonurea**) has the shortest duration of action (less risk of hypoglycemia)
6. **Father goose gliding into the scene: "glinide" suffix of the meglitinides (repaglinide, nateglinide**) MOA similar to sulfonureas sulfonureas bind the ATP-dependent K+ channels on beta cells → leading to depolarization of beta cells → calcium influx → release of endogenous insulin)
7. Candy wrapper on the ground: C-Peptide (cleaved from proinsulin in the secretory granule) is released with endogenous secretion of insulin
8. Father goose cannot lay eggs: meglitinides (glinides) are NOT sulfa drugs (can be used in patients with an allergy to sulfa)
9. Falling candy: sulfonurease and meglitinides can cause hypoglycemia
10. Fat old hag: sulfonureas and meglitinides can cause weight gain
11. "Do not drink" next to mother sulfonurea swan: some 1st generation sulfonureas (cloropramide) cause a disulfuram like reaction with ingestion of alcohol
12. These need functional beta cells in order to work
13. 2 fingers: sulfonureas and meglitinides (glinides) are oral agents used in the treatment of TYPE 2 diabetes requiring functional beta cells for endogenous insulin release
14. **ExenaTIDE detergent: "-tide" suffix of GLP-1 agonists (exenatide, liraglutide)**
15. Langerhansel "Gulp" activated when looking at Hag: GLP-1 agonists (exenatide, liraglutide) activate the Glucagon Like Peptide Receptor (GLP-1) (increased insulin release and satiety, decreasing glucagon release and gastric emptying)
16. **4 DRIPPNG laundry items hanging: Dipeptidyl peptidase (DPP-4) inhibitors (gliptins) prevent the breakdown of GLP-1**
17. Clipped in clothespins: "-gliptin" suffix of the DPP-4 inhibitors (stigaliptin, saxagliptin, linagliptin)
18. Laundering old hag letting out endogenous gulps: DPP-4 inhibitors (gliptins) increase levels of endogenously secreted GLP-1 (increased insulin release and satiety, decreased glucagon release and gastric emptying)
19. Falling empty glucagon packets: GLP-1 agonists and DDP-4 inhibitors decrease glucagon secretion this aids in lowering serum glucose levels
20. Sealed gastric container: GLP-1 and DDP-4 inhibitors decrease gastric emptying leading to increase satiety and delayed glucose absorption
21. Clothespin clipping nose: DPP-4 inhibitors (gliptins) can increase risk for upper respiratory infections an nasopharangyiis
22. Creping detergent lady Squeezing pancreas sponge: GLP-1 agonists (exenatide) can cause pancreatitis, seek immediate medical care
23. Green candies NOT falling off the tree: GLP-1 agonists and DPP-4 inhibitors do NOT cause hypoglycemia
24. 2 fingers: GLP-1 and DPP-4 inhibitors are oral agents used in the treatment of TYPE 2 diabetes requiring functional beta cells for endogenous insulin release
25. C-Wrapper: GLP-1 agonists and DPP-4 inhibitors increase endogenous insulin release and C-Peptide levels

Metformin, Rosiglitazone, pioglitazone, pramlintide, canagflozin, acarbose, miglitol

1. 2nd grade: these agents are used in the treatment of type II diabetics (require functional beta cells for endogenous insulin release)
2. **Skinny Kid on his knee saying a metaphor: Metformin** (a biguanide) is the first line oral agent for the management of type II diabetes
3. Girl eating the mitochondrial candy then puking: metformin inhibits the mitochondrial enzyme glycerophosphate dehydrogenase (mGDP) → decreasing hepatic gluconeogenesis
4. AMPKandy: metformin activates the enzyme AMP-activated protein Kinase (AMPK) → decreased gluconeogenesis, increased insulin sensitivity
5. Girl stopping candy release from liver bag: metformin modulates enzyme function to decrease hepatic gluconeogenesis
6. INSIDE open candy box: Metformin increases insulin sensitivity (valentines mailbox is to simulate "welcome inside" mat
7. Spilled sour milk: metformin can cause lactic acidosis. This is due to metformin inhibiting lactic acid ability to enter gluconeogenic pathways into the liver
8. Cracked kidney tray: renal insufficiency increases the risk of metformin induced lactic acidosis
9. Nauseated: most common side effect with metformin use is GI side effects (nausea, anorexia, vomiting, diarrhea)
10. Skinny kid: metformin can cause modest weight reduction
11. **Glitter: "-glitazone" suffix of the thiazolidinedione's** (glitazones –rosiglitazone, pioglitazone) work to increase by increase glucose utilization and decreasing glucose production
12. PPARy in circle: thiazolidinedione (glitazones) are ligands of peroxisome proliferator activated receptor gamma (PPARy) an intracellular nuclear receptor that regulates gene transcription causing increased insulin sensitivity, found in muscle, fat, and the liver
13. Turtle neck: PPAR-y upregulates adiponectin (increased insulin sensitivity and fatty acid oxidation)
14. Elevated fatty donut jar: thiazolidinedione (glitazones) increase the differentiation and number of adipocytes
15. Eating Fatty donut: thiazolidinedione's (glitazones) increase triglyceride storage and fatty acid oxidation → decreased serum triglycerides
16. 4 an open door: thiazolidinedione's (glitazones) upregulate GLUT4 in peripheral tissues (increased glucose uptake)
17. Inside open candy box: thiazolidinedione's (glitazones) increase insulin sensitivity
18. Takes days to weeks after therapy to get a response
19. Fat belly on PPAR-y kid: thiazolidinedione (glitazones) can cause weight gain
20. Baggy pants on PPAR-y kid: thiazolidinediones (glitazones) can cause fluid retention and peripheral edema, and decompensation of CHF
21. Falling heart balloon: thizolidinediones (glitazones) induced fluid retention can exacerbate heart failure
22. Fractured chair leg: thiazolidinediones (glitazones) can increase the risk of atypical extremity fractures in women (due to decreased bone mineral density)
23. **Amy and Lynn: Amylin** (islet amyloid polypeptide) analogues (pramlintide) a (decreased glucagon, gastric emptying, and appetite) drug
24. Closed gastric water cooler: amylin analogues (pramlintide) decrease gastric emptying
25. Falling empty glucagon packets: amylin analogues decrease glucagon secretion
26. 1 and 2 fingers being held up by Amy and Lynn: amylin analogues can be useful in the management of type I and type II diabetes
27. Eaten cupcake: amylin analogues can be used to control the postprandial glucose spike
28. Fallin candy: pramlintide can cause hypoglycemia
29. Nauseated: pramlintide can cause GI side effects (N&V, anorexia)
30.

31. **A-Carb wigglers: acarbose and miglitol** (alpha-glucocidase inhibitors)
32. "monosaccharide free": inhibition of alpha-glucosidase enzymes decreases the conversion of disaccharides into absorbable monosaccharides
33. Brush border flags: alpha-glucosidase inhibitors decrease the activity of disaccharides on the intestinal brush border
34. Kid can't open the bag, delayed bag opening: alpha-glucosidase inhibitors delay carbohydrate absorption
35. Eaten cupcake: alpha-glucosidase inhibitors can be used to control post prandial glucose spike
36. Leaky bathroom puddle: alpha-glucosidease inhibitors can cause GI side effects (diarrhea, flatulence, abdominal pain) due to fermentation of the undigested carbs by the gut flora
37. **Flossing: "-flozin" suffix of the SGLT2 inhibitors** (canigflozin, dapagflozin) 2nd or third line drug
38. Salty Glucose Co.: sodium glucose cotransporter 2 (SGLT2 reabsorbs glucose in the proximal tubule (inhibition leads to urinary glucose loss)
39. Pro Cart Track: Proximal convoluted tubule of the nephron (site of activation of SGLT2)
40. Bladder cup: SGLT2 inhibitors can increase the risk of UTI due to increased urine glucose concentration
41. Snow hitting crotch: SGLT2 inhibitors can increase the risk of vaginal candidiasis (Corey the Canadian flag)
42. Fainting kid in the blue: SGLT2 inhibitors can cause hypotension due to osmotic diuresis
43. Cracked kidney tray: SGLT2 inhibitors are contraindicated in renal insufficiency
44.



Osteoporosis drugs: Bisphosphonates: raloxifene: calcitonin: denosumab

1. Fresh piece of calcified chalk: Bisphosphonates, SERMs, denosumab, and calcitonin are useful in the treatment of osteoporosis (inhibit bone resorption → modest increase in bone mineral density and decreased fracture risk)
2. Osteo-builders: osteoblasts
3. Destructive class: osteoclasts
4. **DONATE: "-Dronate" suffix of bisphosphonates** (alendronate, pamidronate, zoledronate), the first line treatment for osteoporosis
5. Two P coins: bisphosphonates have a chemical structure similar to pyrophosphate
6. Large T-Rex appetite: bisphosphonates attach to hydroxyapatite in the bone
7. Classmate stuck in donation box: osteoclasts bind to the bisphosphonate, inhibiting their adherence to the bony surface
8. Class waiting to enter: osteoclast precursors
9. Preventing class from entering: bisphosphonates decrease the development and recruitment of osteoclast precursors
10. Classmates popping balloon: bisphosphonates induce osteoclast apoptosis
11. Elevated calci-yum ice cream: bisphosphonates are useful in the acute treatment of hypercalemia
12. Massive calcified rock with metastatic crab fossils: hypercalcemia of malignancy is a common cause of severe hypercalcemia requiring acute treatment (with bisphosphonates and calcitonin)
13. Disorganized bone homo paget display: bisphosphonates and calcitonin are useful in the management of pagets disease (uncontrolled osteoclast resorption with secondary disorganized bone formation)
14. Corroded neck on dinosaur: bisphonates can cause upper GI side effect (acid reflux, esophagitis, esophageal ulcers) sit upright 30 min and drink water to treat
15. Crumbling jaw bone: bisphosphonates can cause osteonecrosis of the jaw
16. Falling calci-yum ice cream: bisphosphonates can cause hypocalcemia
17. Female symbol: estrogen therapy can treat and prevent postmenopausal osteoporosis (not recommended due to increased risk of breast cancer and other side effects) estrogen therapy will inhibit osteoclast differentiation.
18. Female guarding class entrance: estrogen inhibits differentiation of osteoclast precursors
19. **Relax: raloxifene** (a selective estrogen receptor modulator SERM) is useful in the treatment and prevention of postmenopausal osteoporosis
20. Relaxing the waiting classmates: raloxifene has estrogen agonist activity in bone (inhibits osteoclast differentiation) and estrogen antagonist activity in breast and uterus (reduced risk of breast cancer)
21. **PthD: parathyroid hormone (PTH)**
22. Convincing osteo-builder to give crank drill: PTH stimulates osteoblasts to express RankL
23. Crank drill: receptor activator of nuclear factor kappaB ligand (RANKL)
24. Active classmate with crank drill: RankL binds to RANK on the osteoclast, increasing its activity
25. Dino suit man grabbing crank drill: denosumab (monoclonal antibody against RANKL) is useful in the treatment of osteoporosis
26. Antibody spikes: denosumab is a monoclonal antibody
27. **Curator toning it down: calcitonin** ("tones down calcium) has some utility in the treatment of osteoporosis, released from the parafolicular cells of the
28. Curator grabbing classmate: calcitonin inhibits osteoclasts → decreased bone resorption
29. Calci-Yum ice cream pouring down flank: calcitonin promotes Ca2+ excretion by the kidney
30. Used in the same clinical scenarios as bisphosphonates but not 1st line
31. Massive calcified rock with crab fossils: hypercalcemia or malignancy is a common cause of sever hypercalcemia requiring acute treatment with bisphosphonates and calcitonin
32. Falling calci-yum ice cream: calcitonin can cause hypo calcemia

3.1 - Propylthiouracil, methimazole, levothyroxine

1. Evil follicu-LAIR: thyroid follicular cell (site of iodine uptake and thyroid hormone production)
2. Salty sodium peanuts entering lair: sodium enters thyroid follicular cell through the sodium-iodide symporter
3. Iodide vial smuggled in with salty peanuts: the sodium-iodide symporter concentrates iodide in the follicular cell
4. Follicu-LAIR truck lumen: thyroid follicle lumen (site of iodide storage as thyroglobulin)
5. TransPOrter: thyroid peroxidase (TPO - enzyme involved in iodide oxidation and organification)
6. Rusty oxidized transport truck: TPO oxidizes iodide into iodine
7. "Thyro-global" truck: thyroglobulin (tyrosine rich protein precursor to thyroid hormones located in the follicular lumen)
8. Organic foods transporter truck: TPO facilitates iodine organification (iodination of tyrosine residues on thyroglobulin)
9. Coupled tyres of transport truck: TPO facilitates coupling of iodinated tyrosine residues
10. Time bomb prep table in the follicu-LAIR: thyroid hormones (T4 and T3) are cleaved from thyroglobulin in the follicular cell (T4 in greater quantities)
11. T4 time bomb: tetraiodothyronine (thyroxine, T4)
12. T3 time bomb: triiodothyronine (T3) is the more potent form of thyroid hormone
13. T4 detonator in the periphery: 5' deiodinase in the peripheral tissues converts T4 to T3
14. Sensitive to catfish: thyroid hormone increases the sensitivity of peripheral tissues to catecholamines (increased number of beta-adrenergic receptors)
15. Anxious henchman with big bowtie: hyperthyroidism is associated with hypermetabolic and hyperadrenergic symptoms (e.g. tachycardia, palpitations, insomnia, anxiety, tremor, heat intolerance, weight loss)
16. Bulging infrared goggles: Grave's ophthalmopathy (increased volume of retroorbital connective tissue, due to cellular proliferation, inflammation, and the accumulation of glycosaminoglycans) → exophthalmos
17. Radioactive vial: hyperthyroidism due to Graves' disease can be treated with ablating doses of radioactive iodine (131-I)
18. Undone bowtie: radioactive iodine treatment can cause hypothyroidism
19. Anxious radioactive henchman: radioactive iodine treatment can exacerbate HYPERthyroidism
20. Bulging radioactive goggles: radioactive iodine treatment can exacerbate Grave's ophthalmopathy
21. "PTU!" agent firing at the transporter: propylthiouracil (PTU - a thionamide) treats hyperthyroidism by inhibiting TPO
22. Evil math equations striking transporter: methimazole (thionamide) treats hyperthyroidism by inhibiting TPO
23. "PTU!" agent firing at the bomb trigger: PTU treats hyperthyroidism by inhibiting 5' deiodinase → decreased conversion of T4 into T3
24. Silenced bugle gun pointed at catfish tank: beta blockers treat the hyperadrenergic symptoms of hyperthyroidism
25. Silenced bugle gun pointed at trigger: beta blockers treat hyperthyroidism by inhibiting 5' deiodinase → decreased conversion of T4 into T3

3.1 - Propylthiouracil, methimazole, levothyroxine

26. Moon face death coaster blocking trigger: glucocorticoids treats hyperthyroidism by inhibiting 5' deiodinase → decreased conversion of T4 into T3
27. Moon face death coaster hitting goggles: glucocorticoids treat Grave's ophthalmopathy
28. Thwarted Dr. Storm: treat thyroid storm by 1) blocking sympathetic effects (beta blockers); 2) blocking thyroid hormone synthesis (PTU); and blocking conversion of T3 to T4 (beta blockers, PTU, glucocorticoids)
29. Broken liver beaker: PTU can cause severe hepatotoxicity
30. Chemical spots: PTU can cause a maculopapular rash
31. Plastic chew bones: PTU and methimazole can cause aplastic anemia
32. Guard wolf: PTU and methimazole can cause drug induced lupus
33. Inflamed leash: PTU can cause ANCA-associated vasculitis
34. Tarantula: methimazole is a first trimester teratogen
35. Fat, cold, fatigued mixologist: hypothyroidism is associated with dry brittle hair, lethargy, fatigue, weakness, decreased BMR, cold intolerance, and myxedema
36. Mixing cold drinks: untreated hypothyroidism can lead to myxedema coma (progressive weakness, stupor, hypothermia, hypoventilation, hypoglycemia, hyponatremia, death)
37. Synthetic T4 time bombs: levothyroxine (synthetic T4) treats hypothyroidism
38. Anxious agent taking cover: levothyroxine therapy can cause HYPERthyroidism
39. Obstructive box of anions: anions such as perchlorate, pertechnetate, and thiocyanate competitively inhibit the sodium-iodide transporter (treat accidental radioactive iodine exposure)
40. Fresh piece of calcified chalk: bisphosphonates, SERMs, denosumab, and calcitonin are useful in the treatment of osteoporosis (inhibit bone resorption → modest increase in bone mineral density and decreased fracture risk)

GI and Endocrine

3.3 - Teriparatide, vitamin D, cinacalcet, sevelamer

1. Osteo-builders: osteoblasts (activated by teriparatide and vitamin D → increase bone mineral density)
2. Destructive classmates: osteoclasts (indirectly activated by teriparatide and vitamin D → increase bone resorption/turnover)
3. Released calcified bones: osteoclasts release calcium from bone
4. Released P fossil: osteoclasts release phosphate from bone
5. PthD paleontologist: parathyroid hormone (PTH)
6. PthD lab: parathyroid gland
7. Calcified bone receiving: calcium-sensing receptor on the parathyroid gland (senses increased serum calcium)
8. PthD stuck behind bones: high serum calcium levels inhibit PTH production and secretion
9. PthD convincing osteo-builder to give up crank-drill: PTH stimulates osteoblasts to release receptor activator of nuclear factor kappa-B ligand (RANKL) → activates osteoclasts
10. Classmate receiving crank-drill: RANKL binds to RANK on the osteoclast surface → increased differentiation and activity → increased bone resorption
11. PthD teaching osteo-builders: PTH stimulates maturation of osteoblasts → increased bone formation (net effect of PTH)
12. PthD gathering bones and dropping P fossils: PTH increases calcium resorption by the kidney (and increases phosphate excretion).
13. 1-head added to Calci-TRON: 1-alpha-hydroxylase in the kidney converts 25-hydroxyvitamin D into 1,25-dihydroxyvitamin D
14. PthD adding final piece to Calci-TRON: PTH increases activity of 1-alpha-hydroxylase in the kidney → increased production of 1,25-dihydroxyvitamin D (calcitriol)
15. PthD teaching assistant (TA): teriparatide (recombinant PTH)
16. TA teaching osteo-builders: intermittent doses of teriparatide stimulates maturation of osteoblasts → increased bone formation
17. Fresh piece of calcified chalk: teriparatide can be used to treat osteoporosis (increase bone density)
18. TA gathering bones and dropping P fossils: teriparatide increases calcium resorption by the kidney (and increases phosphate excretion)
19. TA adding final piece to Calci-TRON: teriparatide increases activity of 1-alpha-hydroxylase in the kidney → increased production of 1,25-dihydroxyvitamin D (calcitriol)
20. Solar D3 battery: vitamin D3 (cholecalciferol) is obtained via dairy products or UVB radiation in sunlight
21. Earth-friendly D2 battery: vitamin D2 (ergocalciferol) is obtained via plants
22. Robot body added to D battery in liver-barrow: 25-hydroxylase in the liver converts vitamin D to 25-hydroxyvitamin D
23. Calci-TRON gathering bones and fossils from dump site: calcitriol stimulates reabsorption of calcium AND phosphate by the kidney
24. Calci-TRON gathering bones and fossils from GI truck: calcitriol stimulates intestinal absorption of calcium AND phosphate
25. Calci-TRONl delivering crank-drills: calcitriol stimulates osteoblasts to release RANKL → activates osteoclasts
26. Calci-TRON collapsing PthD lab: calcitriol inhibits PTH production by the parathyroid gland

3.3 - Teriparatide, vitamin D, cinacalcet, sevelamer

27. Calci-TRON teaching osteo-builders: calcitriol stimulates maturation of osteoblasts → increased bone formation
28. Fresh piece of calcified chalk: calcitriol can be used to treat osteoporosis (increase bone density)
29. Calci-TRON stabilizing rickety tower: vitamin D (e.g. calcitriol) can be used to treat osteoporosis (increase bone density)
30. Calci-TRON stabilizing broken kidney: calcitriol can be useful in chronic kidney disease (prevent hypocalcemia)
31. Scaly knee and elbow pads: topical vitamin D can be used to treat psoriasis
32. Calci-TRON saving falling calcified bones: calcitriol is useful in the long term management of hypocalcemia (e.g. hypothyroidism)
33. Falling PthD: hypocalcemia is commonly caused by hypoparathyroidism (decreased production of calcitriol by the kidney)
34. Undone bowtie on PthD: thyroid surgery can cause hypoparathyroidism and hypocalcemia
35. Shaking structure: hypocalcemia can cause seizure
36. Tense fist: hypocalcemia can cause paresthesias, muscle cramps, trismus, and tetany
37. Raised calci-yum ice cream: teriparatide and vitamin D therapy can cause hypercalcemia
38. Calculator at the calcified bone receptor: cinacalcet (a calcimimetic) activates the calcium sensing receptor on the parathyroid gland → decreased production of PTH
39. Calculating pile of calcified bones: cinacalcet is useful in the treatment of hypercalcemia due to hyperparathyroidism
40. Shoveling fossils in the GI truck: sevelamer (a phosphate binding polymer) decreases absorption of phosphate in the GI trac
41. Shoveling pile of fossils: sevelamer is useful in the treatment of hyperphosphatemia due to chronic kidney disease

Growth hormone: mecasermin: octreotide: pegvisomant

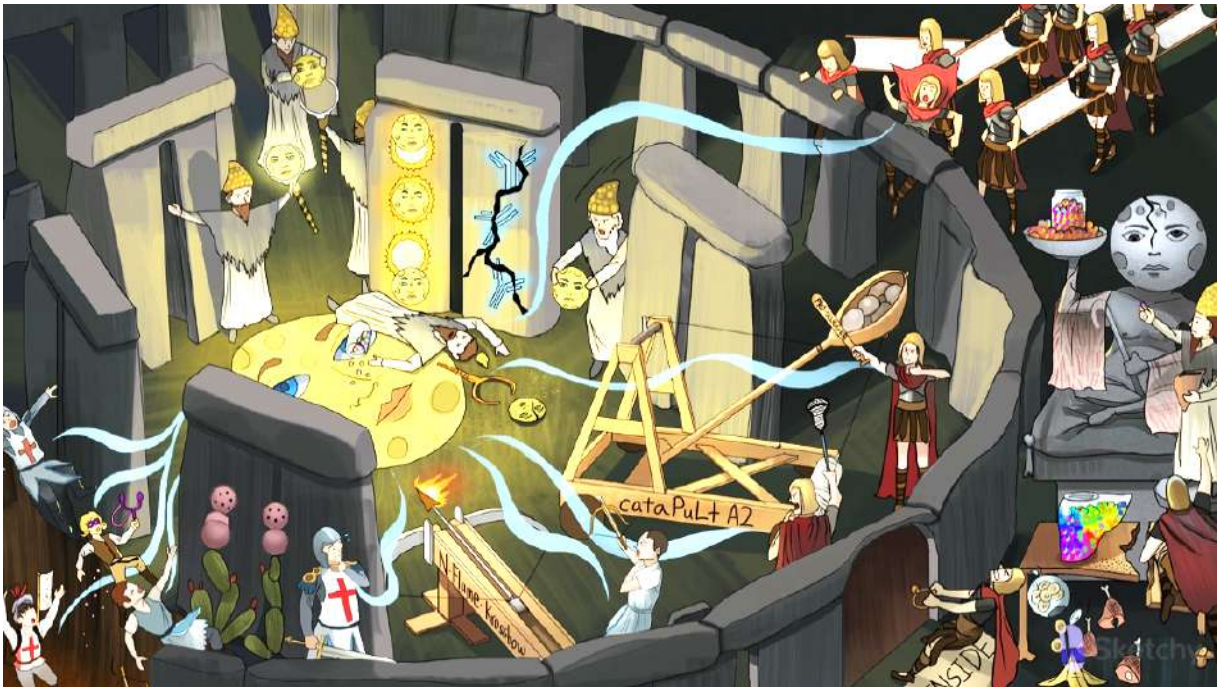
1. **Magic growing beans: Growth hormone** (somatotropin)
2. Front of pituitary sack: GH is secreted from the anterior pituitary
3. Tyrosine tire: the GH receptor is associated with JAK tyrosine kinase "jackin up that cell growth"
4. Growing "welcome INSIDE" mat: insulin-like growth factor (IGF-1) (mediates the growth promoting effects of GH)
5. Tall growing vine: IGF-1 is responsible for long bone growth (pubertal growth spurt) think of a child shooting up just like the vine off the ground
6. Vine sprouting from the Liver rock: GH stimulates the liver to produce IGF-1
7. Striated muscle leaf: GH has anabolic effects in muscle
8. Falling fatty donut jar: GH has catabolic effects in adipose tissue, reduced adiposity, increased muscle mass
9. Short kid: GH therapy is useful in GH deficiency and idiopathic short stature (controversial)
10. Pradre willi: GH therapy is useful for increasing growth in Prader-willi syndrome
11. Turning X girl: GH therapy is useful for increasing growth in turner syndrome, transmittance of a single X chromosome (XO)
12. **Sermon: Mecasermin** (recombinant IGF-1) treats growth failure due to severe IGF-1 deficiency
13. Falling candy: mecasermin (recombinant IGF-1) can cause hypoglycemia
14. Giant: GH secreting pituitary adenoma causes acromegaly in adults and gigantism in children
15. Octagon stop sign: octreotide (somatostatin analog) treats acromegaly and gigantism (inhibit secretion of GH)
16. VIP Customers only: octreotide treats VIPoma (neuroectoderm tumor secreting VIP)
17. Customers only: octreotide treats carcinoid tumors (ileal tumor with hepatic mets secreting serotonin) flushing, wheezing, and secretory diarrhea
18. BIG "welcome inside mat": Octotreotide treats insulinoma (fasting hypoglycemia)
19.
20. Giant glucagon packet: octreotide treats glucagonoma (manifests as weight loss and necrolytic migrator erythema affecting limbs and skin surrounding the lips)
21. Giant gas tank: octreotide treats gastrinoma (Zollinger ellisson syndrome)
22. Exposed variceal pipes: octreotide can control bleeding of esophageal varices (decreased portal blood flow and variceal pressure)
23. Nauseated and pointing up: AE's include GI side effects, N&V, abdominal pain
24. Yellow stool: octreotide can cause steatorrhea (decreased pancreatic secretions and gall bladder contractility)
25. **Burglar with broomstick: cabergoline and bromocriptine** (D2 receptor agonists) treat acromegaly (inhibit secretion of GH from pituitary
26. Double rope ladder: D2 dopamine receptor (activated by cabergoline and bromocriptine)
27. Pituitary sack at the end of the broomstick holding in the beans: reinforcing the inhibition of GH at the pituitary
28. **Ants on a tire swing: pegvisomant** (GH receptor antagonist) treats acromegaly
29.

ADH, Desmopressin (DDAVP), Vasopressin receptor antagonist

1. Collecting duct (CD) – the site of action of antidiuretic hormone (ADH, vasopressin)
2. Hydrating waterboy: antidiuretic hormone (ADH, vasopressin)
3. Posterior water jug: ADH is released from the posterior pituitary
4. V1 hole on the Q shaped green: ADH activates V receptors coupled to Gq (activates PLC → IP3 + DAG → increased intracellular Ca2+)
5. Constricted golfclub: ADH activation of V1 on vascular smooth muscle causes vasoconstriction and increased BP
6. V2 hole on the S shaped green: ADH activates V2 receptors coupled to Gs (activates adenylyl cyclase → increased cAMP)
7. Translocation of pure water: ADH activation of V2 on the basolateral membrane of the CD causes translocation of aquaporin 2 to the apical membrane and reabsorption of free water
8. Endothelial tile: extrarenal V2 receptors are located on the vascular endothelium
9. Von Wille brand pool table: ADH activation of V2 on vascular endothelium causes release of von Willebrand factor (vWF)
10. 8-ball: ADH activation of V2 on vascular endothelium causes release of factor VIII
11. Insipidus fountain: polyuria diabetes insipidus (DI)
12. Dehydrating kidney sand trap: nephrogenic DI
13. Ignoring water boy: nephrogenic DI occurs when the nephron does not respond appropriately to ADH
14. Lift-ium balloons: lithium can cause drug-induced nephrogenic DI
15. Chloro-thighs: thiazide diuretics treat nephrogenic DI
16. Almond cart: amiloride (a K+ sparing diuretic treats nephrogenic DI)
17. Falling lift-ium balloon man: amiloride treats lithium induced DI (blocks Li+ entry into collecting duct cells → increased Li+ clearance)
18. Fire extinguisher: NSAIDs (e.g. indomethacin) treat nephrogenic DI
19. Dehydrating brain sand trap: central DI
20. Absent waterboys: central DI occurs when the pituitary does not release adequate amounts of ADH
21. Waterboy entering exogenously: exogenous administration of ADH treats central DI
22. Desert-mobile: Desmopressin acetate (DDAVP – a long acting synthetic analog of ADH) treats central DI
23. V-2 engine: DDAVP has high specificity for the V2 receptor
24. Scratched von Wille brand felt: DDAVP treats von Willebrand disease (releases vWF from vascular endothelium)

ADH, Desmopressin (DDAVP), Vasopressin receptor antagonist (continued)

25. Bruised with mucosal bleeding: von Willebrand disease (vWD – deficient vWF) can be associated with increased bruisability and muscosal bleeding
26. Missing 8-ball in "A" frame: DDAVP treats hemophilia A (releases factor VIII from vascular endothelium)
27. Bleeding knee joint: hemophilia A (X-linked deficiency of factor VIII) can be associated with hemarthrosis and prolonged bleeding after minor procedures
28. Wet mattress: DDAVP treats nigh enuresis (decreased urine production)
29. Falling salty peanut shells: DDAVP can cause hyponatremia
30. Bulging venous golf clubs: ADH is useful in the management of esophageal variceal bleeding (constricts mesenteric arterioles → reduced portal pressure)
31. Inappropriate water hazard: syndrome of inappropriate ADH (SIADH)
32. Over-hydrating waterboy: SIADH is caused by the overproduction of ADH
33. Vaporizer: "-vaptan" suffix of V2 ADH receptor antagonists (e.g. conivaptan, tolvaptan) used to treat SIADH
34. Wet pants: vaptans promote free water excretion (correcting hyponatremia)
35. Elevated peanuts hitting head: vaptans may cause hypernatremia or central pontine myelinolysis (osmotic demyelination syndrome – due to overly rapid correction of Na+)
36. Bicycle: demeclocycline treats SIADH (vaptans are first line)



Glucocorticoids

1. Adrenal cap: cortisol (an endogenous glucocorticoid) is released from the adrenal cortex
2. Moon face: glucocorticoids
3. Moon scepter in outer circle: the glucocorticoid receptor is located in the cytoplasm
4. Activated scepter in inner circle: the activated glucocorticoid receptor enters the nucleus and regulates gene transcription
5. Inhibited pro-slugger bat: glucocorticoids prevent production of inflammatory prostaglandins by COX
6. Inhibited lacrosse stick: glucocorticoids prevent production of inflammatory leukotrienes by LOX
7. Inhibited N-Flame Krossbow: glucocorticoids inhibit NF-KB (transcription factor for proinflammatory cytokines, e.g. IL-2, TNF-alpha)
8. Inhibited T-knight and antibody archer: glucocorticoids prevent activation of T-cells and B-cells (by inhibiting production of proinflammatory cytokines)
9. Blocked adhesion of first responders: glucocorticoids prevent production of neutrophil adhesion molecules → demargination and decreased migration
10. Crowded first responders: demargination of neutrophils causes neutrophilia
11. Falling T-knight, helper T-squire, and antibody archer: glucocorticoids reduce T-cell and B-cell counts
12. Helper T-squire lowest: glucocorticoids are most effective at reducing helper T-cell counts
13. Falling eo-slingshot: glucocorticoids reduce peripheral eosinophil counts
14. Eclipsed inflammatory sun: glucocorticoids are useful for treating inflammatory disorder (e.g. gout, rheumatoid arthritis, asthma, IBD)
15. Cracked antibodies: glucocorticoids are useful for immunosuppressive therapy (e.g. transplant rejection prevention, treatment of autoimmune disorders)
16. Locked welcome inside mat: glucocorticoids cause insulin resistance
17. Liver bag producing candy: glucocorticoids stimulate gluconeogenesis
18. Sugar-filled liver jar: glucocorticoids increase hepatic glycogen storage
19. Cracked moon: adrenal insufficiency (can be due to Addison's disease – primary adrenal insufficiency)
20. Fainted druid: acute adrenal insufficiency can manifest as circulatory shock and death
21. Falling candy: acute adrenal insufficiency can manifest as hypoglycemia
22. Exogenous moon face: exogenous glucocorticoids treat/prevent acute adrenal insufficiency
23. Shriveled adrenal hat: chronic exogenous glucocorticoid use causes adrenal cortical atrophy (secondary adrenal insufficiency)
24. Falling meat: glucocorticoids promote proteolysis
25. Falling fatty donut jar: glucocorticoids promote lipolysis
26. Moon face: moon facies (due to fat deposition)
27. Fat belly: fat redistribution → central adiposity
28. Thin arms: myopathy, muscle wasting, proximal weakness
29. Thin striped fabric: glucocorticoids inhibit fibroblast proliferation → skin thinning, striae, impaired wound healing
30. Fractured osteoporotic altar: glucocorticoids decreased bone mass → osteoporosis, fractures
31. Cracked head: glucocorticoid induced psychosis (hypomania, confusion, hallucinations)
32. Banana peel: glucocorticoids can cause hypoglycemia (due to mineralocorticoid effects)
33. Cane: glucocorticoids can cause immune-suppression
34. Pulmonary cacti: glucocorticoids can cause reactivation of latent infections (e.g. TB)

Benzodiazepines, Flumazenil

1. Ben's diner: benzodiazepines
2. Pam-cakes: "-pam" suffix of benzodiazepines (e.g. diazepam, lorazepam, oxazepam)
3. Fast ox: oxazepam (a short-acting benzodiazepine)
4. "All A.M.": "-olam" suffix of short-acting benzodiazepines (triazolam, alprazolam, midazolam)
5. "Addictive flavor": benzodiazepines have the potential to cause addiction (more common with short-acting agents)
6. Liver spot: benzodiazepines are metabolized by the liver (long acting agents form active metabolites)
7. Cab-A: benzodiazepines bind to an allosteric site on the GABA-A receptor
8. CNS light: benzodiazepines potentiate GABA-A transmission in the CNS
9. "Chlo-Rider": the GABA-A receptor is a chloride channel
10. "Take it easy": GABA (with glycine) is a major inhibitory neurotransmitter in the CNS
11. "open more frequently": benzodiazepines increase the frequency of ion channel opening
12. Alcoholic on Cab-A: alcohol binds the GABA-A receptor at a separate allosteric site
13. Hangover special: benzodiazepines treat alcohol withdrawal
14. Alcohol withdrawal symptoms (8-12 hours) – insomnia, tremulousness, anxiety, autonomic instability
15. Alcohol withdrawal symptoms (48-96 hours) – delirium tremens (fever, disorientation, severe agitation)
16. Long tapering flag: long-acting benzodiazepines (e.g. diazepam, chlordiazepoxide) are useful in the treatment of alcohol withdrawal
17. Ivy: IV administration of benzos is useful for the management of alcohol withdrawal, seizures, and anesthesia
18. Unplugging jackhammer: benzodiazepines treat status epilepticus
19. Sedated customer: IV benzos can be used in general anesthesia (muscle relaxation, amnesia)
20. Lite: IV benzos can induce conscious sedation for minor procedures and surgeries
21. Sleeping customer: benzodiazepines treat insomnia (not first line due to side effect of physical dependence)
22. Crying kid in pajamas: benzodiazepines treat parasomnias in children (e.g. sleepwalking, night terrors)
23. Relaxing chair: benzodiazepines treat spasticity caused by upper motor neuron disorders (e.g. MS, stroke, spinal cord trauma, tetanus)
24. Anxious customer: benzodiazepines treat generalized anxiety disorder (SSRIs and SNRIs are first line)
25. The Scream: benzodiazepines treat panic disorder (SSRIs and SNRIs are first line)
26. All are welcome: benzodiazepines can cause tolerance (downregulation of GABA-A)
27. Question mark hat: benzodiazepines can cause anterograde amnesia (useful during conscious sedation)
28. Disoriented old man: elderly patients are more sensitive to the side effects of benzodiazepines (including somnolence, confusion, disorientation)
29. Unbalanced stack: benzodiazepines can cause central ataxia (causing falls in the elderly)
30. Bee swatter smacking head: benzodiazepines should be avoided with other CNS depressants (e.g. 1st generation antihistamines, alcohol, barbs, neuroleptics)
31. Barbershop next to Cab-A: barbiturates bind the GABA-A receptor at a separate allosteric site
32. Antagonizing fluffy muzzled dog: flumazenil (competitive antagonist at the BZD receptor) reverses benzo induced sedation (but precipitates seizures)

Zolpidem, Zaleplon, Zopiclone, Melatonin

1. 3 Zs: Zolpidem, Zaleplon, esZopiclone (nonbenzodiazepine hypnotics)
2. "Chlo-Rider": the GABA-A receptor is a chloride channel
3. CNS light: benzodiazepines potentiate GABA-A
4. "Take it easy": GABA (with glycine) is a major inhibitory neurotransmitter in the CNS
5. Grabbing same cab handle: nonbenzodiazepine hypnotics and benzos bind to the same allosteric site on GABA-A
6. Alcoholic on Cab-A: alcohol binds the GABA-A receptor at a separate allosteric site
7. Barbershop next to Cab-A: barbiturates bind the GABA-A receptor at a separate allosteric site
8. "fast": zaleplon and zolpidem have a rapid onset of action
9. Quick jump and fall: nonbenzodiazepine hypnotics have a short duration of action
10. Liver spot: zaleplon and zolpidem are rapidly metabolized by the liver
11. Sleeping: nonbenzodiazepine hypnotics treat insomnia
12. "Fall asleep": zaleplon and zolpidem treat sleep onset insomnia (eszopiclone has the longest half life and is effective for both sleep onset and sleep maintenance insomnia)
13. Disoriented old man: elderly patients are more sensitive to the side effects of nonbenzodiazepine hypnotics (e.g. cognitive impairment and delirium)
14. Unbalanced stack: nonbenzodiazepine hypnotics can cause central ataxia (causing falls in the elderly)
15. "Cannot combine with other CoupoNS": avoid use with other CNS depressants
16. Bee swatter smacking head: avoid use with other CNS depressants (e.g. 1st generation antihistamines, alcohol, benzos, barbs)
17. "not tolerated": nonbenzodiazepine hypnotics are less likely to cause tolerance
18. "break bad habits": nonbenzodiazepine hypnotics are less likely to cause withdrawal symptoms and dependence
19. Antagonizing fluffy muzzled dog: flumazenil (competitive antagonist at the BZD receptor) reverses benzo induced sedation (but precipitates seizures)
20. "melt away": melatonin and ramelteon (a melatonin receptor agonist) treat insomnia
21. Dark and light: melatonin receptors maintain circadian rhythm
22. Nucleus above "X": MT1 and MT2 melatonin receptors are located in the suprachiasmatic nucleus of the hypothalamus (activated by ramelteon)
23. Peacefully sleeping elderly: ramelteon has few side effects and are safe in geriatric patients

Barbiturates

1. Cab-A: benzodiazepines bind to an allosteric site on the GABA-A receptor
2. Ben's diner next to Cab-A: benzodiazepines bind the GABA-A receptor at a separate allosteric site
3. Alcoholic on Cab-A: alcohol binds the GABA-A receptor at a separate allosteric site
4. "Chlo-Rider": the GABA-A receptor is a chloride channel
5. CNS light: benzodiazepines potentiate GABA-A
6. "Take it easy": GABA (with glycine) is a major inhibitory neurotransmitter in the CNS
7. "Open longer": barbiturates increase the duration of opening of the GABA-A receptor
8. Long tapering flag: barbiturates have long durations of action ("hangover" effects more common)
9. Intubated customer: IV thiopental can be used for induction of anesthesia
10. Ivy: IV administration of barbiturates is useful for induction of anesthesia (thiopental) and management of seizures (Phenobarbital)
11. "The ol' quick shave": thiopental has a rapid onset and short duration of action (highly lipid soluble)
12. Hair "redistributed" onto arms and belly: plasma levels of thiopental decrease rapidly due to redistribution to skeletal muscle and adipose
13. Decay line: rapid decay of plasma thiopental levels (due to redistribution)
14. Brief peak: rapid accumulation of thiopental in brain tissue and rapid redistribution
15. Growth line: rapid accumulation of thiopental in skeletal muscle and adipose (recovery from anesthesia)
16. Unplugging jackhammer: IV phenobarbital can be used to treat seizures
17. Perm is done!: primidone (a barbiturate used to treat seizures and essential tremor)
18. Tremulous hand: primidone treats essential tremor (first line with propranolol)
19. Fainting: barbiturates can cause hypotension
20. Collapsed heart and lungs: barbiturates can cause profound cardiac and respiratory depression
21. Brain hair dryer: barbiturates can cause severe CNS depression (e.g. coma) and should be avoided in the elderly
22. "All are welcome": chronic barbiturate use leads to tolerance
23. "Addicted": chronic barbiturate use leads to physical dependence
24. Activated chrome bumper: barbiturates (e.g. phenobarbital) are potent inducers of the cytochrome P450 system

Propofol, Etomidate, Ketamine, Barbiturates, Benzodiazepines

1. Ivy: IV anesthetics (e.g. propofol, etomidate, ketamine)
2. "Prospero…fall asleep!": propofol (IV anesthetic for induction and maintenance)
3. "Introducing": propofol can be sued for induction of anesthesia
4. "Maintain": propofol can be used for maintenance of anesthesia
5. Cab-A: propofol and etomidate potentiate chloride current through the GABA-A receptor complex
6. Dilated sleeves and pants: propofol causes profound vasodilation (arterial and venous) → hypotension
7. "Intimidator": etomidate (IV anesthetic for induction)
8. "Introducing": etomidate can be used for induction of anesthesia
9. Stabilized patient: etomidate preserves cardiovascular stability
10. "snaKE TAMINg": ketamine (IV anesthetic for induction)
11. "Introducing": ketamine can be used for induction of anesthesia
12. Hitched nomadic camel: ketamine inhibits the NMDA receptor complex
13. Dissociative trance: ketamine causes "dissociative anesthesia" (eyes remain open with a slow nystagmic gaze)
14. Unpleasant hallucinations: ketamine can cause unpleasant emergence reactions (e.g. vivid colorful dreams, hallucinations, out of body experiences)
15. Stimulated heart cobra: ketamine causes cardiovascular stimulation (e.g. increased blood pressure, heart rate, cardiac output)
16. Ben's diner: benzodiazepines (IV anesthetics used perioperatively)
17. Bowel water pump: benzodiazepines are used for conscious sedation for minor procedures (e.g. colonoscopy)
18. Barber: IV barbiturates (e.g. thiopental)
19. "Introducing": IV barbiturates (e.g. thiopental) can be used for induction of anesthesia
20. "The ol' quick shave": thiopental has a rapid onset and short duration of action (highly lipid soluble)

Nitrous Oxide, Volatile anesthetics

1. Kid inhaling balloon: Inhaled anesthetics
2. "laughing gas": nitrous oxide (N2O – a gaseous anesthetic)
3. Air tank in water: volatile anesthetics (e.g. enflurane, isoflurane, halothane) are liquid at room temperature
4. Balloon flower: volatile anesthetics (e.g. enflurane, isoflurane, halothane) are fluorinated
5. Moving freely in ball pit: highly soluble inhaled anesthetic (e.g. halothane)
6. Impeded by ball pit: less soluble inhaled anesthetic (e.g. N2O)
7. Passed out earlier: less soluble inhaled anesthetics (e.g. N2O) have a faster onset of action
8. Immediate rescue: less soluble inhaled anesthetics (e.g. N2O) have a faster recovery
9. Passed out later: more soluble inhaled anesthetics (e.g. halothane) have a slower onset of action
10. Long tapering flag: more soluble inhaled anesthetics (e.g. halothane) have a longer duration of action
11. Partition>>>: higher blood:gas partition coefficient (e.g. halothane) → higher solubility → slower onset of action
12. Steeper arterial tension curve (e.g. N2O) → lower blood:gas partition coefficient → lower solubility → faster onset of action
13. Less steep arterial tension curve (e.g. halothane) → higher blood:gas partition coefficient → higher solubility → slower onset of action
14. Mac and cheese: minimum alveolar concentration (MAC)
15. 1 out of 2 unresponsive: MAC corresponds to the dose of anesthetic that causes 50% of patients to become unresponsive to painful stimuli
16. Inverted bowl of potent mac and cheese:1/MAC corresponds to the potency of an inhaled anesthetic
17. Deflating lung balloons: inhaled anesthetics can cause respiratory depression (leading to decreased minute ventilation and hypercapnia)
18. Red brain wig: fluorinated anesthetics increase cerebral blood flow (decrease cerebral vascular resistance)
19. Cracked liver: halothane can be hepatotoxic (e.g. massive hepatic necrosis)
20. Smacked in the flank: enflurance can be nephrotoxic
21. Shaking: enflurance can induce seizures
22. Magnificent birthday: malignant hyperthermia (skeletal muscle hypersensitivity to volatile anesthetics)
23. "Sucks": succinylcholine (depolarizing muscle relaxant) can also causes malignant hyperthermia
24. Defective RYAN: malignant hyperthermia is related to a defect in ryanodine receptors (RyR) in the sarcoplasmic reticulum
25. Flame theme: defective RyR release excess Ca2+ → excessive ATP dependent uptake by the SR → heat production
26. Bite out of muscle: excess heat production and consumption of ATP induces muscle damage (e.g. rhabdomyolysis)
27. Trampoline: dantrolene (muscle relaxant) treats malignant hyperthermia
28. Blocking Ryan: dantrolene blocks ryanodine receptors

Opioid analgesics, Opioid antitussives, Opioid antidiarrheal, Methadone, Buprenorphine, Naloxone, Naltrexone

1. Utopia: opiates
2. µssage: µ-opioid receptor (mediates most clinical and adverse effects: e.g. analgesia, sedation, constipation, respiratory depression)
3. Open banana barrels: opiate receptors open K+ channels
4. Closed Calci-Yum ice cream cooler: opiate receptors close VG Ca2+ channels
5. Disconnected presynaptic wire: closure of presynaptic VG Ca2+ channels prevents release of neurotransmitters (e.g. glutamate, acetylcholine, norepinephrine, serotonin, substance P)
6. "Fantasy": fentanyl (opioid analgesic)
7. "More fun": morphine (opioid analgesic)
8. Distant tram: tramadol (a weak µ-opioid receptor agonist used to manage chronic pain)
9. North-South: tramadol also inhibits reuptake of norepinephrine and serotonin
10. Colon µssage table: µ-opioid receptors are located in the GI tract (delay stool transit)
11. Removed muddy slippers: opioids (e.g. loperamide, diphenoxylate) can be used as antidiarrheals
12. Lop-eared rabbit: loperamide (opioid antidiarrheal)
13. Loping back and forth: loperamid increases colonic phasic segmentation (increase stool transit time)
14. Dolphins: diphenoxylate (opioid antidiarrheal)
15. Barcode: codeine (opioid antitussive)
16. Orphan: dextromethorphan (opioid antitussive)
17. Tethered nomadic camel: dextromethorphan antagonizes NMDA receptors
18. Cerebral towel: opiates cause CNS depression (e.g. sedation)
19. Deflated lung vest: opiates can cause respiratory depression
20. Constricted hood: opiates cause miosis (constricted pupils)
21. Plunger: opiates can cause constipation
22. Biliary tree: opiates can cause biliary colic (contract biliary smooth muscle)
23. "All are welcome": patients may develop tolerance to opiates
24. "Out of order": tolerance does not develop for miosis or constipation
25. Causing pain: opiate induced hyperalgesia can occur with chronic use
26. Anxious, hot, and moist: opioid withdrawal (rhinorrhea, lacrimation, yawning, hyperventilation, hyperthermia, muscle aches, vomiting, diarrhea, anxiety)
27. DONE timer: methadone (long acting opioid used to attenuate withdrawal symptoms)
28. Long tapering flag: methadone and buprenorphine have a long half lives (used in opioid detoxification)
29. Blueprint: buprenorphine (long acting partial µ-opioid agonist used to attenuate withdrawal symptoms)
30. Irritable, moist, tachypneic baby: neonatal abstinence syndrome (diarrhea, sweating, sneezing, crying, tachypnea, irritability)
31. Partial µssage: partial µ-opioid agonists (e.g. buprenorphine, nalbuphine, butorphanol)
32. Falling into the withdraw spa: partial µ-opioid agonists can induce withdrawals)
33. No lax zone: naloxone (µ-opioid antagonist) used to reverse acute opioid toxicity (can precipitate withdrawals)
34. No tricks zone: naltrexone (µ-opioid antagonist) helps maintain abstinence in heroin addicts)
35. Tempting alcohol: naltrexone (µ-opioid antagonist) helps reduce cravings for alcohol and nicotine
36. Getting fit: naltrexone (µ-opioid antagonist) can help with weight loss

SSRIs, SNRIs, Cyproheptadine

1. expreSS tRIps: selective serotonin reuptake inhibitors (SSRIs)
2. Parrot: paroxetine (SSRI)
3. Fly out: fluoxetine (SSRI)
4. Desert Airline: sertraline (SSRI)
5. City: citalopram (SSRI)
6. Smiley face: serotonin (5-HT)
7. Keeping post-it out of the drawer: SSRIs inhibit the presynaptic reuptake of serotonin (5-HT)
8. Fax machine: venlafaxine (SNRI)
9. Dual copier/scanner: duloxetine (SNRI)
10. North and South: SNRIs (e.g. venlafaxine, duloxetine) inhibit the presynaptic reuptake of norepinephrine and serotonin
11. Happy and sad masks: SSRIs and SNRIs are first line agents for the treatment of depression
12. 5H-TV: serotonin (5-hydroxytryptamine, 5-HT)
13. Anxious coworker: SSRIs and SNRIs are 1st line agents for the treatment of generalized anxiety disorder (GAD)
14. The Scream: SSRTs and SNRIs treat panic disorder
15. Dog tags: SSRIs and SNRIs treat PTSD
16. Obsessively neat: SSRIs are useful in the management of OCD
17. Binge drawer: SSRIs are useful in the management of bulimia
18. Shy guy: SSRIs are useful in the management of social anxiety disorder
19. Pain in the Diasweetes machine: SNRIs (e.g. venlafaxine, duloxetine) treat diabetic neuropathy
20. Chronically frayed wire: SNRIs treat chronic pain (e.g. neuropathic pain)
21. Fiber bars: SNRIs (e.g. venlafaxine, duloxetine) treat fibromyalgia
22. 2 month calendar: SSRIs and SNRIs take 1-2 months to achieve maximum effect (not for acute treatment)
23. Inappropriately wet head: SSRIs may cause hyponatremia (SIADH)
24. Rejected advances: SSRIs can cause sexual dysfunction
25. Fat belly: SSRIs can cause weight gain
26. Sleeping on the job: SSRIs can cause drowsiness
27. Excessive smiley faces: SSRIs and SNRIs can cause serotonin syndrome
28. Hot and hypertensive: serotonin syndrome is characterized by hyperthermia and hypertension
29. Hyperactive foot tap: serotonin syndrome is characterized by neuromuscular hyperactivity (e.g. hyperreflexia, clonus)
30. Tricycle and mouse traps: serotonin syndrome can occur if SSRIs or SNRIs are combined with other drugs that increase serotonin levels (e.g. TCAs, MAO inhibitors)
31. "Silly pranks prohibited": cyproheptadine (5HT-2 blocker) treats serotonin syndrome
32. Hypertensive coworker: SNRIs can cause hypertension
33. Withdrawn with the flu: withdrawal symptoms from SSRIs and SNRIs include flu-like symptoms

Tricyclic Antidepressants (TCAs)

1. Tricycle: TCAs
2. Imprint: imipramine (and derivatives desipramine, clomipramine – TCAs)
3. Tripping: amitriptyline, nortriptyline
4. Prevented from picking up smiley face and compass balls: TCAs inhibit presynaptic uptake of serotonin and norepinephrine
5. Happy and sad masks: TCAs can be useful in treatment resistant depression
6. Resistant door: TCAs can be useful in treatment resistant depression
7. Pain in the Diasweetes machine: TCAs treat diabetic neuropathy
8. Chronically frayed wire: TCAs treat chronic pain (e.g. neuropathic pain)
9. Pounding head bell: TCAs can be used for migraine prophylaxis
10. Obsessively neat: clomipramine (TCA) treats OCD (SSRIs first line)
11. Rejected advances: TCAs can cause sexual dysfunction
12. Anti-muscarinic tea party: TCAs inhibit muscarinic acetylcholine receptors → dry mouth, constipation, blurred vision, urinary retention
13. Northside Prep: nortriptyline and desipramine (secondary amines)
14. Protected by secondary sign: secondary amines (e.g. nortriptyline and desipramine) are associated with less cholinergic effects
15. Confused elderly: TCAs are relatively contraindicated in elderly patients due to severe anticholinergic and antihistamine effects
16. Bee swatter: TCAs block H1 histamine receptors
17. Sleeping kid: TCAs can cause sedation
18. Hefty kid: TCAs can cause increased appetite and weight gain
19. Extinguished alpha flame: TCAs block alpha-1 receptors
20. Passed out: TCAs can cause orthostatic hypotension
21. Inactivated peanut butter jar: TCAs block the cardiac fast Na+ channels
22. Wide QRS crack: TCAs can widen the QRS complex on ECG
23. Twisted torsades streamer: TCAs can induce torsades
24. Baking soda: sodium bicarb treats widened QRS and ventricular arrhythmia caused by TCA overdose
25. Shaking kid: TCAs can induce seizures
26. Stack of smiley faces: TCAs can cause serotonin syndrome

MAO Inhibitors

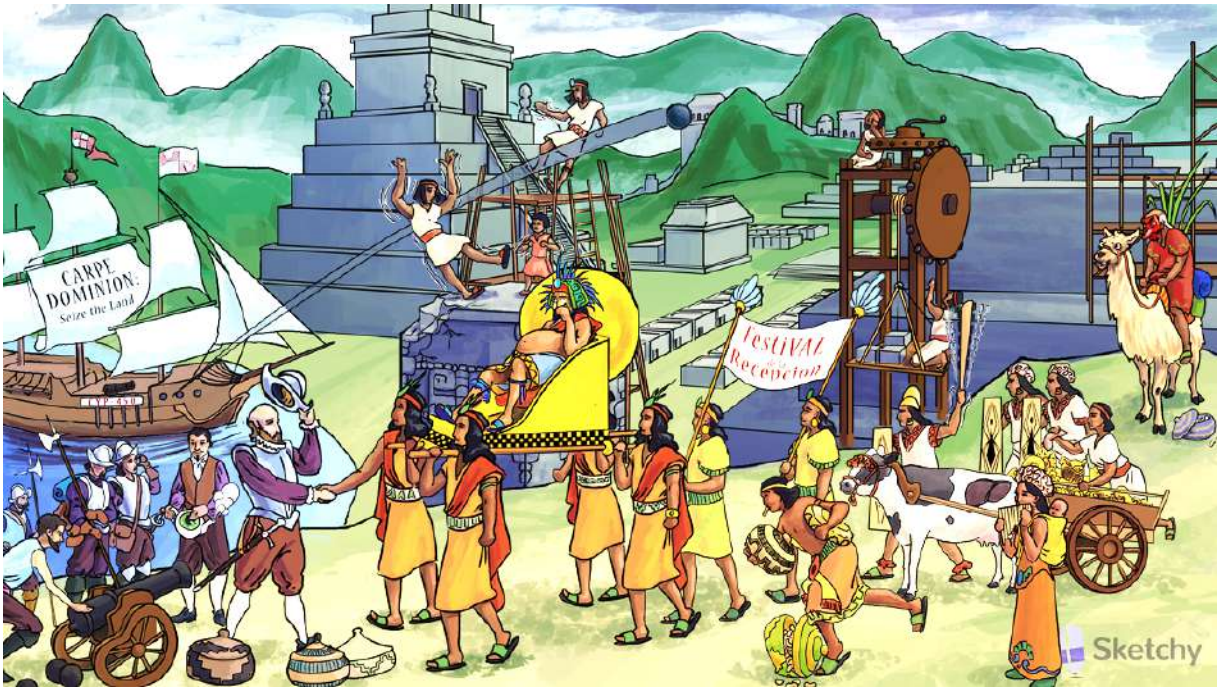
1. Albino mouse: monoamide oxidase A (MAO-A)
2. Albino mouse eating smiley face: MAO-A breaks down serotonin
3. Albino mouse eating north compass: MAO-A breaks down norepinephrine
4. Albino mouse eating rope: MAO-A breaks down dopamine
5. Black mouse: MAO-B
6. Mouse trap: MAO inhibitors
7. Irreversible trap: MAO inhibitors are irreversible
8. "Try a sip of wine": tranylcypromine (MAO inhibitor)
9. Funnel: phenelzine (MAO inhibitor)
10. Boxed wine: isocarboxazid (MAO inhibitor)
11. "Not typical": MAO inhibitors may be useful in atypical depression
12. Happy and sad mask: MAO inhibitors can treat depression (not 1st line)
13. Resistant wine bottle: MAO inhibitors can be useful in treatment resistant depression
14. Sledge hammer: selegiline (selective MAO-B inhibitor)
15. Brain tied with rope: selegiline (selective MAO-B inhibitor) increase dopamine levels in the CNS
16. Cog wheels: selegiline is useful in the management of Parkinson's disease (increases dopamine levels in the CNS)
17. Aged meats, wine, cheese: MAO inhibitors should be avoided with these tyramine containing foods
18. Albino mouse eating GI meat: tyramine is normally broken down by MAO-A in the GI tract
19. Trap releasing north compass cheeses: in the presence of MAO inhibitors, tyramine enters the circulation and acts as a sympathomimetic agent
20. Hypertensive and sweaty: tyramine toxicity can precipitate a hypertensive crisis (e.g. hypertension, blurry vision, diaphoresis)
21. Pile of smiley faces: MAO inhibitors can cause serotonin syndrome
22. Tricycle: MAO inhibitors should be avoided with other drugs that increase serotonin levels (e.g. TCAs, SSRIs, SNRIs → cause serotonin syndrome)
23. Phantom of the alpha: phentolamine (alpha-1 and alpha-2 blocker) can be used to manage hypertensive symptoms of tyramine toxicity

Atypical antidepressants: Bupropion, Mirtazapine, Trazodone

1. "NET DAT ball": bupropion inhibits the norepinephrine transporter (NET) and the dopamine transport (DAT)
2. Pro ball player: bupropion (atypical antidepressant)
3. Aroused from sleep: bupropion exerts CNS activating effects
4. "Pros don't smoke": bupropion can be used to treat tobacco dependence
5. Shaking: bupropion can induce seizures
6. Shaking binge snacker: bupropion is contraindicated in bulimia (may induce seizures)
7. Shaking skinny player: bupropion is contraindicated in anorexia nervosa (may induce seizures)
8. Kissing couple: bupropion does not cause sexual dysfunction
9. "Lose weight": bupropion is less likely to cause weight gain
10. "Mirth and Misery": mirtazapine (atypical antidepressant
11. Happy and sad masks: atypical antidepressants can be used as 1st line agents to treat depression
12. Retired 52 and 53: mirtazapine blocks 5HT-2 and 5HT-3 receptors
13. Bee swatter: mirtazapine inhibits H1 histamine receptors
14. Sleeping fan: mirtazapine can cause sedation
15. Hefty fan: mirtazapine can cause weight gain
16. Kissing couple: mirtazapine does not cause sexual dysfunction
17. Trombone: trazodone (serotonin modulator)
18. Smiley face drummer: trazodone is a serotonin modulator (antagonizes 5-HT receptors and inhibits 5-HT reuptake)
19. Retired 52: trazodone inhibits 5HT-2 receptors
20. Extinguished alpha lighter: trazodone antagonizes alpha-1 receptors
21. Erect trombone: trazodone can cause priapism
22. Fainting: trazadone can cause orthostatic hypotension
23. Sleeping players: trazodone can cause sedation
24. Bee swatter: trazodone inhibits H1 histamine receptors
25. Rejected advances: trazodone can cause sexual dysfunction
26. Pile of smiley faces: trazodone can cause serotonin syndrome

Lithium

1. Stabilizing poles: mood stabilizers (e.g. lithium, valproate, carbamazepine, lamotrigine, antipsychotics)
2. Stabilizing chair lift: lithium treats bipolar disorder (acute mania and maintenance)
3. Narrow window: lithium has a very narrow therapeutic index
4. Early nausea: acute lithium toxicity causes GI symptoms (e.g. nausea, vomiting, diarrhea)
5. Late trembling: chronic lithium toxicity causes neurologic symptoms (e.g. tremor)
6. Late falling: chronic lithium toxicity causes neurologic symptoms (e.g. ataxia)
7. Undone bowtie: lithium therapy can cause hypothyroid
8. Hefty snowboarder: signs of lithium induced hypothyroidism include weight gain, dry skin, hair loss, and constipation
9. Insipidus fountain: lithium can cause nephrogenic diabetes insipidus
10. Thighs on high dive: thiazide diuretics (increase lithium levels)
11. “Low clearance”: diuretics (e.g. thiazides) and NSAIDs decrease clearance of lithium (decrease GFR)
12. Tarantula: lithium is teratogenic (Ebstein’s anomaly)
13. Large right head: atrialization of the right ventricles (seen in Ebstein’s anomaly with ASD and malformed tricuspid)
14. “Winter festival”: valproate treats bipolar disorder (acute mania and maintenance)
15. Classic car carving: carbamazepine treats bipolar disorder (acute mania and maintenance)
16. Llama: lamotrigine treats bipolar disorder (maintenance only)
17. Psychotic painting on the high peak: first generation (e.g. haloperidol) and second generation (e.g. quetiapine) antipsychotics treat acute mania

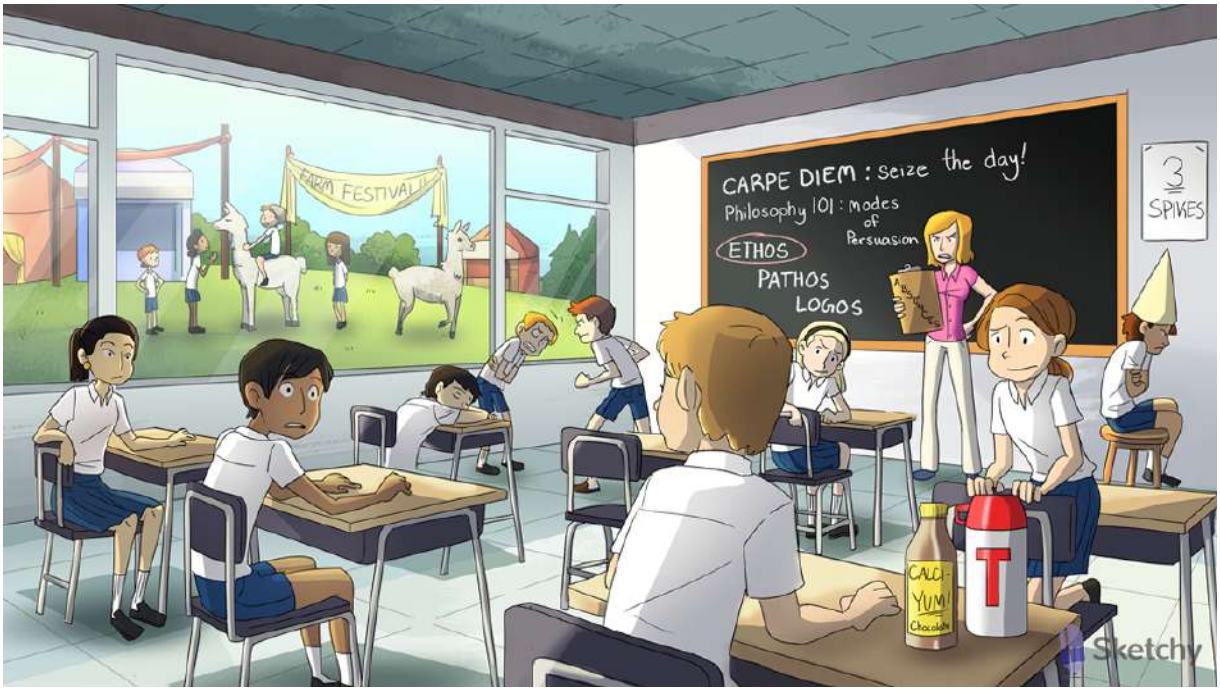


Valproate, Topiramate, Lamotrigine, Levetiracetam

1. "Seize the land": broad spectrum antiepileptic agents (e.g. valproate, topiramate, lamotrigine, levetiracetam)
2. Focal arm shaking: broad spectrum antiepileptic agents (e.g. valproate) treat focal seizures
3. Generalized body shaking: broad spectrum antiepileptic agents (e.g. valproate) treat generalized seizures
4. Juvenile shaking arms: broad spectrum antiepileptic agents (e.g. valproate) treat juvenile myoclonic epilepsy (a type of generalized seizure disorder)
5. Welcome festival: valproate (broad spectrum antiepileptic)
6. Inactivated baskets of salty peanuts: valproate increases Na+ channel inactivation
7. Elevated cab: valproate increases GABA levels in the CNS
8. Nauseated: valproate can cause GI distress (e.g. nausea, vomiting)
9. Fat belly: valproate can cause increased appetite and weight gain
10. Trembling weapon: valproate can cause tremor
11. Liver spot: valproate can cause fatal hepatotoxicity
12. Squeezed pancreas sponge: valproate can cause pancreatitis
13. Tarantula: valproate is teratogenic
14. Tubes: valproate therapy during pregnancy can cause neural tube defects (e.g. spinal bifida)
15. Toupee: topiramate (broad spectrum antiepileptic drug)
16. Inactivated baskets of salty peanuts: topiramate increases Na+ channel inactivation
17. Binding to cab driver: topiramate allosterically binds to the GABA-A receptor
18. Fatigued soldiers: topiramate can cause somnolence and fatigue
19. Scratching head: topiramate can cause confusion and cognitive slowing
20. Thin arm: topiramate can cause weight loss
21. High pressure eye kettle: topiramate can cause acute angle closure glaucoma
22. Llama: lamotrigine (broad spectrum antiepileptic drug)
23. Inactivated baskets of salty peanuts: lamotrigine increases Na+ channel inactivation
24. Sloughed off red mask: topiramate can cause Stevens-Johnson syndrome (SJS/TEN)
25. Cross-eyed: topiramate can cause diplopia
26. Elevator: levetiracetam (broad spectrum antiepileptic drug)
27. Sleeping on the job: levetiracetam can cause somnolence
28. Chrome CYP450 cannon: many antiepileptic drugs are metabolized by the hepatic cytochrome P450 system

Carbamazepine, Phenytoin, Gabapentin, Tiagabine, Vigabatrin

1. "Seize the Night": narrow spectrum antiepileptic agents (e.g. carbamazepine, phenytoin, phenobarbital, gabapentin)
2. Focal arm shaking: narrow spectrum antiepileptic agents (e.g. carbamazepine, phenytoin) treat focal seizures (and generalized tonic-clonic)
3. Classic car: carbamazepine (narrow spectrum antiepileptic drug)
4. Inactivated salty sodium chip bags: carbamazepine increases Na+ channel inactivation
5. Three gems: carbamazepine is a first line therapy for trigeminal neuralgia
6. Unbalanced stack: carbamazepine can cause ataxia
7. Misaligned headlights: carbamazepine can cause diplopia
8. Inappropriate wet head: carbamazepine can cause syndrome of inappropriate ADH (SIADH)
9. Sand timer: carbamazepine can cause agranulocytosis
10. Activated chrome bumper: carbamazepine induces cytochrome P450
11. Eosinophilic dress: carbamazepine can cause drug reaction with eosinophilia and systemic symptoms (DRESS) syndrome
12. Tarantula: carbamazepine is teratogenic
13. Neural exhaust tube: carbamazepine therapy during pregnancy can cause neural tube defects (e.g. spina bifida)
14. Sloughed off red mask: carbamazepine can cause Stevens-Johnson syndrome (SJS/TEN)
15. Classic tow truck: phenytoin (narrow spectrum antiepileptic drug)
16. Inactivated salty sodium chip bags: phenytoin increases Na+ channel inactivation
17. Unbalanced stack: phenytoin can cause ataxia
18. Misaligned headlights: phenytoin can cause diplopia
19. Spilled salad: phenytoin can cause folate deficiency → megaloblastic anemia
20. Expanding gum: phenytoin can cause gingival hyperplasia
21. Big bushy beard: phenytoin can cause hirsutism
22. Lupus wolf: phenytoin and carbamazepine can drug-induced lupus
23. Eosinophilic dress: phenytoin can cause drug reaction with eosinophilia and systemic symptoms (DRESS) syndrome
24. Sloughed off red mask: phenytoin can cause Stevens-Johnson syndrome (SJS/TEN)
25. Tarantula: phenytoin is teratogenic
26. Cleft trucker hat: phenytoin therapy during pregnancy can cause left palate
27. Activated chrome bumper: phenytoin induces cytochrome P450
28. Fractured osteoporotic axle: phenytoin can decrease bone density
29. "Status": status epilepticus (treat acutely with benzodiazepines and phenytoin for maintenance)
30. Ben's Diner: IV benzodiazepines (e.g. diazepam, lorazepam) acutely treat status epilepticus (give phenytoin for maintenance)
31. Barbershop: IV phenobarbital (barbiturate) can be used in treatment refractory seizures
32. "Grab a pint": gabapentin (narrow spectrum antiepileptic drug)
33. Closed Calci-Yum ice cream cooler: gabapentin blocks voltage gated Ca2+ channels
34. Chronically frayed wire: gabapentin treats chronic pain (e.g. neuropathic pain)
35. Diasweeties: gabapentin treats painful diabetic nephropathy
36. Fiber bars: gabapentin treats fibromyalgia
37. Zeus: gabapentin treats post-herpetic neuralgia (reactivated varicella-zoster virus – VZV)
38. Unbalanced stack: gabapentin can cause ataxia
39. Raised CAB: vigabatrin and tiagabine (narrow spectrum antiepileptic drugs)
40. V cab transmission: vigabatrin irreversible inhibits GABA transaminase (decrease GABA degradation)
41. Tied up cab driver: tiagabine inhibits GABA reuptake



Ethosuximide, Valproate, Lamotrigine

1. "Seize the day": antiepileptic therapy for absence seizures (e.g. ethosuximide)
2. "Absences"; absence seizure (a type of generalized seizures)
3. Inattentive student: absence seizures are characterized by sudden momentary lapse in awareness accompanied by staring, blinking, or clonic jerks
4. "3 spikes": absence seizure manifest as 3 Hz spike wave complexes on EEG
5. "Ethos": ethosuximide (a narrow spectrum anti-epileptic drug used to treat absence seizures)
6. Closed Calci-Yum chocolate: ethosuximide blocks Ca2+ channels
7. Closed T-thermos: ethosuximide blocks T-type Ca2+ channels in the thalamus
8. Punched in stomach: ethosuximide can cause GI distress (e.g. pain, nausea, vomiting)
9. Sleeping student: ethosuximide can cause lethargy or fatigue
10. FestiVAL banner: valproate is effective against absence seizures
11. Llama: lamotrigine is effective against absence seizures

First generation antipsychotics – Haloperidol, Trifluoperazine, Fluphenazine, Chlorpromazine, Thioridazine

1. Typical post-impressionist: first generation (typical) antipsychotics (FGAs)
2. "Gazing": "-azine" suffix of FGAs (e.g. trifluoperazine, fluphenazine, chlorpromazine, thioridazine)
3. Halo: haloperidol (high potency FGA)
4. Snapping double rope: FGAs block D2 receptors in the CNS
5. Trying to fly: trifluoperizine, fluphenazine (high potency FGAs)
6. "Color theory": thioridazine (low potency FGA)
7. "Color-Pro": chlorpromazine (low potency FGA)
8. Blocking positive voices: FGAs treat the positive symptoms of schizophrenia
9. Crazy peak: antipsychotics treat acute psychosis in many conditions (e.g. bipolar)
10. Agitated peak: antipsychotics (e.g. haloperidol) treat acute agitation or aggression
11. Marionette: FGAs can be useful for the management of Tourette syndrome
12. Long tapering flag: FGAs have a long half life (highly lipophilic)
13. Antimuscarinic tea party: FGAs (low potency > high potency) block muscarinic receptors → dry mouth, constipation, blurred vision, urinary retention
14. Passed out: FGAs (low potency > high potency) can cause orthostatic hypotension
15. Extinguished alpha flame: FGAs (low potency > high potency) block alpha-1 receptors
16. Bee swatter: FGAs (low potency > high potency) block H1 histamine receptors
17. Van Gogh's bed: FGAs (low potency > high potency) can cause sedation
18. EXTRA pyramid hat on the roof: FGAs (high potency > low potency) cause extrapyramidal symptoms (EPS)
19. Cocked head: acute dystonia (EPS seen within minutes)
20. Falling chair: akathisia (EPS seen within days)
21. Cog wheels: drug induced Parkinsonism (EPS seen within weeks)
22. Sticking out tongue: FGAs (high potency > low potency) can cause tardive dyskinesia
23. Elevated milk production: FGAs (high potency > low potency) can cause hyperprolactinemia → galactorrhea, amenorrhea, impotence
24. "Now More Spicy": FGAs (high potency > low potency) can cause neuroleptic malignant syndrome (NMS)
25. Rigidly holding pipe: NMS is characterized by generalized "lead-pipe" rigidity
26. Crazy, sweaty, and tachycardic: NMS is characterized by altered mental status, fever, autonomic instability
27. Eaten chicken: NMS is characterized by rhabdomyolysis
28. Twisted streamer: FGAs can cause torsades de pointes
29. Shaking: FGAs can cause lower the seizure threshold
30. Corn Yellow paint: chlorpromazine can cause corneal deposits
31. Deposits on retinal palette: thioridazine can cause retinal deposits

Second generation antipsychotics – Olanzapine, Quetiapine, Aripiprazole, Ziprasidone, Risperidone, Clozapine

1. Atypical surrealist: second generation (atypical) antipsychotics (SGAs)
2. "Quiet please, only whispering is appropriate": quetiapine, olanzapine, risperidone, aripiprazole (SGAs)
3. Zipper: ziprasidone (SGA)
4. Clozapine: clozapine (SGA)
5. Snapping double rope: SGAs block D2 receptors in the CNS
6. Cut smiley cake: SGAs block serotonin receptors (5-HT 2A)
7. Hearing positive and negative voices: SGAs treat schizophrenia (positive and negative symptoms)
8. Happy and sad masks: SGAs can treat depression (treatment resistant)
9. Resisting opening: treatment resistant depression
10. Obsessively neat: SGAs (e.g. risperidone) can help manage OCD (adjunctive with SSRIs)
11. Marionette: risperidone can help manage Tourette syndrome
12. Bee swatter: SGAs block H1 histamine receptors → sedation
13. Extinguished alpha candle: SGAs block alpha-1 receptors → orthostatic hypotension
14. Antimuscarinic tea party: SGAs (especially clozapine) block muscarinic receptors → dry mouth, constipation, blurred vision, urinary retention
15. Obscured tea party: SGAs have lower affinity for muscarinic receptors than FGAs (less antimuscarinic symptoms)
16. Passed out: SGAs can cause sedation and orthostatic hypotension(block H1 and alpha-1)
17. Fat face: SGAs (e.g. olanzapine, clozapine) can cause weight gain
18. Bunch of candy: SGAs (e.g. olanzapine, clozapine) can cause hyperglycemia
19. Elevated butter: SGAs (e.g. olanzapine, clozapine) can cause dyslipidemia
20. Melting sand timers: clozapine can cause agranulocytosis
21. Surreal heart: clozapine can cause myocarditis or cardiomyopathy
22. Shaking clock: clozapine reduces seizure threshold
23. EXTRA pyramid hat: extrapyramidal symptoms (e.g. acute dystonia, akathisia, parkinsonism) due to D2 blockade (FGA > SGA)
24. Whispering to EXTRA hat: risperidone has the highest risk of causing EPS among the SGAs
25. Elevated milk release: elevated prolactin levels due to D2 blockade (FGA > SGA)
26. "Now more spicy": neuroleptic malignant syndrome (e.g. mental status changes, rigidity, autonomic instability, fever) (FGA > SGA)
27. Bite out of chicken leg: NMS is associated with rhabdomyolysis
28. Twisted torsades streamer: SGAs can cause torsade de pointes

Levodopa, Carbidopa, Entacapone, Tolcapone, Selegiline, Ropinirole, Pramipexole, Amantadine

1. Cracked open cogwheels: parkinsonism therapy
2. Bank vault threshold: blood brain barrier (BBB)
3. "L" rope crank inside vault: levodopa (L-DOPA) crosses the BBB
4. Unfurled rope in vault: levodopa is converted to dopamine by DOPA decarboxylase in the CNS
5. Unfurled rope in lobby: levodopa is converted to dopamine by DOPA decarboxylase in the periphery (can't cross BBB)
6. Nauseated hostage: levodopa can cause GI distress (due to peripheral conversion into dopamine)
7. Arrhythmia rope: levodopa can cause cardiac arrhythmias (due to peripheral conversion into dopamine)
8. Passed out hostage: levodopa can cause orthostatic hypotension (due to peripheral conversion into dopamine)
9. Psychiatrically disturbed hostage: levodopa can cause neuropsychiatric symptoms e.g. anxiety, agitation, insomnia, confusion, hallucination (due to excess dopamine in the CNS)
10. End of rope wearing-off: chronic levodopa therapy can cause a wearing-off reaction (akinesia and dyskinesia re-emerge at the end of each dose)
11. "Too long!": chronic levodopa therapy can cause response fluctuations (wearing-off reaction, on-off phenomenon) and dyskinesias
12. Flashing on and off: chronic levodopa therapy can cause an on-off phenomenon (periods of akinesia alternate with periods of improved mobility, not related to dose)
13. Narrowing window: the therapeutic window of levodopa therapy narrows as Parkinson's progresses (unpredictable response to therapy)
14. Writhing sneeze: chronic levodopa therapy can cause dyskinesias (choreoathetosis of the face and distal extremities)
15. Damaged psychotic painting: levodopa is contraindicated in psychotic patients
16. Police car on periphery: carbidopa (peripheral DOPA decarboxylase inhibitor)
17. Scared into vault: carbidopa increases the bioavailability of levodopa (prevents peripheral conversion into dopamine)
18. Pulling away from hostages: carbidopa decreases peripheral side effects of levodopa therapy (but exacerbates neuropsychiatric side effects)
19. InTerCOM guard shooting "L" crank: catechol-O-methyltransferase (COMT) converts levodopa to 3-O-methyldopa (3-OMD) in the periphery
20. Tall Al Capone gangster: tolcapone (a peripheral and central COMT inhibitor) increases the bioavailability of levodopa

Levodopa, Carbidopa, Entacapone, Tolcapone, Selegiline, Ropinirole, Pramipexole, Amantadine (continued)

22. Al Capone gangster at entrance: entacapone (a peripheral COMT inhibitor) increases the bioavailability of levodopa
23. InTerCOM guard in vault: catechol-O-methyltransferase (COMT) converts dopamine to 3-methoxytyramine (3-MT) in the CNS
24. Tall gangster in vault: tolcapone (a peripheral and central COMT inhibitor) increases dopamine levels in CNS
25. Hepatic gun: tolcapone can cause hepatic failure
26. Black mouse eating rope: monoamine oxidase B (MAO-B) selectively metabolizes opamine
27. Sledge hammer: selegiline (a selective MAO-B inhibitor) increases dopamine levels in the CNS
28. Double rope ladder: D2 dopamine receptor
29. Rope in a roll: ropinirole (D2 dopamine receptor agonists) is an important initial treatment of Parkinson's
30. Big pecs: pramipexole (D3 dopamine receptor agonist) is an important initial treatment of Parkinson's
31. Restless legs: dopamine receptor agonists (e.g. ropinirole, pramipexole) treat restless leg syndrome (RLS)
32. "Rock and roll": dopamine receptor agonists (e.g. ropinirole) may enhance impulse control disorders (e.g. gambling, shopping, hypersexuality)
33. Manatee: amantadine can treat some motor symptoms of Parkinson's
34. Breaking open rope: amantadine enhances the effect of endogenous dopamine (by increasing its synthesis/release and inhibiting its uptake)
35. Tri-hex Benz car: trihexyphenidul and benztropine (antimuscarinic agents used to treat parkinsonism)
36. Trembling getaway car: trihexyphenidyl and benztropine (antimuscarinic agents) improve tremor and rigidity of Parkinson's with no effect on bradykinesia

Cyclophosphamide, Ifosfamide, Busulfan, Nitrosoureas (Carmustine, Lomustine, Streptozocin)

1. Cyclops Polyphemus: cyclophosphamide (cytotoxic alkylating agent)
2. Cross-linking ankle chain: alkylating agents donate an alkyl group → DNA cross-links (cell cycle NONspecific)
3. Activating chrome bumper: cyclophosphamide is ACTIVATED by hepatic cytochrome P450 enzymes
4. Torn cancer crab: cyclophosphamide treats many hematologic and solid malignancies (e.g. leukemias and lymphomas, breast cancer, ovarian cancer)
5. Torn antibody: cyclophosphamide is a potent immunosuppressive therapy (e.g. treatment of nephrotic syndrome, nephritic syndrome, vasculitis, autoimmune hemolytic anemia)
6. Broken marrow: cyclophosphamide can cause myelosuppression
7. Red urine: cyclophosphamide can cause hemorrhagic cystitis
8. Protective maze: co-administration of 2-mercaptoethanesulfonate (MESNA) prevents hemorrhagic cystitis
9. Cancer crab belt buckle: cyclophosphamide increases risk of bladder cancer (high grade transitional cell carcinoma)
10. Inappropriately wet head: cyclophosphamide can cause hyponatremia due to SIADH
11. Dried up fruit tree: cyclophosphamide can cause infertility and premature menopause
12. Beautiful sirens: busulfan (cytotoxic alkylating agent)
13. Cross-linking ankle chains: alkylating agents donate an alkyl group → DNA cross-links (cell cycle NONspecific)
14. Severely depleted marrow: busulfan is useful as a conditioning agent prior to bone marrow transplantation
15. Fibrotic lung pattern: busulfan can cause lung toxicity (e.g. acute lung injury, interstitial fibrosis, alveolar hemorrhage)
16. Beautiful TAN sirens: busulfan can cause a hyperpigmentation reaction ("busulfan tan")
17. Centaurs: nitrosoureas (cytotoxic alkylating agents)
18. Mustang: "-mustine" suffix of nitrosoureas (e.g. carmustine, lomustine)
19. Striped zebra centaur: streptozotocin (nitrosoureas – cytotoxic alkylating agent)
20. Brain tree: nitrosoureas are highly lipophilic → cross BBB → treat brain tumors (e.g. glioblastoma multiform)
21. Dizzy centaur: nitrosoureas can cause neurotoxicity (e.g. convulsions, dizziness, ataxia)

Methotrexate, leucovorin, 5-fluorouracil, hydroxyurea

1. Hexagonal plates- pyrimidines are shaped like hexagons. These drugs block synthesis of thymidine, a pyrimidine nucleoside
2. Dumplings- dUMP (deoxyuridine monophosphate) is precursor to dTMP
3. T shape chopsiticks- after eating dumpling, turns into dTMP
4. sushi boat /belt- cycle powered by folate cycle
5. 4 leaves on boat-tetrahydrofolate (THF)
6. C shaped sushi on boat is the carbon for donation.
7. Transfer of C sushi catalyzes the converion of THF to DHF and methylation of dUMP to dTMP, catalyzed by thymidylate synthase
8. DHF converted back to THF by dihydrofolate reducatase, adding 2 hydrogens is reducing it
9. Adding C shape sushi- methylate the THF to become a carbon donor again.
10. Methotrexate-MTX-meat stix chef. A cytotoxic folate analog, preventing conversion of DHF to THF. Inhibits dihyrofolate reductase.
11. Build up of boats- build up of DHF. Stop DNA and RNA synthesis in rapidly dividing cells.
12. Sushi phase: S phase affected. DNA production blocked (chopsticks clamping down on noodles)

Treatment:

13. Cracked crab- agents treat cancers
14. Empty uterus backpack-MTX with misoprostol used as abortifacient and ectopic pregnancy (baby keychain on the side)
15. Mole keychain- tx invasive molar pregnancy, trophoblastic tumors and choriocarcinoma
16. Silver knee/elbow pads-MTX tx psoriasis
17. Joint lantern with flame- MTX first line tx for rheumatoid arthritis or DMARD
18. Torn antibody latern- MTX used for immunosuppressive therapy such as IBD, SLE, vasculitis, dematomyositis

MTX Side effects:

19. Foliage falling: folate deficiency
20. Blasting firework lantern: megaloblastic anemia
21. Falling pan of sushi: pancytopenia, myelosuppression
22. Cane: immunosuppressed have increased risk for infection
23. Fibrotic lung bonsai: lung fibrosis (restrictive lung dz)
24. Liver spot on apron- hepatotoxicity, monitor LFTs
25. Bald guy- causes baldness
26. Guy eating hot meat stick- mucositis
27. Lucky feline- leucovorin/ folonic acid, antidote

---

28. Full guy- 5-FU. Complexes with THF and inhibits thymidylate synthase to block thymidine production (touching sushi donation)
29. Buildup of dumpling plates- increase dUMP via inhibition of thymidylate synthase
30. Stained pants- diarrhea
31. Sensitive photos- photosensitivity and rash
32. 5-FU also increases myelosuppression and infection
33. Knocked over cat- no antidote for 5-FU

---

34. UDP sign- UDP (uridine diphosphate) is precursor to pyrimidine nucleosides
35. Crossed out OXY- ribonucleotide reductase (converts UDP to deoxy-UDP)
36. Hydro rock area- hydroxyurea , ribonucleotide reductase inhibitor, blocks thymidine synthesis (inhibited wait list waitress)
37. Zen sickle- tx sickle cell,
38. Raised baby with Hb coin - increase HbF, protection against HbS
39. Also myelosuppression and increased infection side effect

Hunchback of notre DNA: purine inhibitors- Azathioprine, 6-mercaptopurine, mycophenolate mofetil
1. pentagon pedestal with 3 P hammers: PPRP (phosphoribosyl pyrophosphate), precursor to IMP. Ribose sugar with 3 Ps attached
2. gargoyle imp: IMP is intermediate purine nucleotide, precursor to AMP and GMP
3. golden statues on side- right statue is GruMPy=GMP. Left statue is grAMPs- AMP. The final products of IMP.
4. purine shape behind statues' head
5. gold- pure As Gold nmeumonic
6. Esmeralda- Aza-meralda. AZA is prodrug of cytotoxic purine analog 6-mercaptopurine (purine earrings)
7. CAPTured gypsy- 6-merCAPTopurine, chains also shaped as purines.
8. HiGh Priest- need HGPRT (enzyme) to activate 6-MP
9. staff is prodding captive- activation of 6-MP
10. captive toppling imp- block synthesis of IMP
11. broken stair way- inhibits DNA synthesis, blocks S phase
12. stained glass window with crabs, antibody archers and T knights- treats hematogenous malignancies ex: ALL
13. torn lanterns with antibodies and bone- used for immunosuppressive therapies ex/ SLE, grafts. inflammations
14. bone lantern- tx rheumatoid arthritis, DMARD
15. inflamed colonic lanterns- tx inflammatory bowel dzs
16. nun with bone tray feeding bird- bone marrow suppression
17. statue with cane- immunosuppression and increased risk for infection, monitor pt with CBCs
18. pancreas sponge-pancreatitis
19. liver stain on apron- hepatotoxicity or hepatitis
20. pure nuns- allopurinol, a xanthine oxidase inhibitor (XO)
21. purine bead necklace- inhibition of XO increases level of purine analogs (6-MP) and cause toxicity/ effects
22. quasimoto- quasi-mofetil, mycophenolate mofetil (IMP dehydrogenase inhibitor)
23. knocking over GruMPy statue- decrease GMP synthesis, decreased lymphocyte production
24. swinging on lanterns- for immunosuppressive therapy (grafts, SLE, MG) and rheumatoid arthritis (DMARD)
25. nauseated quasi-mofetil- GI effects
26. also has immunosuppressive side effects -nuns
27. also increased infection in immunosuppressed -cane

Cladribine, Cytarabine, Gemcitabine

1. Clad in bearskins: cladribine (cytotoxic purine analog)
2. Purine shaped hammer: cladribine is a purine analog
3. Hairy caveman: cladribine treats hairy cell leukemia
4. Immunosuppressed cane: cladribine, cytarabine, and gemcitabine can cause immunosuppression and increased risk of infection
5. Saber toothed tiger: cytarabine (cytotoxic pyrimidine analog)
6. Pyrimidine shapes: cytarabine and gemcitabine are pyrimidine analogs
7. Scratched out antibody archers and T-cell swordsman: cytarabine is only active against hematologic malignancies (e.g. AML, non-Hodgkin lymphoma)
8. Gems inside geode: gemcitabine (cytotoxic pyrimidine analog)
9. Cracked crab fossil on solid rocks: gemcitabine is active against both hematologic malignancies and solid tumors
10. Cracked replication fork: cladribine, cytarabine, and gemcitabine inhibit DNA polymerase
11. Stone Phase: antimetabolites (e.g. cladribine, cytarabine, gemcitabine) inhibit the S phase of the cell cycle (DNA synthesis)
12. Broken marrow: cladribine, cytarabine, and gemcitabine can cause myelosuppression

Cisplatin, Carboplatin, Amifostine

1. Platinum: cisplatin, carboplatin, oxaliplatin (cytotoxic platinum analogs)
2. Cross-linked helix necklace: platinum analogs bind DNA and form intrastrand and interstrand cross-links
3. Crumpled crab: platinum analogs treat various solid malignancies (e.g. non-small cell lung cancer, small cell lung cancer, testicular cancer, ovarian cancer, bladder cancer)
4. Ototoxic earrings: platinum analogs can cause ototoxicity → sensorineural hearing loss, tinnitus (especially cisplatin)
5. Neuropathic gloves: platinum analogs can cause neurotoxicity → peripheral neuropathy (especially cisplatin)
6. Nephrotoxic purse: platinum analogs can cause nephrotoxicity → acute kidney injury (especially cisplatin)
7. Muddy drain tube: platinum analogs can cause acute tubular necrosis (ATN – muddy brown casts)
8. Amethyst: amifostine (an organic thiophosphate) can prevent cisplatin-induced nephrotoxicity
9. "Free, rare": amifostine scavenges free radicals produced by cisplatin in the kidney
10. saline fluids: IV saline diuresis prevents cisplatin-induced nephrotoxicity
11. Immunosuppresed cane: platinum analogs can cause immunosuppression and increased risk of infection (especially carboplatin)
12. Depleted bone jewelry box: platinum analogs can cause myelosuppression (especially carboplatin)

Bleomycin, Doxorubicin, Daunorubicin, Actinomycin D

1. Beluga whale: bleomycin (antitumor antibiotic)
2. Oxide bubbles: bleomycin binds DNA and produces free radicals (superoxide, hydroxide)
3. Broken double helix kelp: free radicals produced by bleomycin cause single and double strand breaks in DNA
4. Galleon: bleomycin blocks the G2 phase of the cell cycle
5. Cracked anticancer crab: bleomycin treats many hematologic and solid malignancies (e.g. Hodgkin and Non-Hodgkin lymphoma, germ cell tumors, squamous cell carcinoma of the skin, cervix, and vulva)
6. Lung coral: bleomycin can cause pulmonary toxicity (e.g. pneumonitis, pulmonary infiltrates)
7. Hyper-pigmented striae: bleomycin can cause skin toxicity (e.g. rash, exfoliation, hyperpigmentation, atrophic striae)
8. Poking mouth: bleomycin (and anthracyclines) can cause mucositis and stomatitis
9. Bald beluga: bleomycin can cause alopecia
10. Santa Anthracycline: anthracyclines (antitumor antibiotics)
11. Rubies: "-rubicin" suffix of anthracyclines (e.g. doxorubicin, daunorubicin)
12. Oxide bubbles: anthracyclines produce free radicals (e.g. superoxide, hydroxide)
13. Rubies inserting into helical seaweed: anthracyclines (e.g. doxorubicin) intercalate in DNA → block DNA and RNA synthesis
14. Cracked cancer crab: anthracyclines (e.g. doxorubicin) treats a broad range of solid and hematologic malignancies
15. Dilated heart ruby sacks: anthracyclines (e.g. doxorubicin) can cause cardiotoxicity (e.g. dilated cardiomyopathy)
16. Chelating the heart sack: dexrazoxane (iron chelator) prevents anthracycline-induced cardiotoxicity
17. Up on deck with razor: dexrazoxane (iron chelator)
18. Depleted bone chest: anthracyclines (e.g. doxorubicin) and actinomycin D can cause myelosuppression
19. Poking mouth: bleomycin (and anthracyclines) can cause mucositis and stomatitis
20. Bald pirate: anthracyclines (e.g. doxorubicin) can cause alopecia
21. Doll artifact: actinomycin D (antitumor antibiotic)
22. Artifacts inserting into helical seaweed: actinomycin D intercalates in DNA → block DNA and RNA synthesis
23. Child's artifact: actinomycin D treats numerous pediatric malignancies (e.g. Wilms tumor, Ewing sarcoma, rhabdomyosarcoma)
24. Bald doll: actinomycin D can cause alopecia
25. Depleted bone chest: anthracyclines (e.g. doxorubicin) and actinomycin D can cause myelosuppression

Etoposide, Teniposide, Topotecan, Irinotecan

1. Side of the tower: etoposide and teniposide (topoisomerase II inhibitors)
2. Unwinding strands: topoisomerases relieve DNA supercoiling that occurs during DNA replication
3. Grasping 2 strands: etoposide and teniposide inhibit topoisomerase II (double stranded breaks to relieve supercoiling)
4. Both strands breaking: etoposide and teniposide prevent relegation of the double strand break induced by topoisomerase II
5. "Stairs out": topoisomerase inhibitors block the S phase of the cell cycle (DNA synthesis)
6. "Gone 2 forest": topoisomerase inhibitors block the G2 phase of the cell cycle (double check and repair)
7. Ripped cancer crab: etoposide and teniposide treat many solid and hematological malignancies (e.g. testicular cancer, small cell lung cancer, Hodgkin and non-Hodgkin lymphoma)
8. Spilling bone luggage: topoisomerase inhibitors can cause myelosuppression
9. Immunosuppressed cane: topoisomerase inhibitors can cause immunosuppression
10. Losing hair: topoisomerase inhibitors can cause alopecia
11. Toucan: topotecan and irinotecan (topoisomerase I inhibitors)
12. Single ponytail strand: topotecan and irinotecan inhibit topoisomerase I (single strand nick to relieve supercoiling)
13. Ripped cancer crab: topotecan treats ovarian cancer and small cell lung cancer; irinotecan treats colon cancer
14. Spilling bone luggage: topoisomerase inhibitors can cause myelosuppression
15. Loose bird stool: topotecan and irinotecan can cause severe diarrhea

Vincristine, Vinblastine, Paclitaxel

1. Christine in vines: vincristine (cytotoxic vinca alkaloid)
2. Breaking spindle vines: vinca alkaloids (e.g. vincristine, vinblastine) inhibit microtubule production and mitotic spindle assembly
3. Blasting vines: vinblastine (cytotoxic vinca alkaloid)
4. Cracked cancer crab: vinca alkaloids treat many hematologic and solid malignancies (e.g. leukemias, lymphomas, pediatric tumors, breast cancer, and germ cell cancer)
5. Neuropathic stockings and gloves: vincristine can cause neurotoxicity (e.g. peripheral sensory neuropathy)
6. Plunger: vincristine can cause autonomic dysfunction (e.g. paralytic ileus, constipation)
7. Bald: vinca alkaloids (e.g. vincristine, vinblastine) can cause alopecia
8. Tarzan: taxanes (e.g. paclitaxel, docetaxel, cabazitaxel – cytotoxic plant alkaloids)
9. Stabilizing the vine: taxanes enhance microtubule production and prevent their degradation → improper mitotic spindle function
10. Bald: taxanes (e.g. paclitaxel) can cause alopecia
11. Neuropathic glove: taxanes can cause neurotoxicity (e.g. peripheral sensoryneuropathy)
12. Broken marrow: drugs that affect microtubule function (e.g. vinca alkaloid, taxanes) can cause myelosuppression (especially vinblastine)
13. “M” shape in vines: drugs that affect microtubule function (e.g. vinca alkaloids, taxanes) block the M phase of athe cell cycle (mitosis)

Imatinib, Erlotinib, Sorafenib, Sunitinib, Vemurafenib

1. Broken nib: "-nib" suffix of small molecule kinase inhibitors (e.g. imatinib, erolotinib, vermurafenib)
2. Inhibited tire swing: tyrosine kinase inhibitors ("-tinib" e.g. imatinib, erlotinib, sunitinib)
3. Imitating: imatinib (small molecule tyrosine kinase inhibitor)
4. Cracked crab: small molecule kinase inhibitors treat a variety of hematologic and solid malignancies (e.g. imatinib treats CML)
5. Copious pink, white, and blue granules: chronic myeloid leukemia (CML) (increased levels of mature granulocytes – eosinophils, neutrophils, basophils)
6. BREAKABLE: imatinib blocks the tyrosine kinase domain of the BCR/ABL fusion protein (in CML)
7. Philadelphia, Pa: translocation between chromosomes 9 and 22 → BCR/ABL oncogene on chromosome 22 (Philadelphia chromosome)
8. Congress kit: imatinib blocks the c-kit tyrosine kinase (in GIST)
9. Crab buttons on belly: c-kit tyrosine kinase is found in gastrointestinal stromal tumors (GIST)
10. Baggy pantaloons: imatinib can cause fluid retention → ankle and periorbital edema
11. British Earl: erlotinib (small molecule tyrosine kinase inhibitor)
12. Earl Geoffrey: erlotinib blocks the epidermal growth factor receptor (EGFR) tyrosine kinase
13. Big lapel with crab badge: erlotinib treats solid tumors with EGFR overexpression (e.g. non-small cell lung cancer – NSCLC)
14. Spotty rash: erlotinib can cause a papulopustular acneiform rash
15. Muddy pantaloons: erlotinib can cause diarrhea
16. Rising sun: sunitinib (a small molecule tyrosine kinase inhibitor)
17. Soaring eagle: sorafenib (a small molecule tyrosine kinase inhibitor)
18. Inhibiting vegetables: sunitinib and sorafenib inhibits the vascular endothelial growth factor receptor (VEGFR) tyrosine kinase
19. Flank crab buckles: sunitinib and sorafenib treat cancer with VEGFR overexpression (e.g. renal cell carcinoma)
20. Callused and sunburned: sunitinib and sorafenib can cause hyperkeratosis and skin rashes
21. Bleeding wound: VEGF-targeted therapies (e.g. sunitinib, sorafenib) are associated with an increased risk of hemorrhage
22. Venom: vemurafenib (a small molecule kinase inhibitor)
23. B. Fra: vemurafenib blocks B-Raf kinase
24. Disseminated ink: vemurafenib treats V600E BRAF positive malignant melanoma

Rituximab, Cetuximab, Bevacizumab, Alemtuzumab, Trastuzumab

1. Chimera sigil: rituximab and cetuximab are chimeric monoclonal antibodies
2. Pulling down antibody archer: rituximab depletes B cells (binds CD20)
3. Grabbing "XX" straps: rituximab binds CD20 on B-cells
4. Chronic tapestry with antibody archers and T knights: rituximab treats chronic lymphocytic leukemia (CLL)
5. Rheumatic lantern: rituximab treats rheumatoid arthritis (disease modifying anti-rheumatic drug – DMARD)
6. Torn antibody: Rituximab is useful for immunosuppressive therapy (e.g. microscopic polyangiitis, Wegener's granulomatosis)
7. Immunosuppressed cane: rituximab can cause immunosuppression and increased risk of infection
8. White laurel leaves: rituximab may be associated with a higher risk of progressive multifocal leukoencephalopathy (PML)
9. Swollen cherub with ivy: monoclonal antibodies can cause an infusion reaction (e.g. headache, fever, skin rash, pruritus, dyspnea, hypotension)
10. Delayed onset poisoning: chimeric antibodies (e.g. rituximab, rarely cetuximab) can cause serum sickness (e.g. fever, rash, arthralgia within 7-10 days)
11. Tusks: cetuximab (monoclonal antitumor antibody)
12. Giraffe: cetuximab binds the epidermal growth factor receptor (EGFR)
13. Tire swing: EGFR is a receptor tyrosine kinase
14. Cracked crab: cetuximab treats solid tumors (e.g. colorectal cancer, squamous cell carcinoma)
15. Red spots: cetuximab can cause a papulopustular acneiform rash
16. Beverage lady: bevacizumab (monoclonal antitumor antibody)
17. Chopped vegetables: bevacizumab binds VEGF
18. Chopping vessels: bevacizumab inhibits growth of blood vessels in tumors (binds VEGF)
19. Cracked crab: bevacizumab treats metastatic tumors (e.g. colorectal cancer, squamous cell carcinoma)
20. Wet center of retina pillow: bevacizumab treats wet macular degeneration
21. Blood spatter: bevacizumab can cause bleeding
22. Ice clots: bevacizumab increases the risk for thrombotic events
23. Alms: alemtuzumab (monoclonal antitumor antibody)
24. Pulling down antibody archer and T knight: alemtuzumab depletes B and T cells (binds CD52)
25. 52 pattern: alemtuzumab binds CD52 on B and T cells
26. Chronic tapestry with antibody archers and T knights: alemtuzumab treats chronic lymphocytic leukemia (CLL)
27. Tapestry weaver: trastuzumab (monoclonal antitumor antibody)
28. Tire swing: HER2 is a receptor tyrosine kinase
29. Her 2 babies: trastuzumab binds epidermal growth factor receptor 2 (HER2, c-erbB2)
30. Crab bra: trastuzumab treats HER2 positive breast cancer
31. Unraveling heart: trastuzumab can cause cardiotoxicity (e.g. decreased LVEF, heart failure)

BROUGHT TO YOU BY

MEDAIDPK

EMPOWERING YOU

WITH KNOWLEDGE!

MEDAIDPK.COM