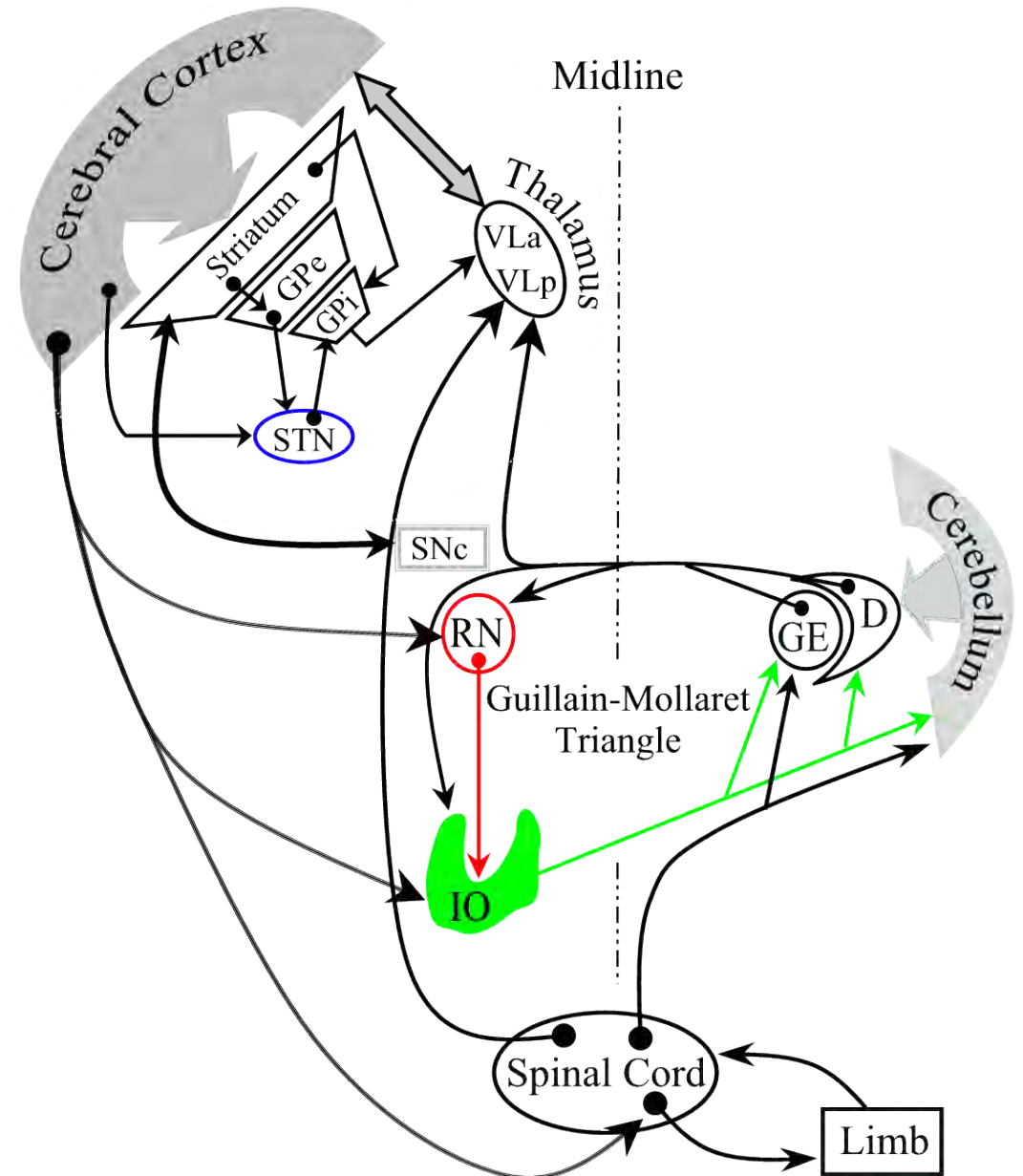
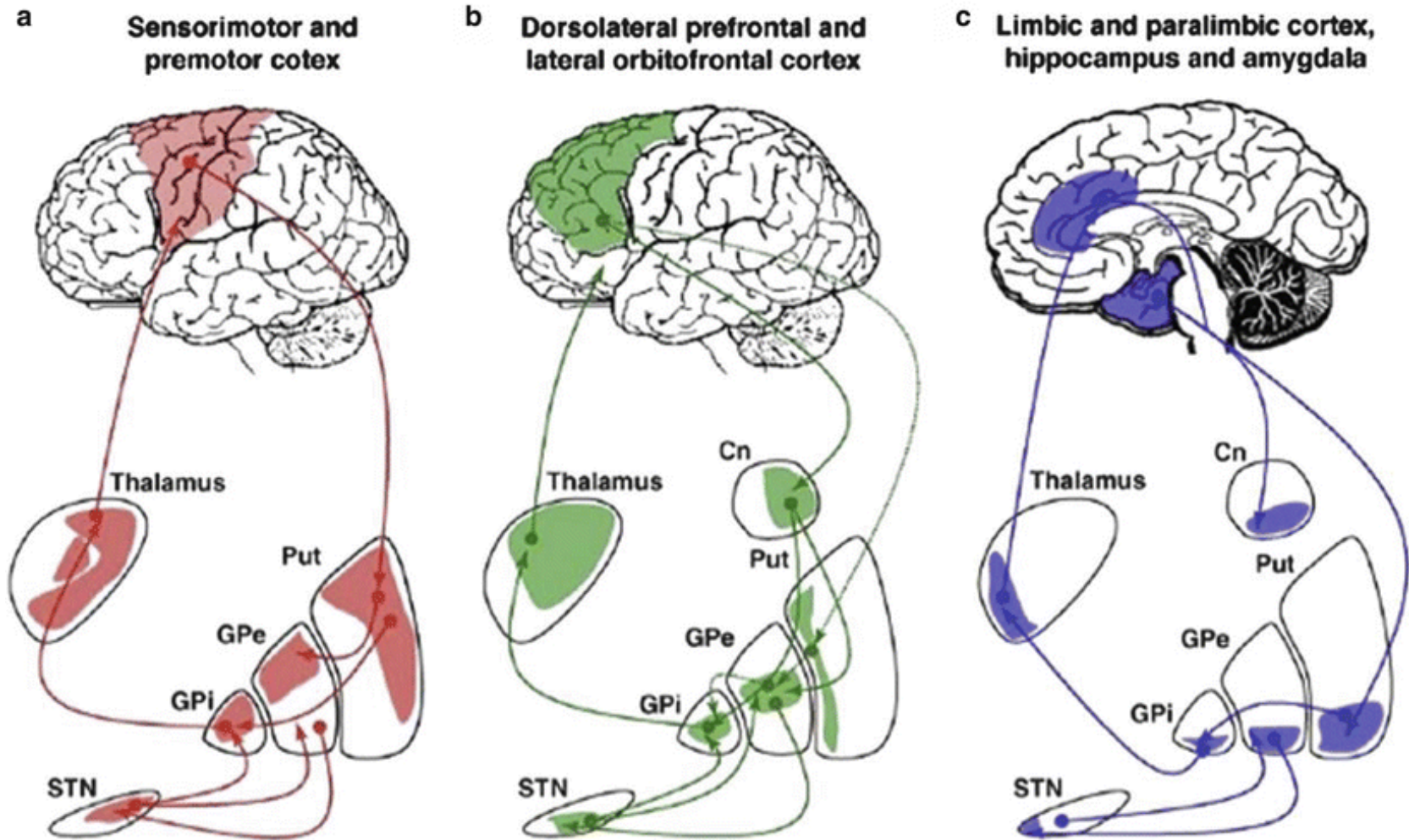


# Principal pathways of motor control

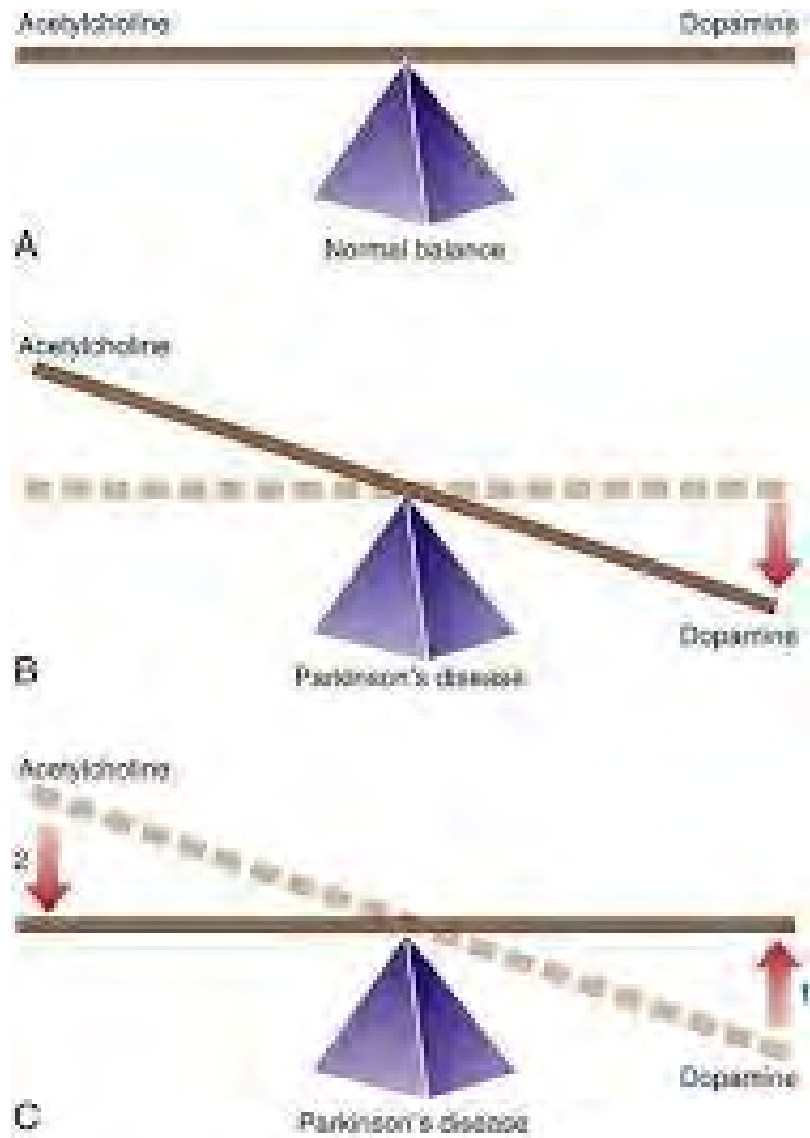
Which pathways are inhibitory?



# Parallel basal ganglia loops



Alexander et al. *Annu Rev Neurosci* 1986;9:357-381.



Parkinson disease  
*circa* 1970

# Why is PD so treatable?

It is a disease affecting multiple neuromodulators.

Table 1. Neurotransmitters and Pharmacologic Agents Relating to Parkinson Disease Symptoms

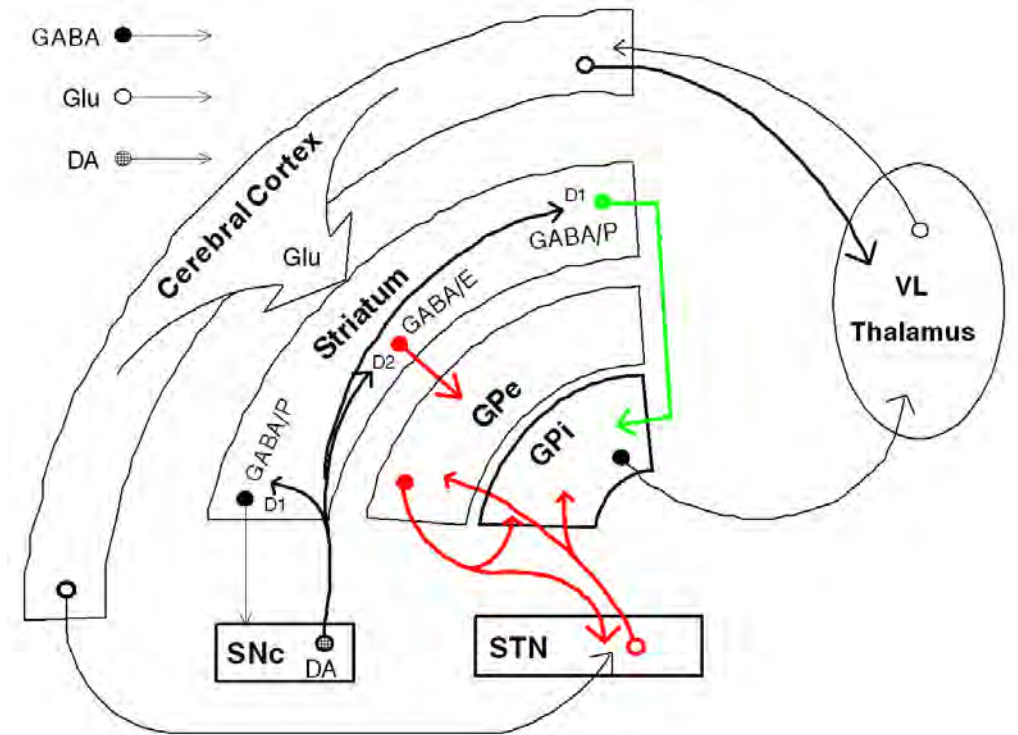
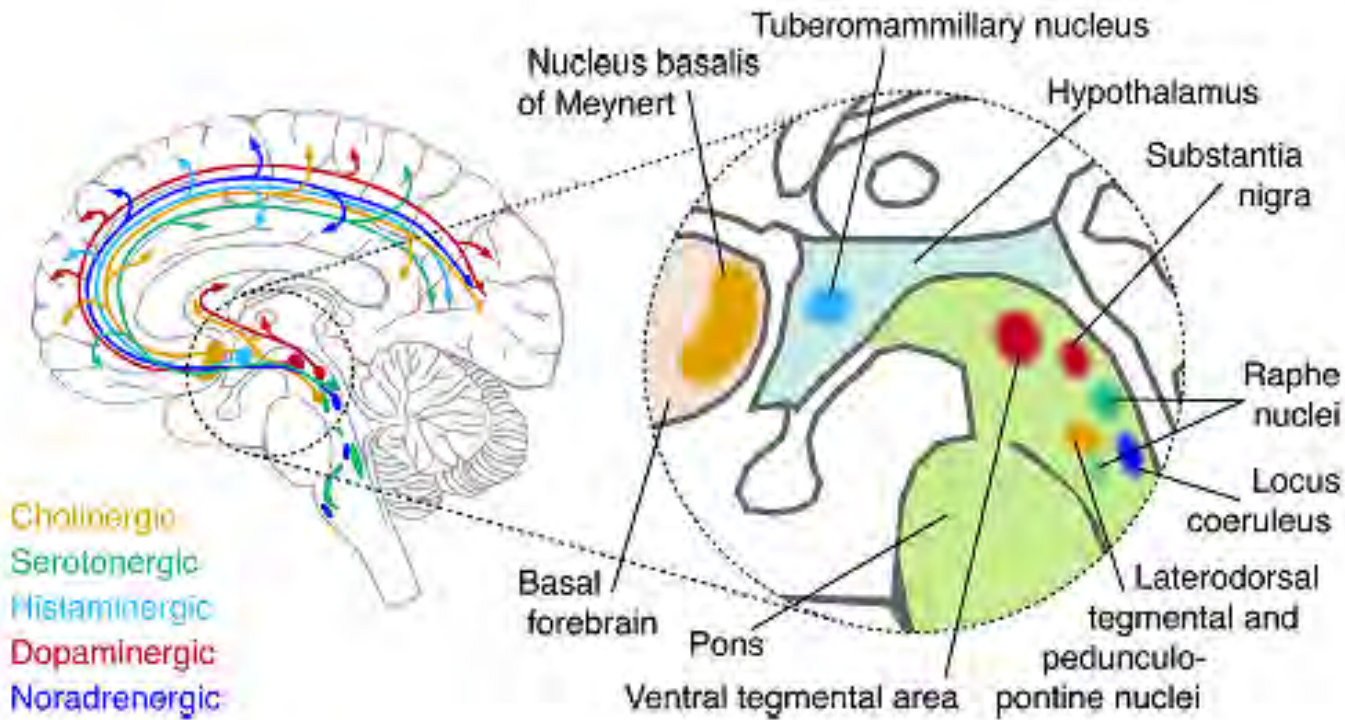
Symptom or Sign	Neurotransmitters and Drugs Influencing the Neurotransmitter				
	Dopamine	Serotonin	Norepinephrine	Acetylcholine	Other
Motor impairment (eg, bradykinesia, rigidity, tremor, gait disturbance)	Levodopa preparations, dopamine agonists (eg, pramipexole, ropinirole), monoamine oxidase-B inhibitors (eg, rasagiline, selegiline), catechol-O-methyl transferase inhibitors (eg, entacapone)			Anticholinergic agents for tremor (eg, trihexyphenidyl) <sup>a</sup> ; cholinesterase inhibitors for gait (eg, rivastigmine) <sup>a,b</sup>	Amantadine <sup>c</sup>
Cognitive impairment	Monoamine oxidase-B inhibitors <sup>a,b</sup>			Cholinesterase inhibitors	
Psychosis	Quetiapine, clozapine <sup>a</sup>	Pimavanserin		Cholinesterase inhibitors <sup>a,b</sup>	
Depression, anxiety	Dopamine agonists <sup>a</sup>	Selective serotonin reuptake inhibitors, selective serotonin and norepinephrine reuptake inhibitors, tricyclic antidepressants	Selective serotonin and norepinephrine reuptake inhibitors, tricyclic antidepressants	Tricyclic antidepressants	

<sup>a</sup> Indicates US Food and Drug Administration approved for another use but off-label use for the sign or symptom in this row.

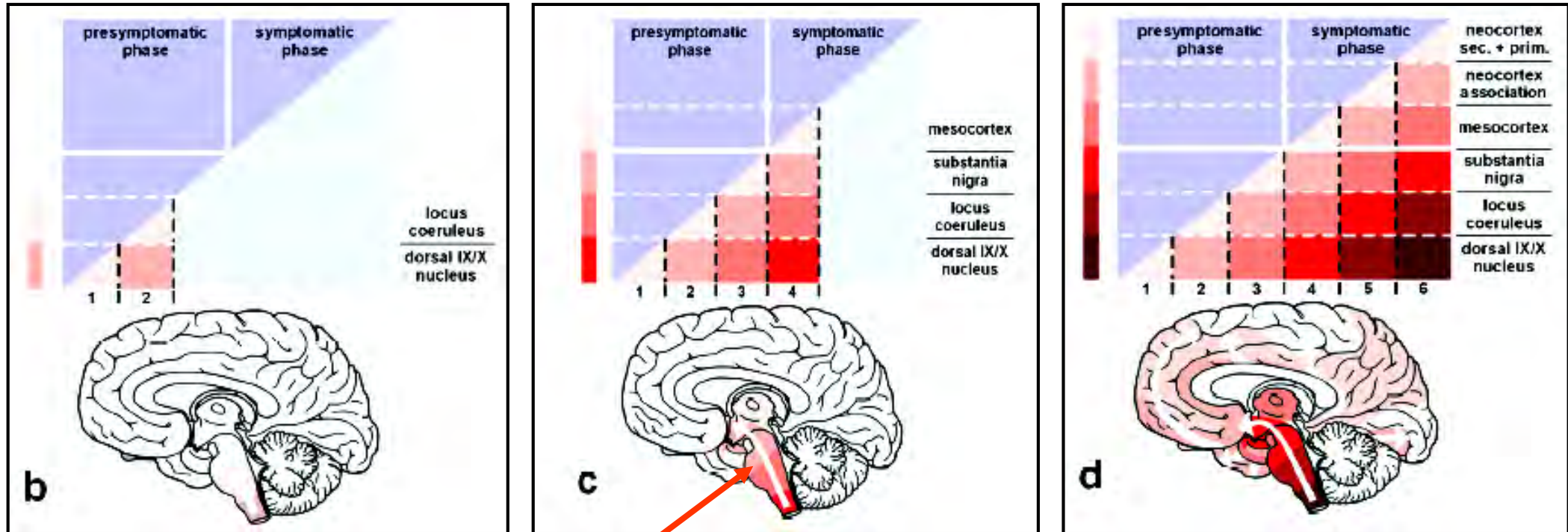
<sup>b</sup> Studied for this use with insufficient evidence to date to support routine use.

<sup>c</sup> Amantadine may affect multiple neurotransmitter systems including dopamine and glutamate.

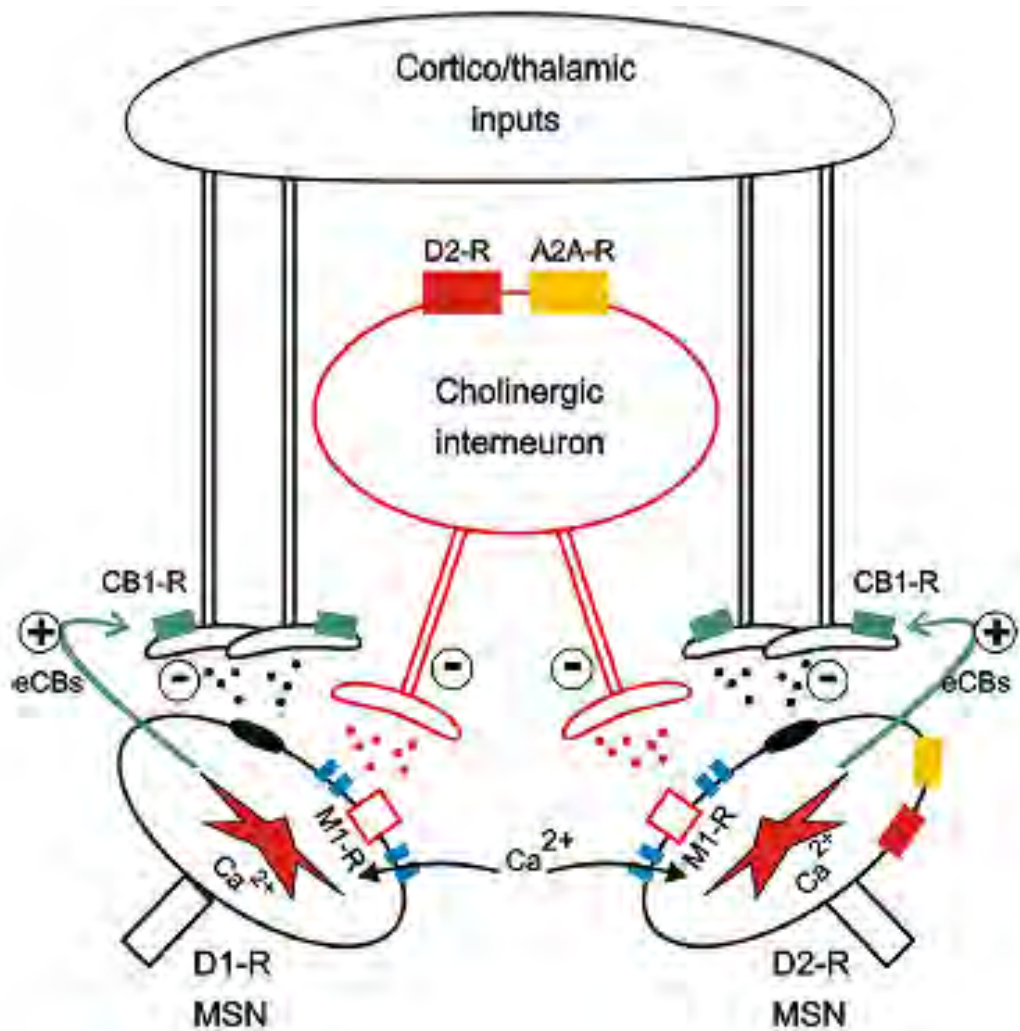
# Neuromodulation of basal ganglia circuitry



# PD starts years before motor symptoms



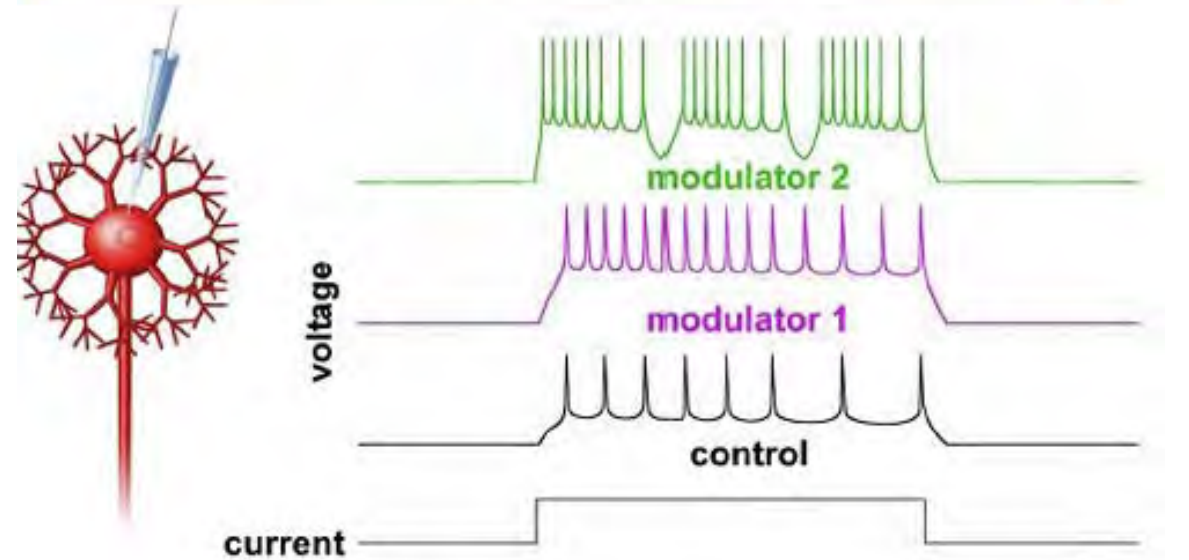
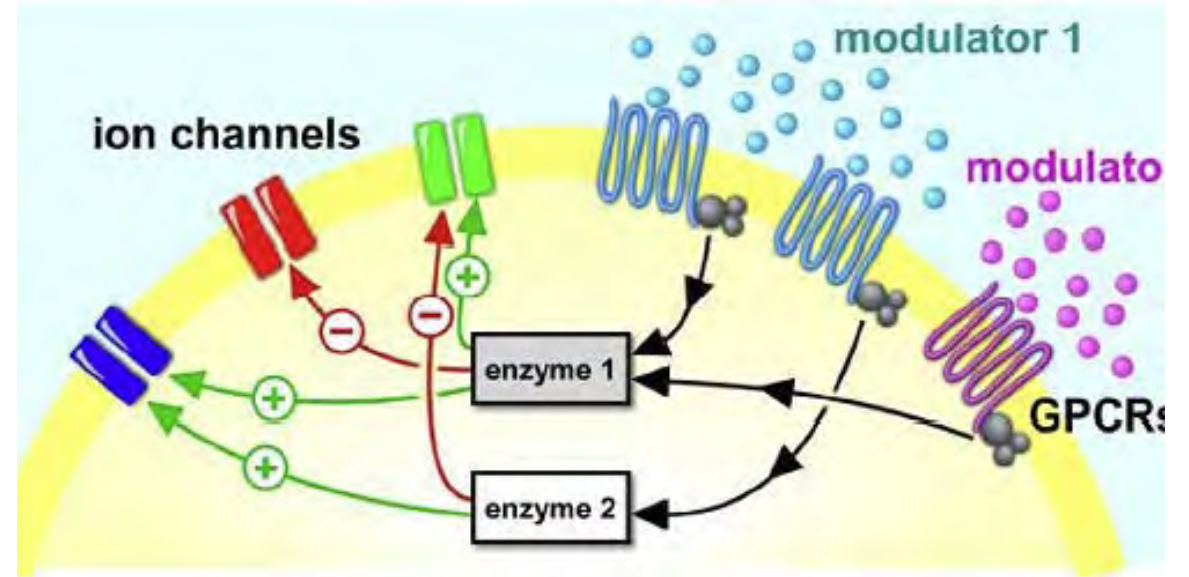
Cholinergic basal forebrain  
 raphe  
 locus ceruleus  
 substantia nigra, VTA



# Striatal cholinergic neurons and microcircuitry

Tozzi et al. *J Neurosci* 2011;31:1850-1862.

# Basic mechanisms of neuromodulation





# Dopamine receptor classification

RECEPTORS	D1	D5	D2	D3	D4
Location	Striatum, nucleus accumbens, Olfactory bulb, amygdala hippocampus, substantia nigra Hypothalamus, frontal cortex	Cortex, substantia nigra, hypothalamus	Striatum, VTA Olfactory bulb, cerebral cortex	Striatum, islands of Calleja, cortex	Frontal cortex, amygdala, hypothalamus, nucleus accumbens
Type	Gs-coupled	Gs-coupled	Gi-coupled	Gi-coupled	Gi-coupled
Mechanism	Increased intracellular level of cAMP by activated adenylylase	Adenylylase ↑	Increased intracellular level of cAMP by activate adenylylase	Adenylylase ↓	Adenylylase ↓
Function	Locomotion, learning and memory, attention, impulse control, sleep, regulation of renal function	Cognition, attention, decision making, motor learning, renin secretion	Locomotion, learning and memory, attention, sleep, reproductive behaviour	Locomotion, cognition, attention, impulse control, sleep, regulation of food intake	Cognition, impulse control, attention, sleep, reproductive behavior
Selective agonist	SKF-38393 SKF-81297 Fenoldopam (SKF-82526)	—	Bromocriptine Pergolide Cabergoline Ropinirole	7-OH-DPAT Pramipexole Rotigotine PD-128907	A-412997 ABT-670 PD-168077

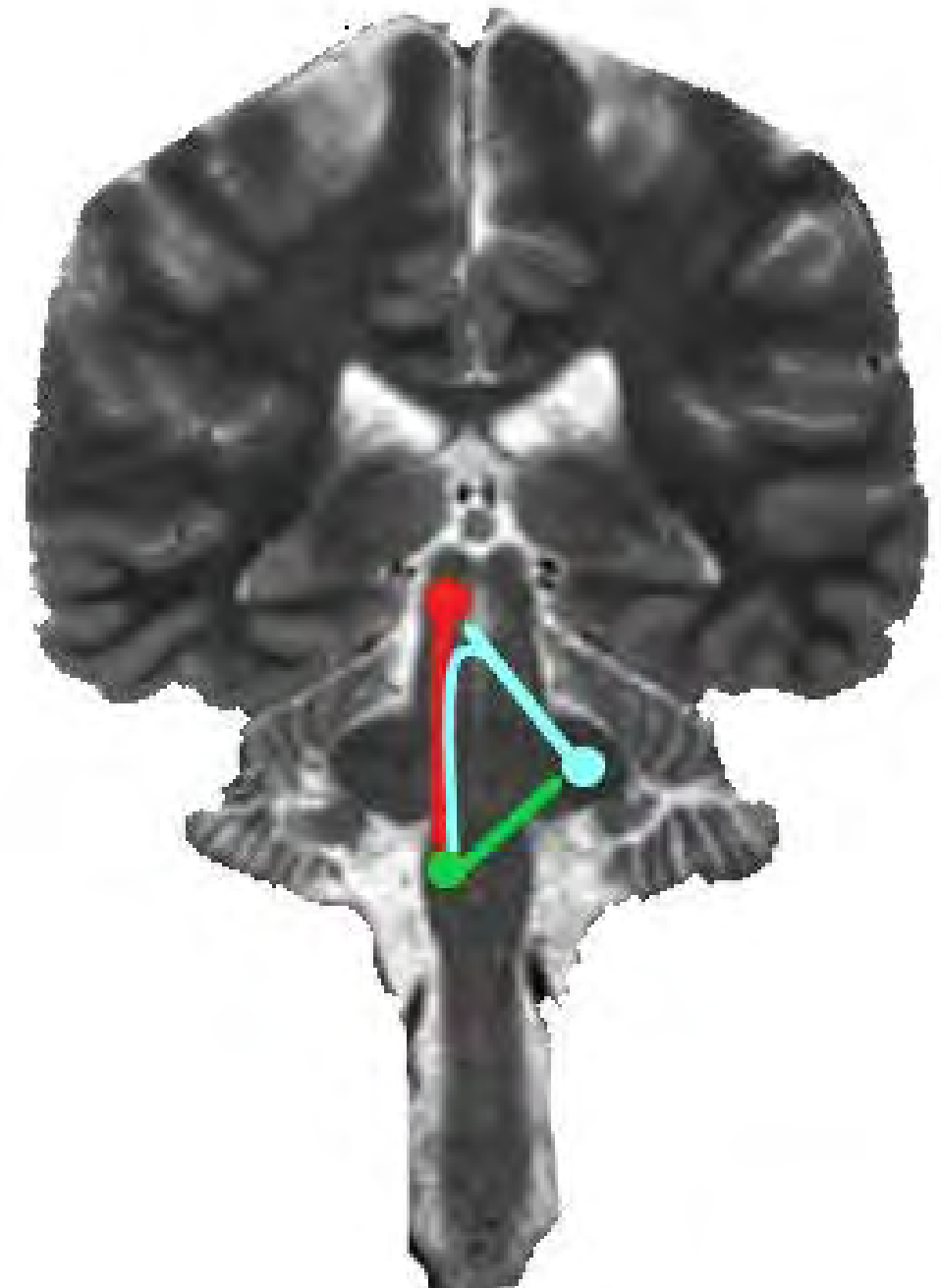
# Cerebellum

Guillain-Mollaret triangle

**What part of the brain has the greatest number of neurons?**

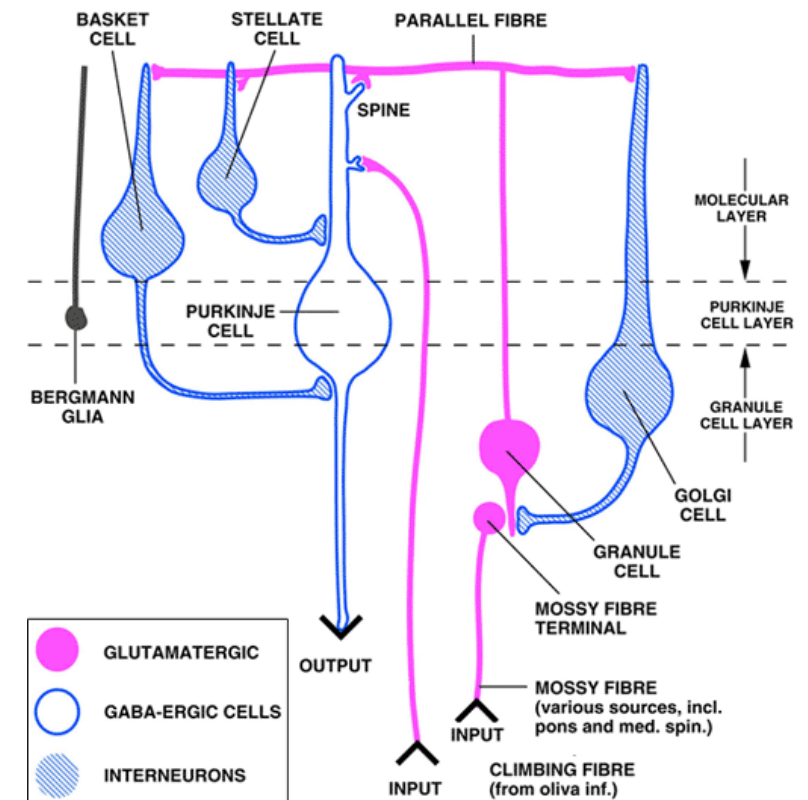
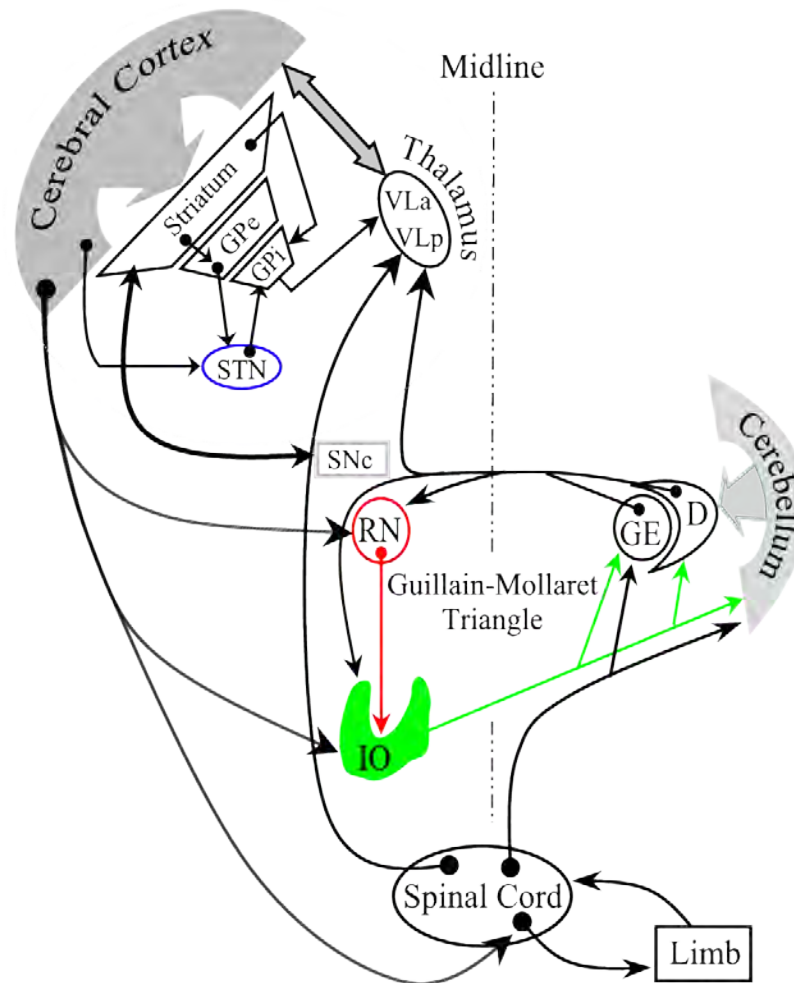
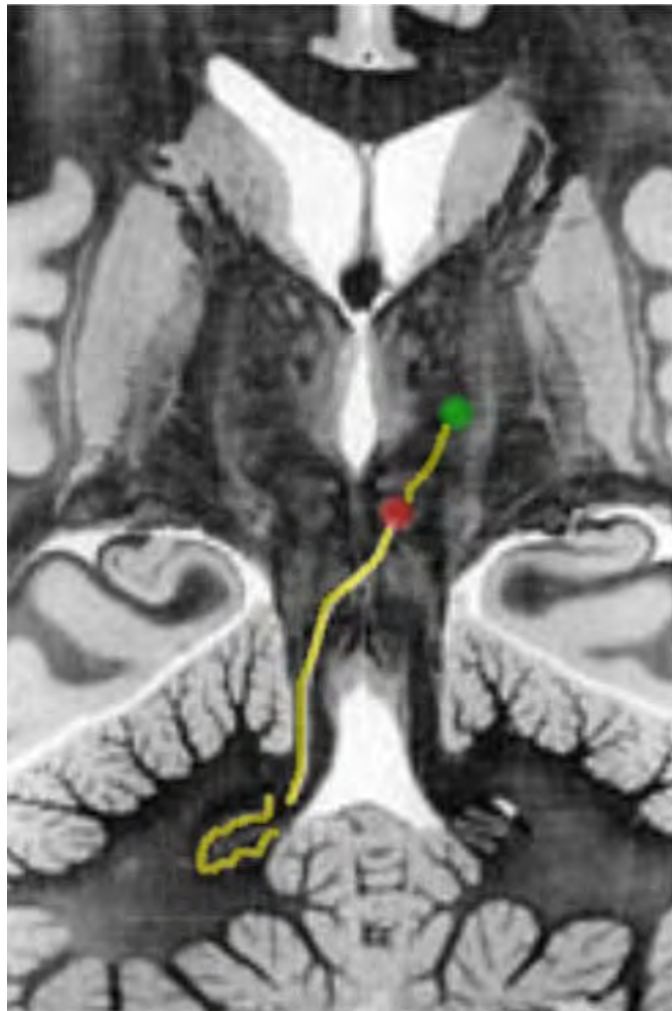
**Answer: cerebellum**

**100 billion of the 120-130 billion total**



# Intention tremor

Abnormal mechanical-reflex oscillation produced by cerebellothalamic pathway lesions

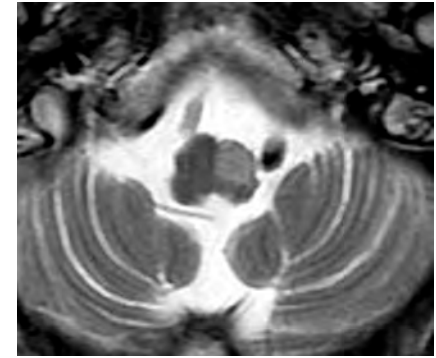
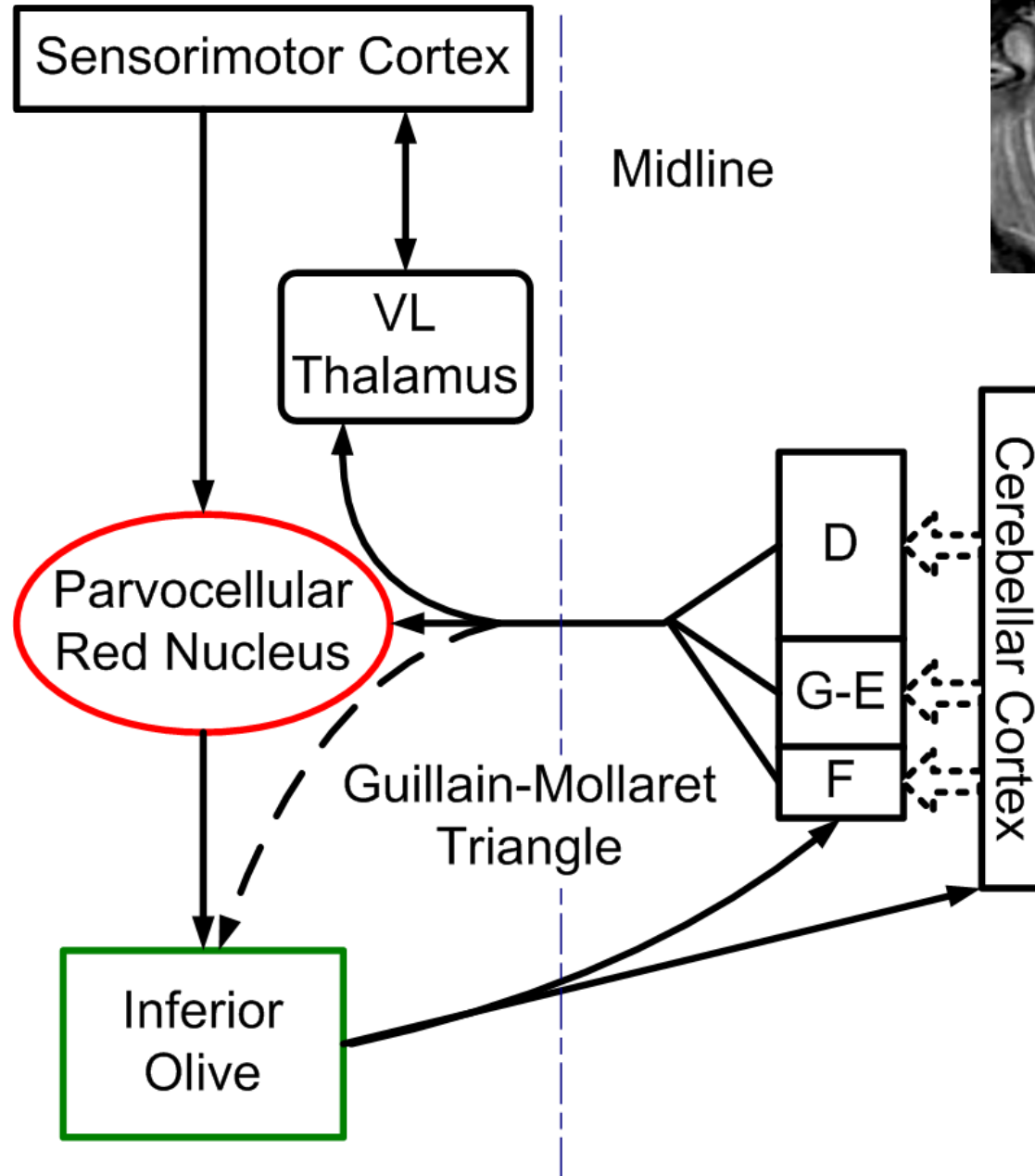




Georges Guillain  
(1876-1961)



Pierre Mollaret  
(1898-1987)





Menu

# MEDICATION

[Home](#) > [What is Parkinson’s Disease?](#) > [Treatment & Medication](#) > [Medication](#)



## MEDICATIONS FOR PARKINSON’S

**There is not yet a cure for Parkinson’s disease, but symptoms can be treated with medication.**

Should I start treating my symptoms with medication now or should I wait a while? Which medications are right for me? These are among the tough questions people with Parkinson’s disease are faced with. Your answers will be balanced among many other considerations.

Before making any decisions about treatment of Parkinson’s disease, you will want to learn about the different types of medications available for Parkinson’s disease and discuss the pros and cons of each with your physician. It may help to know that there is no “right” answer, and if you try something that doesn’t work for you, you can always adjust your plan.

To learn more about adjusting medication plans, view our webinar on [What to Do When Your Medications Stop Working](#).

### Medications to Avoid or Use with Caution

Sign up for our email list and receive our publication on medications with potential complications you should be aware of.

### Levodopa: the most effective

Email Address\*



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Levodopa, also known as L-DOPA, has long been, and continues to be, the most effective drug in treating [Parkinson's disease symptoms](#). Most people with Parkinson's disease will take this drug at some point. There are side effects that can occur with Levodopa including nausea, fatigue and orthostatic hypotension. Often these side effects can be successfully treated so that Levodopa can be tolerated better. In addition, as the disease progresses and the brain has less ability to produce and process dopamine, dyskinesias, or involuntary movements can develop from Levodopa.

First Name\*

Last Name\*

[DOWNLOAD](#)

[Read about dyskinesia, the main levodopa side effect →](#)

## Full List of Medications Approved for the Treatment of Parkinson's Disease in the USA

Below is a full list of Parkinson's medications that have been approved to treat Parkinson's in the United States. ***This material is intended to provide you with information. It should not be used for treatment purposes, but rather as a source for discussion with the patient's own physician.*** Work with your physician to determine which medications are best for you, and know the risks and benefits of each.

Generic Name	Trade Name	Mode of Action	Common Side Effects*
Generic Name Carbidopa-levodopa	Trade Name Sinemet	Mode of Action DOPA decarboxylase inhibitor/DA precursor	Common Side Effects Nausea, dizziness, orthostatic hypotension, anxiety, dyskinesia, confusion, hallucinations, somnolence.
Generic Name Carbidopa-levodopa (controlled release)	Trade Name Sinemet CR	Mode of Action DOPA decarboxylase inhibitor/DA precursor	Common Side Effects Nausea, dizziness, orthostatic hypotension, anxiety, dyskinesia, confusion, hallucinations, somnolence.



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disintegrating tablet)		inhibitor/DA precursor	dyskinesia, confusion, hallucinations, somnolence.
<b>Generic Name</b> Carbidopa-levodopa (extended release capsules)	<b>Trade Name</b> Rytary	<b>Mode of Action</b> DOPA decarboxylase inhibitor/DA precursor	<b>Common Side Effects</b> Nausea, dizziness, orthostatic hypotension, anxiety, dyskinesia, confusion, hallucinations, somnolence.
<b>Generic Name</b> Carbidopa-levodopa-entacapone (enteral suspension)	<b>Trade Name</b> Duopa	<b>Mode of Action</b> DOPA decarboxylase inhibitor/DA precursor	<b>Common Side Effects</b> Nausea, dizziness, orthostatic hypotension, anxiety, dyskinesia, confusion, hallucinations, somnolence.
<b>Generic Name</b> Levodopa Inhalation powder	<b>Trade Name</b> Inbrija	<b>Mode of Action</b> DA precursor	<b>Common Side Effects</b> Nausea, dizziness, orthostatic hypotension, anxiety, dyskinesia, confusion, hallucinations, somnolence.
<b>Generic Name</b> Entacapone	<b>Trade Name</b> Comtan	<b>Mode of Action</b> COMT inhibitor, inhibits breakdown of Levodopa	<b>Common Side Effects</b> Same as carbidopa/levodopa. In addition: diarrhea, discoloration of body fluids.
<b>Generic Name</b> Tolcapone	<b>Trade Name</b> Tasmar	<b>Mode of Action</b> COMT inhibitor, inhibits breakdown of Levodopa	<b>Common Side Effects</b> Same as carbidopa/levodopa. In addition: diarrhea, discoloration of body fluids. Tasmar can cause elevated liver function enzymes.
<b>Generic Name</b> Opicapone	<b>Trade Name</b> Ongentys	<b>Mode of Action</b> COMT inhibitor, inhibits breakdown of Levodopa	<b>Common Side Effects</b> Same as carbidopa/levodopa.



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Entacapone		inhibitor/DA precursor/COMT inhibitor	
<b>Generic Name</b> Pramipexole	<b>Trade Name</b> Mirapex	<b>Mode of Action</b> DA agonist	<b>Common Side Effects</b> Nausea, dizziness, orthostatic hypotension, swelling of ankles, dyskinesia, hallucinations, confusion, somnolence, sleep attacks, impulse control disorders.
<b>Generic Name</b> Pramipexole (extended release)	<b>Trade Name</b> Mirapex ER	<b>Mode of Action</b> DA agonist	<b>Common Side Effects</b> Nausea, dizziness, orthostatic hypotension, swelling of ankles, dyskinesia, hallucinations, confusion, somnolence, sleep attacks, impulse control disorders.
<b>Generic Name</b> Ropinirole	<b>Trade Name</b> Requip	<b>Mode of Action</b> DA agonist	<b>Common Side Effects</b> Nausea, dizziness, orthostatic hypotension, swelling of ankles, dyskinesia, hallucinations, confusion, somnolence, sleep attacks, impulse control disorders.
<b>Generic Name</b> Ropinirole (extended release)	<b>Trade Name</b> Requip XL	<b>Mode of Action</b> DA agonist	<b>Common Side Effects</b> Nausea, dizziness, orthostatic hypotension, swelling of ankles, dyskinesia, hallucinations, confusion, somnolence, sleep attacks, impulse control disorders.
<b>Generic Name</b> Apomorphine (injection)	<b>Trade Name</b> Apokyn	<b>Mode of Action</b> DA agonist	<b>Common Side Effects</b> Nausea, dizziness, orthostatic hypotension, swelling of ankles, dyskinesia, hallucinations, confusion, somnolence, sleep attacks, impulse control disorders.
<b>Generic</b>	<b>Trade</b>	<b>Mode of Action</b> DA	<b>Common Side Effects</b> Mouth irritation or



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<b>Generic Name</b> Rotigotine (transdermal patch)	<b>Trade Name</b> Neupro	<b>Mode of Action</b> DA agonist	<b>Common Side Effects</b> Nausea, dizziness, orthostatic hypotension, swelling of ankles, dyskinesia, hallucinations, confusion, somnolence, sleep attacks, impulse control disorders. Neupro can lead to a skin reaction at the patch site.
<b>Generic Name</b> Selegiline	<b>Trade Name</b> Eldepryl	<b>Mode of Action</b> MAO-B inhibitor; inhibits breakdown of dopamine	<b>Common Side Effects</b> Selegiline can cause insomnia. Dizziness, nausea, gastrointestinal upset, dyskinesia, hallucinations, confusion, headache. Note possible drug <a href="#">interactions</a> .
<b>Generic Name</b> Selegiline (orally disintegrating tablet)	<b>Trade Name</b> Zelapar	<b>Mode of Action</b> MAO-B inhibitor; inhibits breakdown of dopamine	<b>Common Side Effects</b> Selegiline can cause insomnia. Dizziness, nausea, gastrointestinal upset, dyskinesia, hallucinations, confusion, headache. Note possible drug <a href="#">interactions</a> .
<b>Generic Name</b> Rasagiline	<b>Trade Name</b> Azilect	<b>Mode of Action</b> MAO-B inhibitor; inhibits breakdown of dopamine	<b>Common Side Effects</b> Dizziness, nausea, gastrointestinal upset, dyskinesia, hallucinations, confusion, headache. Note possible drug <a href="#">interactions</a> .
<b>Generic Name</b> Safinamide	<b>Trade Name</b> Xadago	<b>Mode of Action</b> MAO-B inhibitor; inhibits breakdown of dopamine	<b>Common Side Effects</b> Dizziness, nausea, gastrointestinal upset, dyskinesia, hallucinations, confusion, headache. Note possible drug <a href="#">interactions</a> . Safinamide exerts its effects through other mechanisms of action as well.
<b>Generic Name</b> Amantadine	<b>Trade Name</b> Symmetrel	<b>Mode of Action</b> Mixed mechanisms, including NMDA antagonism	<b>Common Side Effects</b> Hallucinations, leg swelling, dizziness, mottled skin (livedo reticularis), confusion, dry mouth and



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<b>Generic Name</b> Amantadine (extended release)	<b>Trade Name</b> Gocovri	<b>Mode of Action</b> Mixed mechanisms, including NMDA antagonism	<b>Common Side Effects</b> Hallucinations, leg swelling, dizziness, mottled skin (livedo reticularis), confusion, dry mouth and eyes, constipation, dizziness, orthostatic hypotension, somnolence.
<b>Generic Name</b> Amantadine (extended release)	<b>Trade Name</b> Osmolex	<b>Mode of Action</b> Mixed mechanisms, including NMDA antagonism	<b>Common Side Effects</b> Hallucinations, leg swelling, dizziness, mottled skin (livedo reticularis), confusion, dry mouth and eyes, constipation, dizziness, orthostatic hypotension, somnolence.
<b>Generic Name</b> lstradefylline	<b>Trade Name</b> Nourianz	<b>Mode of Action</b> Adenosine 2A antagonist	<b>Common Side Effects</b> Dizziness, constipation, nausea, dyskinesia, hallucination and sleeplessness
<b>Generic Name</b> Trihexyphenidyl	<b>Trade Name</b> Artane	<b>Mode of Action</b> Anticholinergic	<b>Common Side Effects</b> Dry mouth and eyes, constipation, urinary retention, memory impairment, confusion, depression, hallucinations.
<b>Generic Name</b> Benztropine	<b>Trade Name</b> Cogentin	<b>Mode of Action</b> Anticholinergic	<b>Common Side Effects</b> Dry mouth and eyes, constipation, urinary retention, memory impairment, confusion, depression, hallucinations.

Generic Name	Trade Name	Mode of Action	Common Side Effects*
Carbidopa-levodopa	Sinemet	DOPA decarboxylase inhibitor/DA precursor	Nausea, dizziness, orthostatic hypotension, anxiety, dyskinesia, confusion, hallucinations, somnolence.
Carbidopa-levodopa (controlled release)	Sinemet CR	DOPA decarboxylase inhibitor/DA precursor	Nausea, dizziness, orthostatic hypotension, anxiety, dyskinesia, confusion, hallucinations, somnolence.



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Carbidopa-levodopa (orally disintegrating tablet)	Parcopa	DOPA decarboxylase inhibitor/DA precursor	Nausea, dizziness, orthostatic hypotension, anxiety, dyskinesia, confusion, hallucinations, somnolence.
Carbidopa-levodopa (extended release capsules)	Rytary	DOPA decarboxylase inhibitor/DA precursor	Nausea, dizziness, orthostatic hypotension, anxiety, dyskinesia, confusion, hallucinations, somnolence.
Carbidopa-levodopa-entacapone (enteral suspension)	Duopa	DOPA decarboxylase inhibitor/DA precursor	Nausea, dizziness, orthostatic hypotension, anxiety, dyskinesia, confusion, hallucinations, somnolence.
Levodopa Inhalation powder	Inbrija	DA precursor	Nausea, dizziness, orthostatic hypotension, anxiety, dyskinesia, confusion, hallucinations, somnolence.
Entacapone	Comtan	COMT inhibitor, inhibits breakdown of Levodopa	Same as carbidopa/levodopa. In addition: diarrhea, discoloration of body fluids.
Tolcapone	Tasmar	COMT inhibitor, inhibits breakdown of Levodopa	Same as carbidopa/levodopa. In addition: diarrhea, discoloration of body fluids. Tasmar can cause elevated liver function enzymes.
Opicapone	Ongentys	COMT inhibitor, inhibits breakdown of Levodopa	Same as carbidopa/levodopa.
Carbidopa/Levodopa Entacapone	Stalevo	DOPA decarboxylase inhibitor/DA precursor/COMT inhibitor	Same as carbidopa/levodopa and Entacaopone



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			somnolence, sleep attacks, impulse control disorders.
Pramipexole (extended release)	Mirapex ER	DA agonist	Nausea, dizziness, orthostatic hypotension, swelling of ankles, dyskinesia, hallucinations, confusion, somnolence, sleep attacks, impulse control disorders.
Ropinirole	Requip	DA agonist	Nausea, dizziness, orthostatic hypotension, swelling of ankles, dyskinesia, hallucinations, confusion, somnolence, sleep attacks, impulse control disorders.
Ropinirole (extended release)	Requip XL	DA agonist	Nausea, dizziness, orthostatic hypotension, swelling of ankles, dyskinesia, hallucinations, confusion, somnolence, sleep attacks, impulse control disorders.
Apomorphine (injection)	Apokyn	DA agonist	Nausea, dizziness, orthostatic hypotension, swelling of ankles, dyskinesia, hallucinations, confusion, somnolence, sleep attacks, impulse control disorders.
Apomorphine sublingual film	Kynmobi	DA agonist	Mouth irritation or swelling, nausea, dizziness, sleepiness.
Rotigotine (transdermal patch)	Neupro	DA agonist	Nausea, dizziness, orthostatic hypotension, swelling of ankles, dyskinesia, hallucinations, confusion, somnolence, sleep attacks, impulse control disorders. Neupro can cause a skin reaction.
Selegiline	Eldepryl	MAO-B inhibitor; inhibits breakdown of dopamine	Selegiline can cause insomnia. Dizziness, nausea, gastrointestinal upset, dyskinesia, hallucinations, confusion, headache. Note possible drug <a href="#">interactions</a> .
Selegiline (orally disintegrating tablet)	Zelapar	MAO-B inhibitor; inhibits breakdown of dopamine	Selegiline can cause insomnia. Dizziness, nausea, gastrointestinal upset, dyskinesia, hallucinations, confusion, headache.



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Rasagiline	Azilect	MAO-B inhibitor; inhibits breakdown of dopamine	Dizziness, nausea, gastrointestinal upset, dyskinesia, hallucinations, confusion, headache. Note possible drug <a href="#">interactions</a> .
Safinamide	Xadago	MAO-B inhibitor; inhibits breakdown of dopamine	Dizziness, nausea, gastrointestinal upset, dyskinesia, hallucinations, confusion, headache. Note possible drug <a href="#">interactions</a> . Safinamide acts through multiple mechanisms of action.
Amantadine	Symmetrel	Mixed mechanisms, including NMDA antagonism	Hallucinations, leg swelling, dizziness, mottled skin (livedo reticularis), confusion, dry mouth and eyes, constipation, dizziness, orthostatic hypotension, somnolence.  Dose needs to be adjusted in renal disease.
Amantadine (extended release)	Gocovri	Mixed mechanisms, including NMDA antagonism	Hallucinations, leg swelling, dizziness, mottled skin (livedo reticularis), confusion, dry mouth and eyes, constipation, dizziness, orthostatic hypotension, somnolence.  Dose needs to be adjusted in renal disease.
Amantadine (extended release)	Osmolex	Mixed mechanisms, including NMDA antagonism	Hallucinations, leg swelling, dizziness, mottled skin (livedo reticularis), confusion, dry mouth and eyes, constipation, dizziness, orthostatic hypotension, somnolence.  Dose needs to be adjusted in renal disease.
Istradefylline	Nourianz	Adenosine 2A antagonist	Dizziness, constipation, nausea, dyskinesia, hallucination and sleeplessness
Trihexyphenidyl	Artane	Anticholinergic	Dry mouth and eyes, constipation, urinary retention,



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Benztropine	Cogentin	Anticholinergic	Dry mouth and eyes, constipation, urinary retention, memory impairment, confusion, depression, hallucinations.
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COMT = Catechol-o-methyltransferase

DA = Dopamine

DOPA = Dopamine

MAO = Monoamino oxidase

NMDA = N-methyl-D-aspartate

*\* The most common side effects are listed. Additional side effects should be discussed with your healthcare provider.*

## SUPPORT OUR MISSION

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Every day, we provide the support, education, and research that will help everyone impacted by Parkinson's disease live life to the fullest. We depend on the generosity of donors like you. **Join our cause and donate today.**

**ASK A DOCTOR**

**SHARE YOUR STORY**

### Quick Links

PARKINSON'S  
DISEASE

### About APDA

The American Parkinson Disease Association (APDA) is the largest grassroots network dedicated to

### National Headquarters

135 Parkinson Avenue  
Staten Island, NY 10305



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