

## Module:

Biological foundations of mental health

Week 5:

Reward, emotion and action



Dr Frank Hirth

**Topic 2**  
**The structure and function**  
**of the Basal Ganglia**

*Part 1 of 5*

### Anatomy (1)

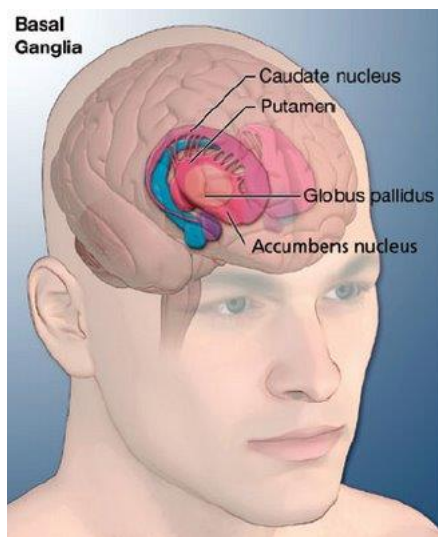


Figure 1: Location of basal ganglia in the brain

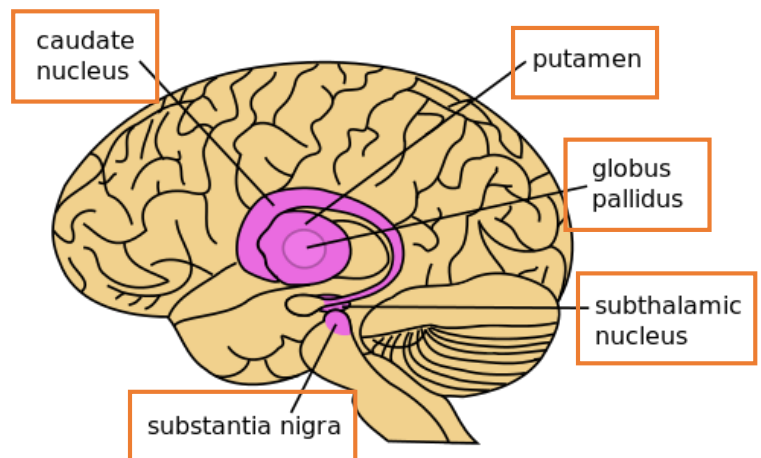
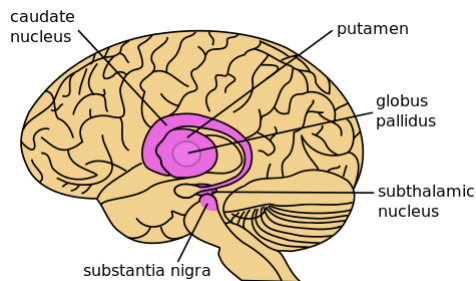


Figure 2: Anatomy of the basal ganglia

## Anatomy (2)



The basal ganglia (BG) consists of an arrangement of basal forebrain nuclei that includes the

- **striatum** (which in primates consists of caudate, putamen and ventral striatum, including nucleus accumbens)
- **globus pallidus** (GP) which consists of the internal and external domains of the globus pallidus (GPi and GPe, respectively)
- the **subthalamic nucleus** (STN), -
- the **substantia nigra** pars reticulata (SNr)

## Anatomy (3)

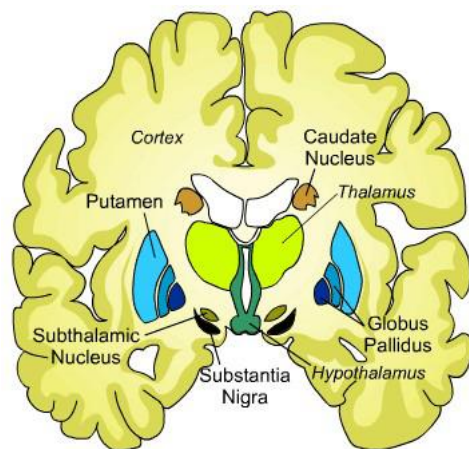
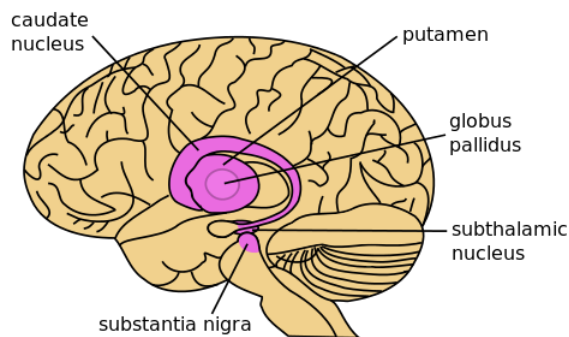
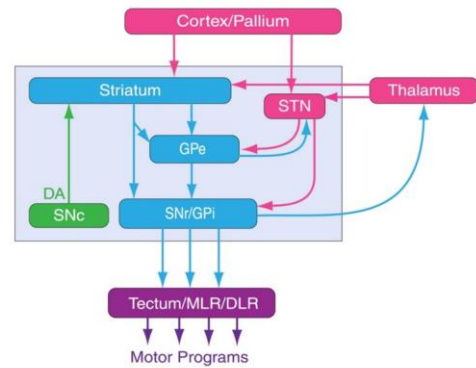
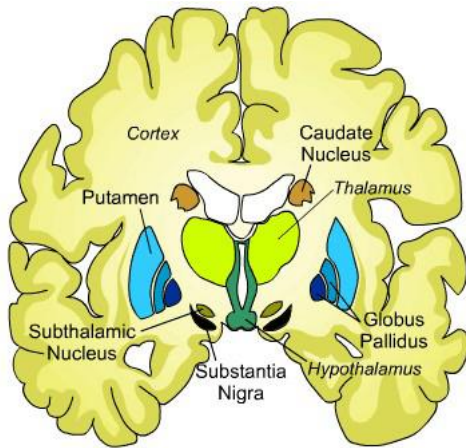


Figure 3: Section through the brain showing the basal ganglia

## Connectivity (1)



## Connectivity (2)

## mammalian/primate brain

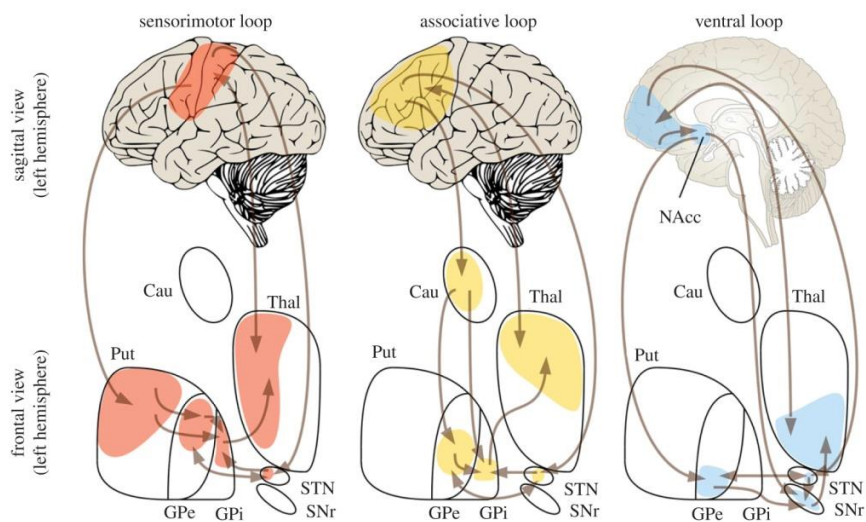
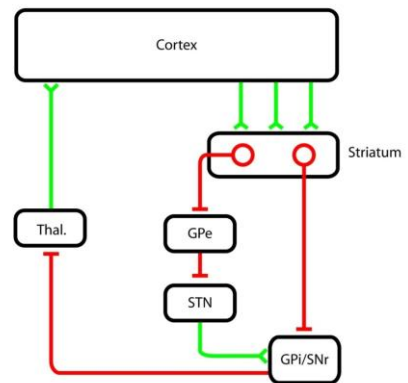
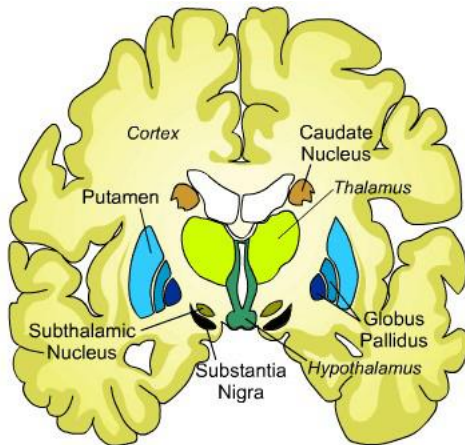


Figure 4: Sensorimotor, associative and ventral (limbic) loops in mammals, here shown for primates

## Connectivity (3)



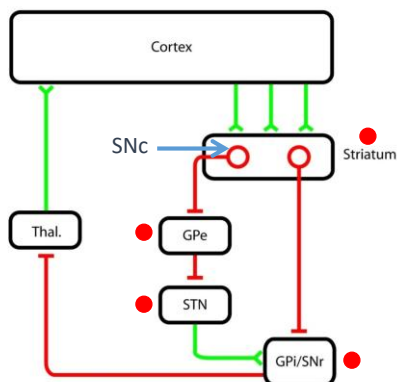
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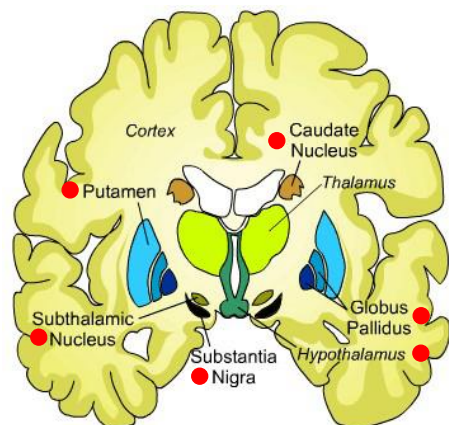
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## Connectivity (4)

- **Input:**
  - Caudate and putamen (together, the striatum)
- **Intrinsic:**
  - Subthalamic nucleus (STN)
  - External segment of globus pallidus (GPe)



- **Output:**
  - Substantia nigra pars reticulata (SNr)
  - Internal segment of globus pallidus (GPi)
- **Neuromodulator:**
  - Substantia nigra pars compacta (SNc)



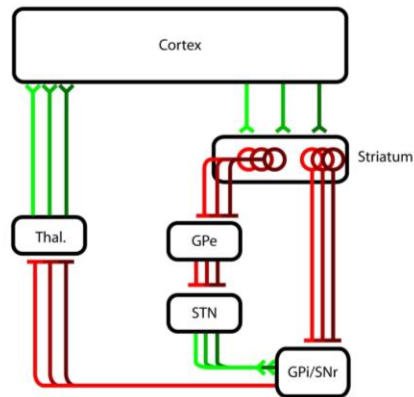
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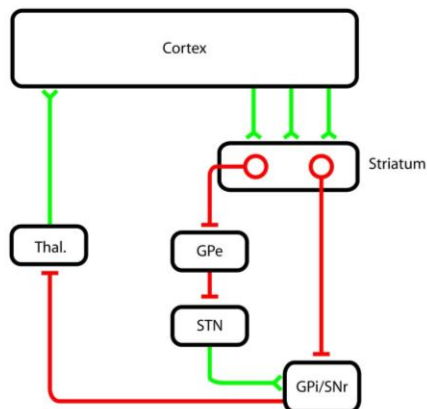
## Connectivity (5)

Functional topography: **Parallel loops** within the basal ganglia subserve distinct functions



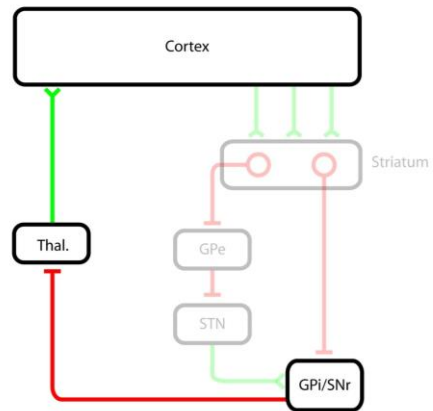
## Connectivity (6)

Movement modulation through disinhibition



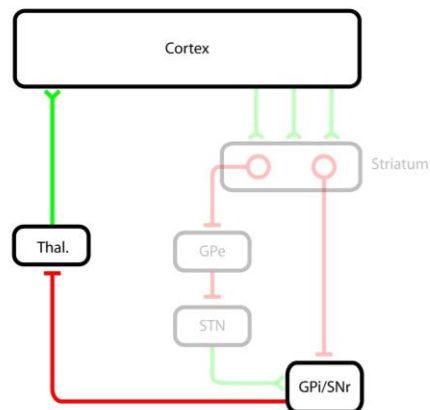
## Connectivity (7)

## Movement modulation through disinhibition



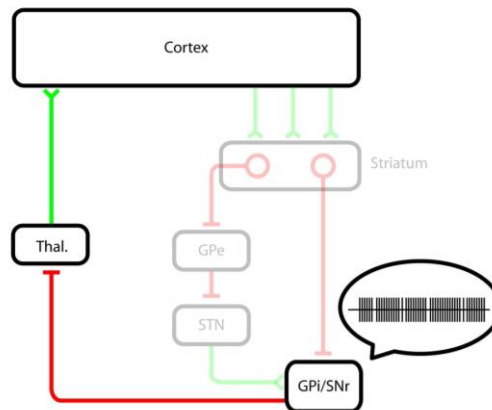
## Connectivity (8)

## Output nuclei of the basal ganglia are inhibitory



## Connectivity (9)

**Output nuclei maintain a high tonic level of discharge, suppressing activity in target regions**



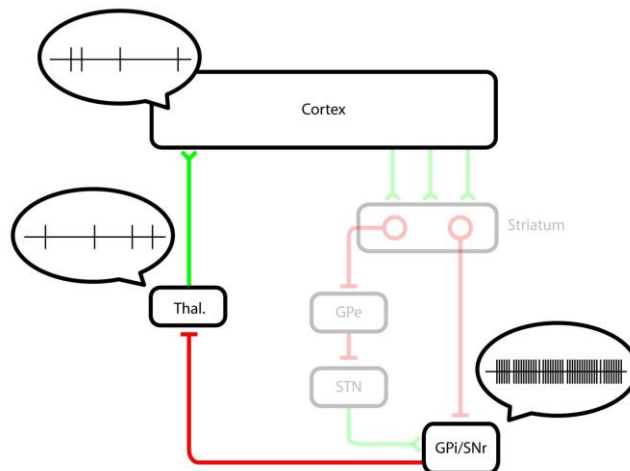
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## Connectivity (10)

**Firing under quiescent conditions**



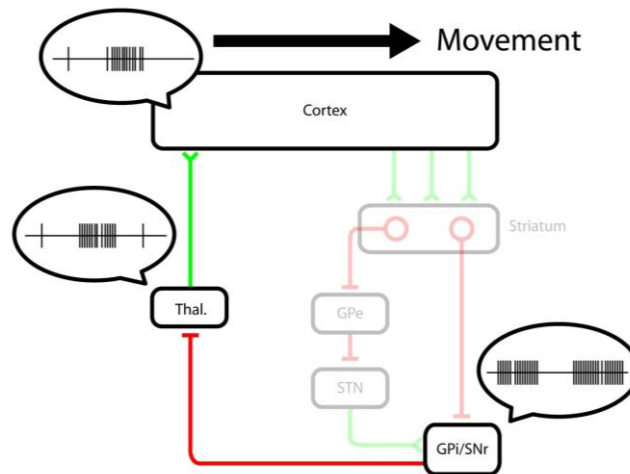
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## Connectivity (11)

**Movement modulation occurs through disinhibition of thalamocortical target regions**



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## Connectivity (12)

**Basal Ganglia: Movement modulation through disinhibition**

1. Output nuclei of the basal ganglia are inhibitory
2. Output nuclei maintain a high tonic level of discharge, suppressing activity in target regions
3. Phasic decrease in firing rate transiently releases target regions from inhibition.
4. *Disinhibited* thalamocortical circuit discharges, promoting movement.

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