The Hypothalamus
Functions of hypothalamus

- Endocrine function
- Caloric balance
- Osmolarity balance
- Thermal regulation
- Autonomic balance

- Sleep
- Affective behavior
- Memory
- Somatic movements
Anatomy of Hypothalamus
Preoptic area

- Medial preoptic: LHRH
- Lateral preoptic: motor control
Motor connections of hypothalamus
Supraoptic region:

- Paraventricular: oxytocin and vasopressin (ADH)
- Anterior: heat dissipation
- Supraoptic: oxytocin and vasopressin (ADH)
- Suprachiasmatic: circadian rhythms
Tuberal region

- Tuberal region
- Precommissural fornix
- Fornix
- Postcommissural fornix
- Paraventricular nucleus
- Dorsomedial nucleus of hypothalamus
- Mammillothalamic tract
- Ventromedial nucleus
- Medial preoptic nucleus
- Lamina terminalis
- Anterior nucleus
- Supraoptic nucleus
- Suprachiasmatic nucleus
- Optic chiasm
- Arcuate nucleus
- Tuberoinfundibular tract
- Dorsomedial: “sham rage”
- Ventromedial: satiety center
- Arcuate: releasing hormones and inhibiting hormones
- Tuberal region: releasing and inhibiting hormones
Mammillary region

Posterior nucleus: heat conservation

Mammillary nucleus: learning and memory
<table>
<thead>
<tr>
<th>Nucleus</th>
<th>Stimulation of</th>
<th>Lesion of</th>
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<tbody>
<tr>
<td>Suprachia. n.</td>
<td>Adjusts circadian rhythms</td>
<td>Abolishes circadian rhythms</td>
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<tr>
<td>Supraoptic n.</td>
<td>Increased blood pressure</td>
<td>Diabetes insipidus</td>
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<tr>
<td>Paraventri. n.</td>
<td></td>
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<tr>
<td>Lat. Hypotha. n.</td>
<td>Increased feeding</td>
<td>Decreased feeding</td>
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<tr>
<td>Ventromedial n.</td>
<td>Decreased feeding</td>
<td>Increased feeding</td>
</tr>
<tr>
<td>Dorsomedial n.</td>
<td>Sham rage</td>
<td>Decreased aggression &amp; feeding</td>
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<tr>
<td>Mammillary body</td>
<td>?</td>
<td>Short-term memory is not processed into long-term memory</td>
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Plans for Action

(prefrontal cortex)
Functions of the prefrontal cortex:

1) Planning
This is the area where volition, thinking ahead, problem solving are located. Before you can have these, and do them flexibly, fluently, adaptively, have to inhibit more primitive, automatic, instinctive behavior patterns; hence

2) Inhibition

3) Selectivity
‘I will do this, I will not do that’
Phineas Gage
Prefrontal Cortex Damage:

• Lack of foresight
• Frequent stubbornness
• Inattentive and moody
• Lack of ambitions, sense of responsibility, sense of propriety (rude)
• Less creative and unable to plan for the future
Sleep
Why Do We Need Sleep?

Adaptive Evolutionary Function
- safety
- energy conservation/ efficiency

Restorative Function
- body rejuvenation & growth

Brain Plasticity
- enhances synaptic connections
- memory consolidation
Sagittal plane

Cerebral cortex

Thalamus

RAS projections to cerebral cortex

Visual impulses from eyes

Cerebellum

Auditory and vestibular impulses from ears and vestibular apparatus

Pons

Reticular formation

Medulla oblongata

Spinal cord

Somatic sensory impulses (from nociceptors, proprioceptors, and touch receptors)

Sagittal section through brain and spinal cord
The ascending arousal system promotes wake

A.  

B.  

Modified from Fuller et al., J Biol Rhythms, 2006
Hypocretin (orexin)
Sleep/Waking “Flip-Flop”

vlPOA = ventrolateral preoptic area
ACh = acetylcholine
NE = norepinephrine
5-HT = serotonin
Narcolepsy VS Insomnia
Melatonin: Produced by pineal gland, released at night-inhibited during the day (circadian regulation); initiates and maintain sleep; treat symptoms of jet lag and insomnia
Biological Clocks

- **Suprachiasmatic nucleus**
  - A nucleus situated atop the optic chiasm responsible for organizing circadian rhythms.

- **Pineal gland**
  - A gland attached to the dorsal tectum; produces **melatonin** and plays a role in circadian and seasonal rhythms.
SCN and sleep

Wild type animal with period of ~24h

SCN lesioning abolishes circadian rhythm

Tau mutant with period of ~20h

Transplanting SCN of donor with ~20-h period

Wild type animal acquires period of donor (~20h)

Modified from Ralph and Lehman, Trends Neuro 1991
Coffee

DRINK COFFEE

Do Stupid Things Faster with More Energy
Coffee

- During waking, brain consume ATP
Coffee

- During waking, brain consume ATP
- ↑ adenosine
Coffee

- During waking, brain consume ATP
- adenosine
  - Adenosine bind to A1 receptor
  - Inhibit acetylcholine neurons
Coffee

- During waking, brain consume ATP

- adenosine

- Adenosine bind to A1 receptor

- Inhibit acetylcholine neurons

- Caffeine and Theophylline are A1 antagonist