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Autonomic Nervous System and Hypothalamus

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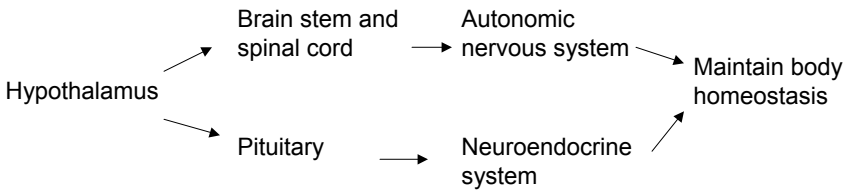


Overview of the Autonomic Nervous System (ANS)

(Also named as the automatic NS, the involuntary NS…)

- Working in concert with the endocrine system, the ANS is the neural part of the functional system that is responsible for homeostasis.
- The ANS is comprised of three divisions: the sympathetic nervous system (SNS), the parasympathetic nervous system (PNS), and the enteric system (digestive reflexes).

Most viscera have a double nerve innervation, from both SNS and PNS, with an opposing yet complementary action in regulation of body function.

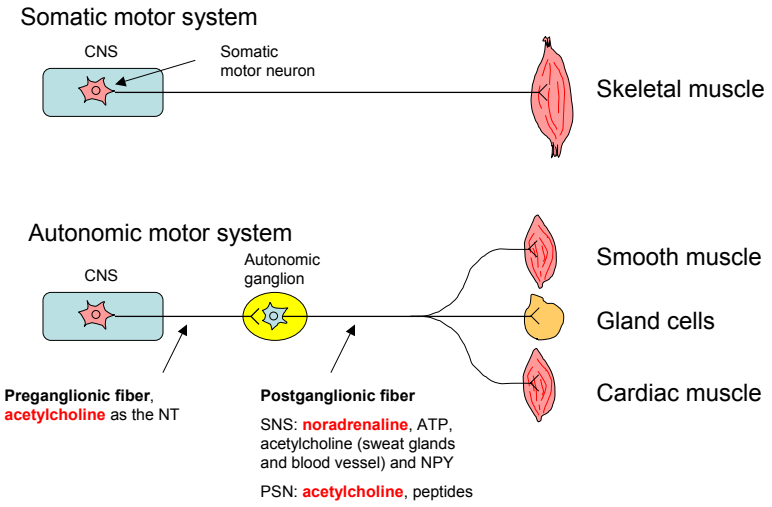
Overview of the Autonomic Nervous System (ANS)

- ANS is a sensory and motor system that regulates visceral functions.

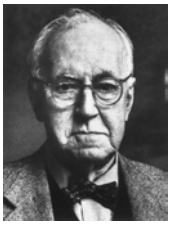
Motor (to effectors)
- cardiac muscle
- Smooth muscle
- Glands

Sensory (from receptors)
- pain
- mechanoreceptors
- chemoreceptors

Anatomy of the ANS

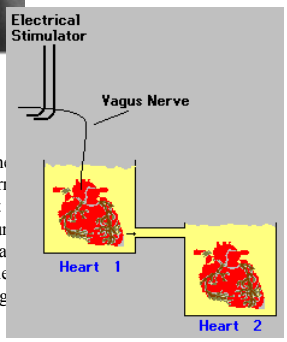


Dale and Loewi: Establishing Acetylcholine as a chemical transmitter



Henry Hallett Dale

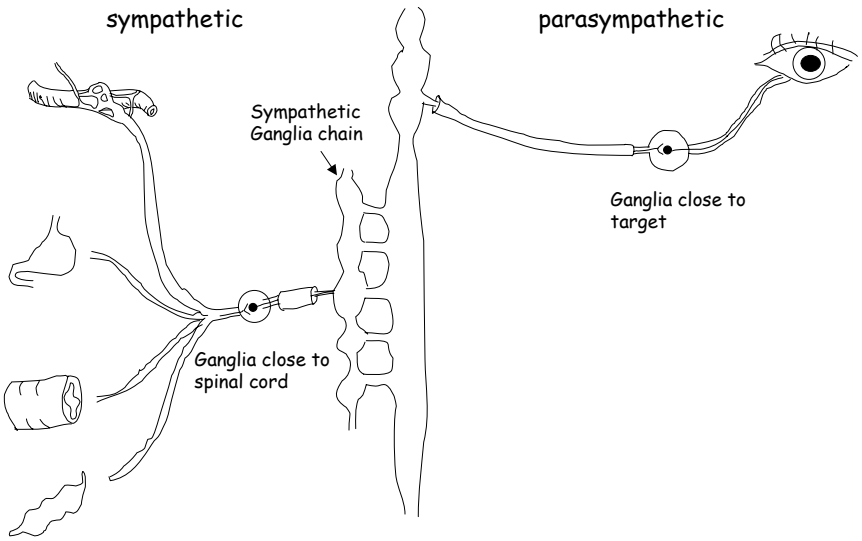
Otto Loewi



Loewi's account for his great discovery of "Vagustoff":

"The night before Easter Sunday of that year (1921) I awoke, turn
few notes on a tiny slip of paper. Then I fell asleep again; it occur
morning that during the night I had written down something most
decipher the scrawl. The next night, at three o'clock, the idea retu
experiment to determine whether or not the hypothesis of chemica
seventeen years ago was correct. I got up immediately, went to the
simple experiment on a frog heart according to the nocturnal desig

Anatomy of the ANS



Classical Comparison of the SNS and the PNS

	SNS	PNS
Location of preganglionic somata	Thoracolumbar cord	Cranial nerve nuclei sacral cord
Location of ganglia	Distant from target organ	Near or in target organ
Length of preganglionic axon	Relatively short	Relatively long
Length of postganglionic axon	Relatively long	Relatively short
Functions	Catabolic	Anabolic
Innervates trunks and limbs in addition to viscera	Yes	No
Postganglionic NT	Noradrenaline	acetylcholine

The SNS: Organized to mobilize the body for activity

Activity of the SNS leads to:

-Prepares for action (fight or flight)

-Pupil dilates

-Heart rate increase

-Gut slows

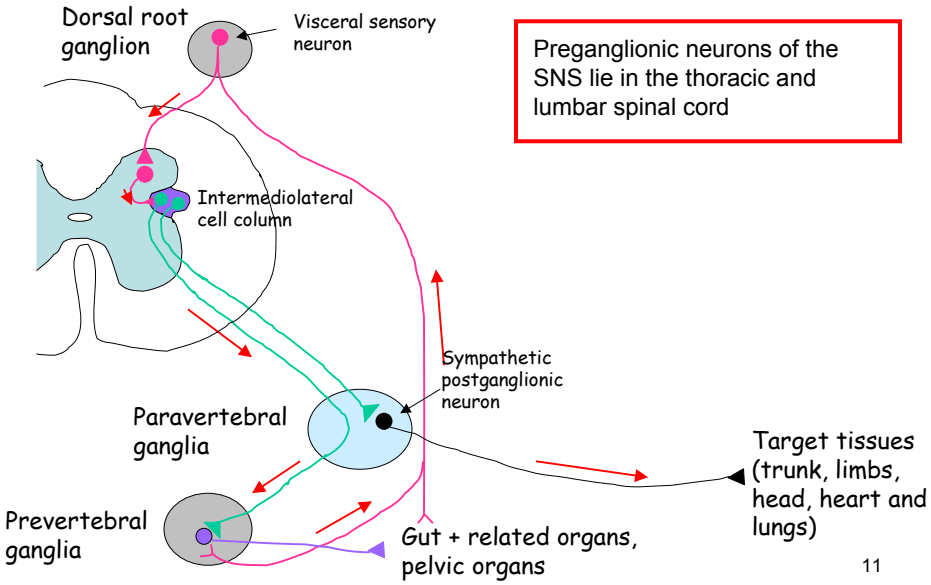
-Blood pressure increase

-Blood vessels in muscles dilate, increase the flow of oxygen.

-Blood vessels in skin and gastrointestinal tract constrict, make more blood available for the action of muscle.

-Sweat (dissipate heat for more efficient muscle action, easy to escape?)

Organization of the SNS



Preganglionic neurons of the SNS lie in the thoracic and lumbar spinal cord

The PNS: Organized for energy conservation

Activity of the PNS leads to:

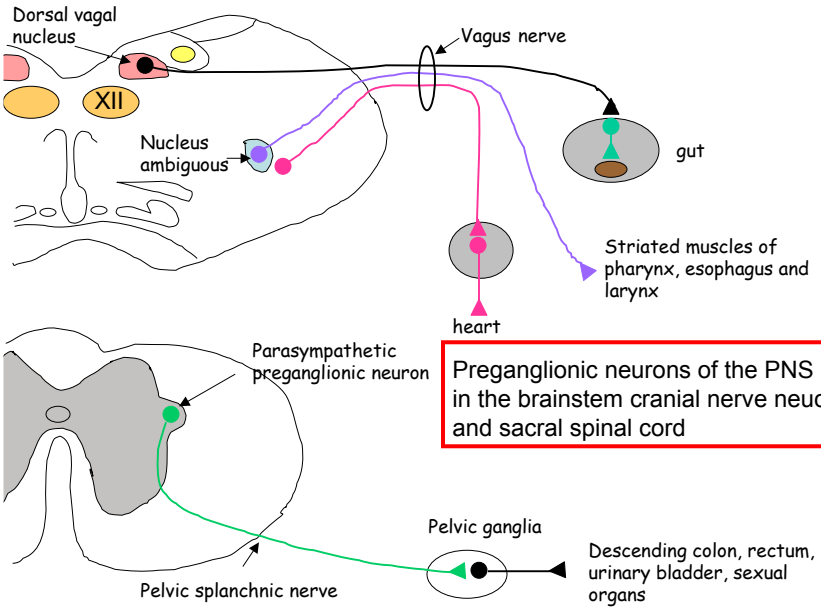
-prepares for "vegetative" functions (rest and digest)

-Pupils constrict

-Heart slows

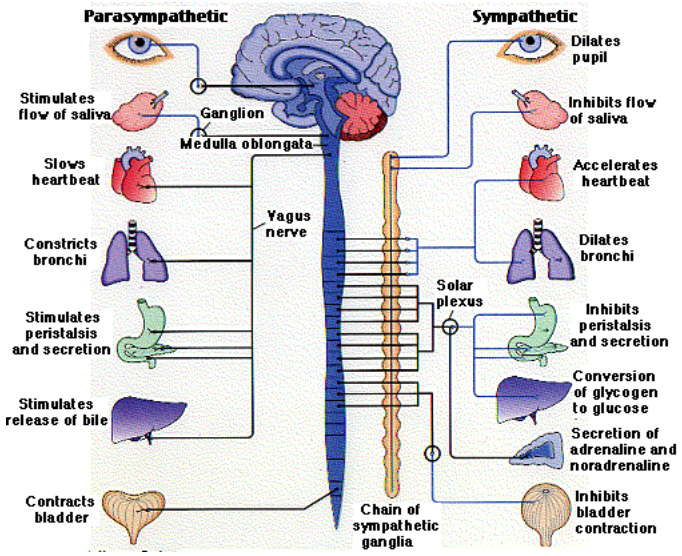
-Gut tube stimulated for digestion, absorption and excretion…

Organization of the PNS

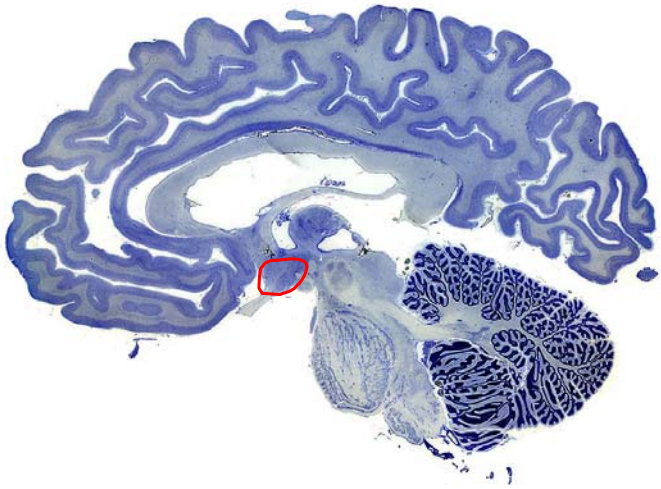


Preganglionic neurons of the PNS lie in the brainstem cranial nerve neuclei and sacral spinal cord

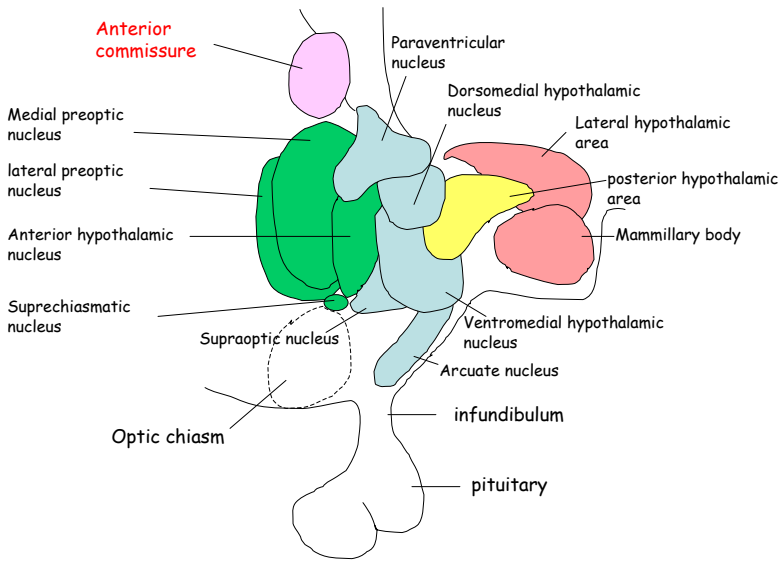
Summary of ANS



The Hypothalamus



The Structure of the Hypothalamus



Hypothalamus: Functional Overview

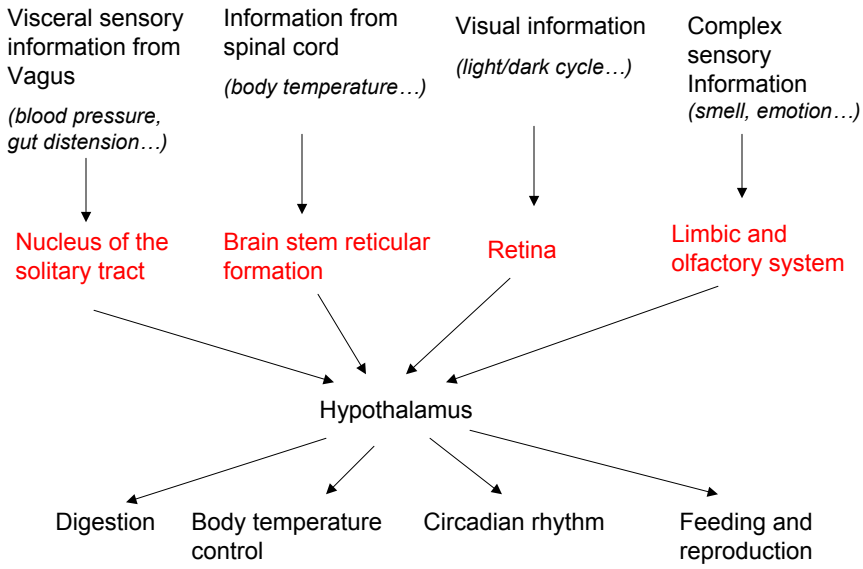
- The main function of the hypothalamus is **homeostasis**. Factors such as blood pressure, body temperature, fluid and electrolyte balance, and body weight are held to a precise value called the set-point. Although this set-point can migrate over time, from day to day it is remarkably fixed.

- To achieve this task, the hypothalamus must receive inputs about the state of the body, and must be able to initiate compensatory changes if anything drifts out of whack…

The hypothalamus receives inputs from:

- **nucleus of the solitary tract** - this nucleus collects all of the visceral sensory information from the vagus and relays it to the hypothalamus and other targets. Information includes blood pressure and gut distension.
- **reticular formation** - this nucleus in the brainstem receives a variety of inputs from the spinal cord. Among them is information about skin temperature, which is relayed to the hypothalamus.
- **retina** - some fibers from the optic nerve go directly to a small nucleus within the hypothalamus called the **suprachiasmatic nucleus**. This nucleus regulates circadian rhythms, and couples the rhythms to the light/dark cycles.
- **limbic and olfactory systems** - structures such as the amygdala, the hippocampus, and the olfactory cortex project to the hypothalamus, and probably help to regulate behaviors such as eating and reproduction.

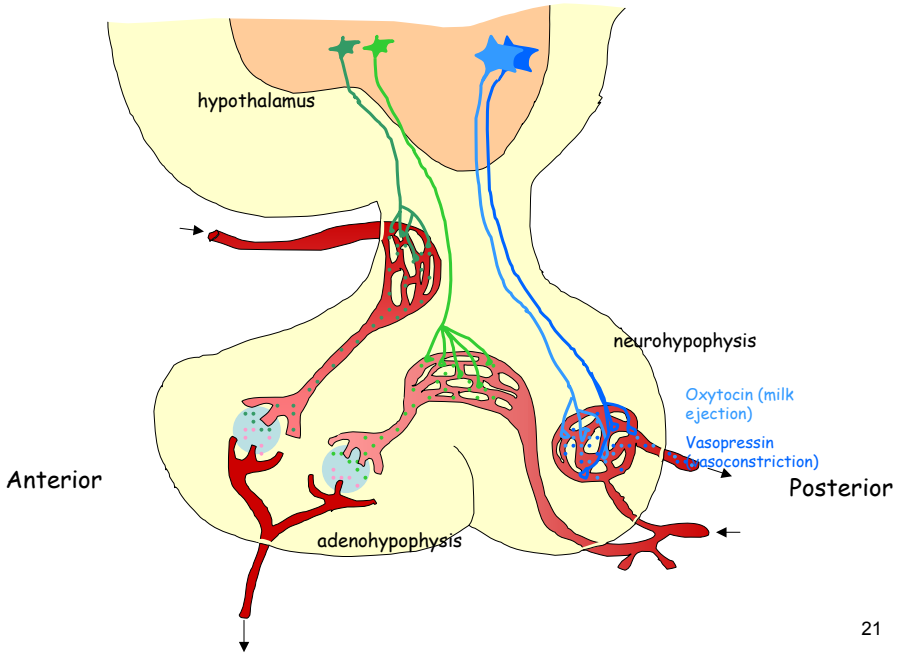
The hypothalamus receives inputs from:



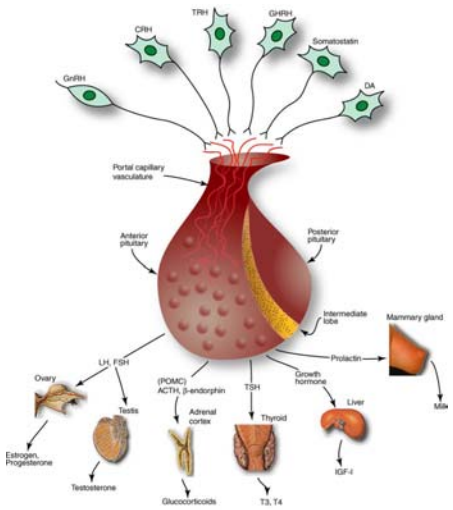
The hypothalamus has two major outputs:

- **neural signals to the autonomic system** - the (lateral) hypothalamus projects to the (lateral) medulla, where the cells that drive the autonomic systems are located. These include the parasympathetic vagal nuclei and a group of cells that descend to the sympathetic system in the spinal cord. With access to these systems, the hypothalamus can control heart rate, vasoconstriction, digestion, sweating, etc.

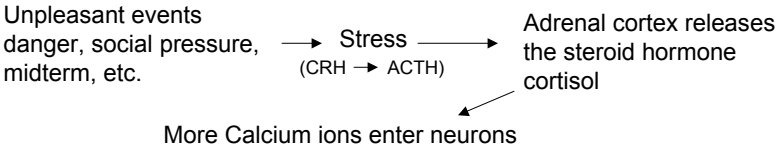
- **endocrine signals to/through the pituitary**:
  Magnocelluar neurons send axons directly to the posterior pituitary and secrete oxytocin and vasopressin directly into bloodstream.
  Parvocellular neurons secret peptides that regulate release of anterior pituitary hormones.



Hypothalamic substances that release or inhibit the release of anterior pituitary hormones



Stress and the Brain



Short-term effect:

Enable the brain to function better and help cope with the stress.

Long-term effect:

The "excitotoxicity" caused by too much Ca leads to cell death in the brain.

Permanent damage to the brain, heightened anxiety, memory loss, premature aging.

Summary