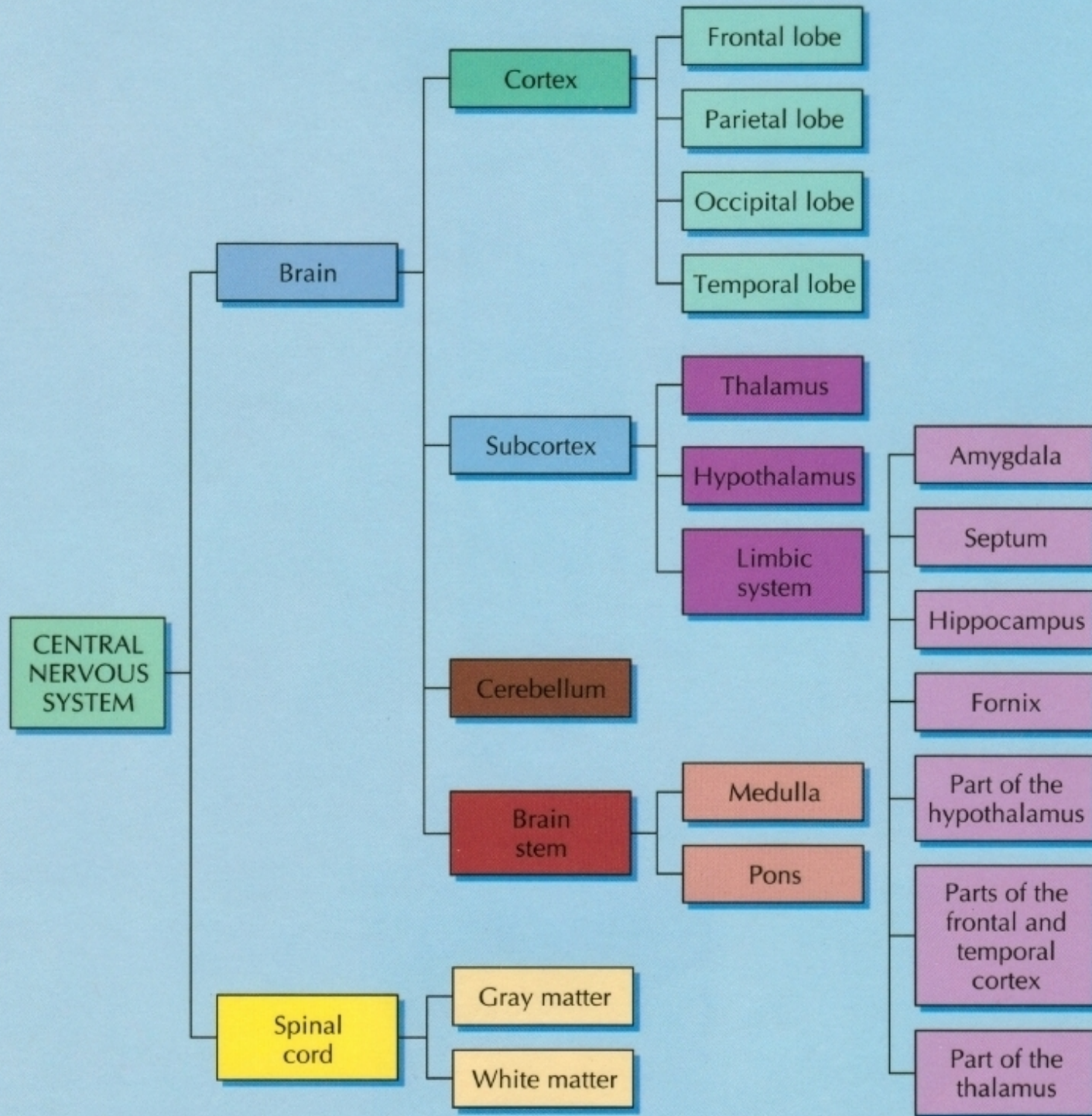
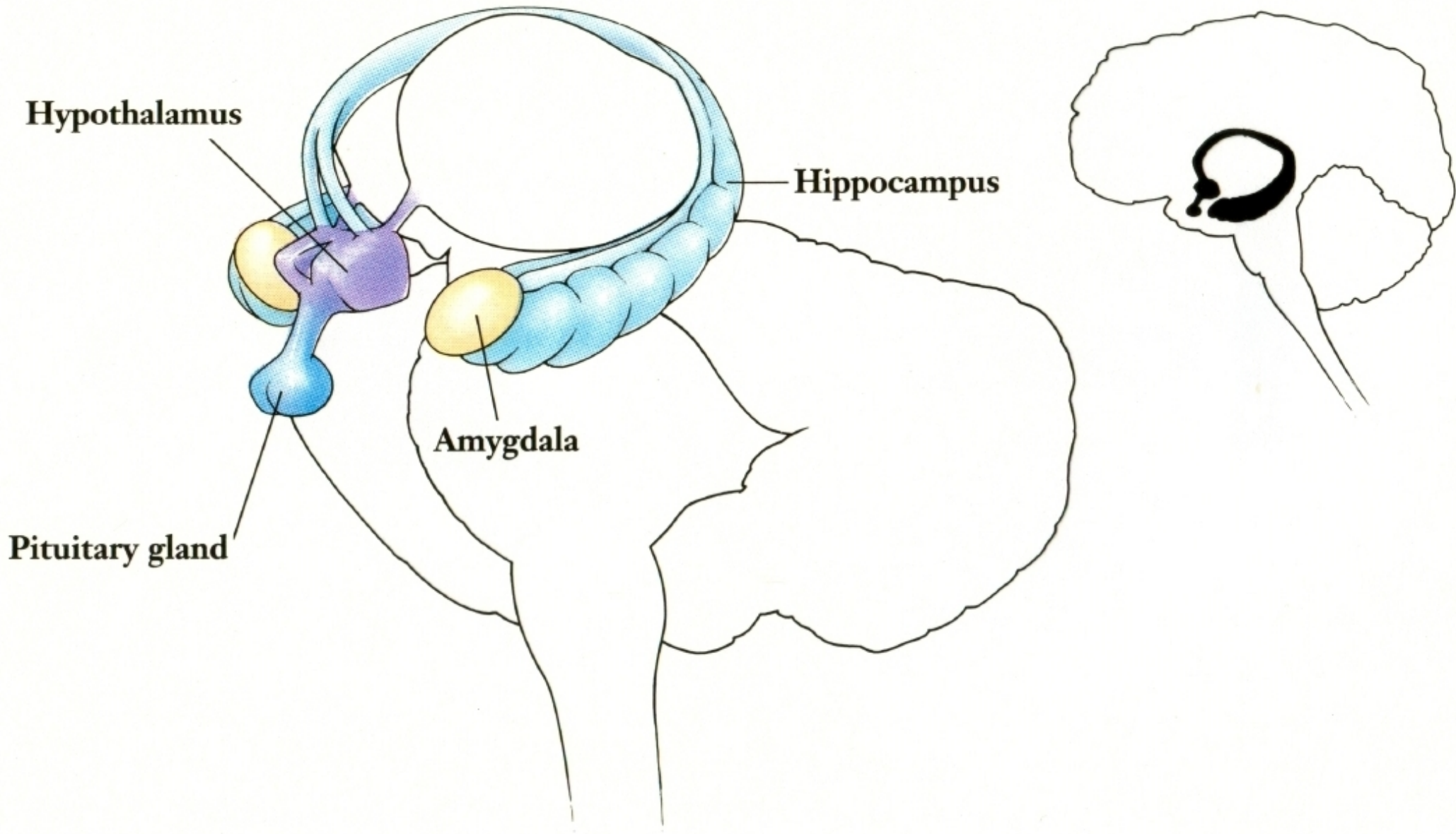


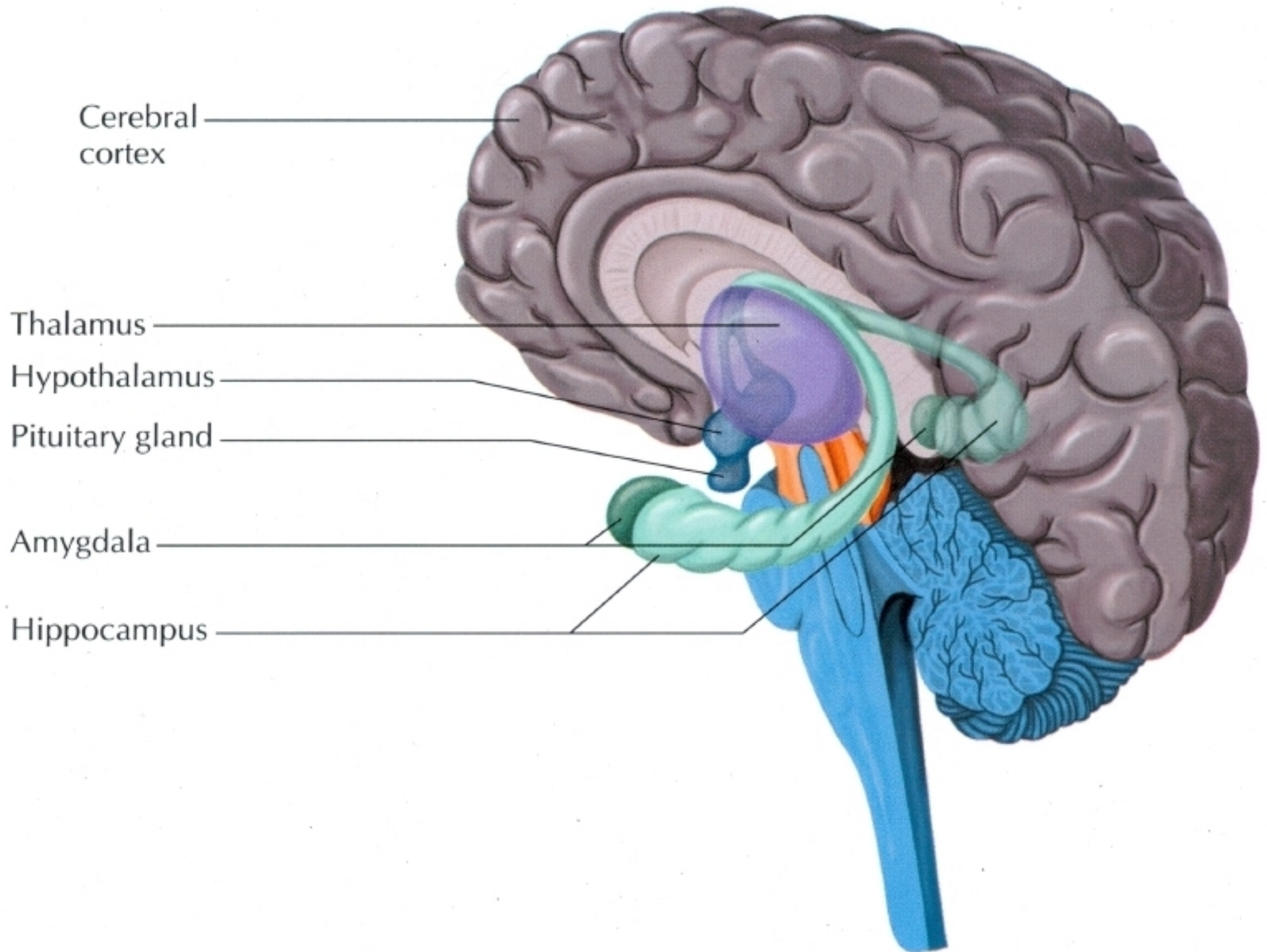
Divisions of the Central Nervous System

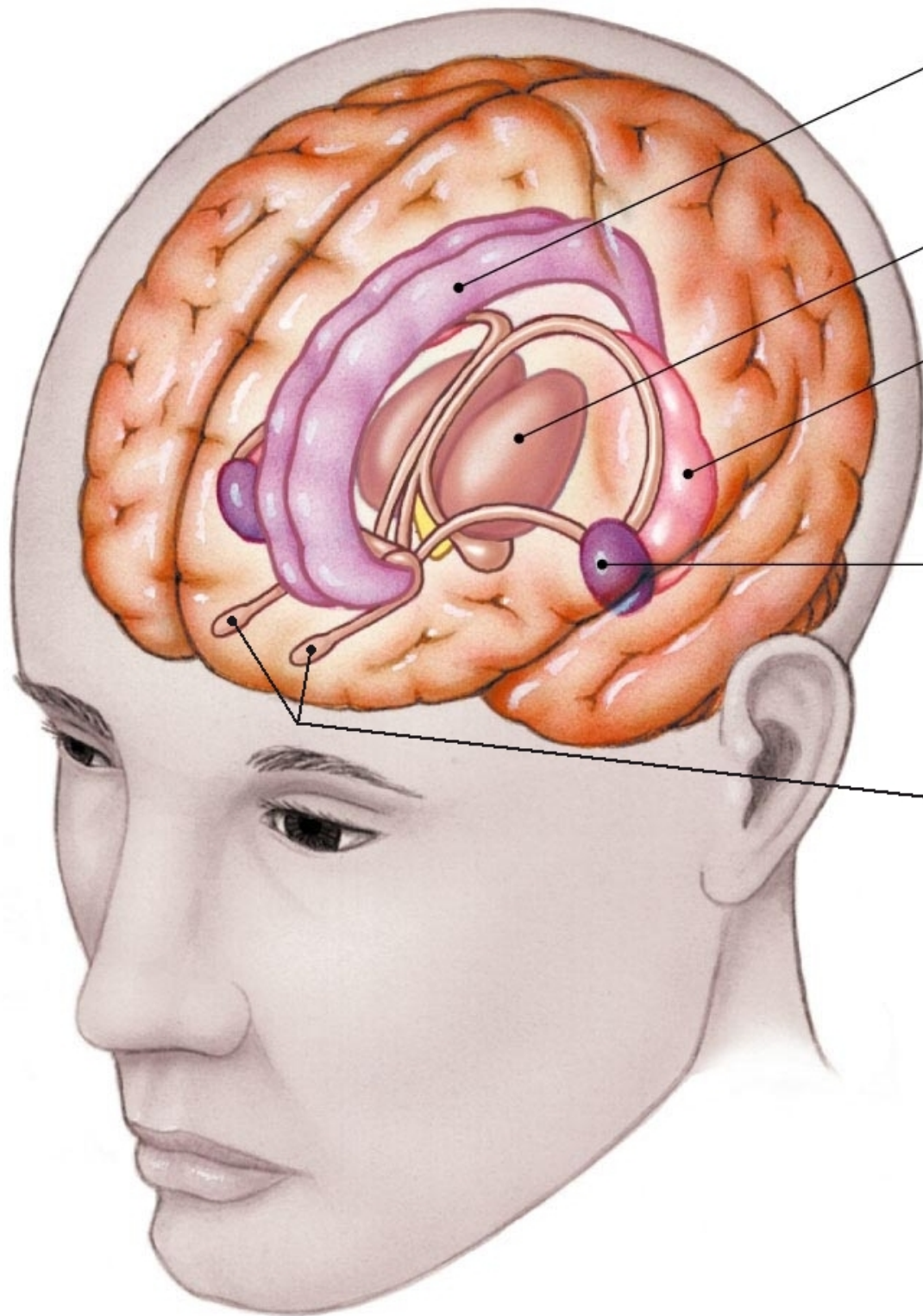


The Limbic System and Hypothalamus



The Forebrain and Limbic System





Cingulate gyrus
plays a role
in emotion.

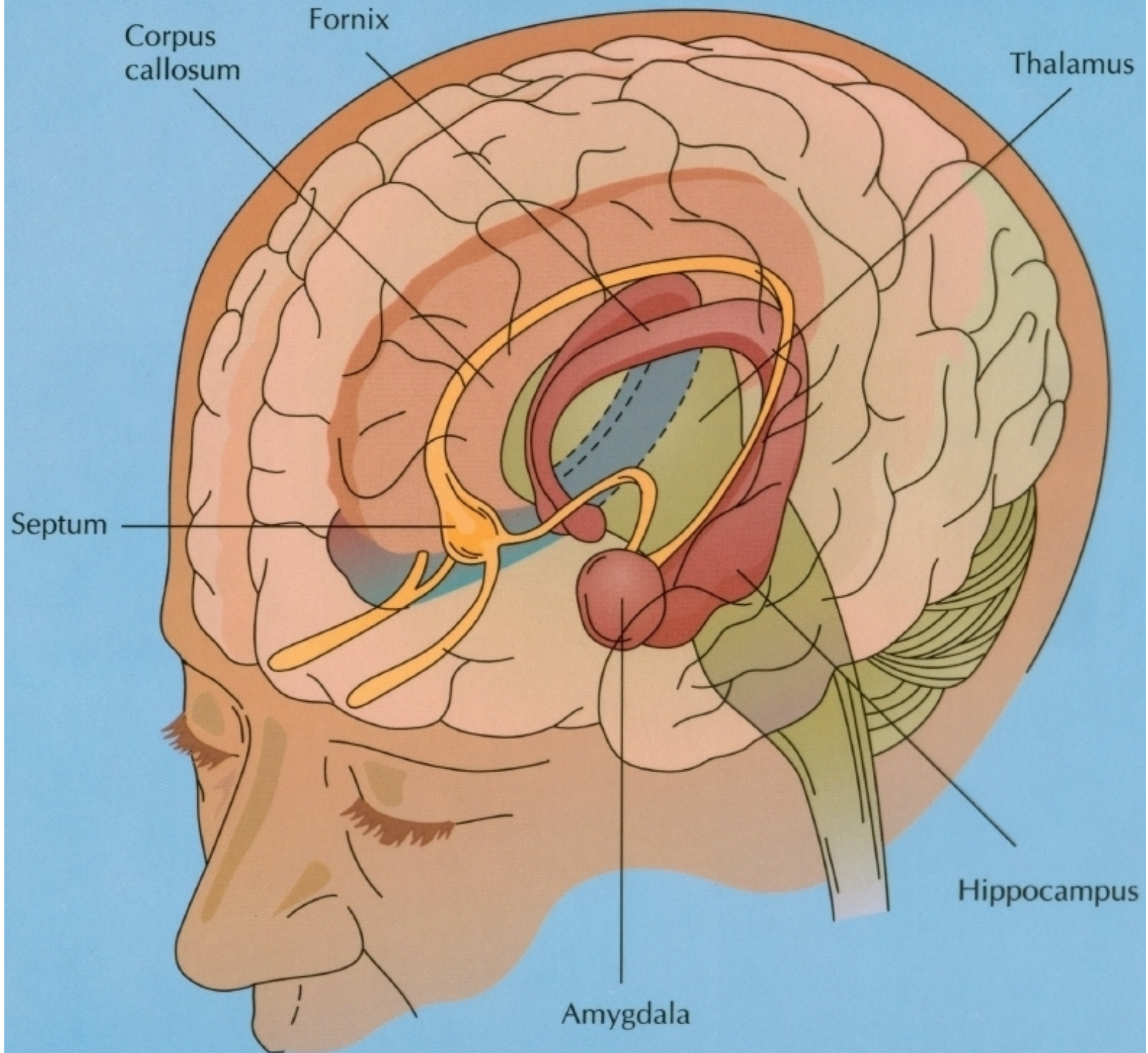
Thalamus

Hippocampus is
involved in learning
and memory.

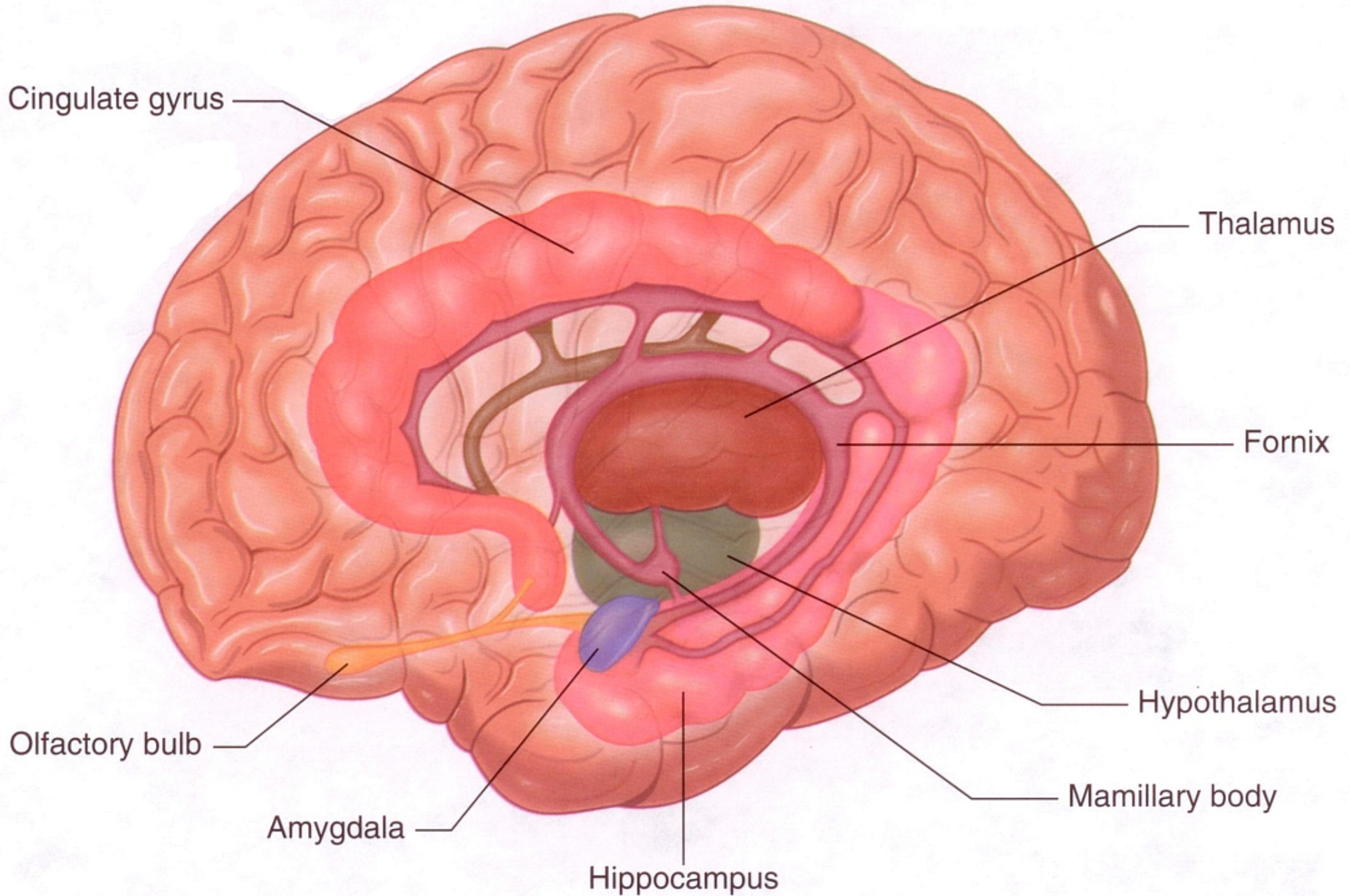
Amygdala is
involved in emotion
and memory.

Olfactory Bulbs

The Limbic System



The Limbic System

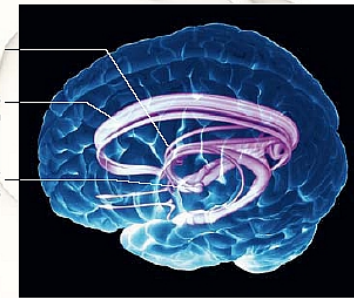


THE LIMBIC SYSTEM

THE LIMBIC SYSTEM IS INVOLVED IN INSTINCTIVE BEHAVIORS, DEEP-SEATED EMOTIONS, AND BASIC IMPULSES SUCH AS SEX, ANGER, PLEASURE, AND GENERAL SURVIVAL. IT ALSO FORMS A LINK BETWEEN CENTERS OF HIGHER CONSCIOUSNESS, IN THE CEREBRAL CORTEX, AND THE BRAINSTEM, WHICH REGULATES THE BODY'S SYSTEMS.

COMPONENTS OF THE LIMBIC SYSTEM

The limbic system includes the areas of the cortex and adjacent parts known as the limbic lobe (see opposite page), along with the amygdala, hypothalamus, thalamus, mammillary bodies, and other deeper, more central brain structures. The system is also "hard-wired" into parts of the sensory system, especially the sense of smell. Nerve fibers link all of these parts intimately and also connect them to other areas of the brain, particularly the lower frontal cortex, with its roles in expectation, reward, and decision-making.



AT THE BRAIN'S CORE
Situated approximately in the anatomical center or core of the brain, the limbic system is a varied collection of structures extending from the cerebrum inward and down to the brainstem.

Cingulate gyrus
Part of limbic cortex just above corpus callosum

Column of fornix

Mammillary bodies
Small lumps of nerve cells, these relay signals to thalamus, contributing to alertness and memory formation

Olfactory bulbs
Tracts of sensory nerve cells extend from nasal cavity into the brain; they part-process smell information before it enters conscious awareness

Hypothalamus
Chief link and mediator between nervous system and hormonal or endocrine system (see p.61)

Pons

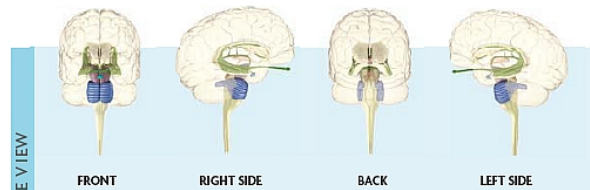
Hippocampus
Named after its vague S-shaped resemblance to a seahorse, this part is involved in memory and spatial awareness

Midbrain
The limbic system extends nerve fibers from thalamus and other higher parts into this uppermost part of the brainstem and also to the basal nuclei

Amygdala
Almond-shaped neuron clusters that are heavily involved in memory and emotional responses

Parahippocampal gyrus
This area of cortex flanking the hippocampus is active when viewing scenes and places

LIMBIC STRUCTURES
The name of this system is derived from the Latin *limbus*, meaning "border" or "edge." Its major structures form a circular, beltlike transition zone between the relatively plain-looking main cerebral cortex and the more distinctive bodies, tracts, and nuclei of the inner, lower brain.

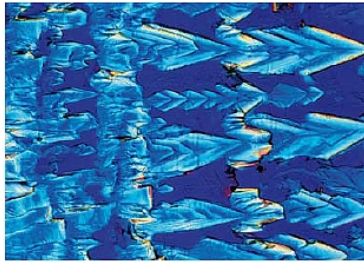


360-DEGREE VIEW

These views of the limbic system show how it is situated in the center of the brain and occupies parts of the inner or medial surfaces of the cerebral cortex. The cingulate gyrus, the hippocampus, and the parahippocampal gyrus—all part of the cerebral cortex—arch around and down below the corpus callosum.

THE HYPOTHALAMUS

Not much larger than the end segment of the little finger, weighing just $\frac{1}{32}$ oz (4g), and comprising only 0.4 percent of total brain volume, the hypothalamus has many and varied vital roles—in conscious behavior, emotions and instincts, and automatic control of body systems and processes. It consists of more than a dozen paired nuclei (regions of interlinked nerve-cell bodies) clustered into the floor of the diencephalon and separated by the lateral ventricle. Its secretory cells make hormones (called releasing factors) that enter the bloodstream, and its neurosecretory cells produce hormonelike substances that travel along nerve axons down to the pituitary gland (see below).



OXYTOCIN CRYSTALS

This birth and breastfeeding hormone is manufactured by neurosecretory cells in the paraventricular and supraoptic nuclei of the hypothalamus.

Fornix

Paraventricular nucleus
Contains neurosecretory cells; also involved in control of blood pressure, body temperature, and appetite

Dorsomedial nucleus
Important in eating, drinking, and regulation and conscious awareness of body weight

Mammillothalamic tract
This bundle of nerve fibers conveys messages between parts of the limbic system

Optic chiasm

Suprachiasmatic nucleus ("body clock")

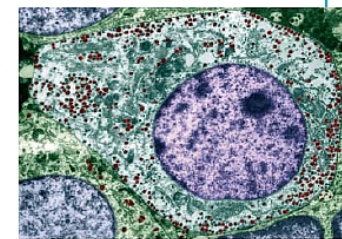
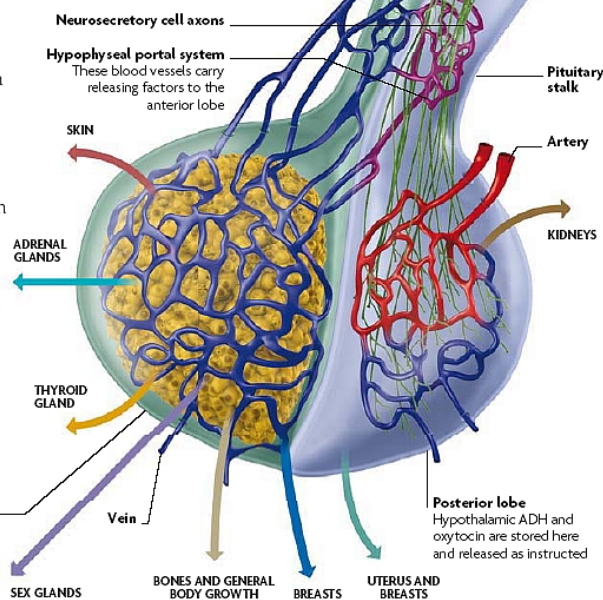
Supraoptic nucleus
Two hormones, an antidiuretic (ADH or vasopressin) and oxytocin, are produced by neurosecretory cells in the supraoptic nucleus

Posterior nucleus
Increases heart rate and blood pressure, dilates pupils, and other autonomic responses as part of "fight or flight" reaction

THE PITUITARY GLAND

The hypothalamus integrates the body's two systems for coordination and control: the nervous system around and above it; and the endocrine system (see p.112-13) via the pituitary just below it. The pea-sized pituitary (hypophysis), often called the body's "master hormone gland," has two distinct lobes. The anterior lobe (adenohypophysis) makes several hormones that release into the bloodstream to regulate other endocrine glands around the body, such as the thyroid. The posterior lobe (neurohypophysis) receives two hormones along axons from the hypothalamus.

Anterior lobe
Forming two-thirds of the pituitary bulk, the anterior lobe manufactures about eight major hormones; it is under the control of nerve messages and regulatory substances, called releasing factors, made in the hypothalamus



ENDOCRINE CELL

This micrograph shows somatotroph cells in the anterior pituitary. These cells store their growth hormone as granules (red dots) ready for export.

KEY TO PITUITARY HORMONES

- Melanocyte-stimulating hormone (MSH)
- Adrenocorticotropic hormone (ACTH)
- Thyroid-stimulating hormone (TSH)
- Follicle-stimulating hormone (FSH), Luteinizing hormone (LH)
- Growth hormone (GH)
- Oxytocin
- Antidiuretic hormone (ADH)
- Prolactin

Smell, Memory, and the Limbic System

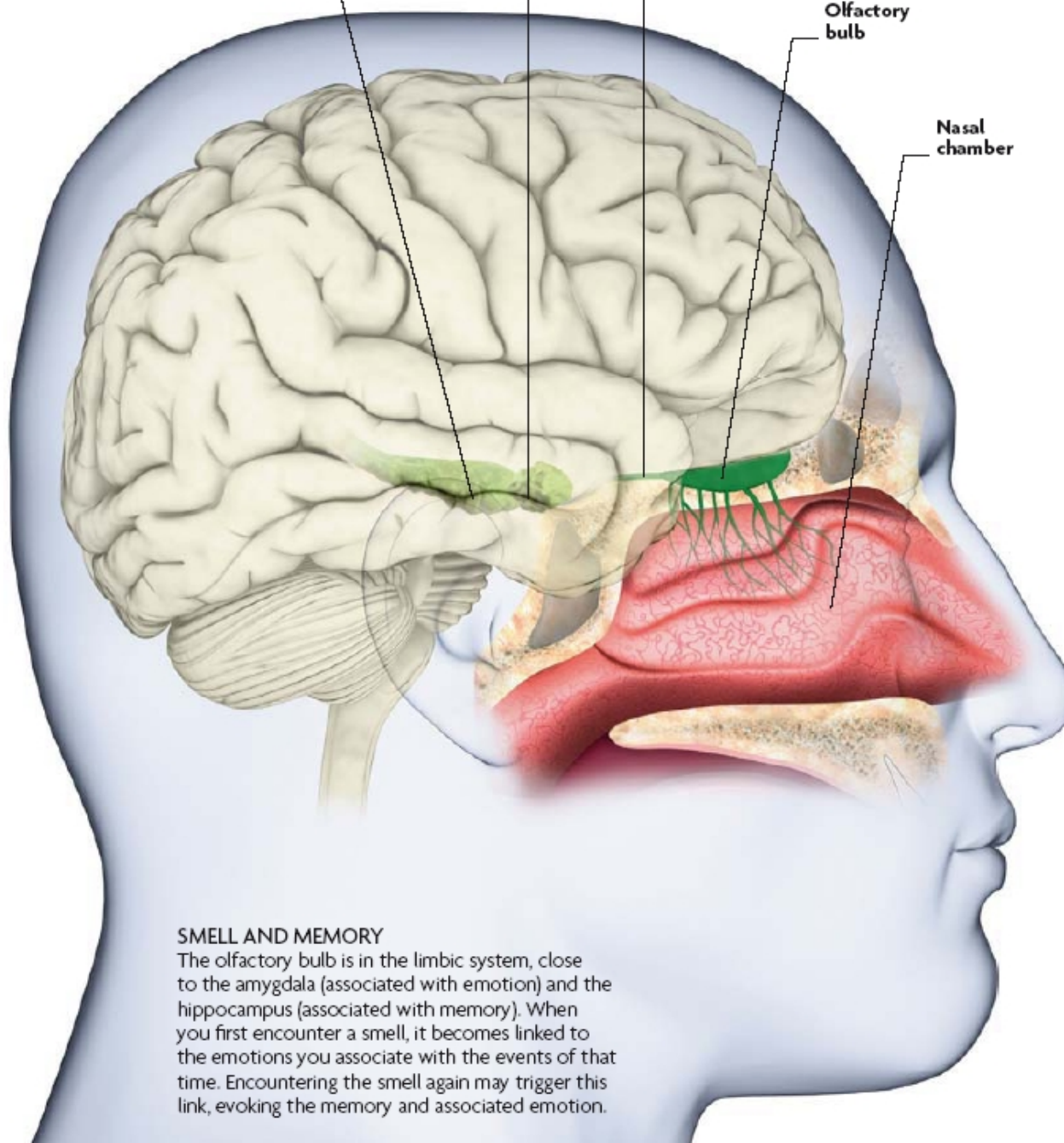
Hippocampus
Only three synapses
separate olfactory nerve
from hippocampus

Amygdala
Only two synapses
separate olfactory
nerve from
amygdala

Olfactory nerve
Carries signals from
olfactory bulb; closely
linked to hippocampus
and amygdala

**Olfactory
bulb**

**Nasal
chamber**



SMELL AND MEMORY

The olfactory bulb is in the limbic system, close to the amygdala (associated with emotion) and the hippocampus (associated with memory). When you first encounter a smell, it becomes linked to the emotions you associate with the events of that time. Encountering the smell again may trigger this link, evoking the memory and associated emotion.