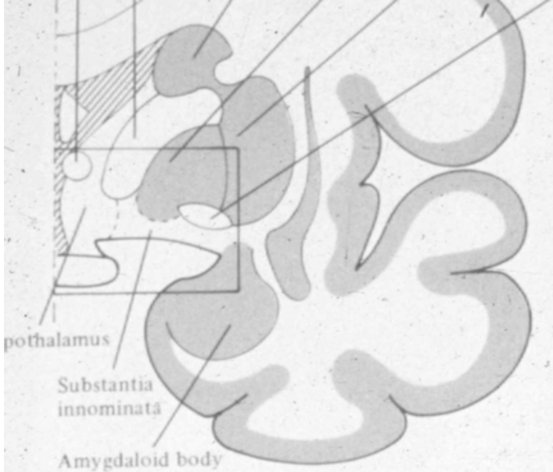
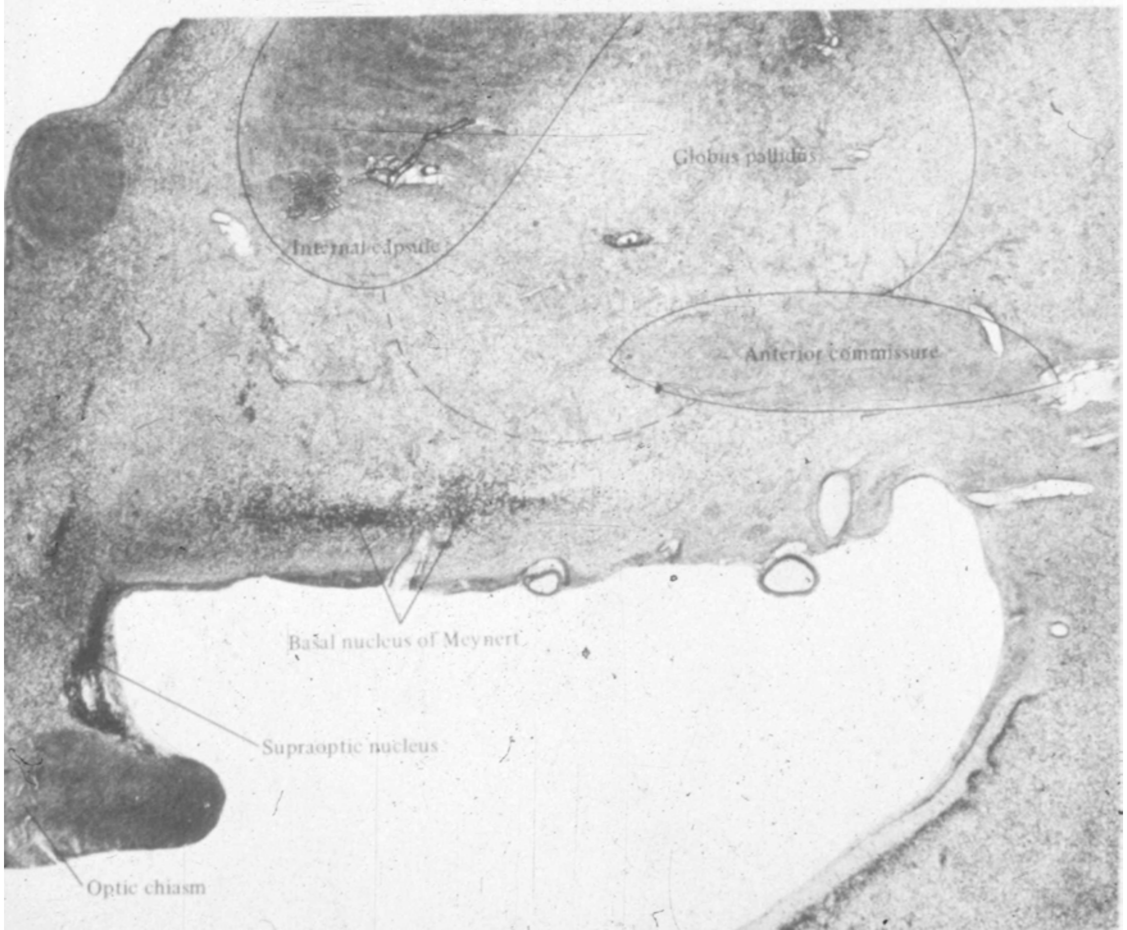
Limbic system-BasalForebrain-Amygdala

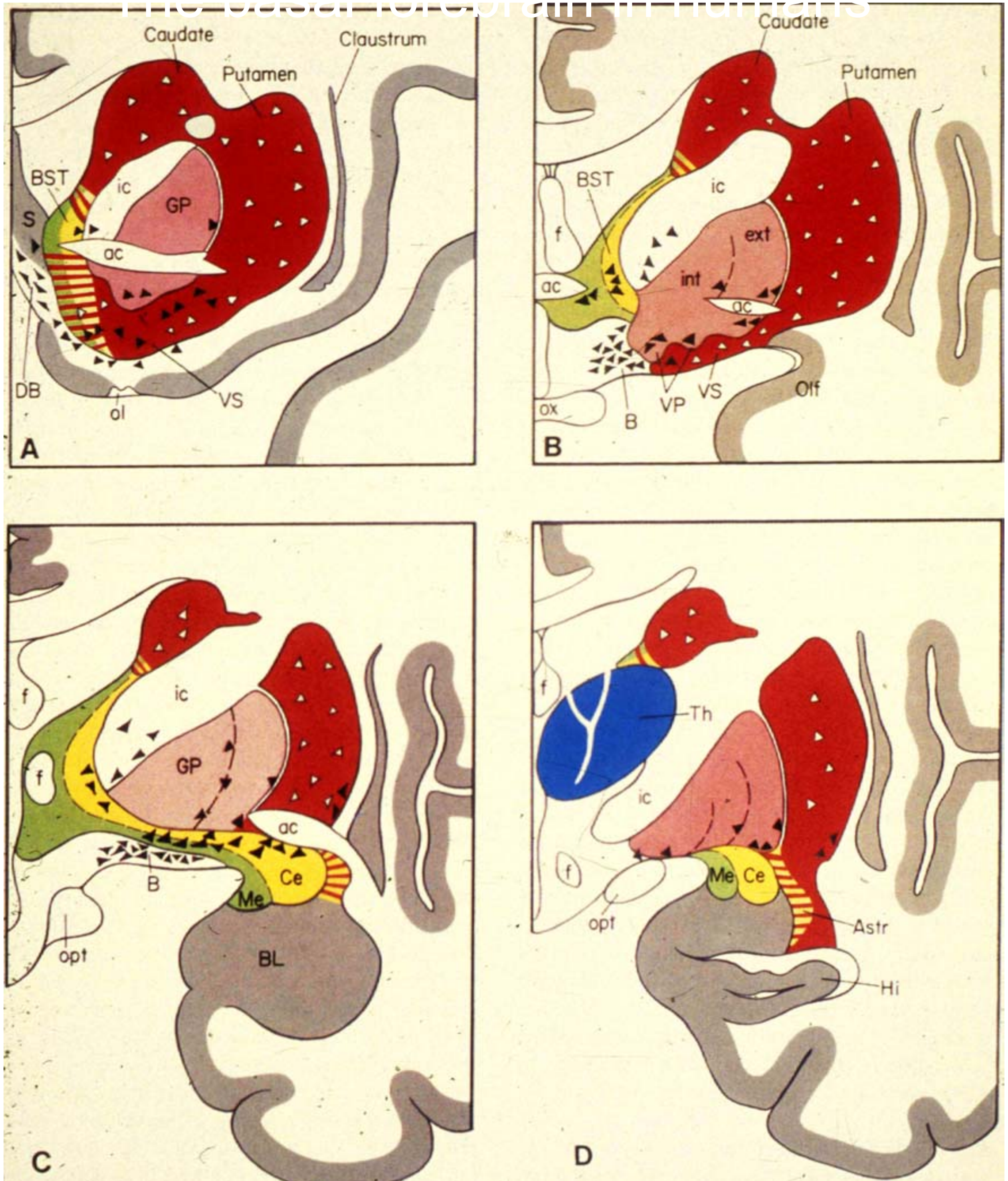


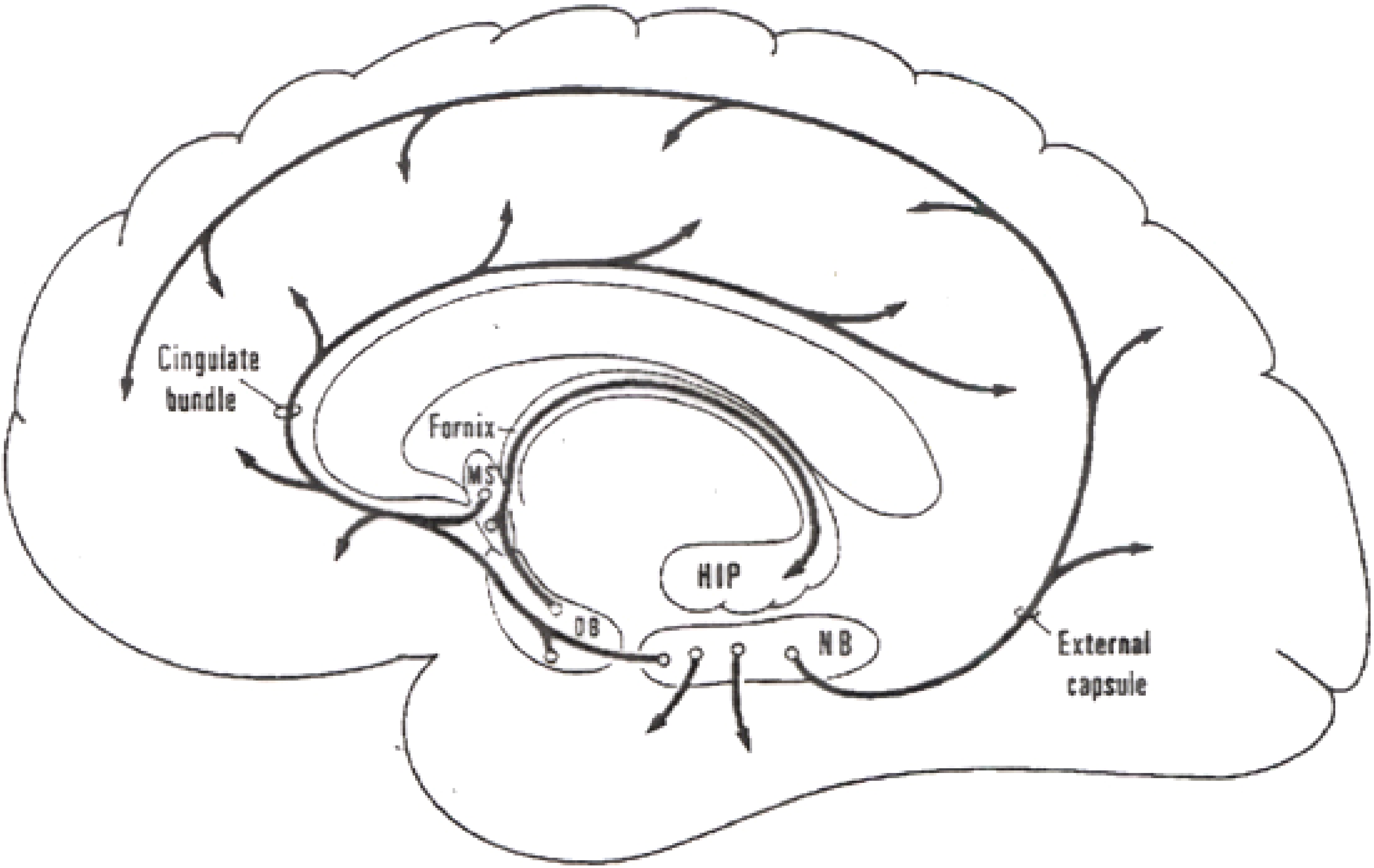
pothalamus
Substantia innominata
Amygdaloid body



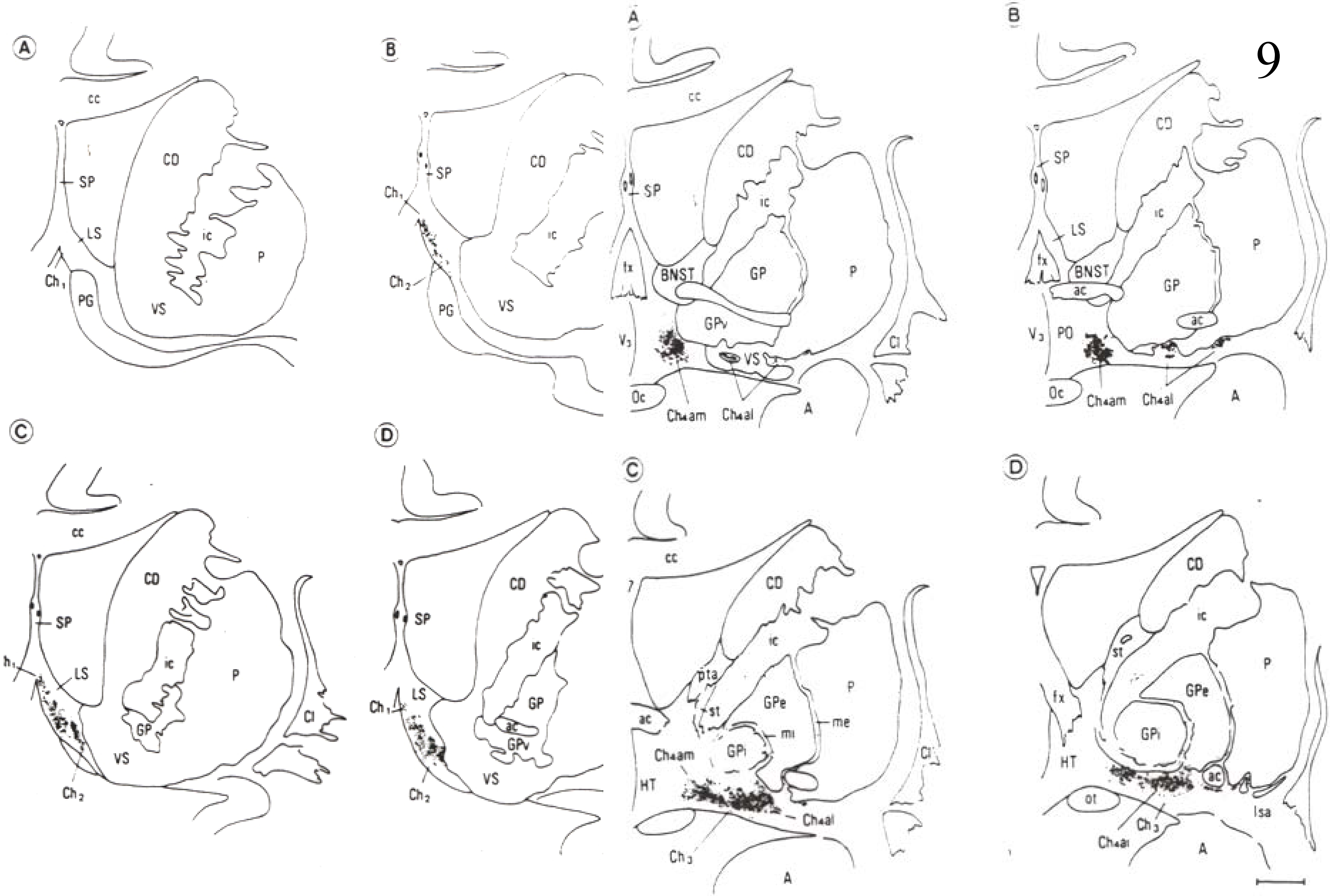
Globus pallidus
Internal capsule
Anterior commissure
Basal nucleus of Meynert
Supraoptic nucleus
Optic chiasm

The basal forebrain in humans



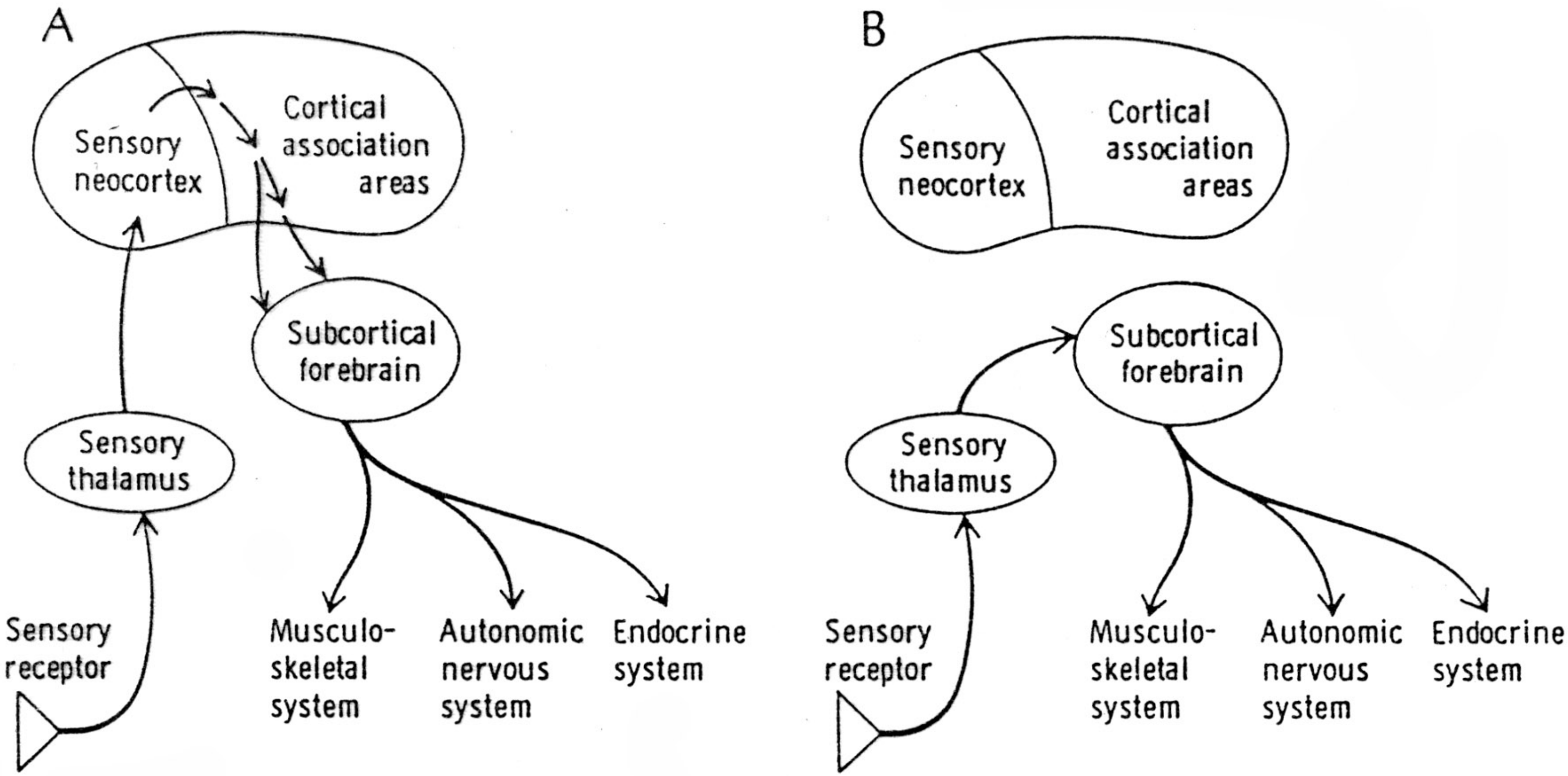


Summary of the major pathways for cholinergic innervation of the cortical mantle by the magnocellular basal complex (Saper, 1990).



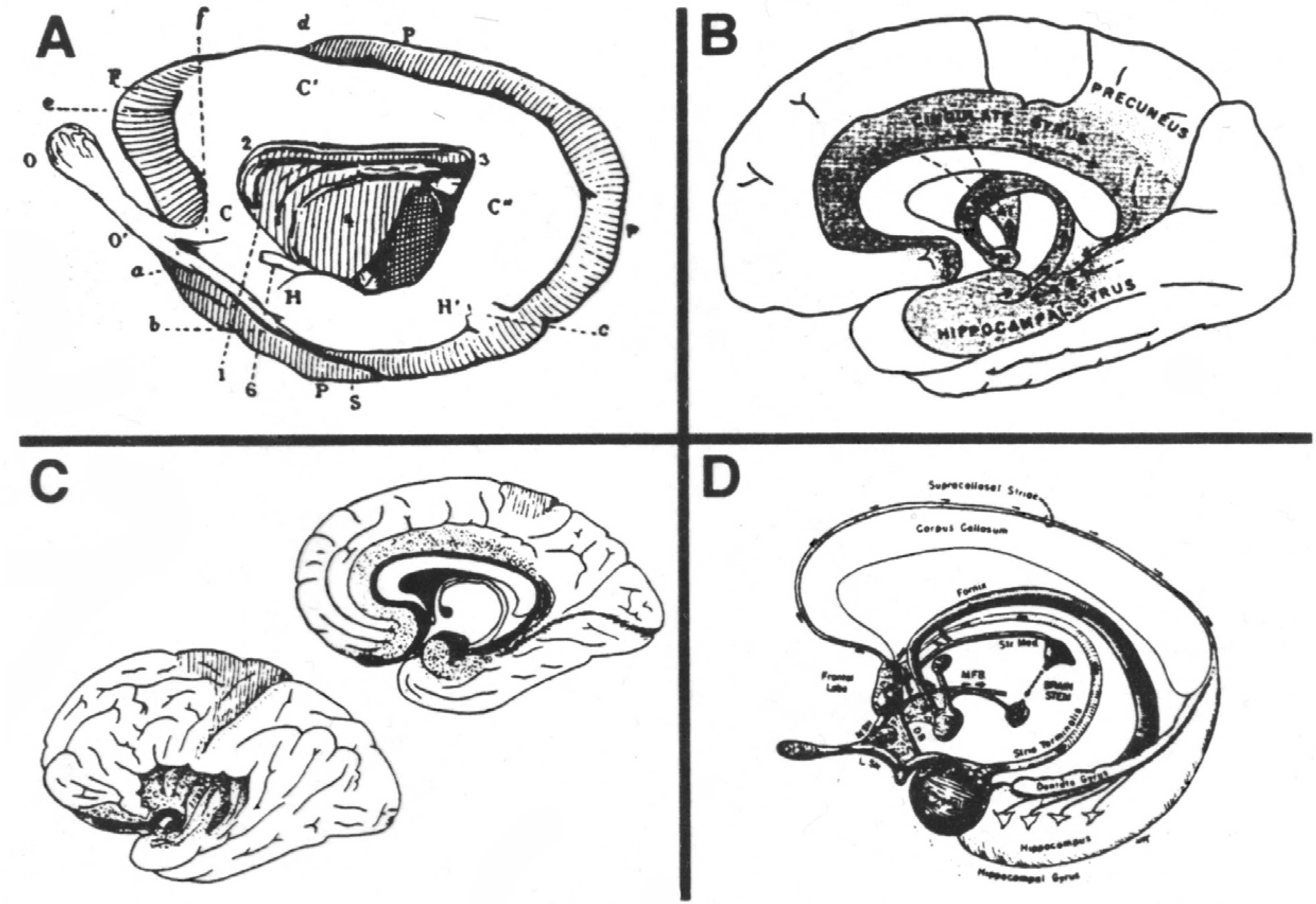
Maps of rostro-caudal cholinergic neurons (stained with the antibodsy against choline acteyltransferase) in serial 40 um coronal sections of the basal forebrain in human. Ch1-Ch4 nomenclature according to Mesulam. From Lehericy et al. 1999

EMOTIONAL PROCESSING

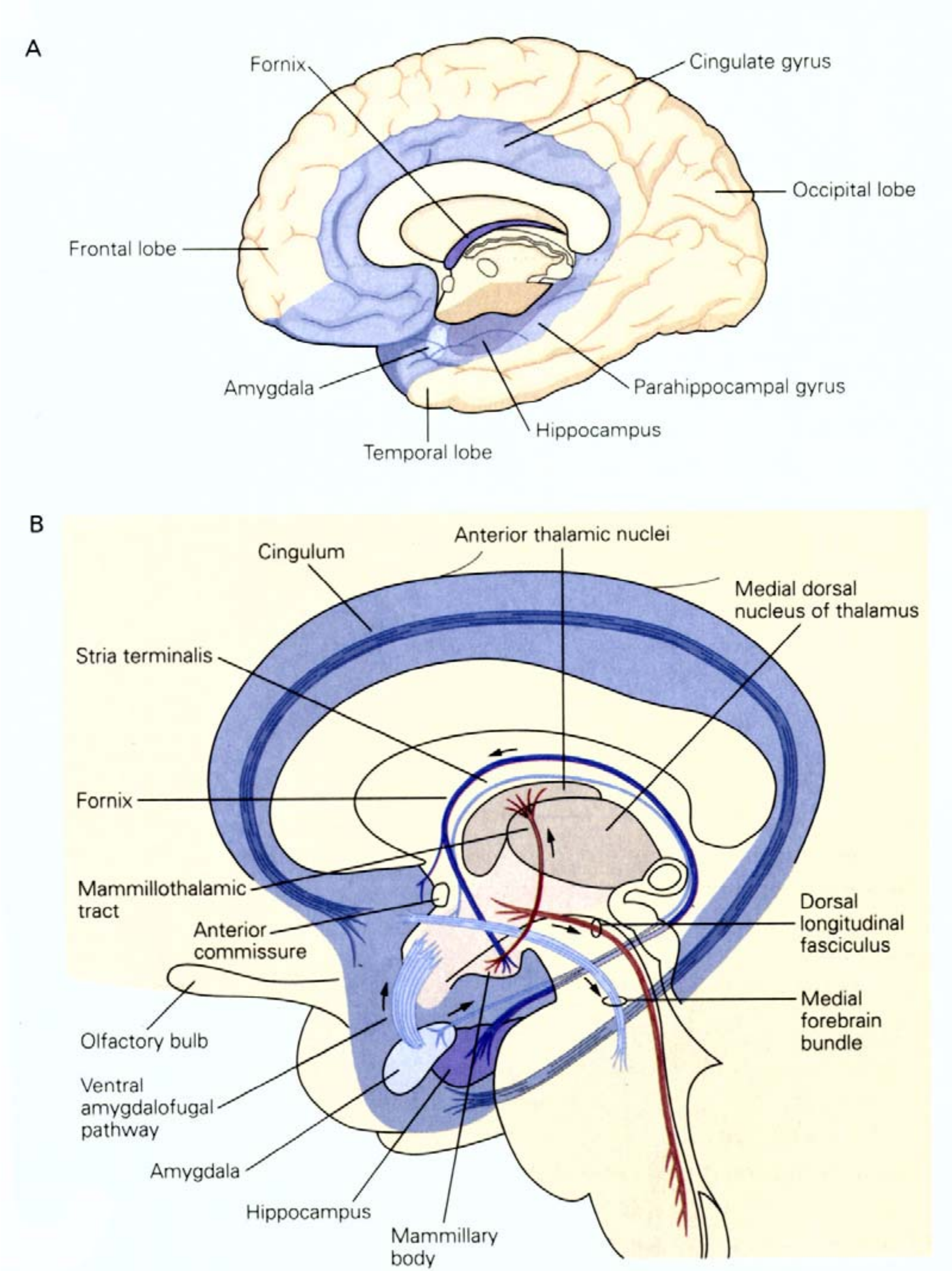


Pathways linking cortical (A) and thalamic (B) sensory receptive areas to regions of the subcortical forebrain that are involved in the processing of emotional information and in the regulation of behavioraql and visceral responses associated with emotional arousal.

THE DEVELOPMENT OF THE LIMBIC SYSTEM CONCEPT



A: The great limbic lobe of Broca (1878); B: Papez's circuit (ca 1938); C: Yakovlev (1948); D: MacLean (1949)



The limbic system consists of the limbic lobe and deep-lying structures. A: the limbic lobe consist of primitive cortical tissue that encircles the ‘upper brainstem’ as well as underlying cortical structures (hippocampus and amygdala)

B: interconnections between different component of the limbic system (from Nieuwenhyus, 1988).

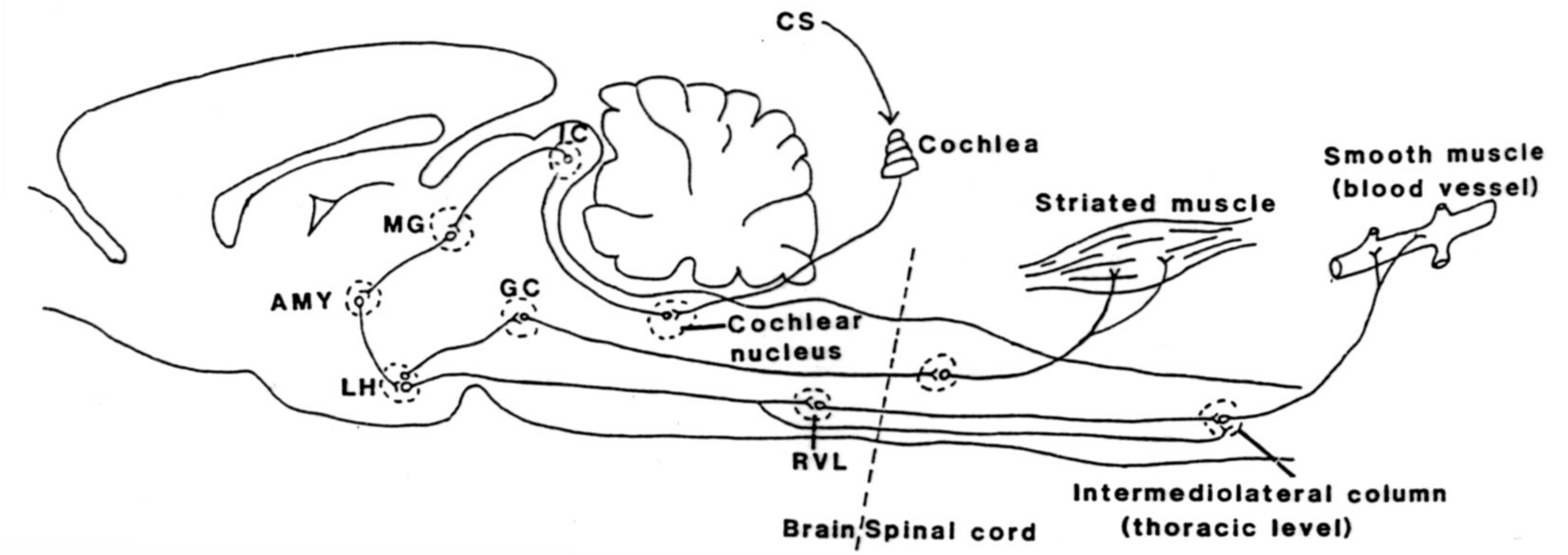
TABLE 1–5. The subcortical limbic structures and the related cortical limbic regions

	Amygdala	Striatum	Pallidum	Thalamus
Orbitofrontal cortex	Basal nucleus (mc)	Ventromedial	Dorsomedial GPi	Anterior (mc)
	Extended amygdala	Caudate	Rostromedial SNr	Medial portion of mediodorsal (mc)
Hippocampus and posterior cingulate	Accessory basal nucleus (mc)	Dorsal caudate	Dorsolateral GPi	Mediodorsal
	Periamygdaloid cortex			Anterior
				Medial pulvinar
Anterior cingulate	Basal nucleus (pc and mc)	Ventral striatum	Ventral pallidum	Midline nuclei
				Dorsal portion of mediodorsal (mc)

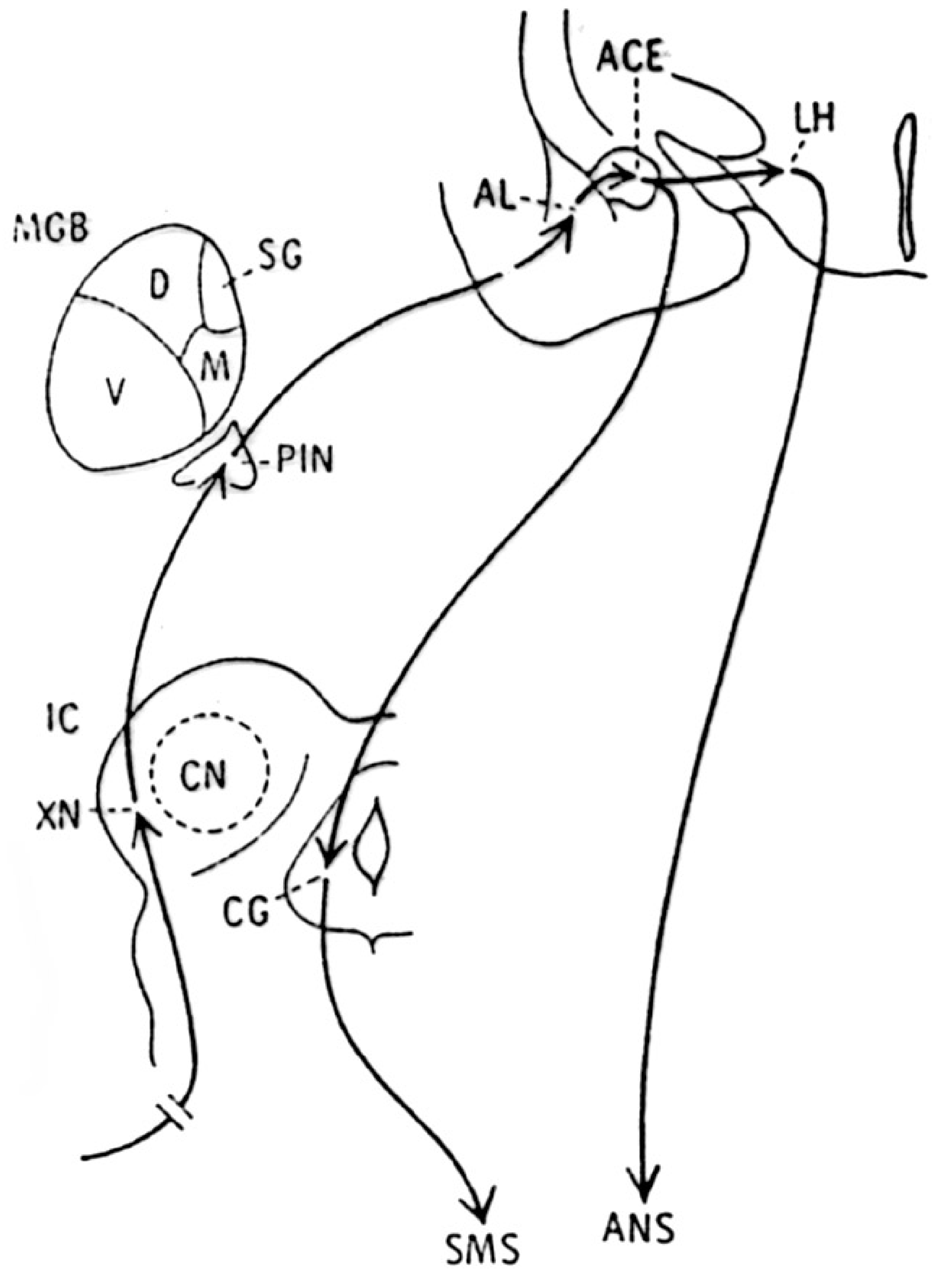
Note: mc = magnocellular; pc = parvocellular; SNr = substantia nigra reticulata; GPi = globus pallidus interna.

TABLE 1–6. The clinical manifestations and regional localization of hypofunctional, hyperfunctional, and dysfunctional limbic syndromes

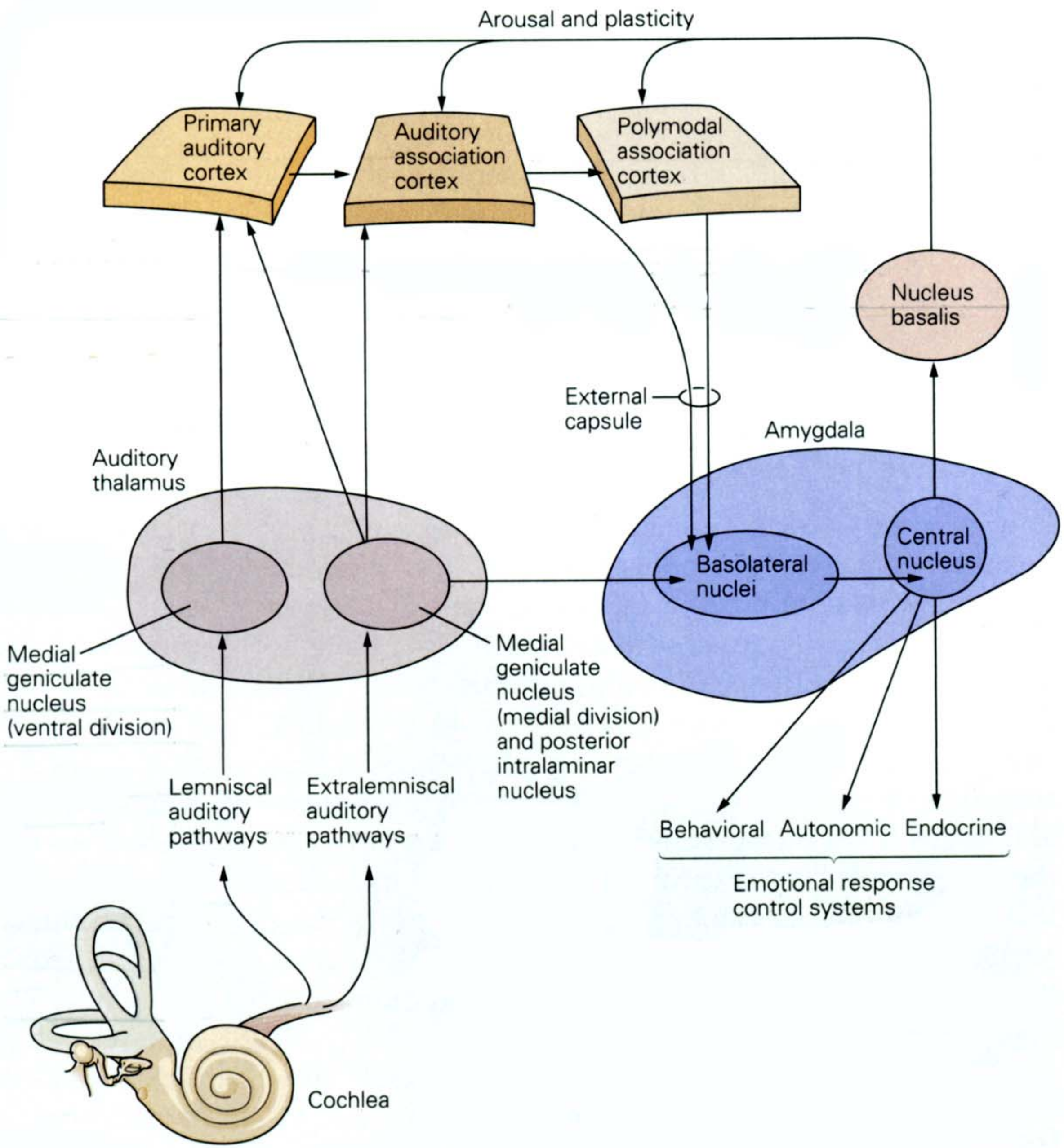
Syndrome and Clinical Manifestation	Regional Localization
Hypolimbic syndromes	
Depression	Medial orbitofrontal circuit
Apathy	Anterior cingulate circuit
Amnesia	Archicortical structures
Klüver-Bucy	Amygdala/temporal pole
Hyperlimbic syndromes	
Mania	Medial right diencephalon
Obsessions/compulsions	Orbitofrontal circuit
Limbic epilepsy	Paleocortical structures
Rage	Hypothalamus/amygdala
Dysfunctional limbic syndromes	
Utilization behavior	Lateral orbitofrontal cortex
Social disdecorum	Lateral orbitofrontal circuit
Anxiety/panic	Medial orbitofrontal cortex
Psychosis	The limbic system



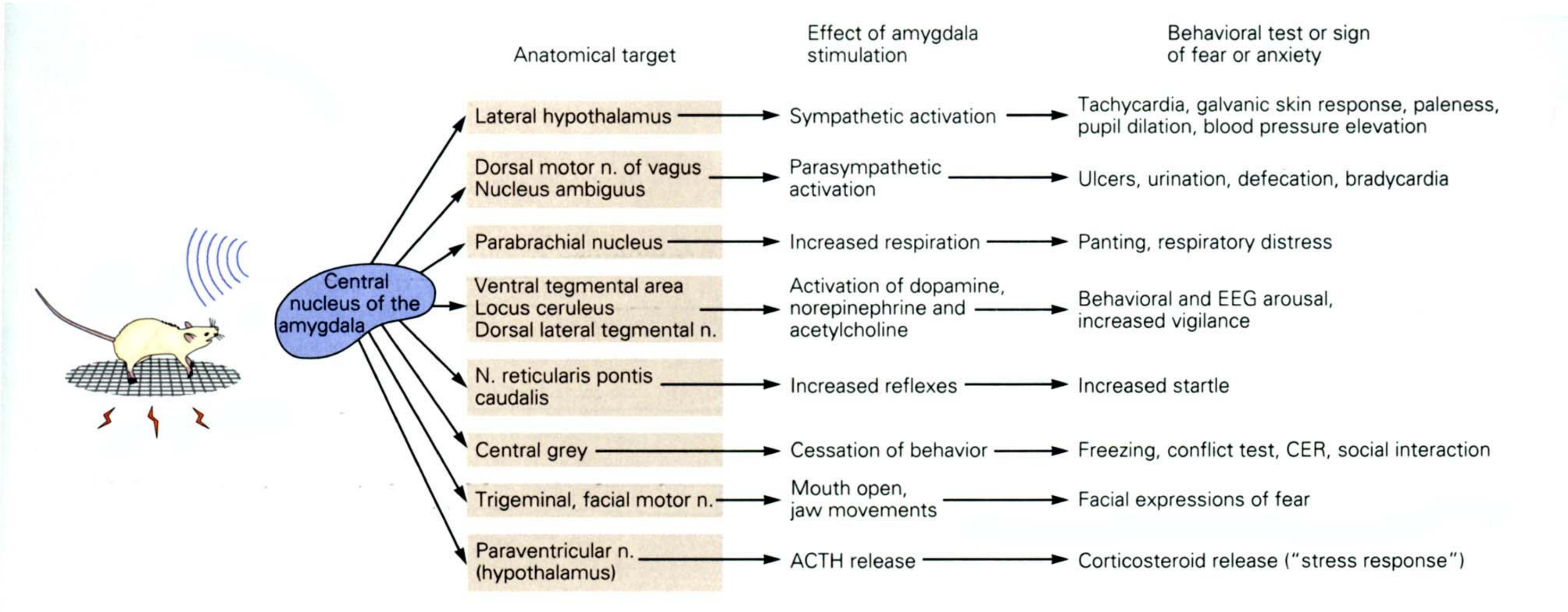
Schematic drawing of a median sagittal section of the rat brain indicating pathways essential for emotional behavior. IC: inferior colliculus; MG: medial geniculate body; AMY: amygdala; GC: central gray; LH: lateral hypothalamus; CS: conditional stimulus; RVL: rostral ventrolateral medulla (after Ledoux, 1987)



Neural circuitry mediating fear conditioning. Acoustic inputs are relayed through the peripheral shell regions of the inferior colliculus to the posterior intralaminar nucleus and the medial division of the medial geniculate body (MGB). These areas then projects to the lateral n. of the amygdala. Efferents from the central amygdala bifurcate with projections to the lateral hypothalamic regions controlling arterial-pressure conditioned responses and projections to the central gray (CG) controlling freezing conditioned responses.

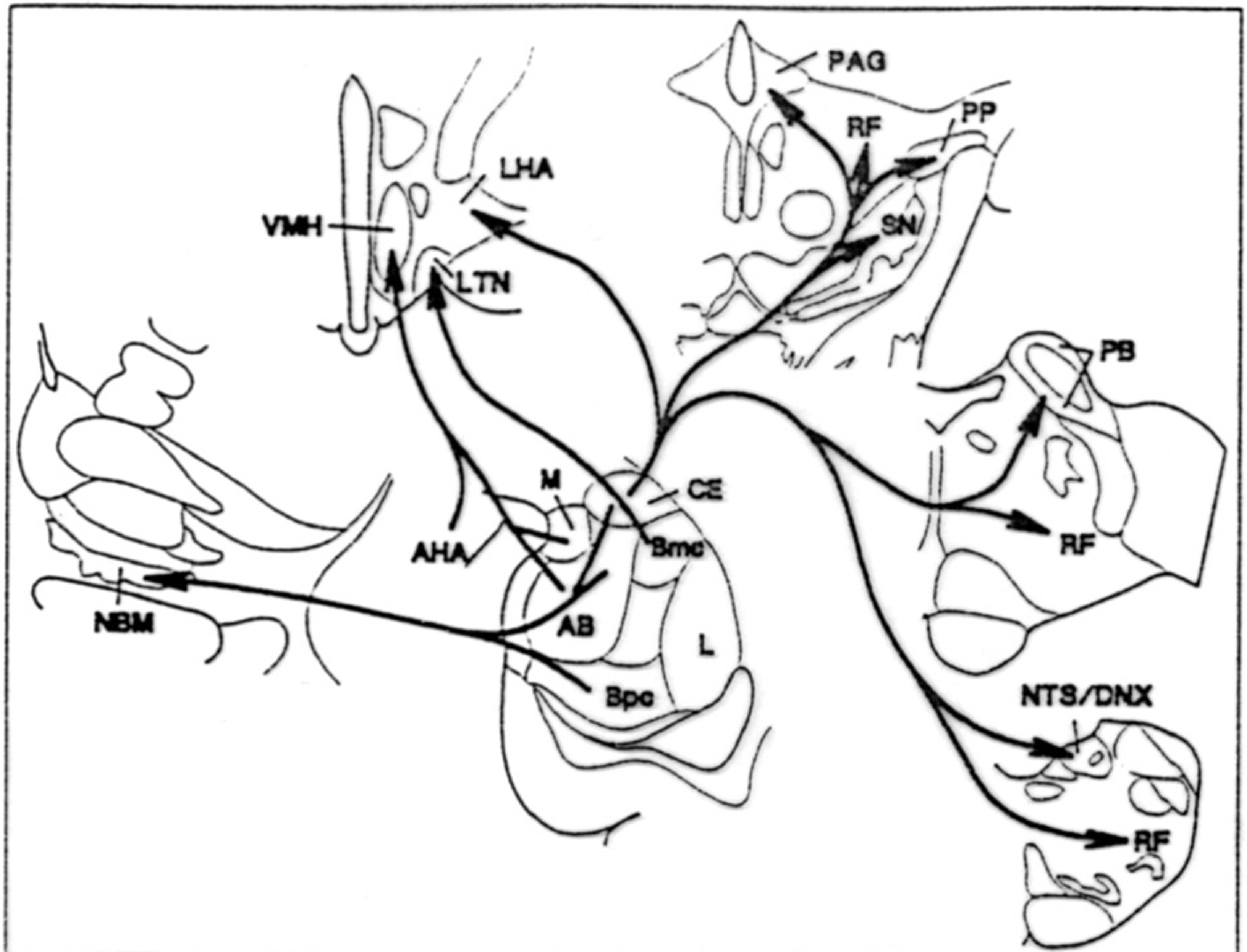


The output from the central amygdaloid nucleus also reaches the basal forebrain (BF) which projects widely to cortical areas. The cholinergic projections from the BF to cortex have been implicated in cortical arousal (LeDoux, 1992; Kandell, 2000)

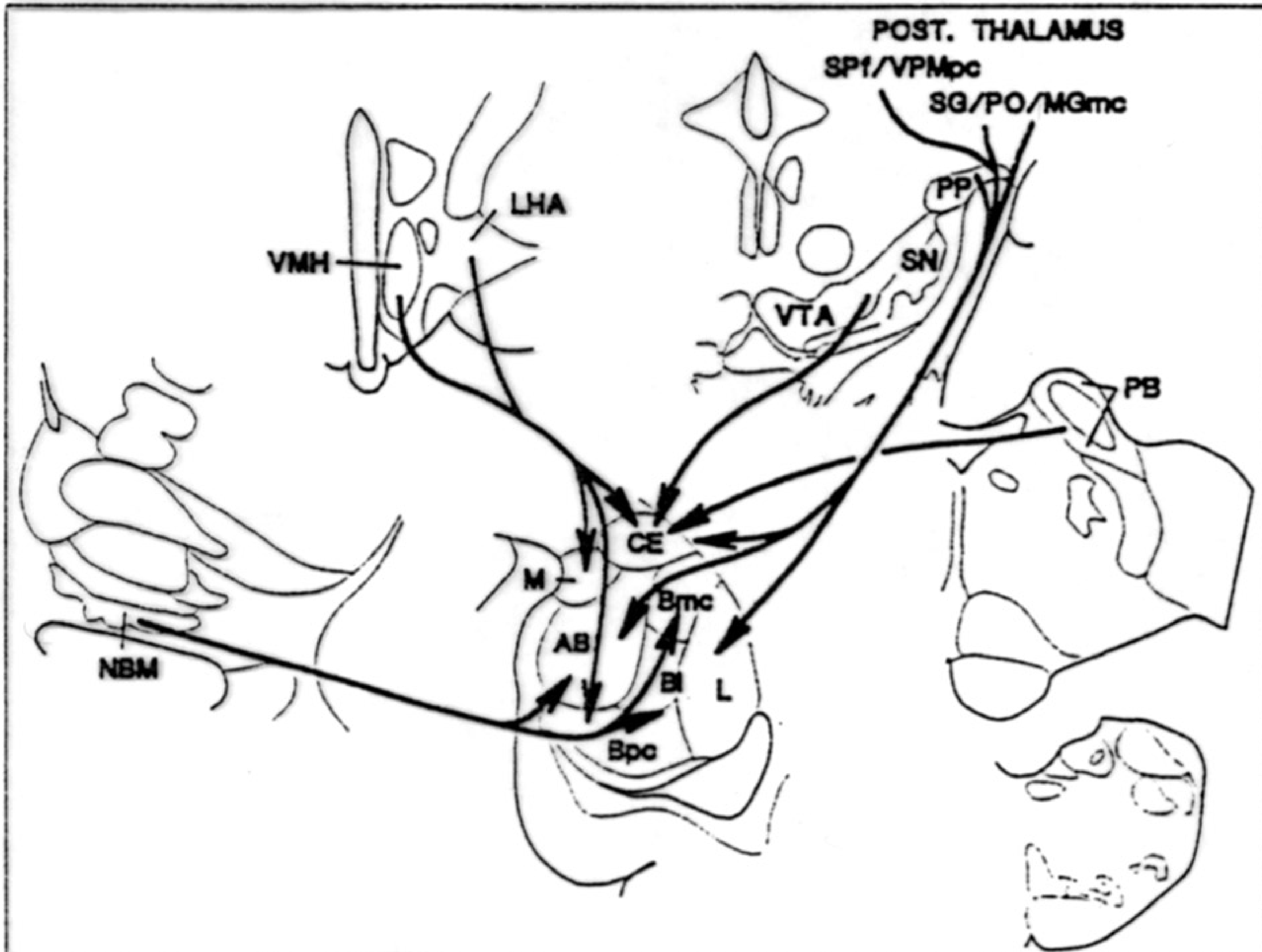


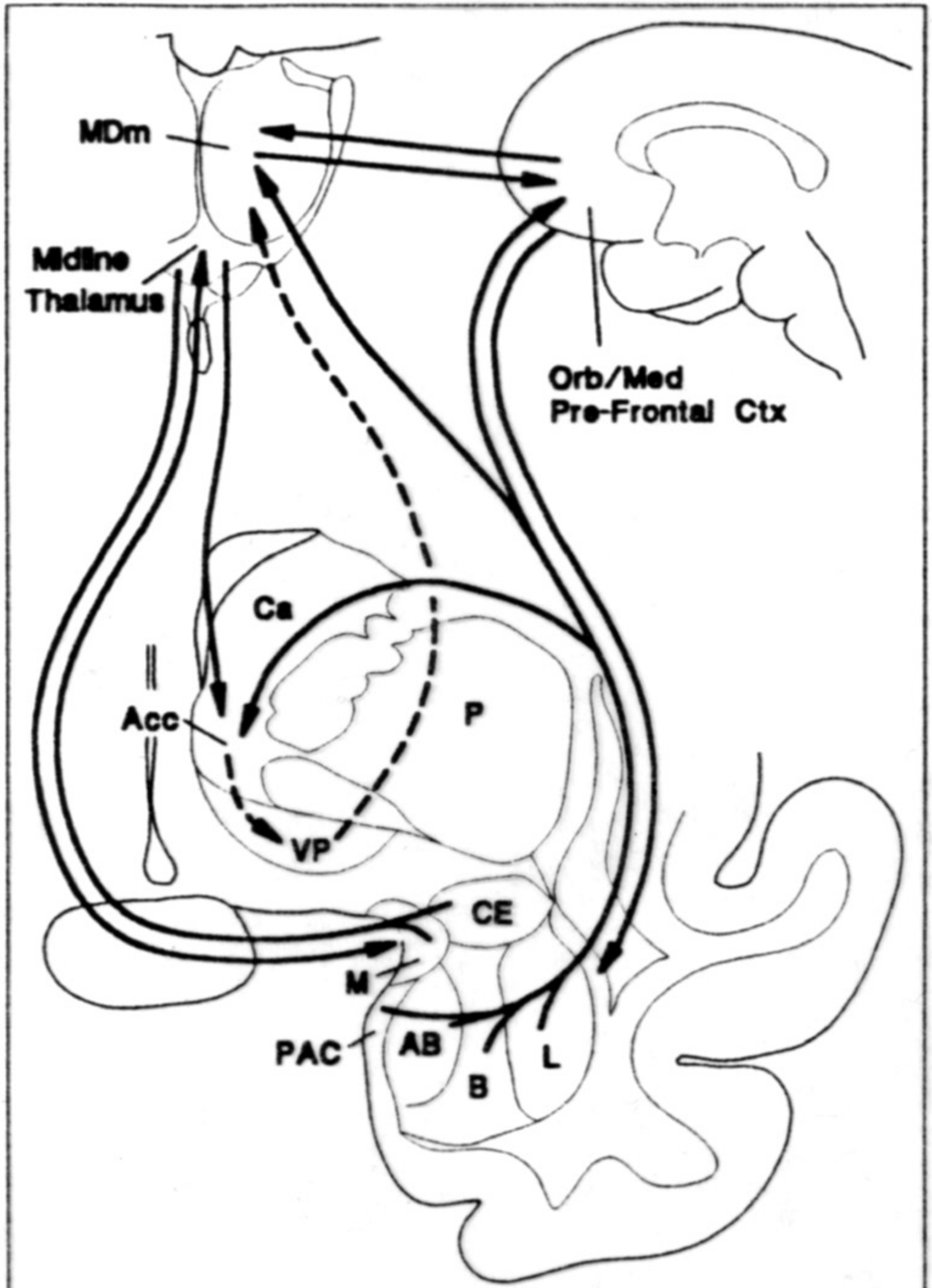
Connections between the central n. of amygdala and a variety of hypothalamic and brainstem areas that may be involved in different animal test of fear and anxiety (Davies, 1992).

SUBCORTICAL EFFERENTS FROM THE AMYGDALA



SUBCORTICAL AFFERENTS TO THE AMYGDALA





AMYGDALOID-PREFRONTAL CONNECTIONS

Various routes through which the amygdaloid complex can influence the function of the frontal lobe. 1) the amygdala has direct reciprocal connections with various regions of the orbital and medial frontal lobe. 2) the amygdala projects to the mediodorsal nucleus of the thalamus (MD) which, in turn projects to the same region of the frontal lobe that receive a direct amygdaloid input. 3) many amygdaloid nuclei project to the n. accumbens (Acc) that in turn projects via the ventral pallidum (VP) to the MD-prefrontal cortex.

AMYGDALO-HIPPOCAMPAL CONNECTIONS

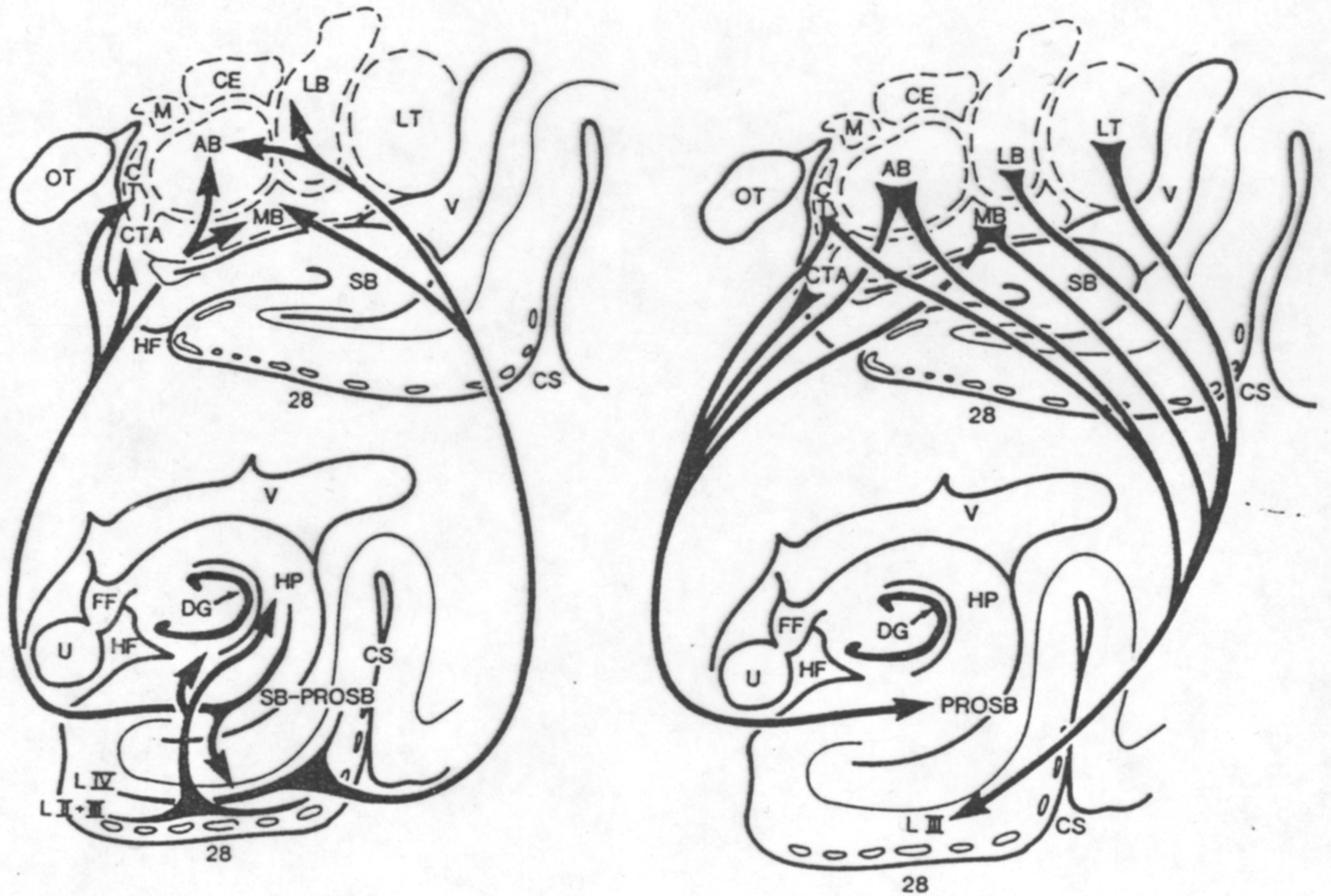
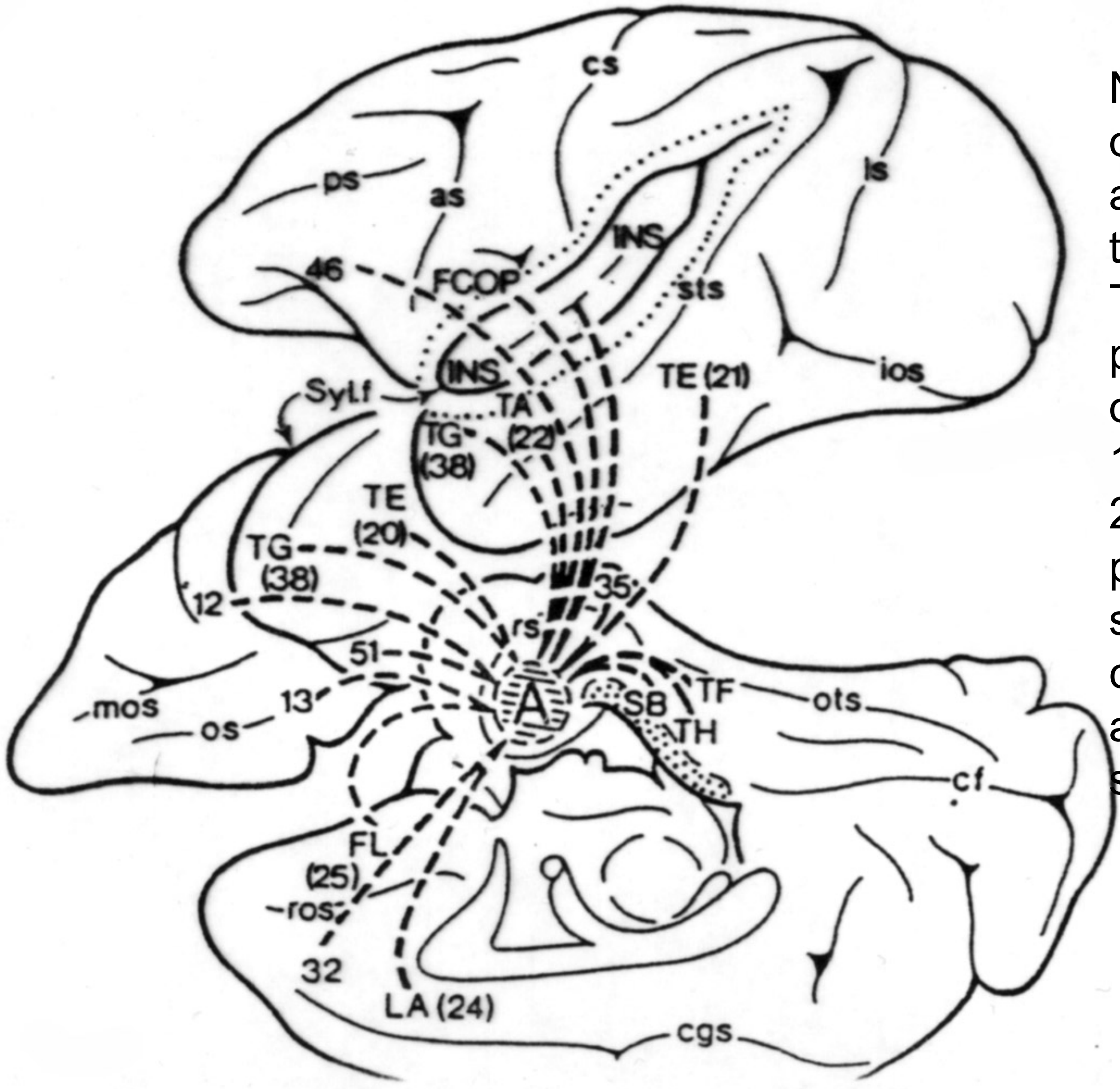


Figure 1. Connectional anatomy of the ventromedial lobe. Some probable hippocampal formation and entorhinal cortex (area 28) efferents to the amygdala (left) and some probable amygdaloid efferents to the hippocampal formation and entorhinal cortex (right) in the human are illustrated based on projections from experimental studies in the nonhuman primate (see text for details). Abbreviations: AB, accessory basal nucleus of the amygdala; CE, central nucleus of the amygdala; CS, collateral sulcus; CT, cortical nucleus of the amygdala; CTA, cortical transition area; DG, dentate gyrus; FF, fimbria fornix; HF, hippocampal fissure; HP, hippocampus; LB, lateral basal nucleus of the amygdala; LT, lateral nucleus of the amygdala; M, medial nucleus of the amygdala; MB, medial basal nucleus of the amygdala; OT, optic tract; PROSB, prosubiculum; SB, subiculum; U, uncal hippocampus; V, lateral ventricle; 28, Brodmann's area 28, entorhinal cortex.

CORTICAL INPUT TO THE AMYGDALA



Note: the projectios originate in associational areas in the temporal (TE, TF,TH, TG) lateral prefrontal (area 46), orbitofrontal (area 12), cingulate (areas, 24, 32), insular (INS), perirhinal (35), subicular (SB) cortical areas. There are no primary sensory projections.

Medial Temporal Lobe. Amygdala and hippocampus

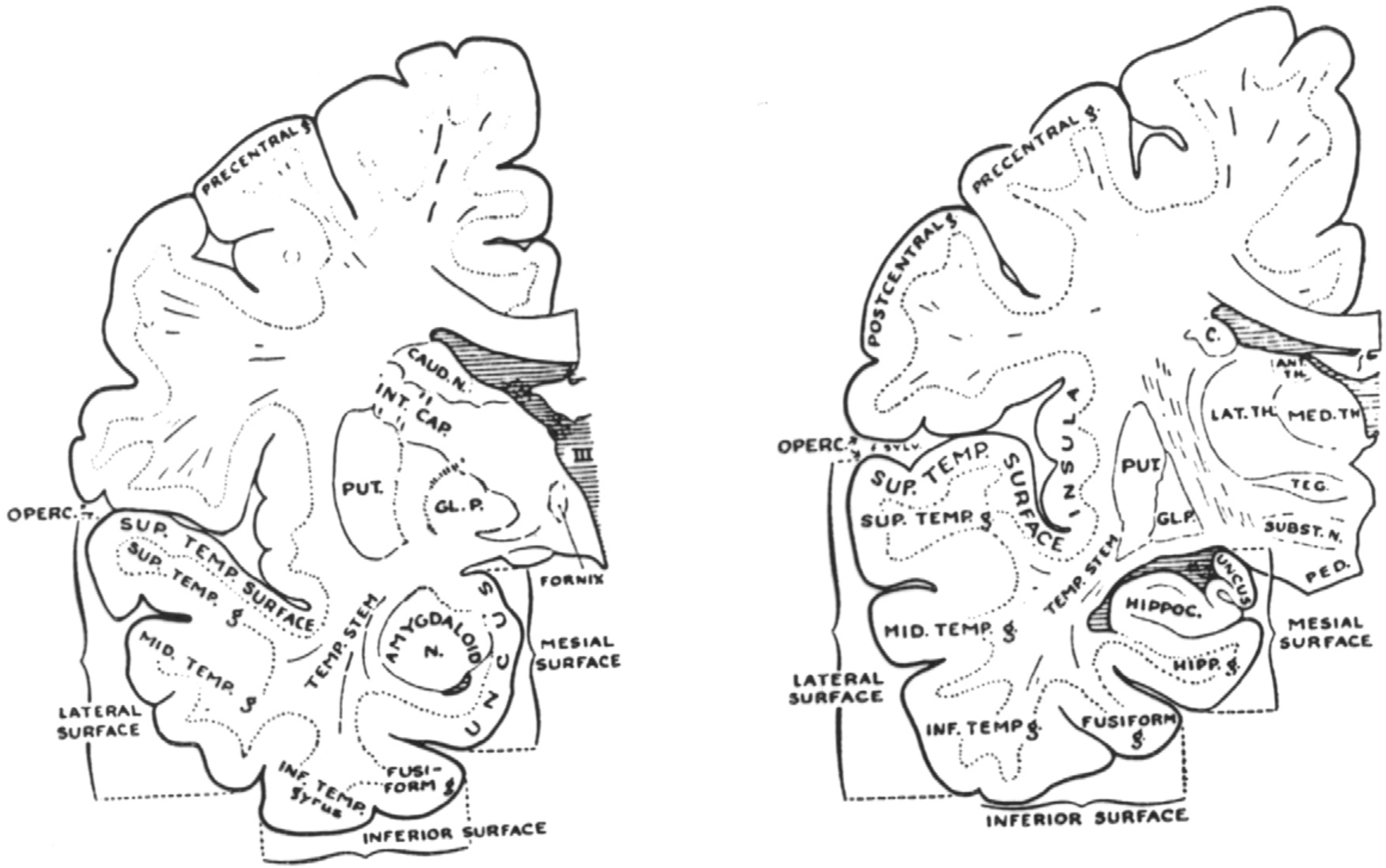


Table 1. Frequently Used Terms and Subdivisions of Hippocampal Formation

Major Division	Common Subdivisions	Alternate Designations		Recognized Layers
Dentate gyrus	suprapyramidal blade			molecular, granule cell
	infrapyramidal blade			
	hilus			
Hippocampus	CA_1 (a, b, c)	regio superior	h_1	molecular, lacunosum, radiatum, pyramidal, oriens
	CA_2	regio inferior	h_2 ($CA_2 + CA_3$ a,b)	
	CA_3 (a, b, c)		h_3 / h_4 (CA_3 c)	
	CA_4 (in hilar region)		h_5 (CA_4)	
Transition cortical areas	prosubiculum			molecular, granule cell
	subiculum			
	presubiculum	area 27		I
	retroplenial e	area 29e		II
	parasubiculum	area 49		III
	entorhinal	areas 28a, b		(lamina dissecans)
	[rhinal fissure]			IV
	perirhinal area	area 35		

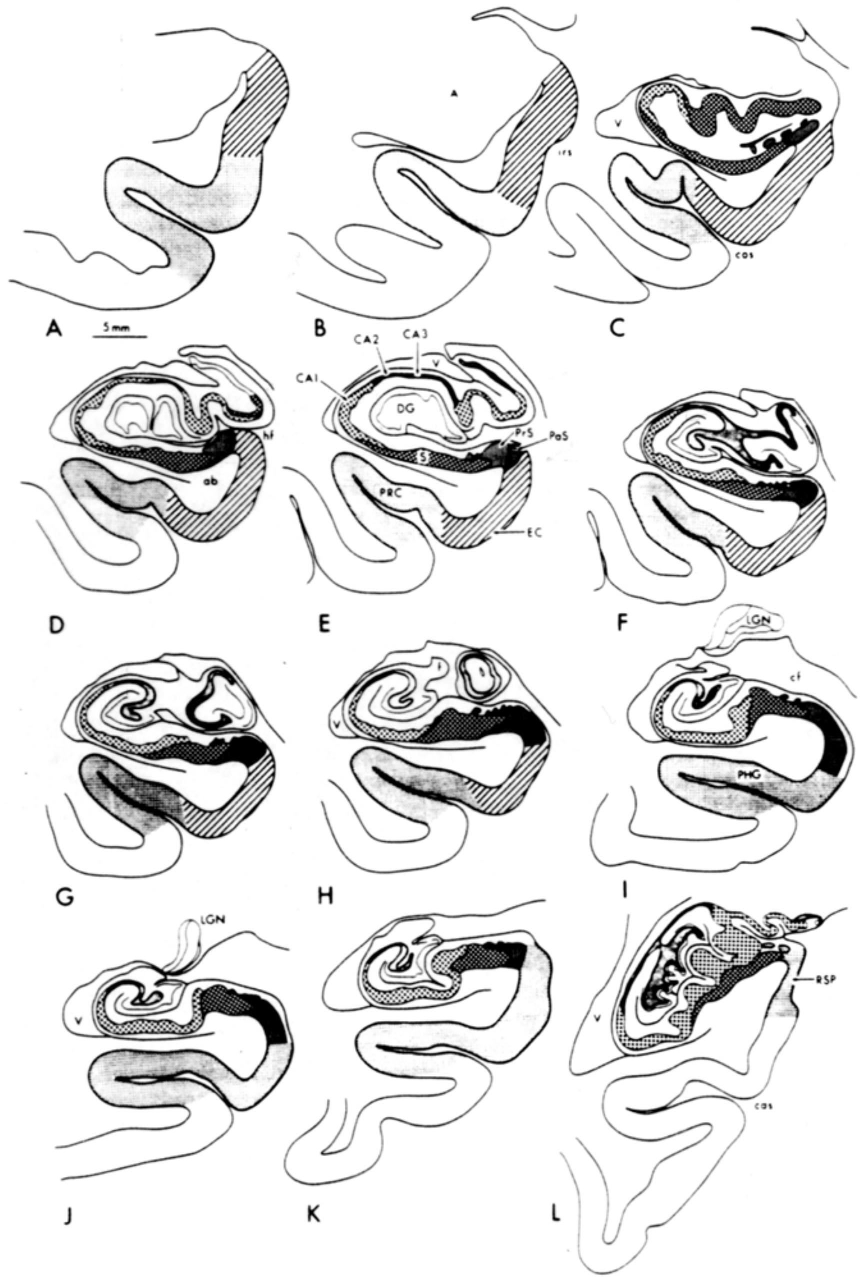


Figure 21.11. A series of coronal sections of the human temporal lobe arranged from rostral (A) to caudal (I). The various cytoarchitectonic fields of the hippocampal formation have been shaded with different hatching patterns (panel E is marked as a template) to show the varying extents of each of the fields at different rostrocaudal levels.

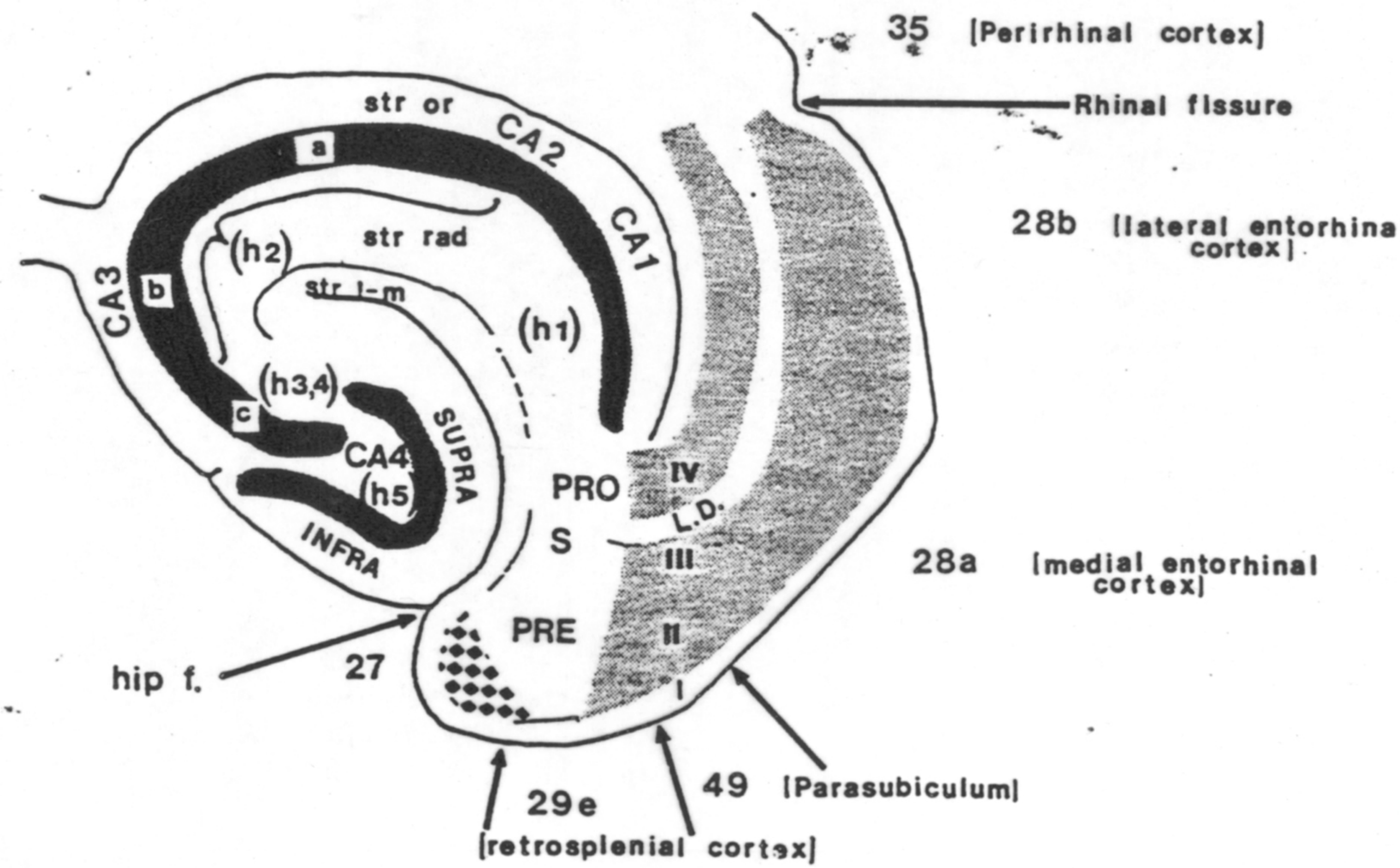
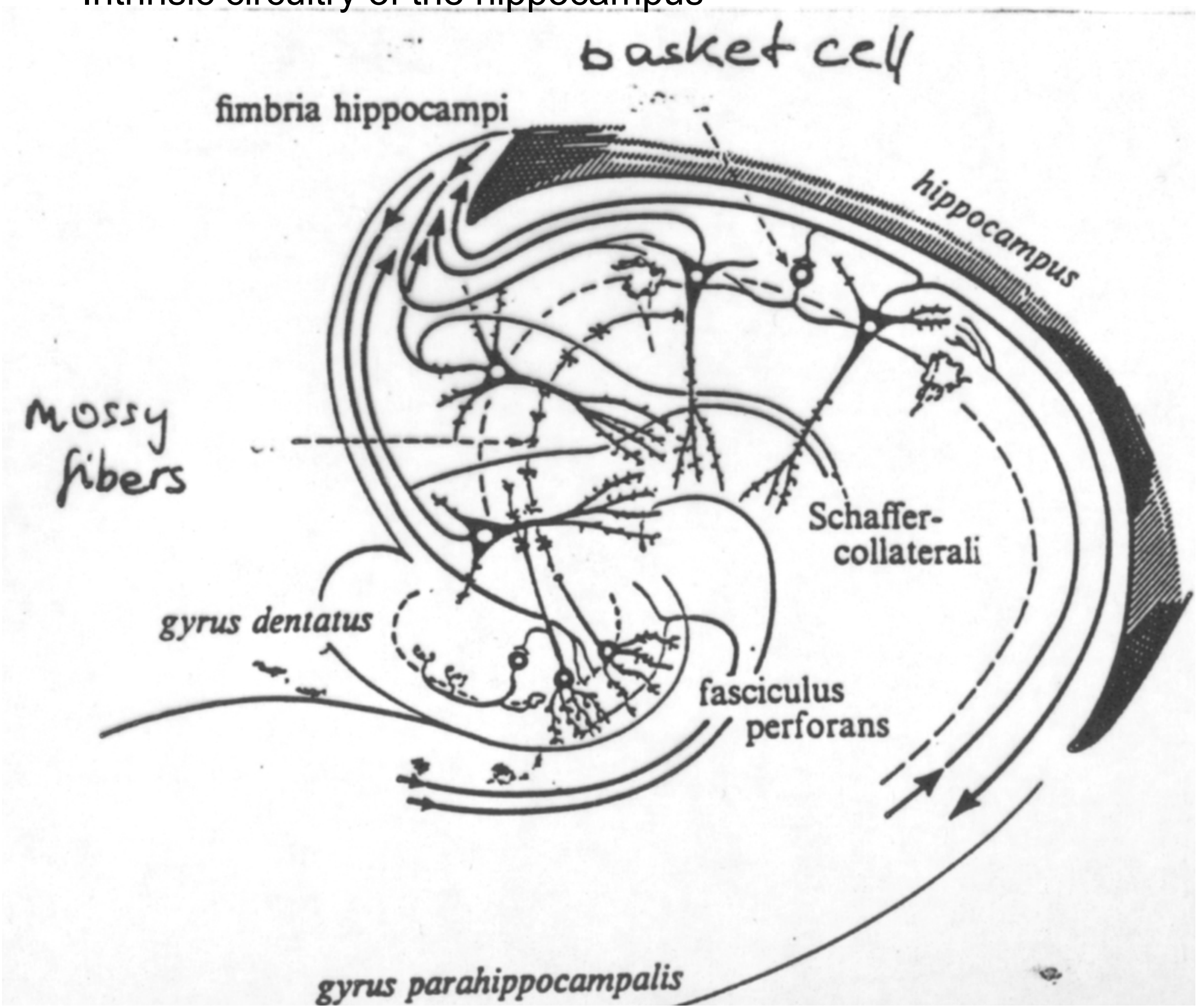


Figure 1. A schematic representation of a cross section through the hippocampal formation. Numerals, by themselves, refer to Brodmann's areas as described in the text. CA_1, CA_2, CA_3, and CA_4 refer to parts of the hippocampus as described by Lorente de No. The small letters in the shaded region refer to subareas of CA_3. Numbers preceded by h's and in parentheses refer to subareas as defined by M. Rose. SUPRA refers to the suprapyramidal blade of the dentate gyrus; INFRA, to the infrapyramidal blade of the dentate; str l-m, to stratum lacunosum-moleculare; str rad, to stratum radiatum. srt or, to stratum oriens; PRO, to prosubiculum, S, to subiculum, PRE, to presubiculum. The densely dotted region near PRE indicates a cell-dense area that is one of the cytoarchitectural markers of the region. Hip f. refers to the hippocampal fissure, largely obliterated in most species. Roman numerals I through IV refer to successively deeper cortical layers. L.D. refers to lamina dessicans, a cell-poor area of transitional cortex.

Intrinsic circuitry of the hippocampus



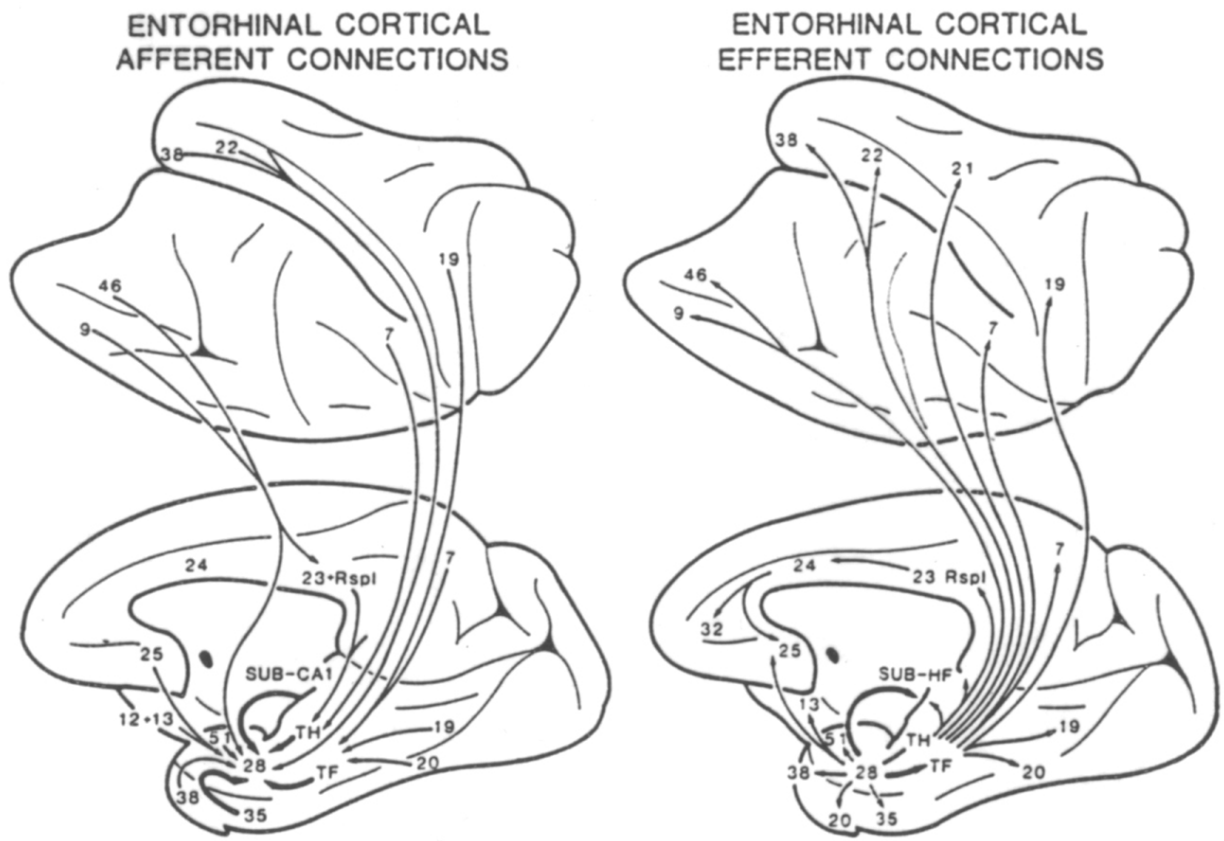
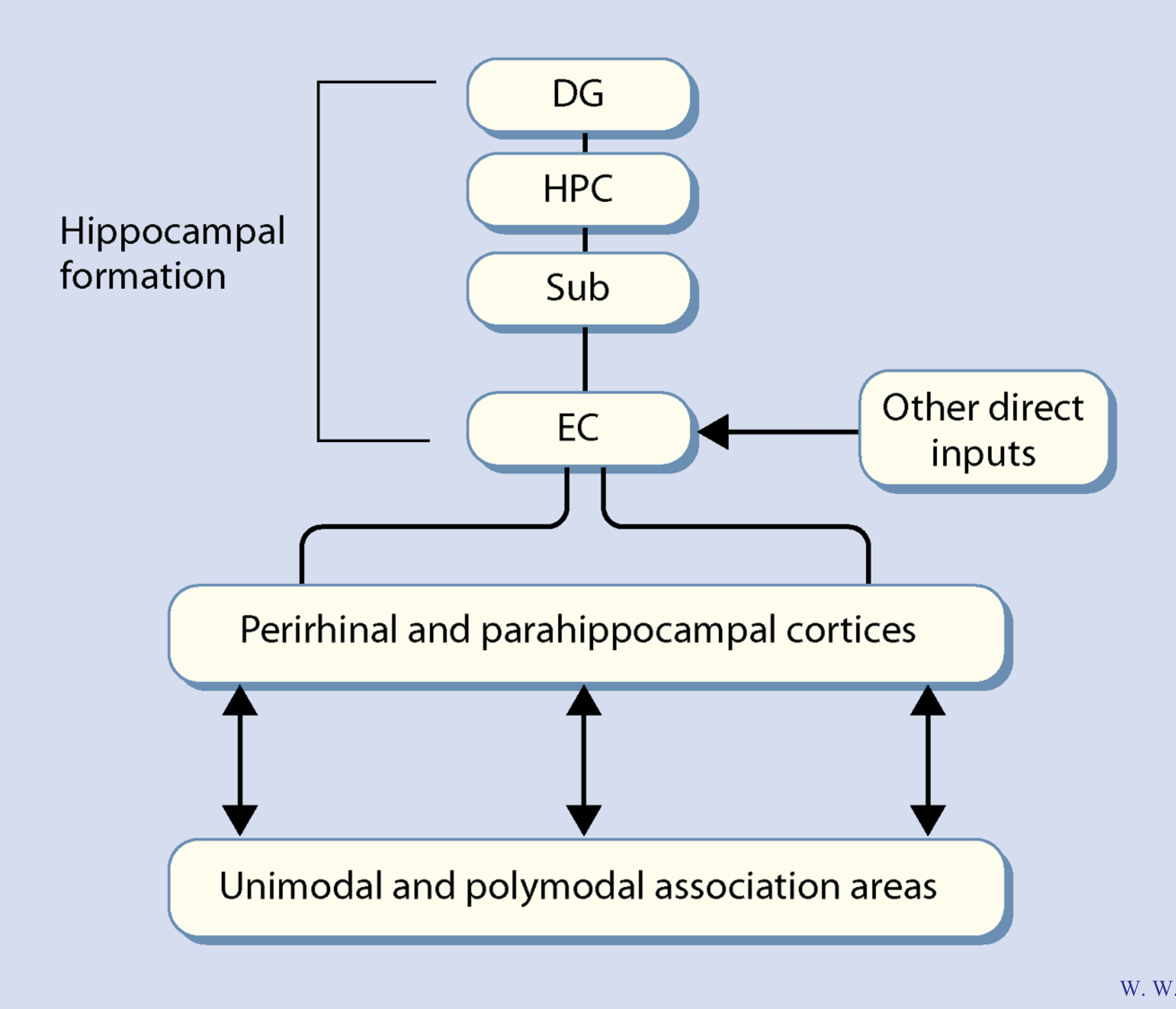


FIGURE 11.1. Major cortical afferent and efferent neural systems of the entorhinal cortex in the rhesus monkey on medial and lateral views of the cerebral hemisphere. Identification of cortical areas corresponds to those of Brodmann and Bonin and Bailey. Note that cortical neural systems from the frontal, parietal, occipital, temporal, and limbic lobes converge on Brodmann's area 28, the entorhinal cortex. Layer IV of the entorhinal cortex receives a powerful output from the subiculum (Sub) and CA1 parts of the hippocampal formation (HF) and gives rise to neural systems that feed back to widespread limbic and association cortical areas.


DG
HPC
Sub
Hippocampal formation
EC
Other direct inputs
Perirhinal and parahippocampal cortices
Unimodal and polymodal association areas