HIPPOCAMPUS and SEPTUM

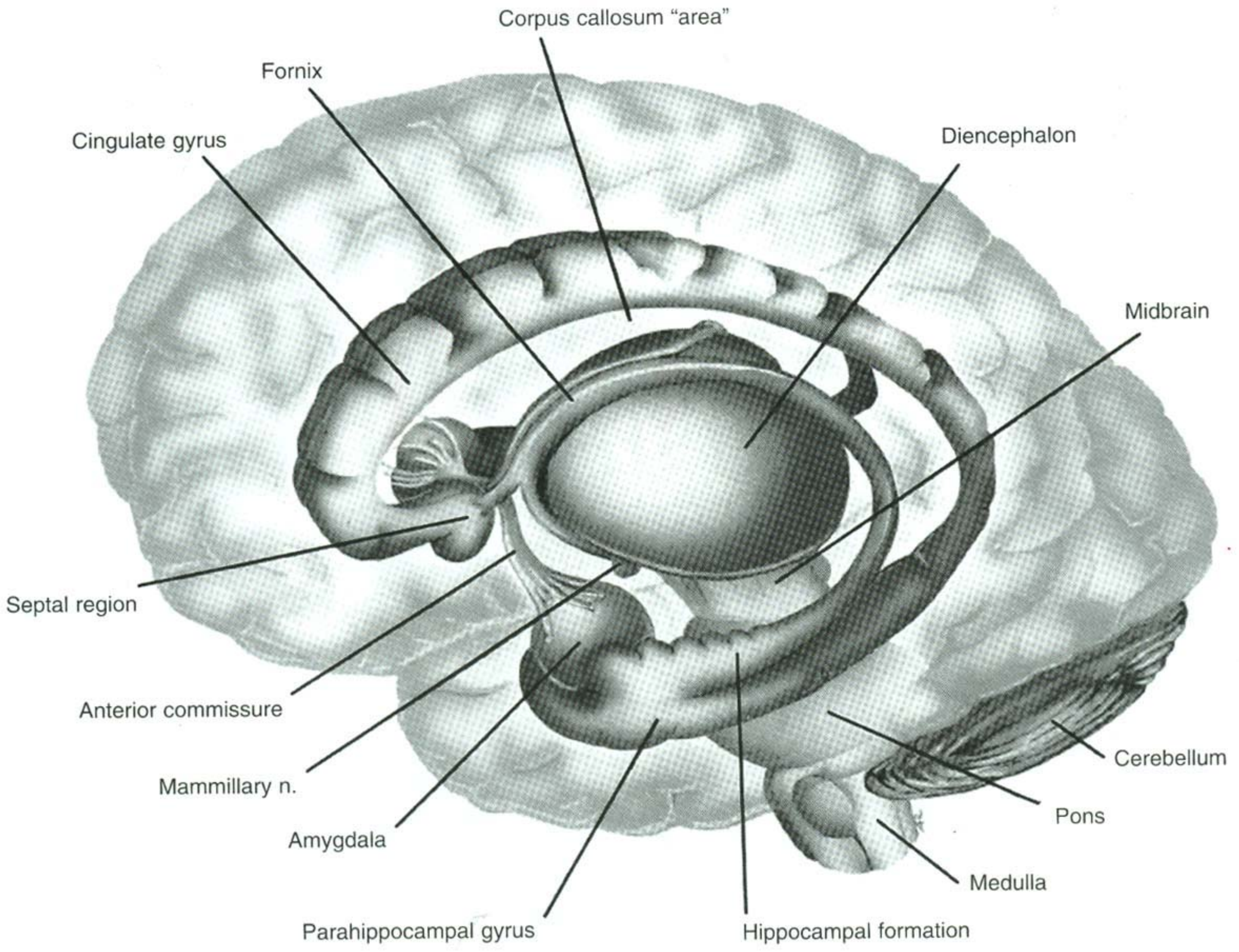
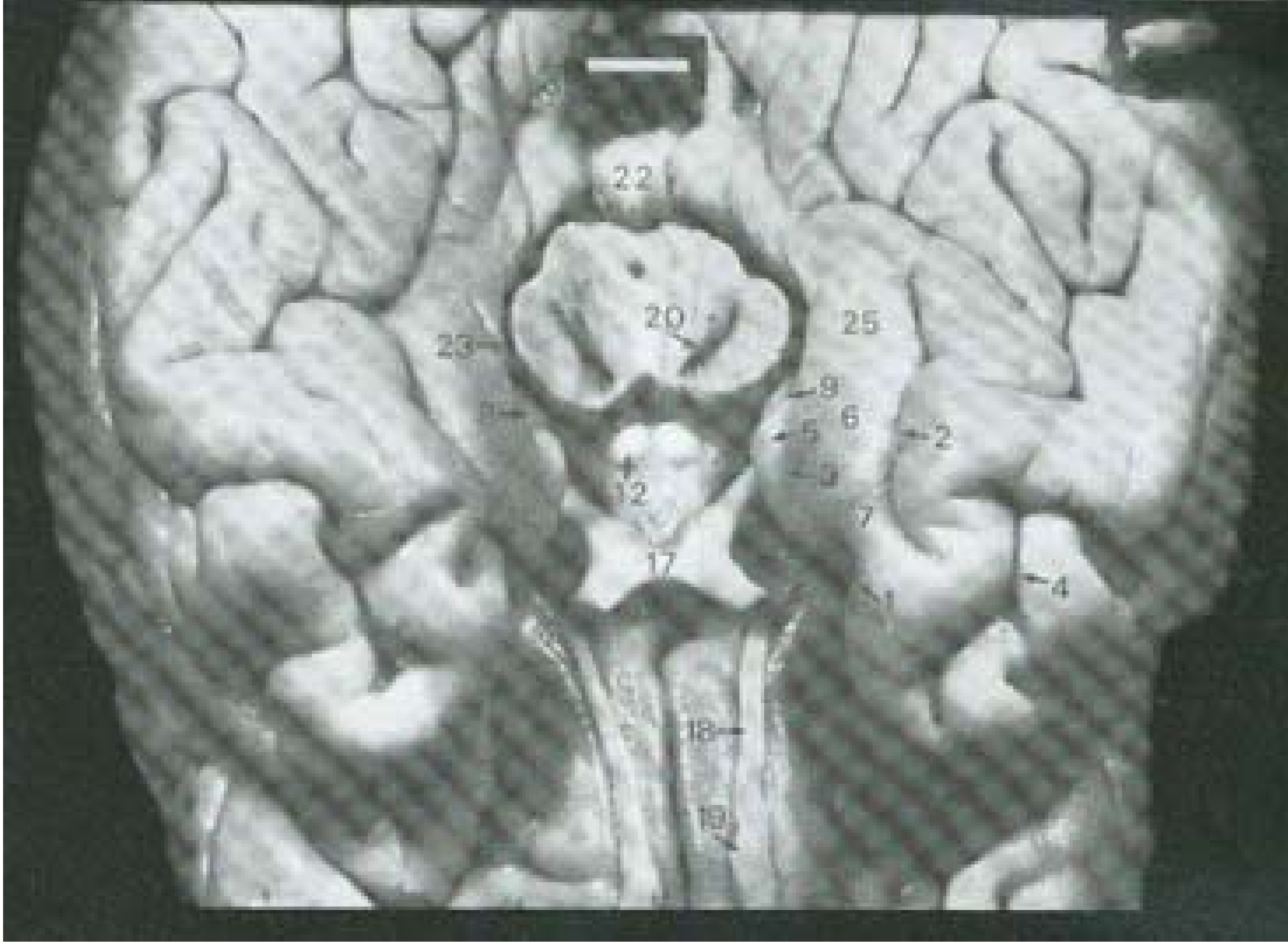


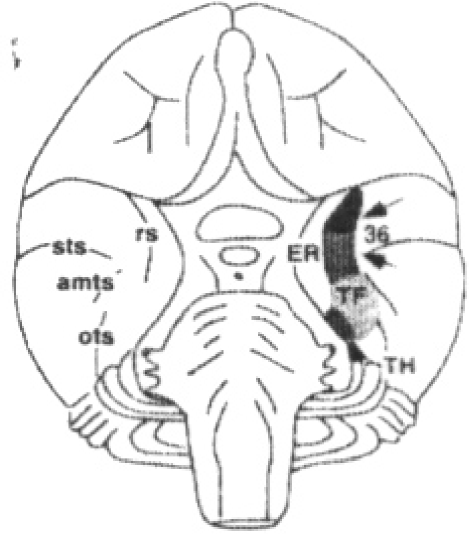
FIGURE 74: Limbic Lobe

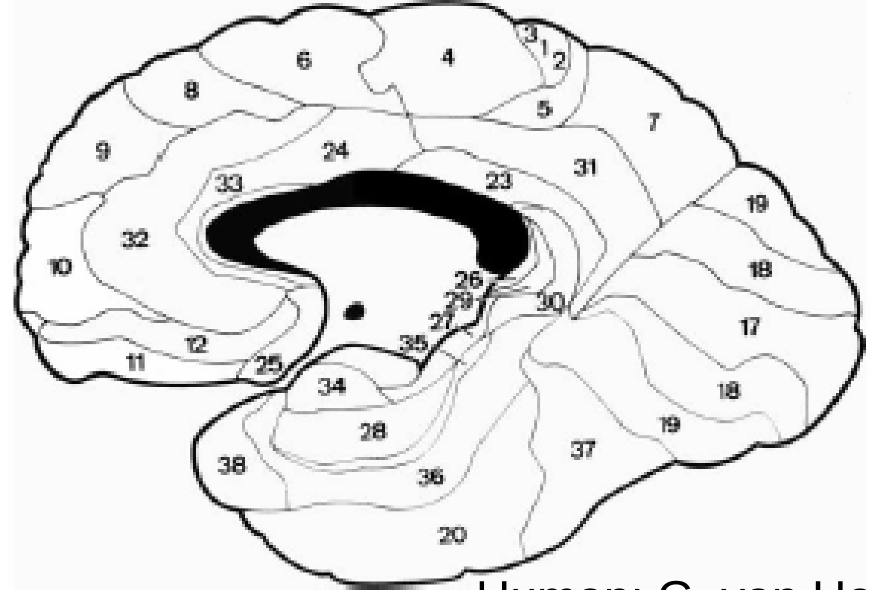
From Hendelman, 2000



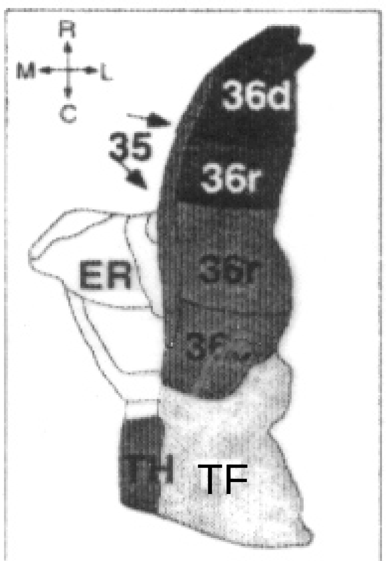
1-rhinal sulcus; 2-collateral sulcus; 3-intrrhinal sulcus; 4-occipitotemoral sulcus; 5-gyrus ambiens; 6-entorhinal ctx; 7-perirhinal ctx, anterior portion; 8-uncus; 9-hippocampal fissure; 10-s. semiannularis; 12- mammillary bodies; 17-optic chisam; 18-olfactory tract; 19-olf. Bulb; 20-substantia nigra; 22-corpus callosum (splenium); 23-choroidal fissure; 25-parahippocampal gyrus (From Insausti and Amaral, 2004)

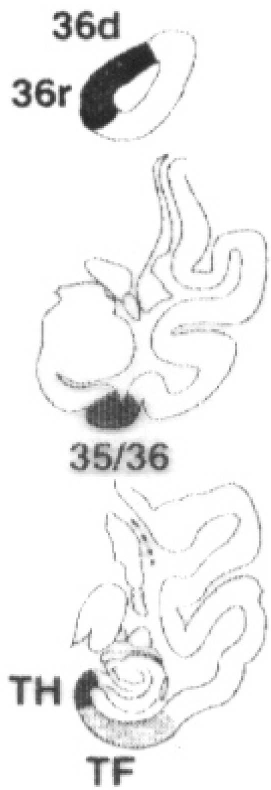
Monkey-From Amaral

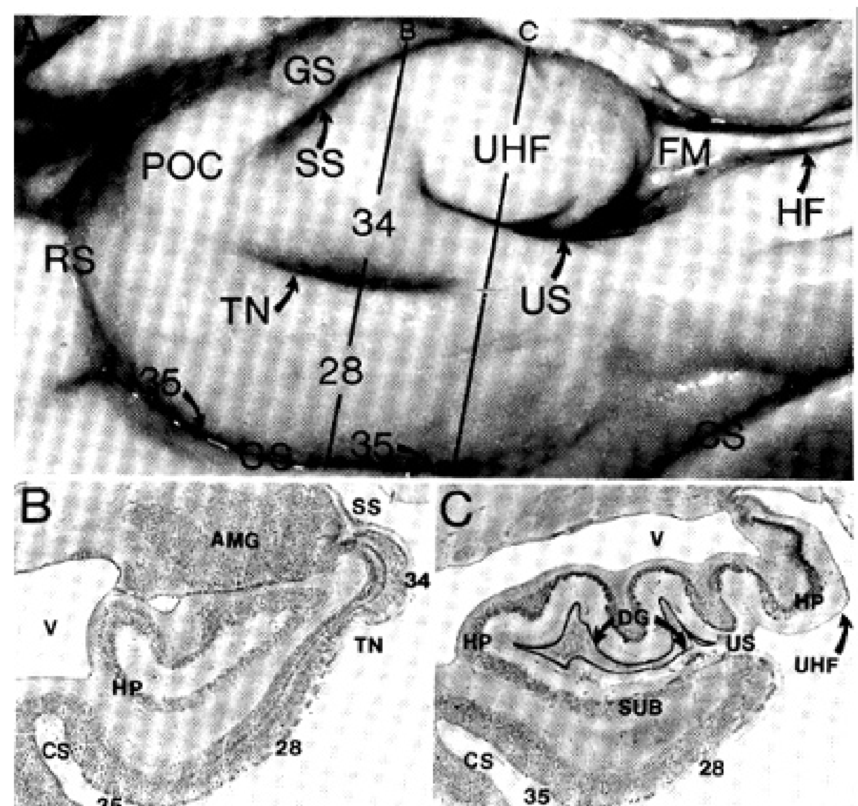


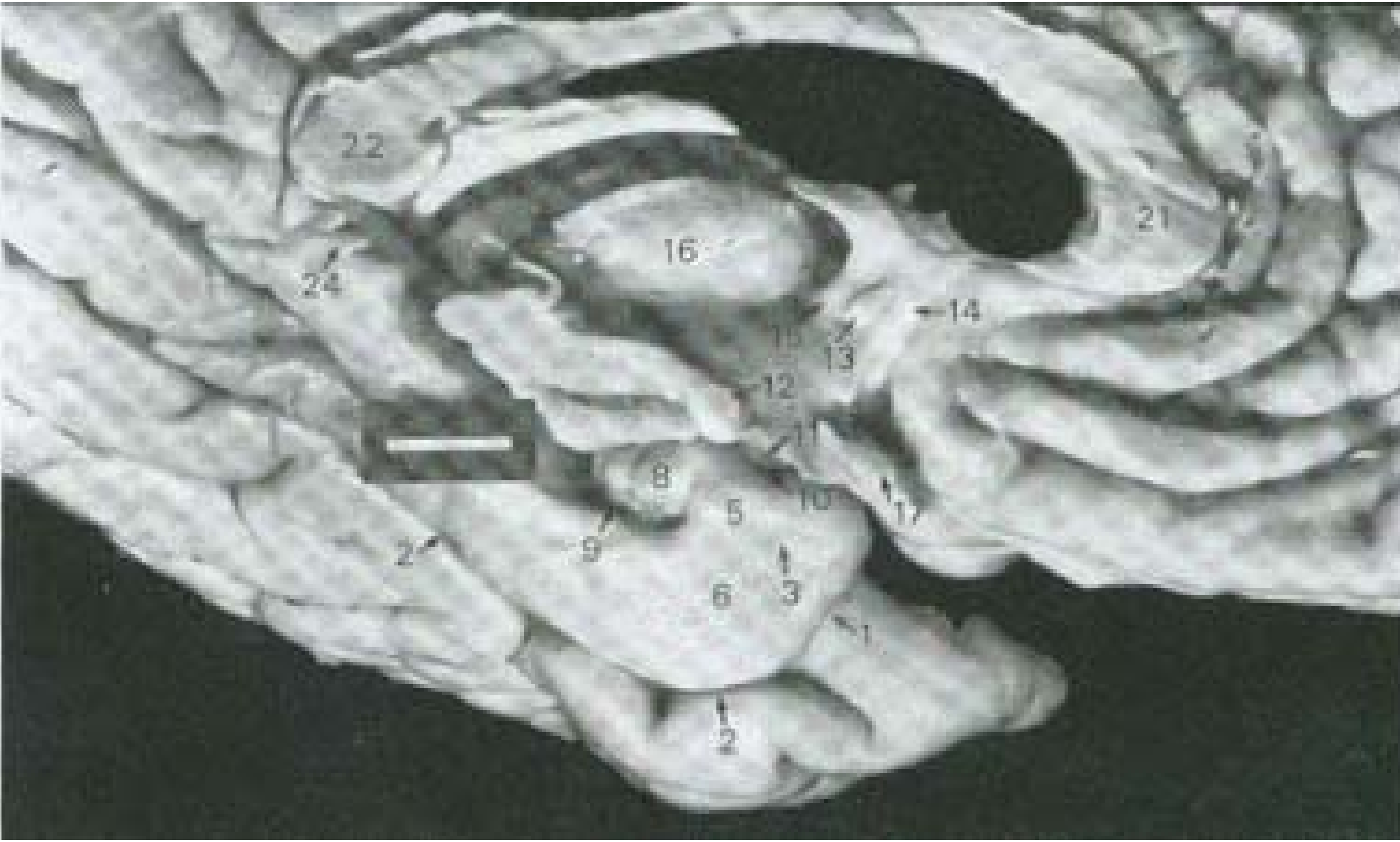


Human: G. van Hoesen



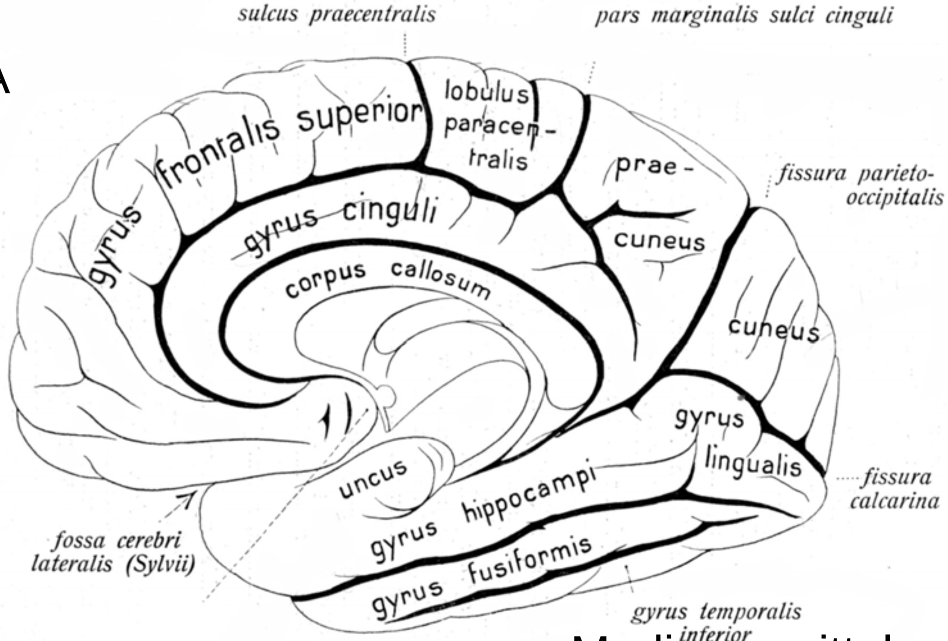




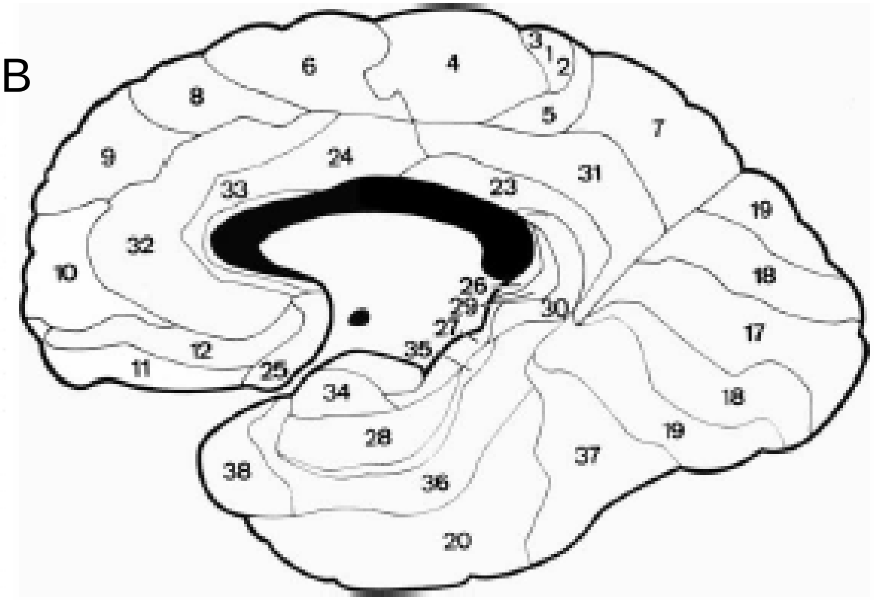


1-rhinal sulcus; 2-collateral sulcus; 3-intrrhinal sulcus; 5-gyrus ambiens; 6-entorhinal ctx; 8-uncus; 9-hippocampal fissure; 10-sulcus semiannularis; 11-gyrus semilunaris;12-mammillary bodies; 13-anterior commissure; 14-precommissural fornix; 15-postcommissural fornix; 16-thalamus; 21-corpus callosum, rostrum; 22-corpus callosum

A

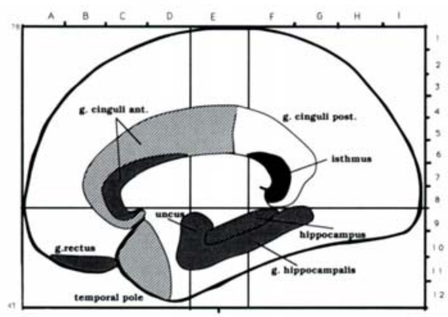


B

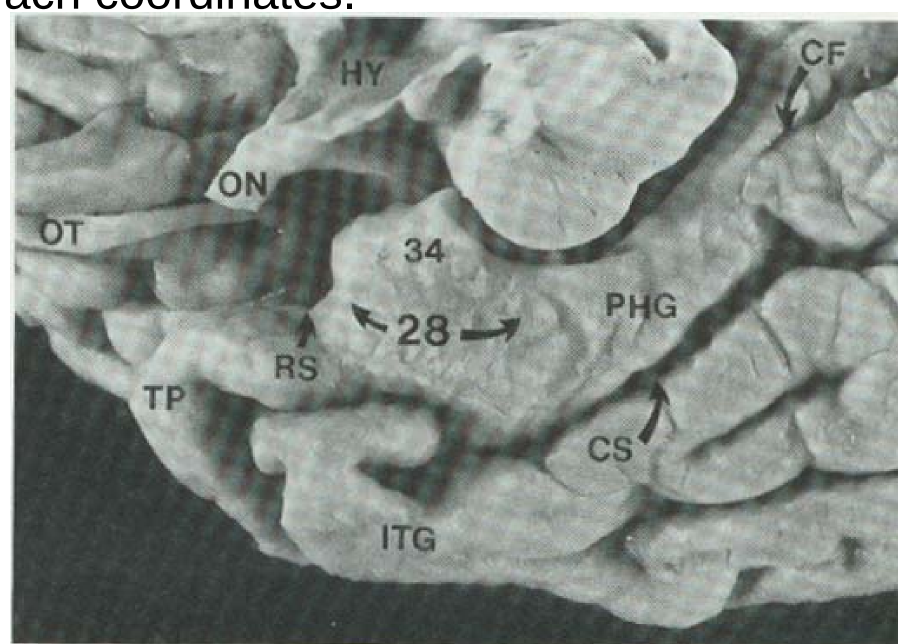


Median sagittal surface of the human (A , B,) brain. A: Sobotta, B: Broadmann; C: Roland, In (C) the scheme is drawn in the Talairach coordinates.

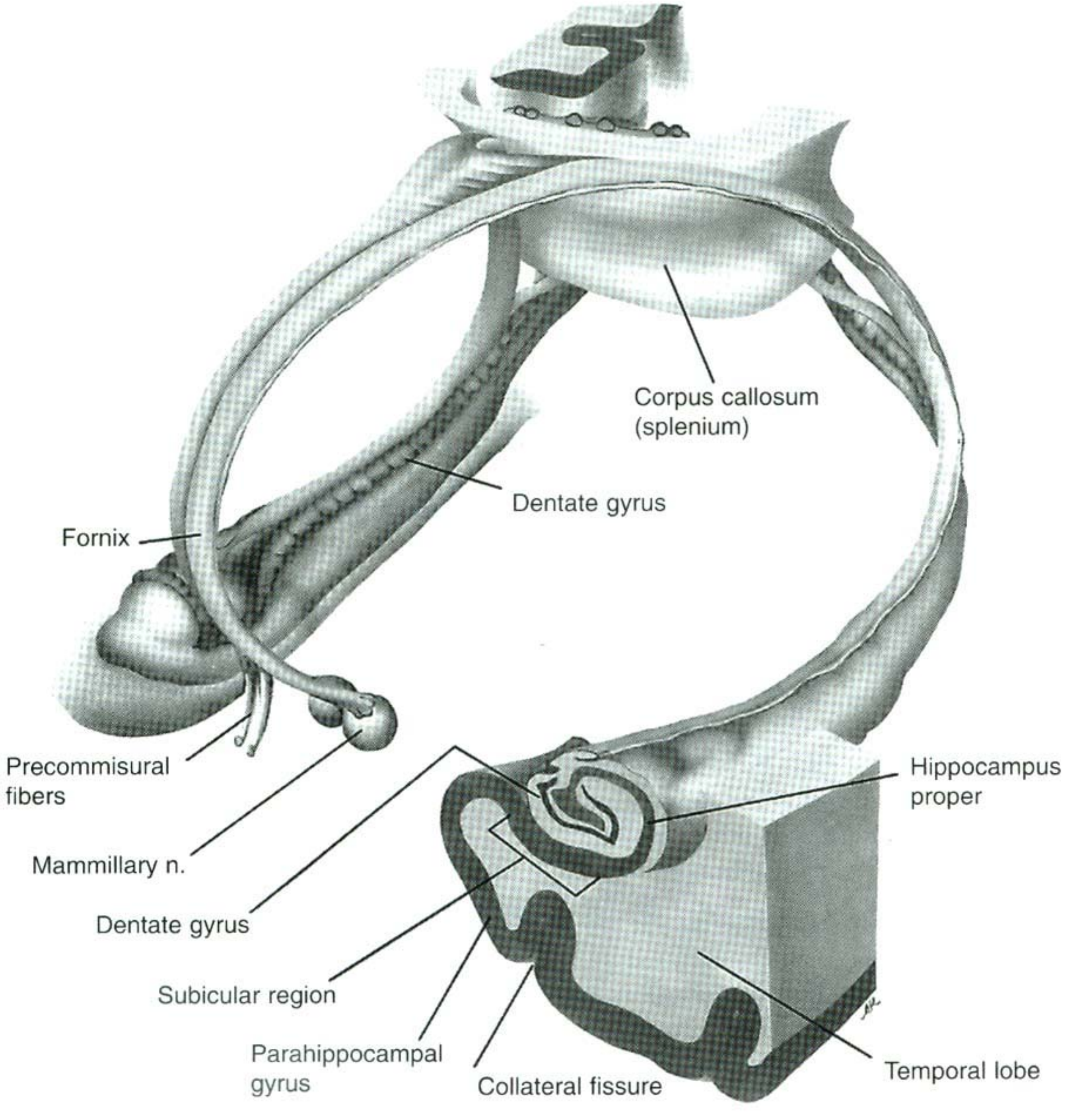
C



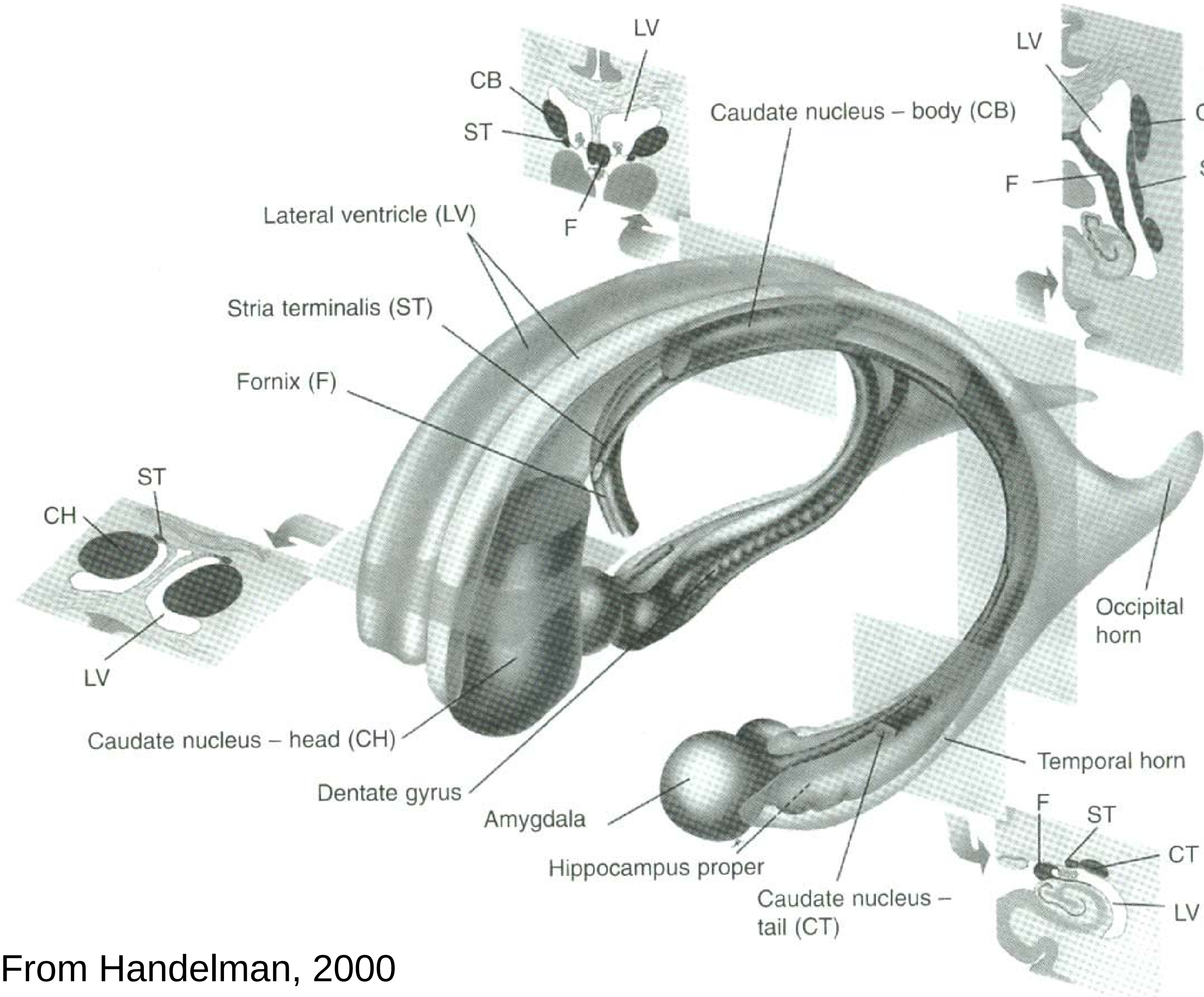
D



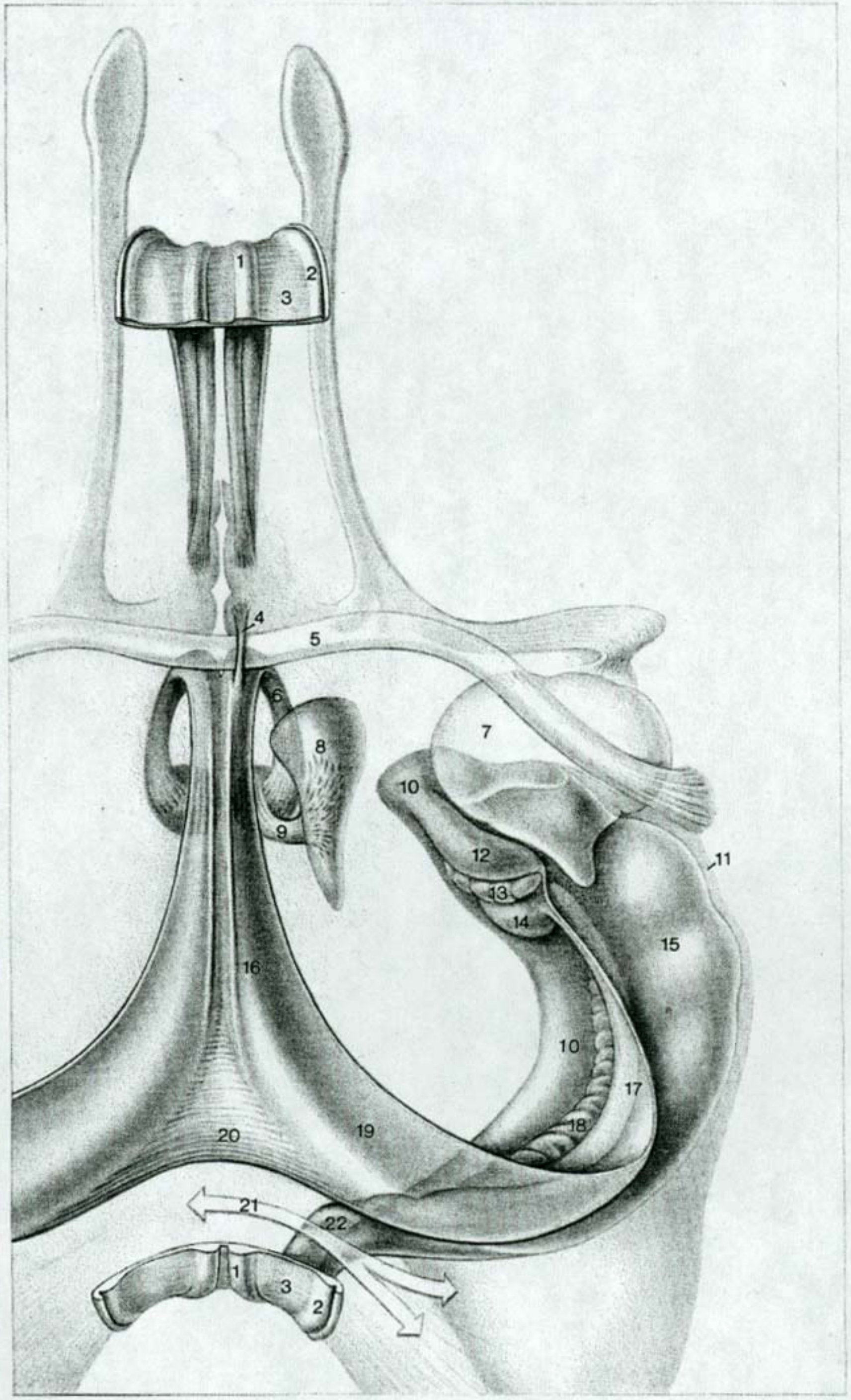
CS-collateral sulcus; FM fimbria; GS-semilunar gyrus; POC-primary olfactory cortex; RS- rhinal sulcus; SS-sulcus semianularis; TN-tentorial notch; UHF-uncal hippocampal formation; CF calcarine fissure; HIP hippocampus; ITG inferior temporal gyrus; OT olfactory tract; PHG-parahippocampal gyrus; TP-temporal pole: 28-atrophic entorhinal area (From G vanHoesen)



From Handelman, 2000



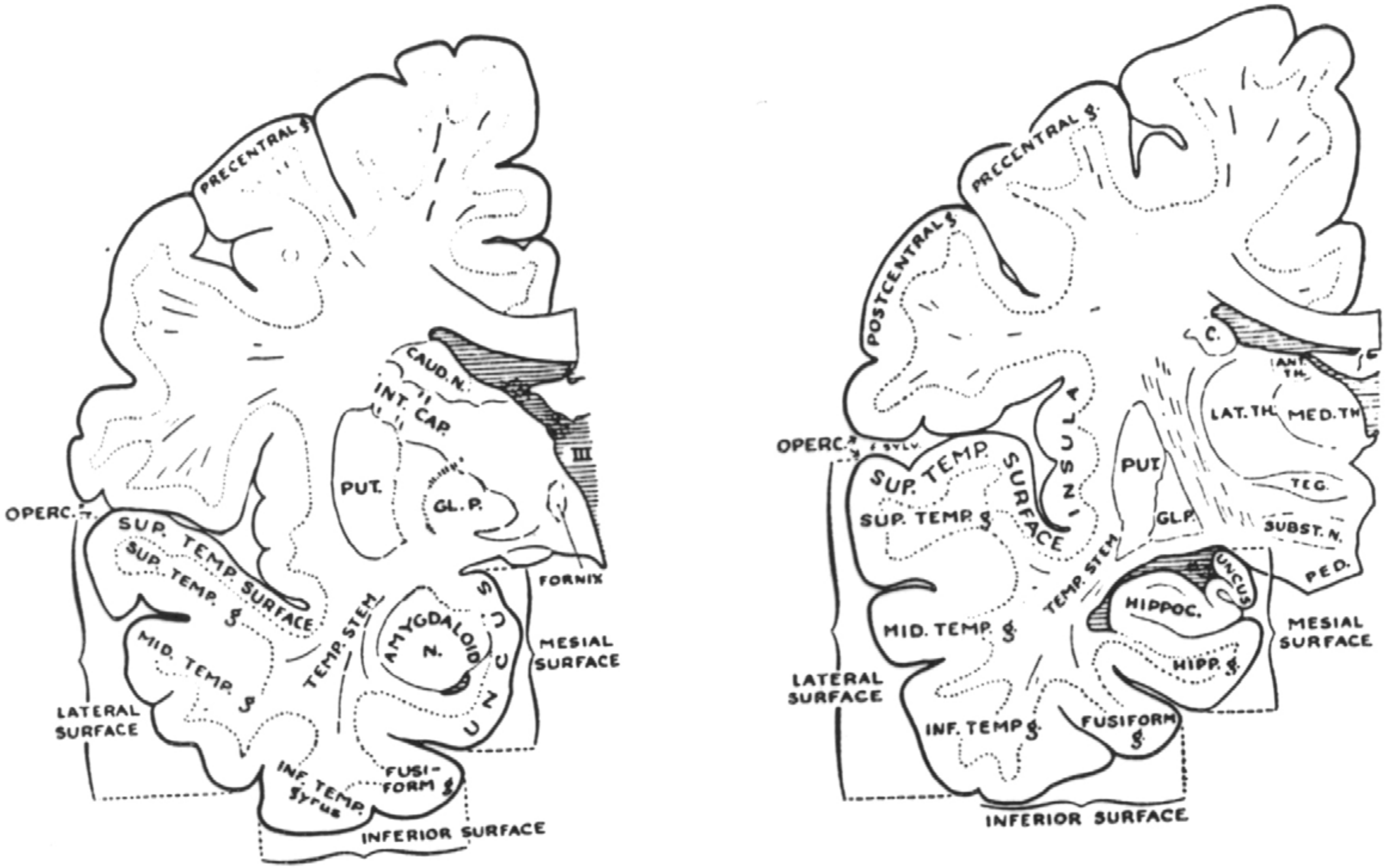
From Handelman, 2000



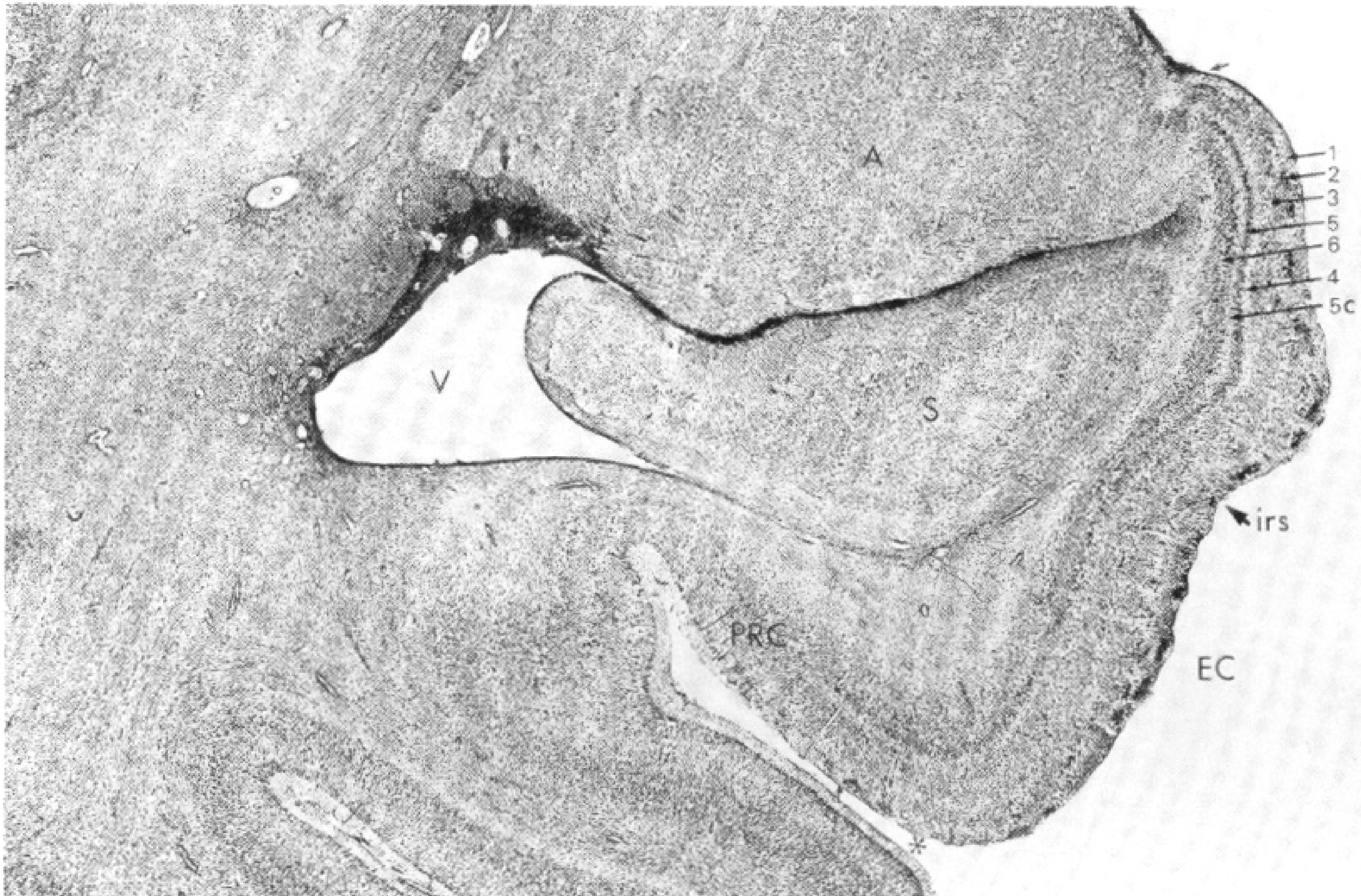
1 Stria longitudinalis medialis
2 Stria longitudinalis lateralis
3 Indusium griseum
4 Fornix precommissuralis
5 Commissura anterior
6 Columna fornicis
7 Corpus amygdaloideum
8 Nucleus anterior thalami
9 Tractus mamillothalamicus
10 Subiculum
11 Ventriculus lateralis, cornu inferius
12 Cornu ammonis (gyrus uncinatus)
13 Limbus Giacomini
14 Cornu ammonis (gyrus intralimbicus)
15 Cornu ammonis (digitationes hippocampi)
16 Corpus fornicis
17 Fimbria hippocampi
18 Gyrus dentatus
19 Crus fornicis
20 Commissura fornicis
21 Site of corpus callosum
22 Gyrus fasciolaris

Neuwenhys

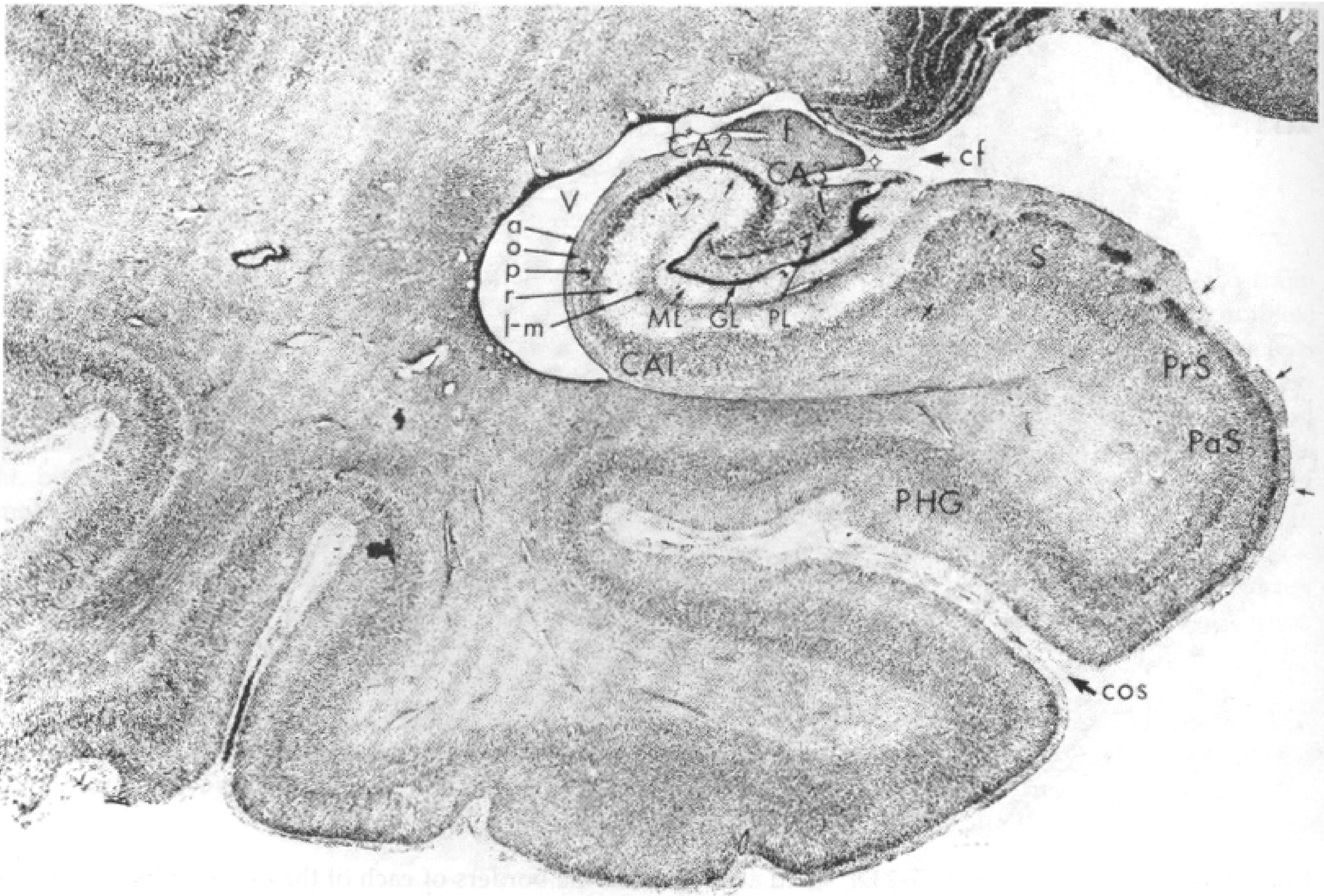
Medial Temporal Lobe. Amygdala and hippocampus



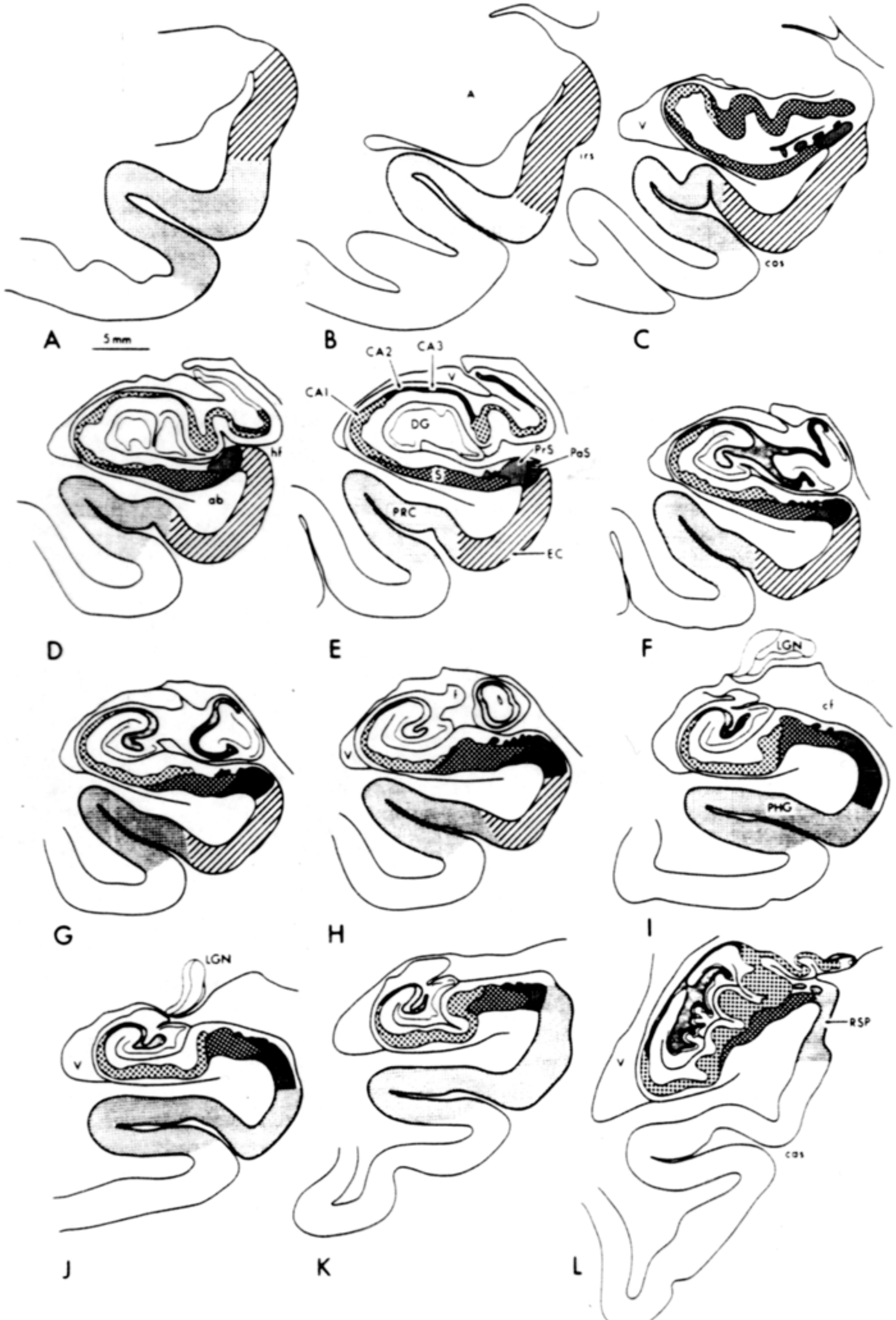
From Amaral



Amaral

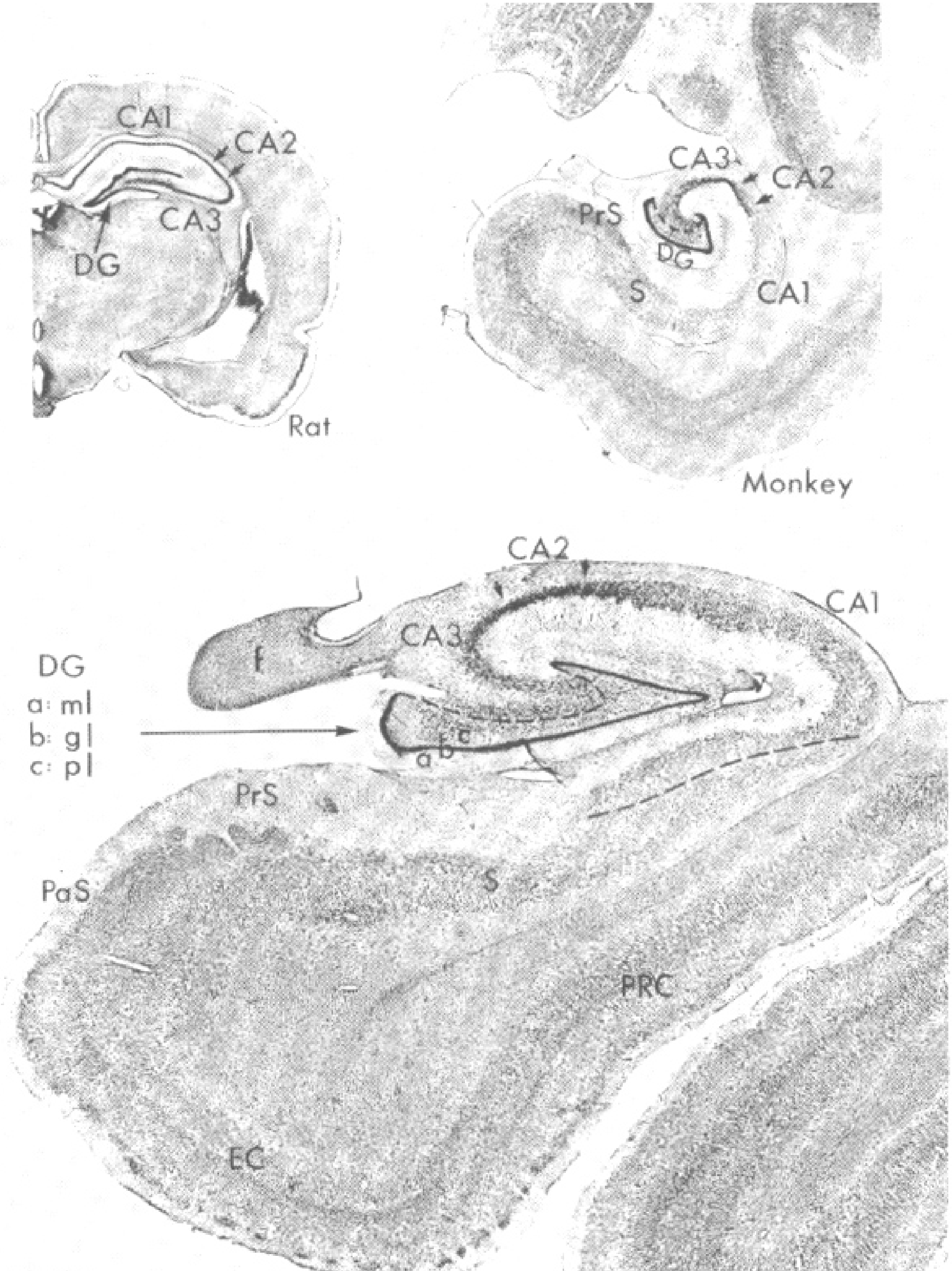


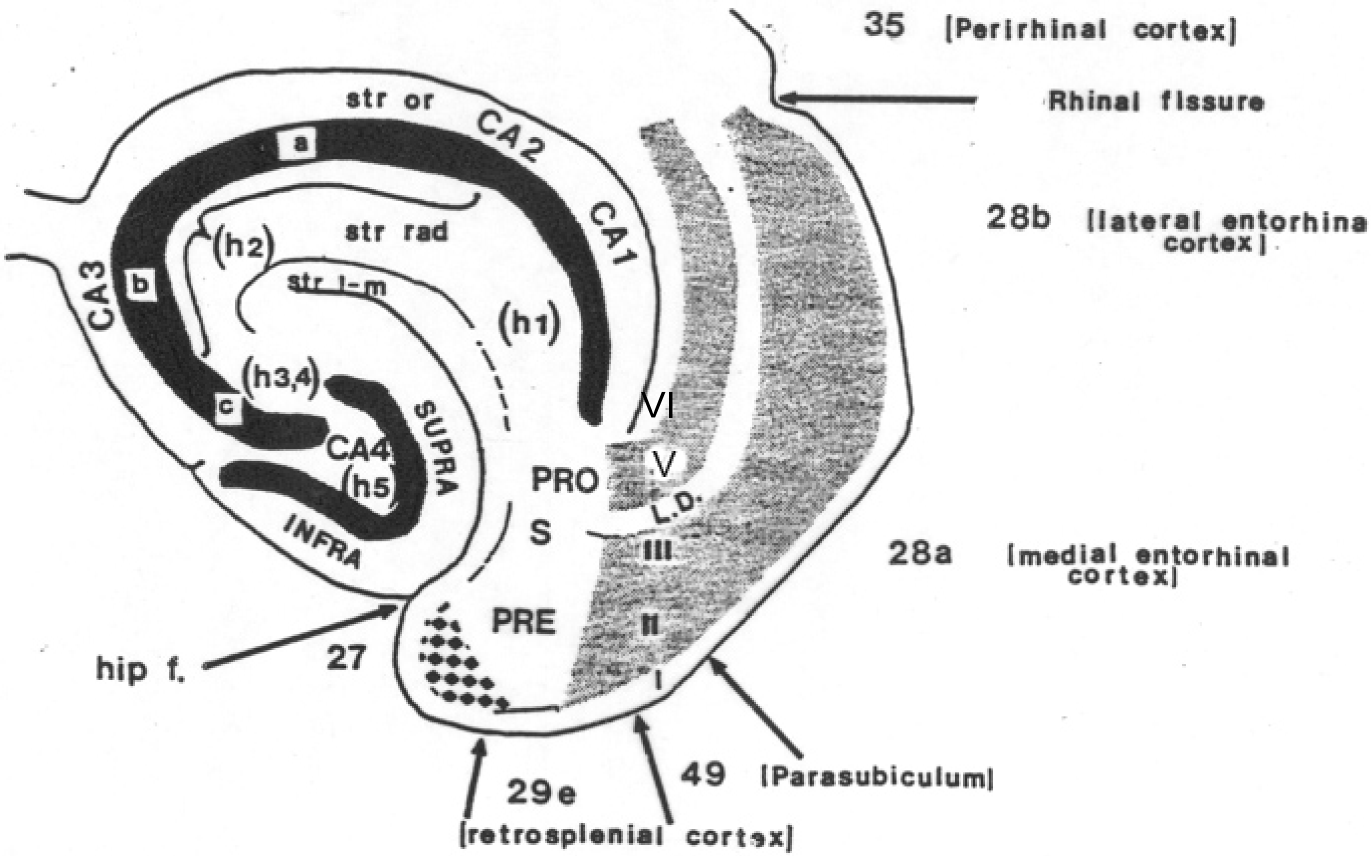
fusiform gyrus



From Amaral

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.


CA1
CA2
CA3
DG
Rat
CA3
CA2
PrS
DG
S
CA1
Monkey
CA2
CA1
CA3
f
DG
a: ml
b: gl
c: pl
a
b
c
PrS
PaS
S
PRC
EC

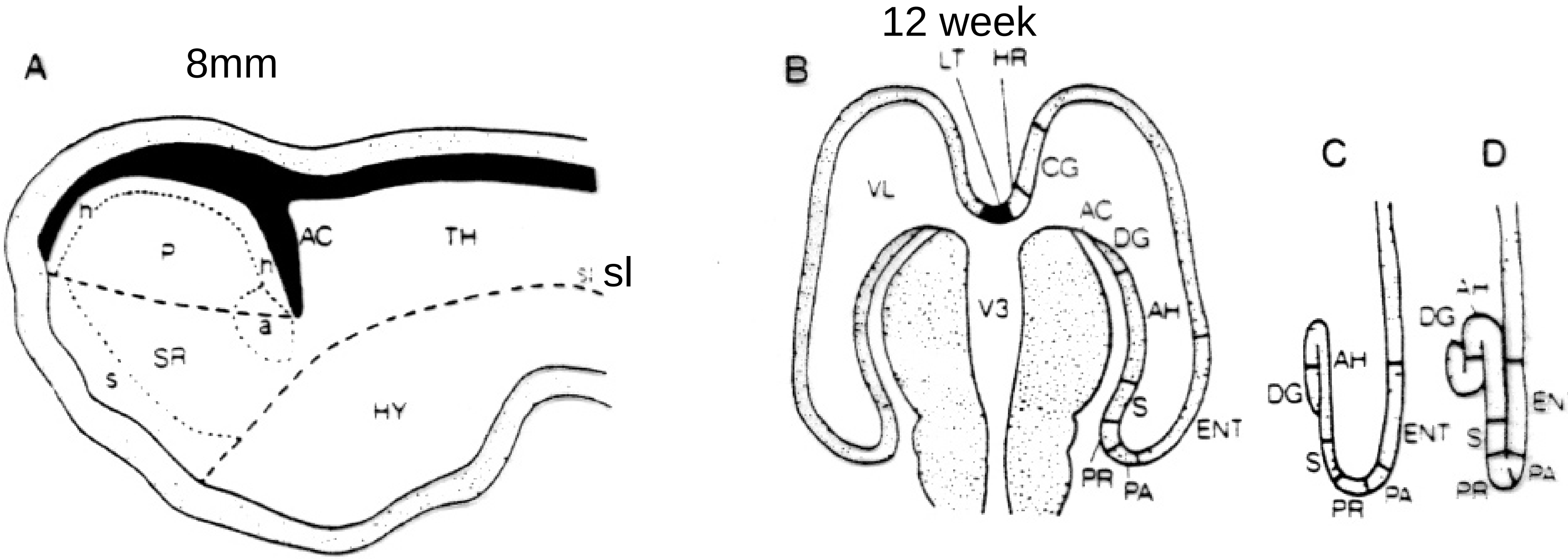


. A schematic representation of a cross section through the hippocampal formation. Numerals, by themselves, refer to Brodmann's areas as described in the text. CA_1, CA_2, CA_3, and CA_4 refer to parts of the hippocampus as described by Lorente de No. The small letters in the shaded region refer to subareas 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.

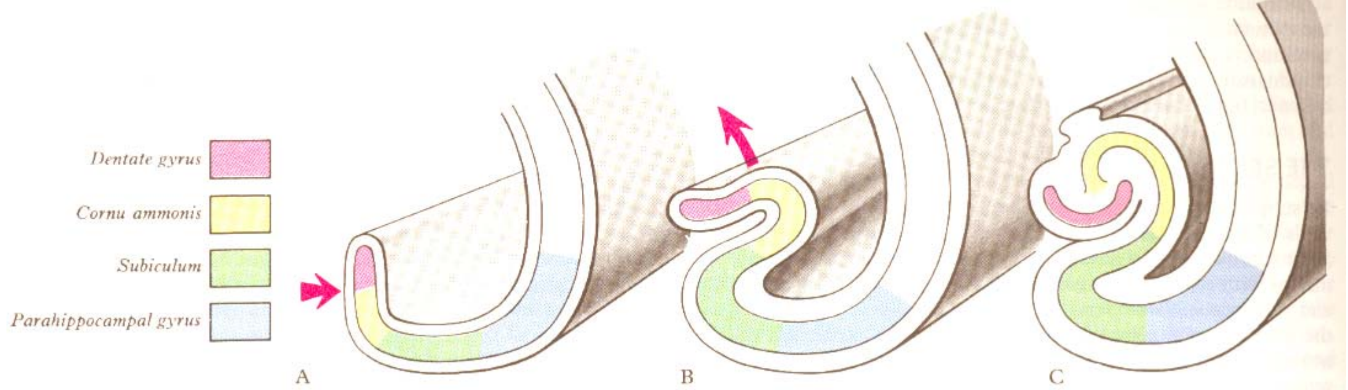
Frequently Used Terms and Subdivisions of Hippocampal Formation

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]			V
	perirhinal area	area 35		VI
	ectorhinal ctx	area 36		

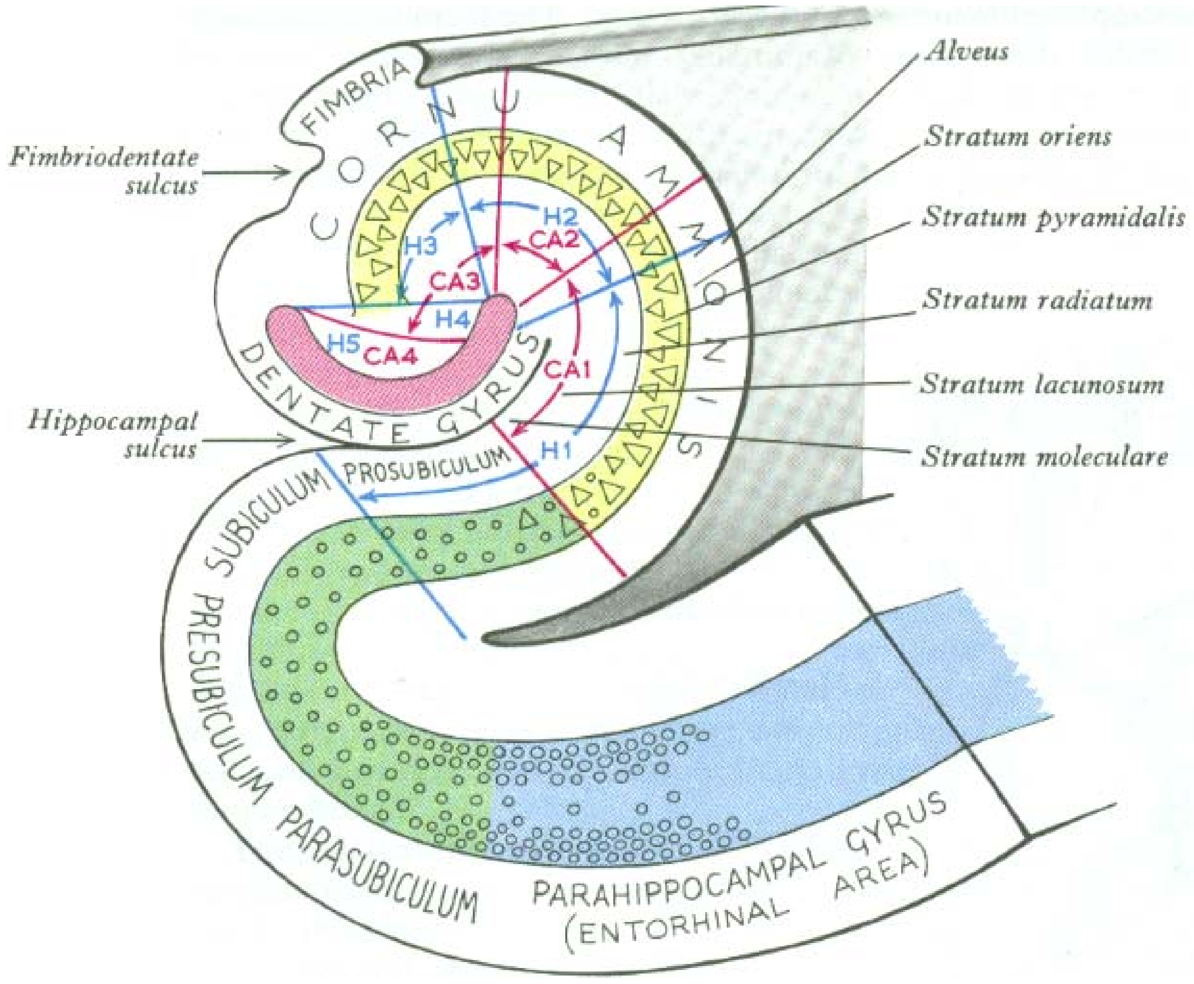
Parahippocampal gyrus (cortex): anterior part (entorhinal cortex and associated perirhinal cortex (areas 35,36); posterior part that includes TF and TH of von Economo.



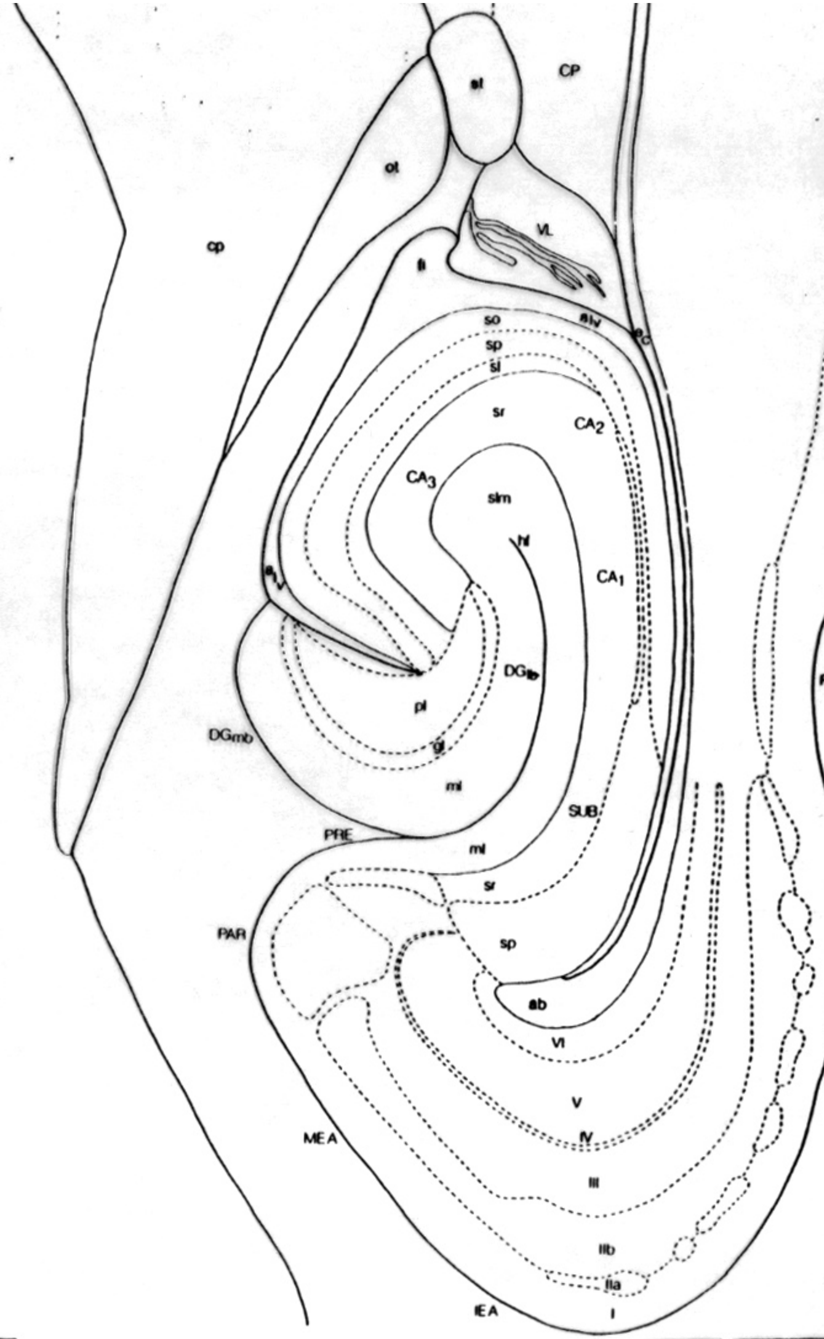
A: midsagittal, B: horizontal; C-D medial wall of the telencephalon to show how the dentate gyrus (DG) and the Ammons's horn (AH)may fold during progressively later stages to assume the shape illustrated in the subsequent figure. AC-choroideal area; CG-cingulate gyrus; ENT-entorhinal area; HR-hippocampal rudiment; HY-hypothalamus; LT-lamina terminalis; P-pallium; PA-parasubiculum; PR-presubiculum; S-subiculum; SR-striatal ridges; TH-thalamus; V3 3rd cventricle; VL-lateral ventricle; a-amygdala; h-hippocampal region; s-septal region; sl-sulcus limitans



The amount of curvature and infolding which occurs varies along the length of the hippocampus. Following folding the original external surfaces of the dentate gyrus and part of the subiculum are in contact. The degree of fusion along the hippocampal sulcus is quite variable (From GRAY's Anatomy).

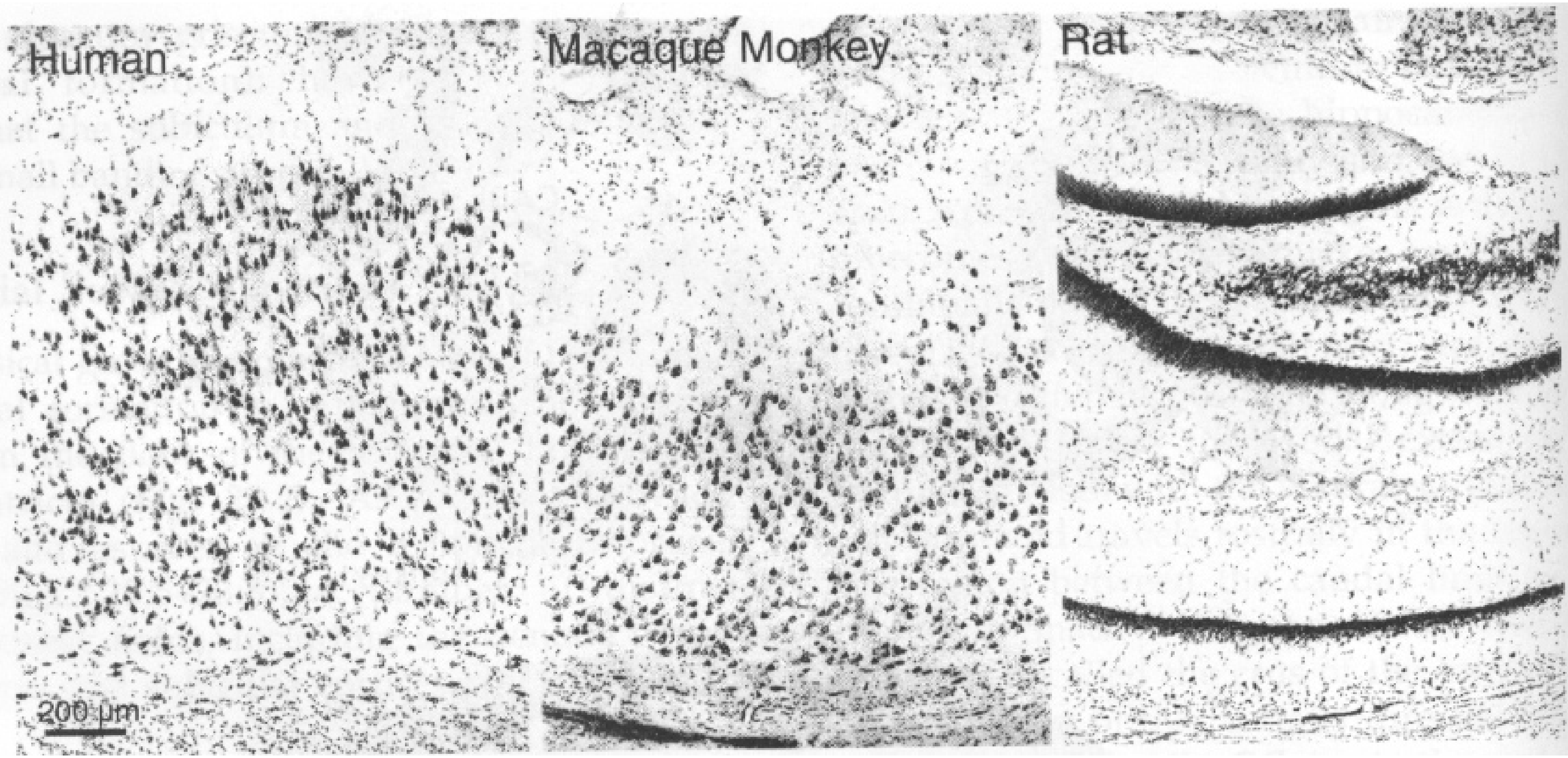



VL
alv
CA3
CA1
PERI
DG
SUB
hf
PRE
PAR
ab
MEA
LEA
III
I

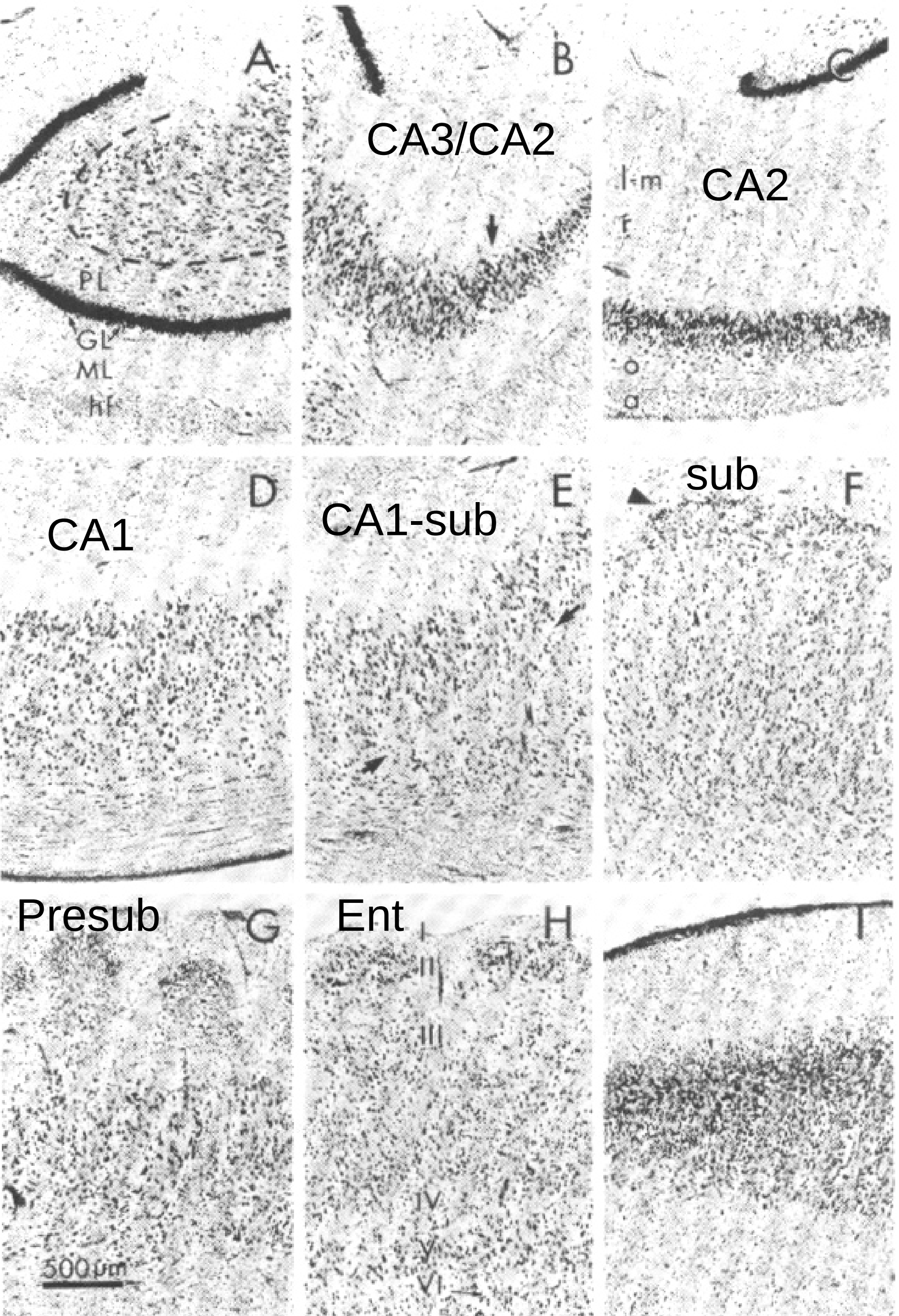

CP
st
ot
VL
cp
fi
so
alv
sp
sl
sr
CA2
CA3
slm
hf
CA1
pl
DGmb
gl
ml
SUB
PRE
ml
sr
PAR
sp
ab
VI
V
IV
MEA
III
IIb
IIa
LEA
I

Swanson

CA1 field of the hippocampus in human, monkey and rat



Insausti and Amaral



A: dentate gyrus: ML-molecular; GL-granualr; PL-polymorph layers. Dashed line marks the border toward the polymorph layer;

B: transition between CA3/CA2;

C: CA2; a-alveus; o-oriens, r radiatum; lm-lacunosum moleculare;
D: CA1;

E: transition CA1/sub;

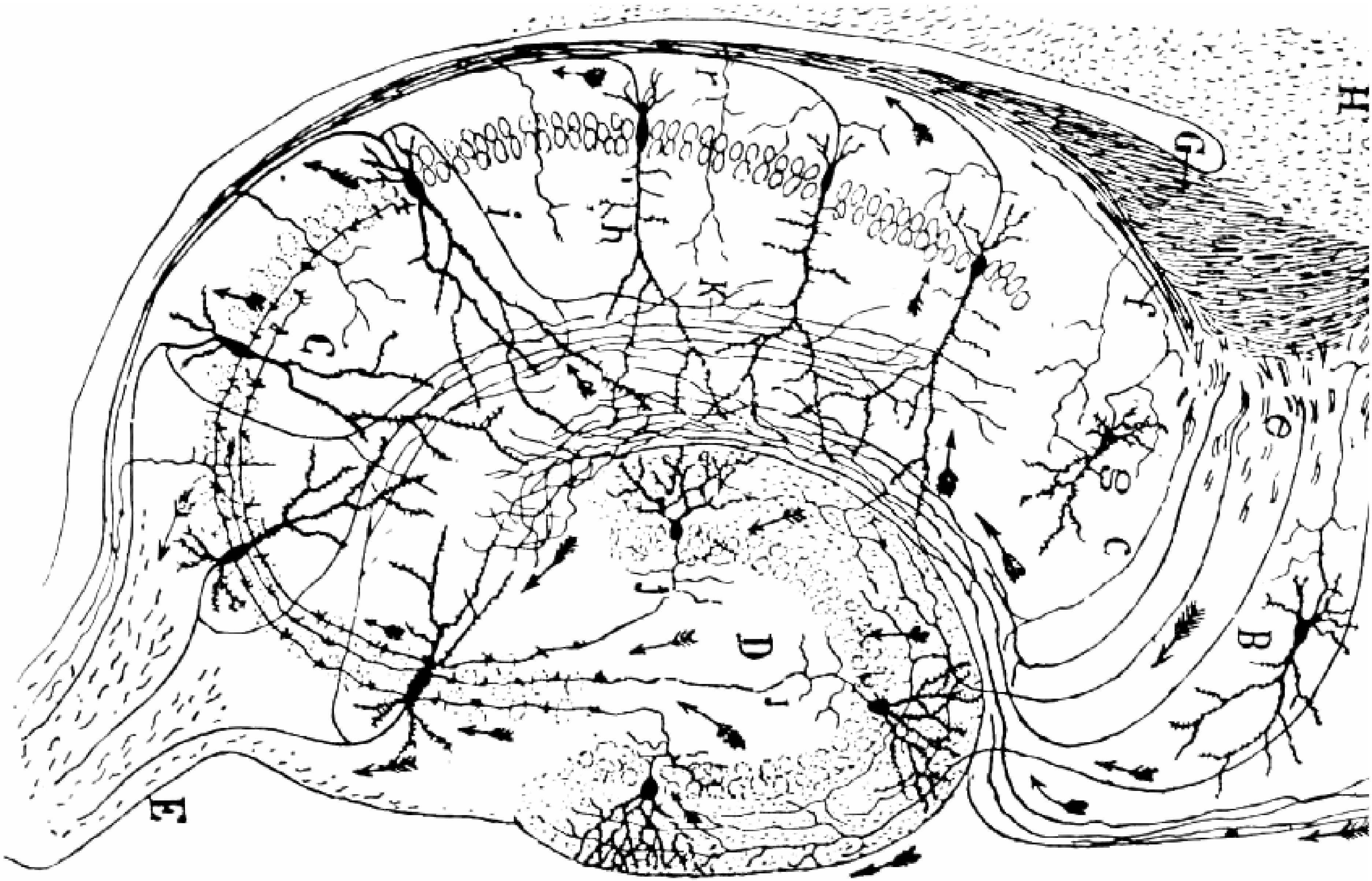
F: subiculum;

G:presubiculum;

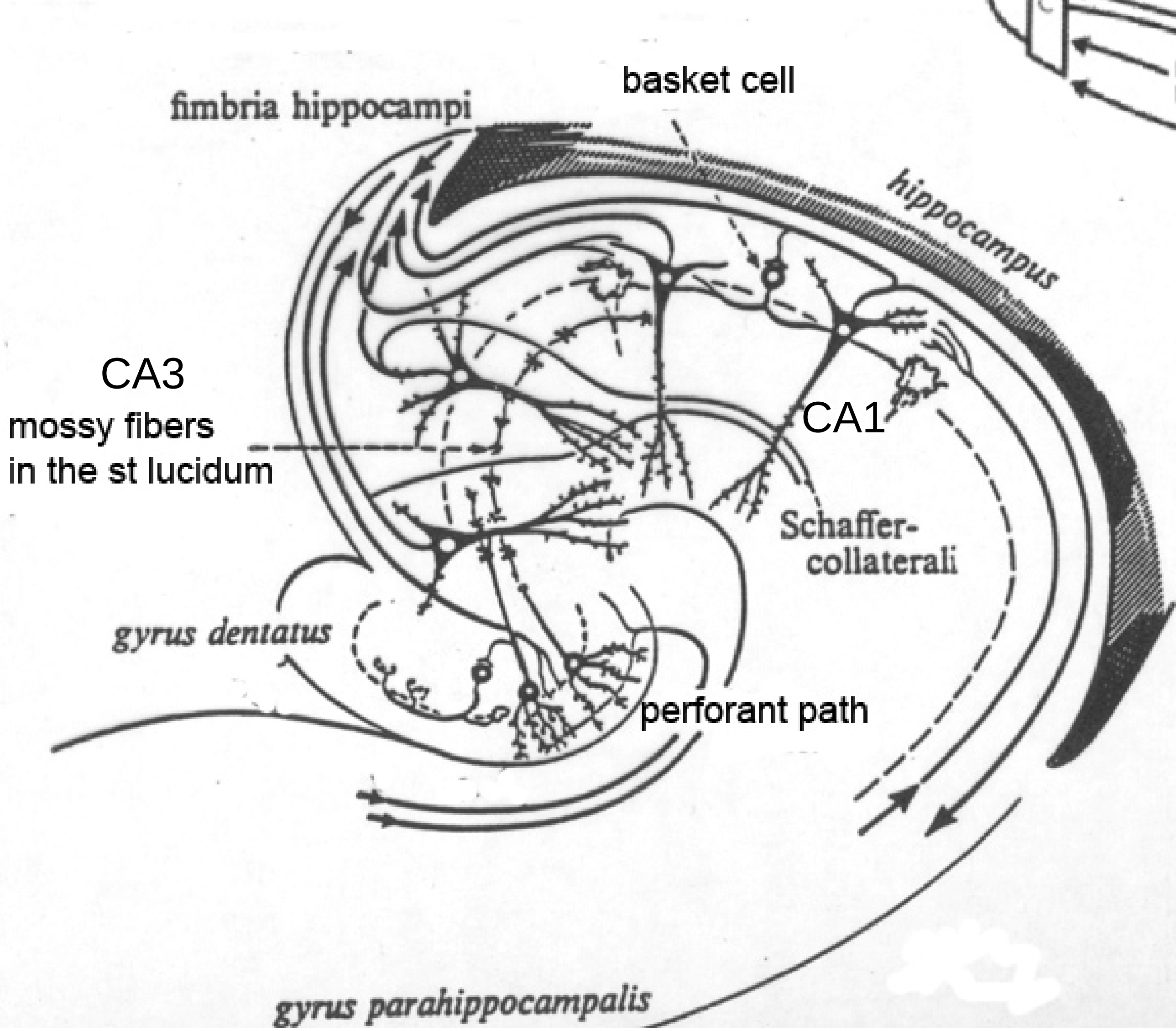
H: entorhinal ctx. Note the cell free layer IV-lamina dissecans;

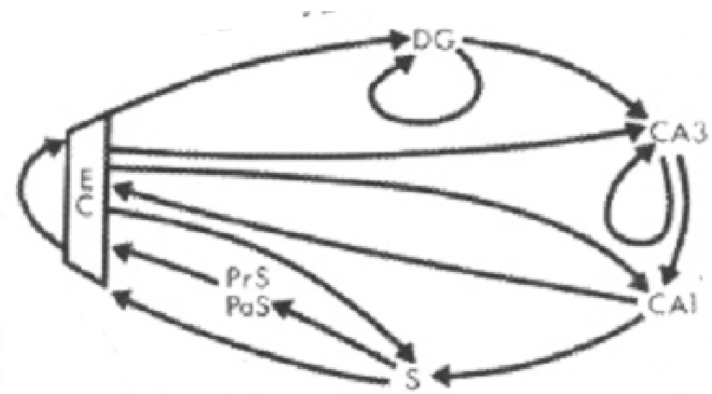
I: transition hippocampus/amygdala

INTRINSIC CIRCUITRY: S. RAMON Y CAJAL (1852-1934)

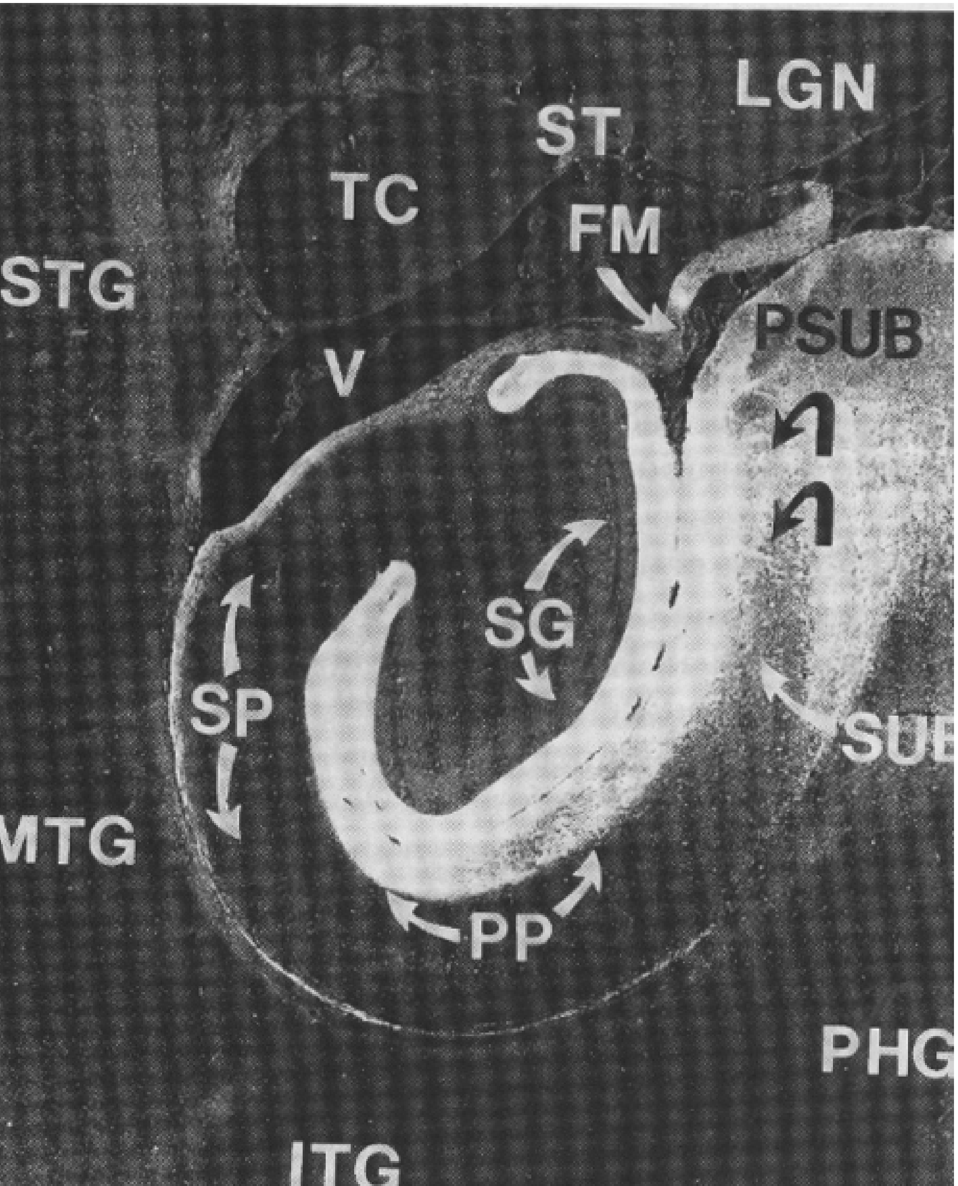


Intrinsic circuitry of the hippocampus

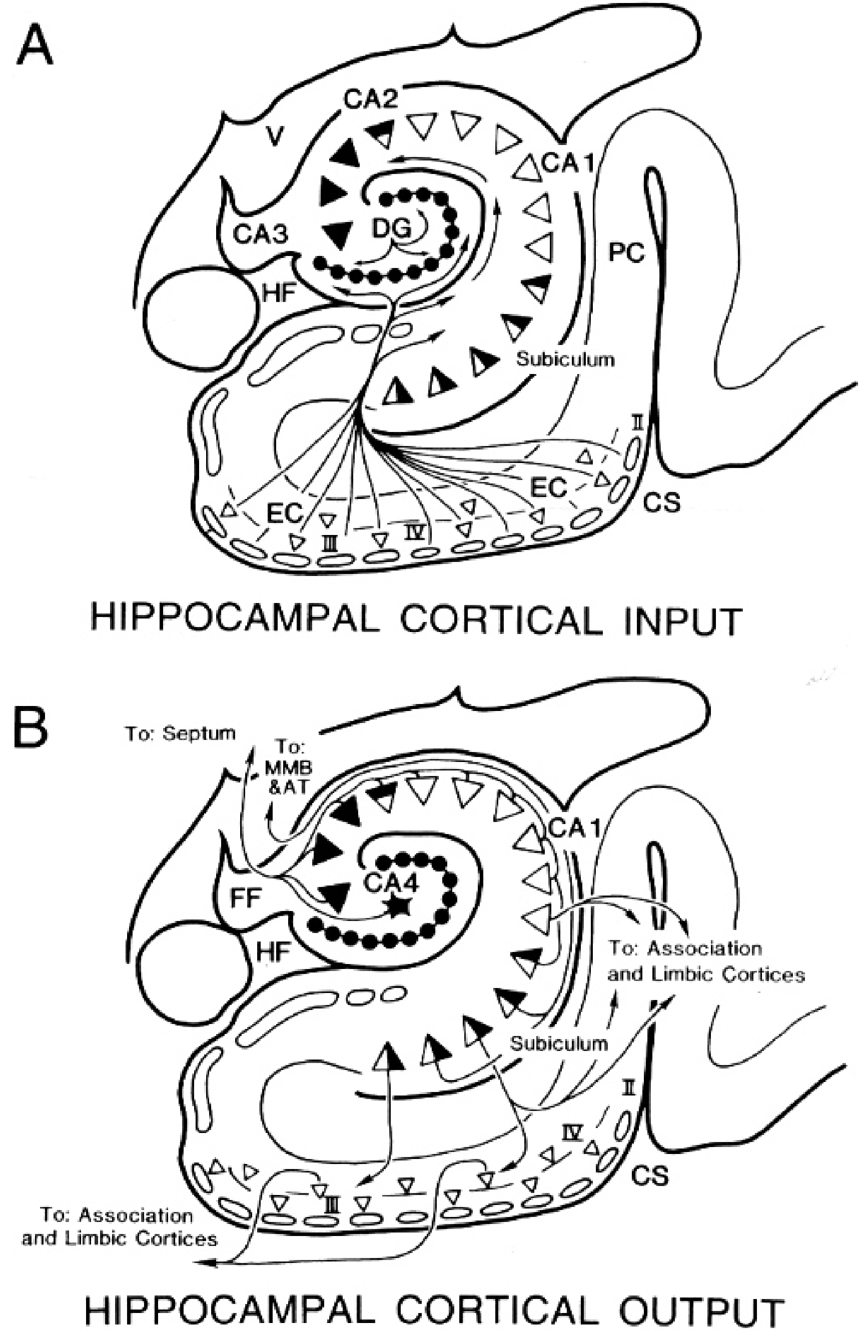




Revisited: Insausti and Amaral, 2004

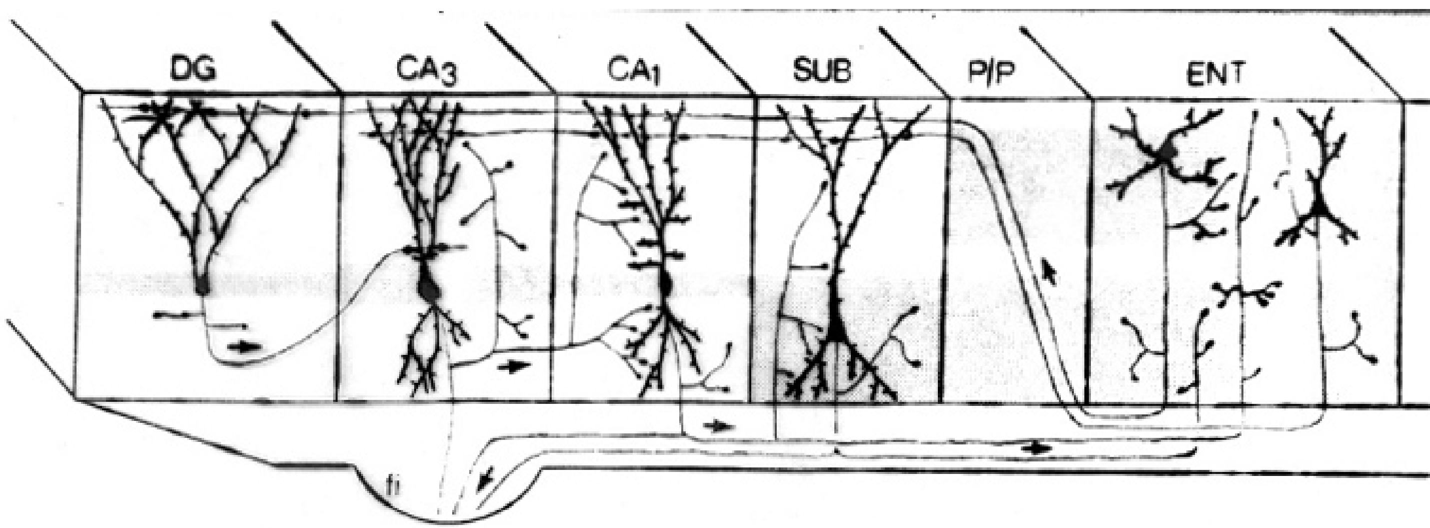


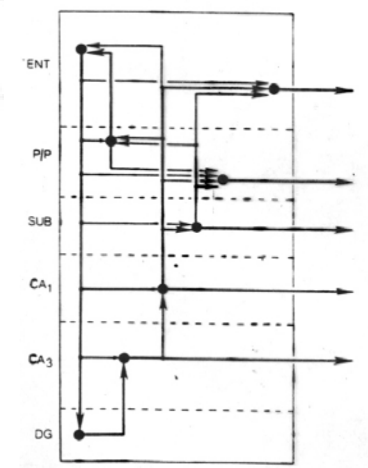
LGN
ST
TC
FM
STG
PSUB
V
SG
SP
SUB
MTG
PP
PHG
ITG

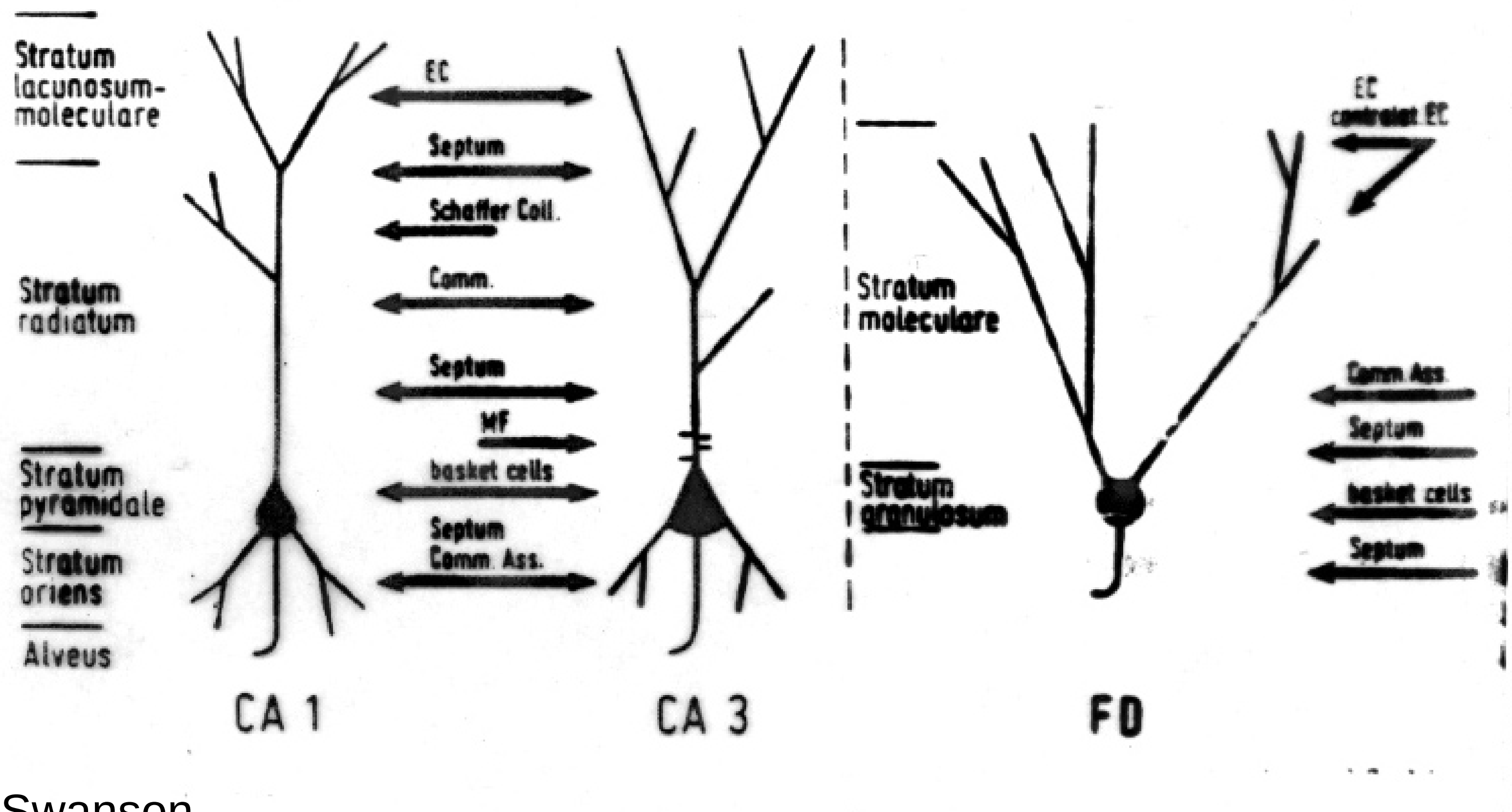


A
CA2
V
CA1
CA3
DG
PC
HF
Subiculum
II
EC
CS
EC
III
IV
HIPPOCAMPAL CORTICAL INPUT
B
To: Septum
To:
MMB
&AT
CA1
FF
CA4
HF
To: Association
and Limbic Cortices
Subiculum
II
IV
CS
III
To: Association
and Limbic Cortices
HIPPOCAMPAL CORTICAL OUTPUT

G. Van Hoesen

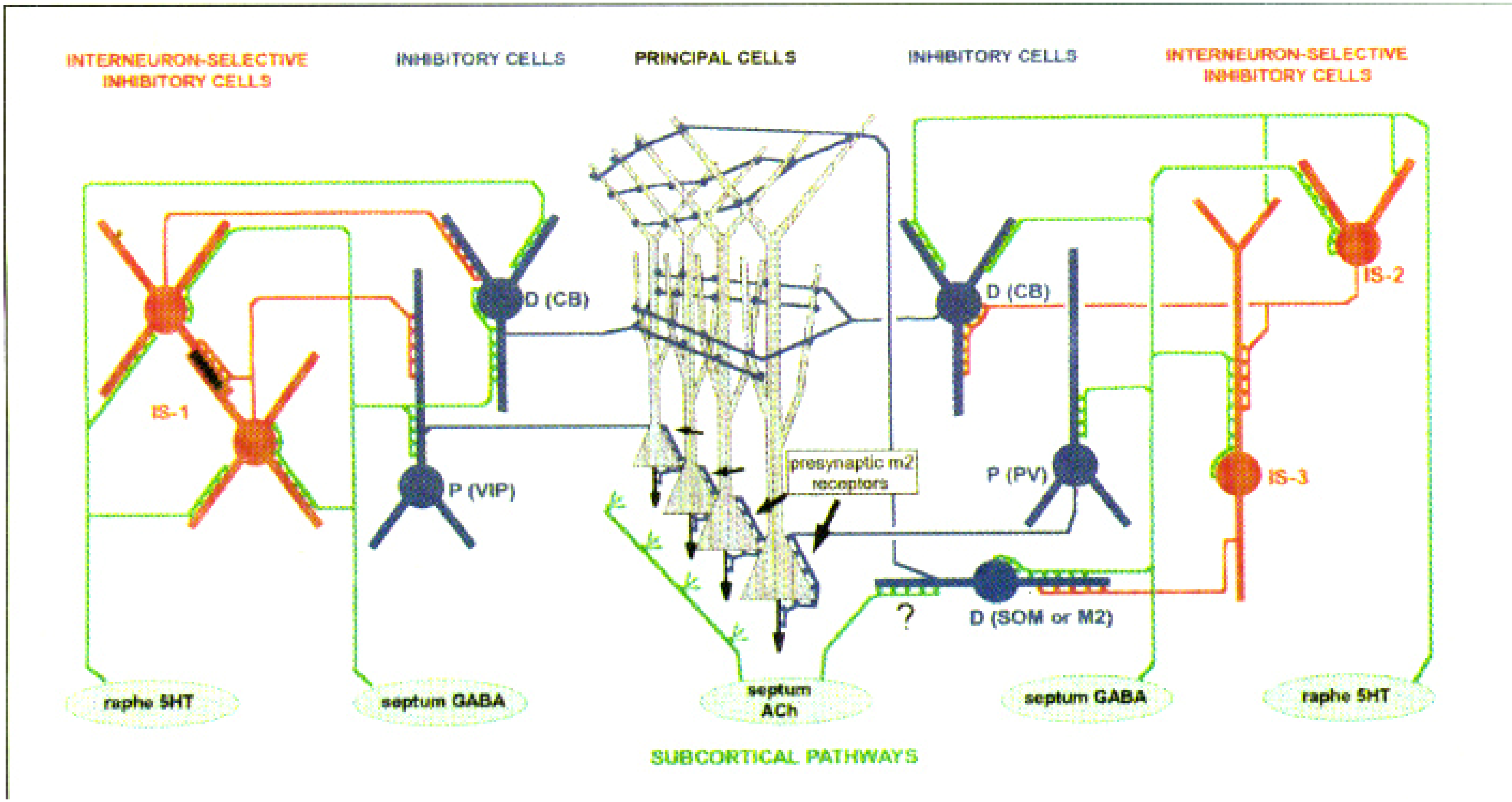






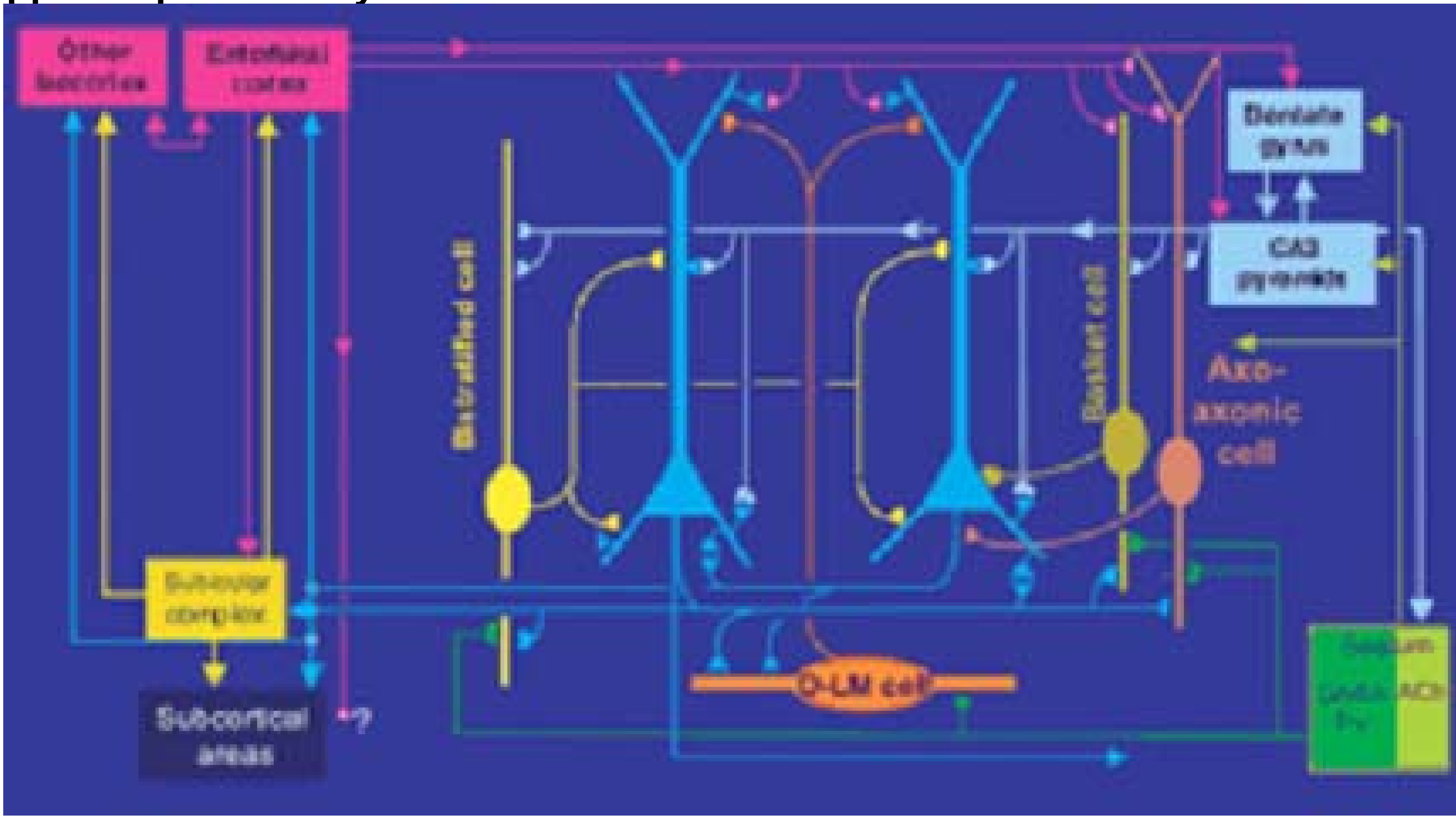
From Swanson

Hippocampal circuitry anno 1998



Freund

Hippocampal circuitry anno 2005



The schematic drawing summarizes the main synaptic connections in the CA1 area of pyramidal cells (blue), parvalbumin expressing basket, axo-axonic, bistratified and O-LM cells. The cells have differential temporal firing patterns during theta and ripple oscillations.The spike probability plots show that during different network oscillations representing two distinct brain states, interneurones of the same connectivity class show *different* firing activities and therefore modulate their specific postsynaptic target-domain in a brain-state-dependent manner. Interneurones belonging to different connectivity classes fire preferentially at distinct time points during a given oscillation. Because the different interneurones innervate distinct domains of the pyramidal cells, the respective compartments will receive GABAergic input at different time points. This suggests a role for interneurones in the temporal structuring of the activity of pyramidal cells and their inputs via their respective target domain in a co-operative manner, rather than simply providing generalized inhibition (SOMOGYI and Klausberger, 2005).

SUBCORTICAL HIPPOCAMPAL EFFERENTS ORIGINATE MAINLY IN THE SUBICULUM

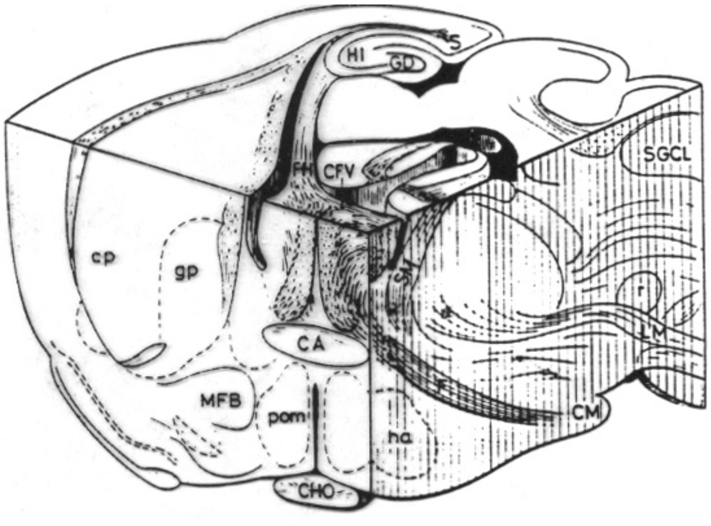


Figure 17 Three-dimensional drawing indicating the course of the fornix.

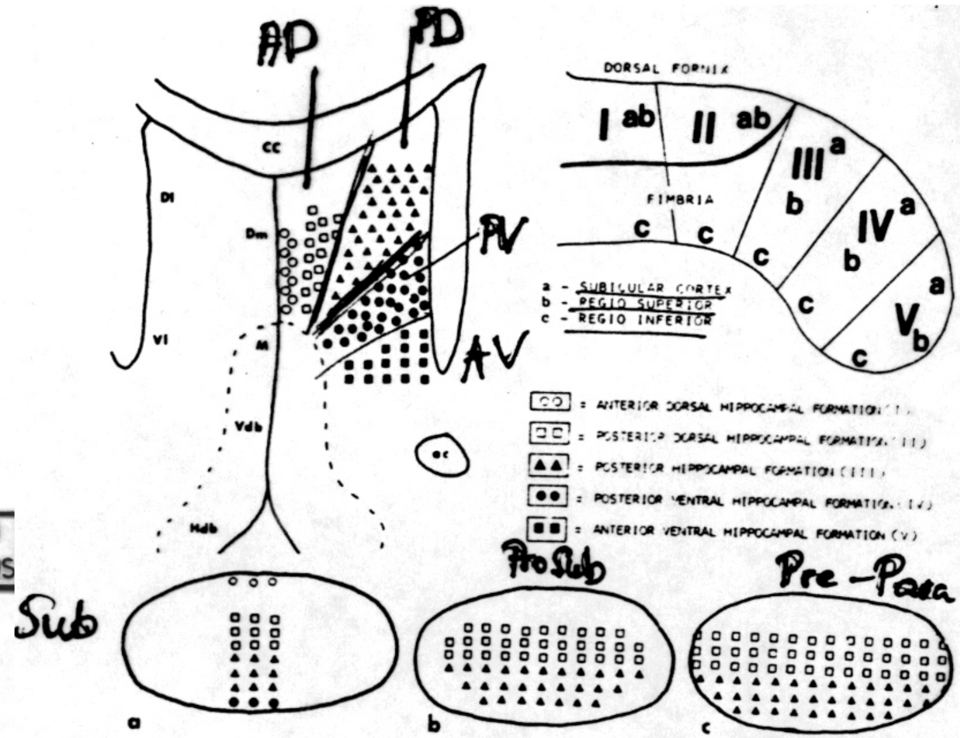


Fig. 11. Schematic diagram summarizing the topographical organization of the fornix projections to the mediolateral extent of the lateral septal nucleus and to the pars posterior of the medial mammillary nucleus. Three diagrams of the pars posterior reflect the differential projections of each of the components of the subicular complex, (a) lateral portion (prosubiculum), (b) central portion (subiculum), and (c) medial portion (pre- and parasubiculum). The dorsal fornix and fimbria, divided into 5 zones, represent the positions of fibers which arise from 5 different levels along the longitudinal axis of the hippocampal formation.

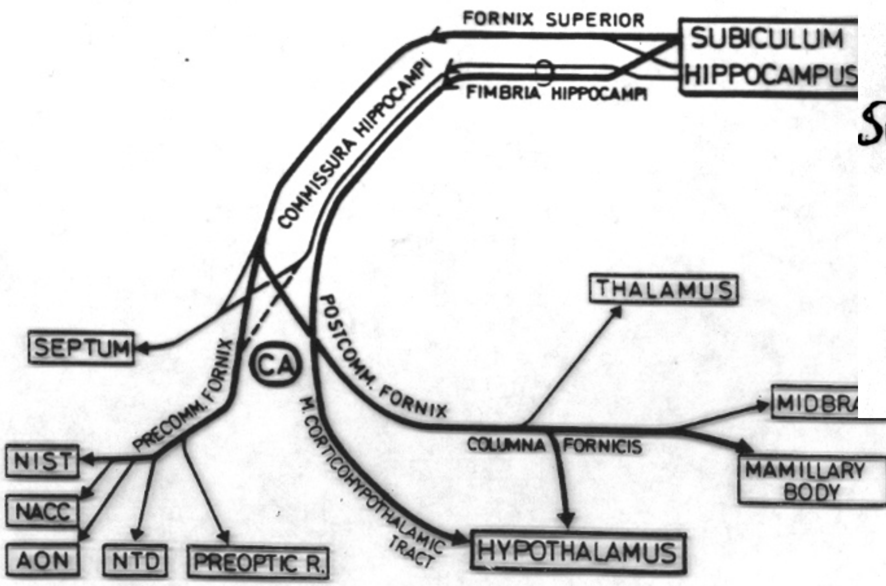
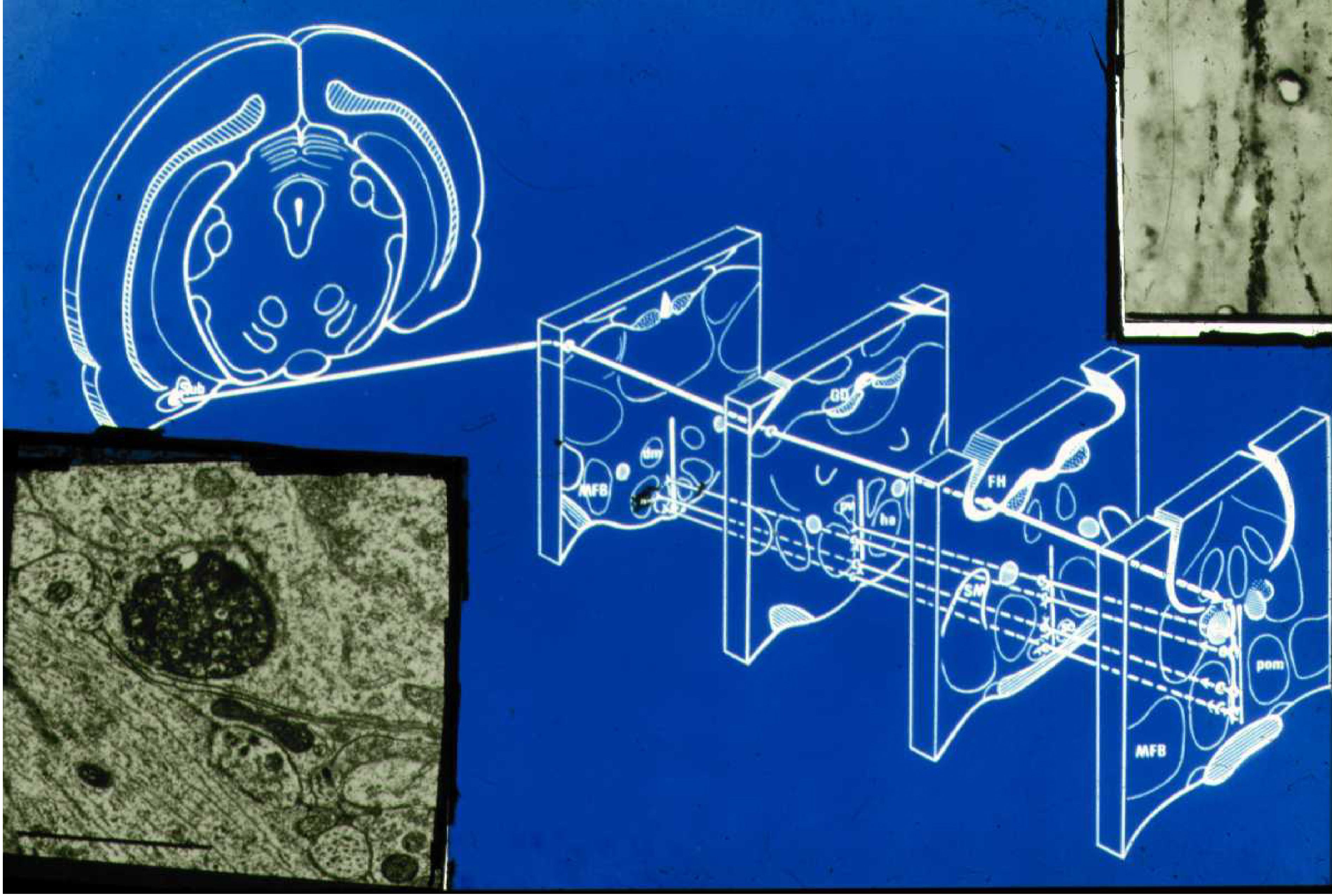


Figure 18 Neural projections of the subiculum and hippocampus proper: NACC, nucleus accumbens; AON, anterior olfactory nucleus; NIST, nucleus interstitialis striae terminalis; NTD, nucleus tractus diagonalis; CA, anterior commissure.



Scheme, to show the origin, course (upper right inset; silver impregnation) and termination (lower left inset; electron micrograph with degenerated terminal after ventral subicular lesion) in the arcuate nucleus of the medial corticohypothalamic tract (Palkovits and Zaborszky, 1979).

CORTICAL CONENCTIONS OF THE HIPPOCAMPUS

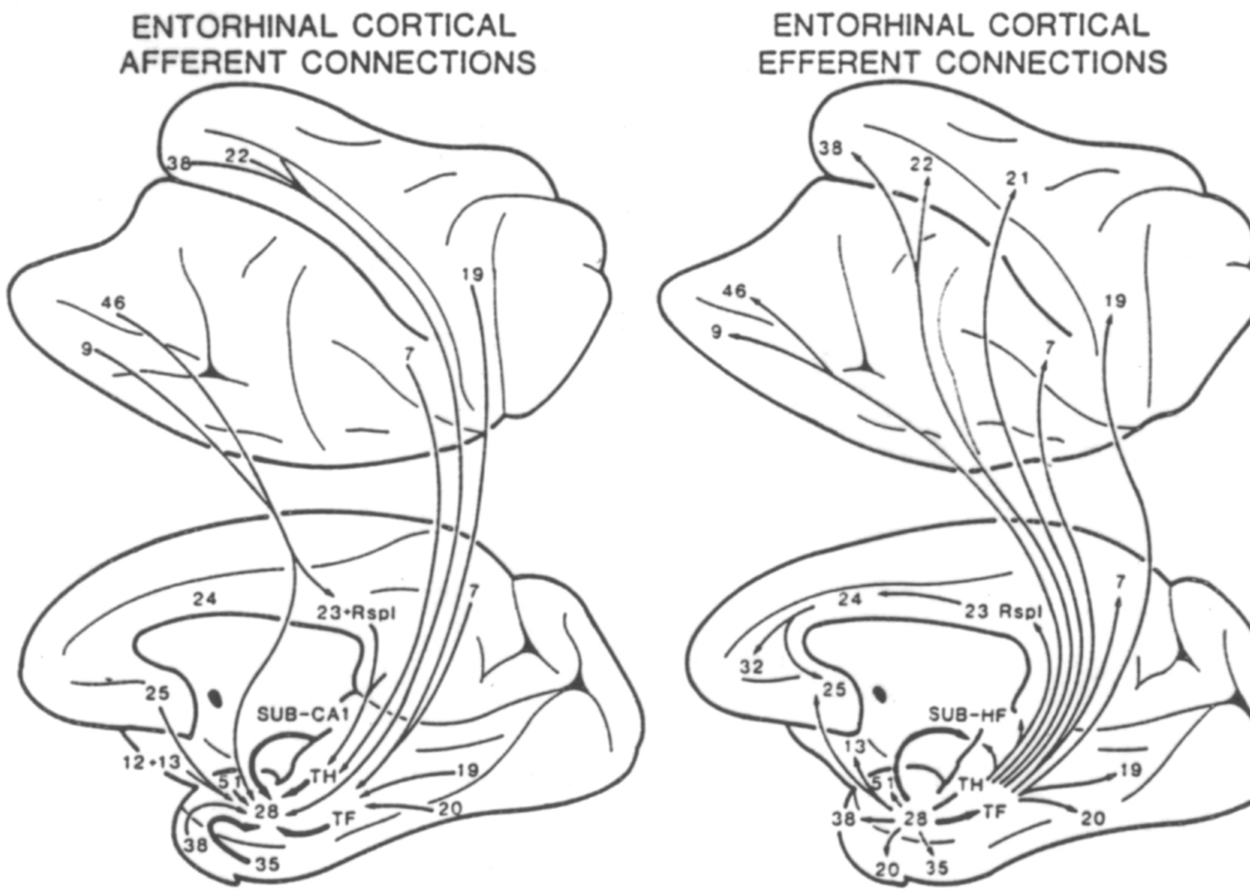


FIGURE 11.1. Major cortical afferent and efferent neural systems of the entorhinal cortex in the rhesus monkey on medial and lateral views of the cerebral hemisphere. Identification of cortical areas corresponds to those of Brodmann and Bonin and Bailey. Note that cortical neural systems from the frontal, 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.

G. Van Hoesen

AMYGDALO-HIPPOCAMPAL CONNECTIONS

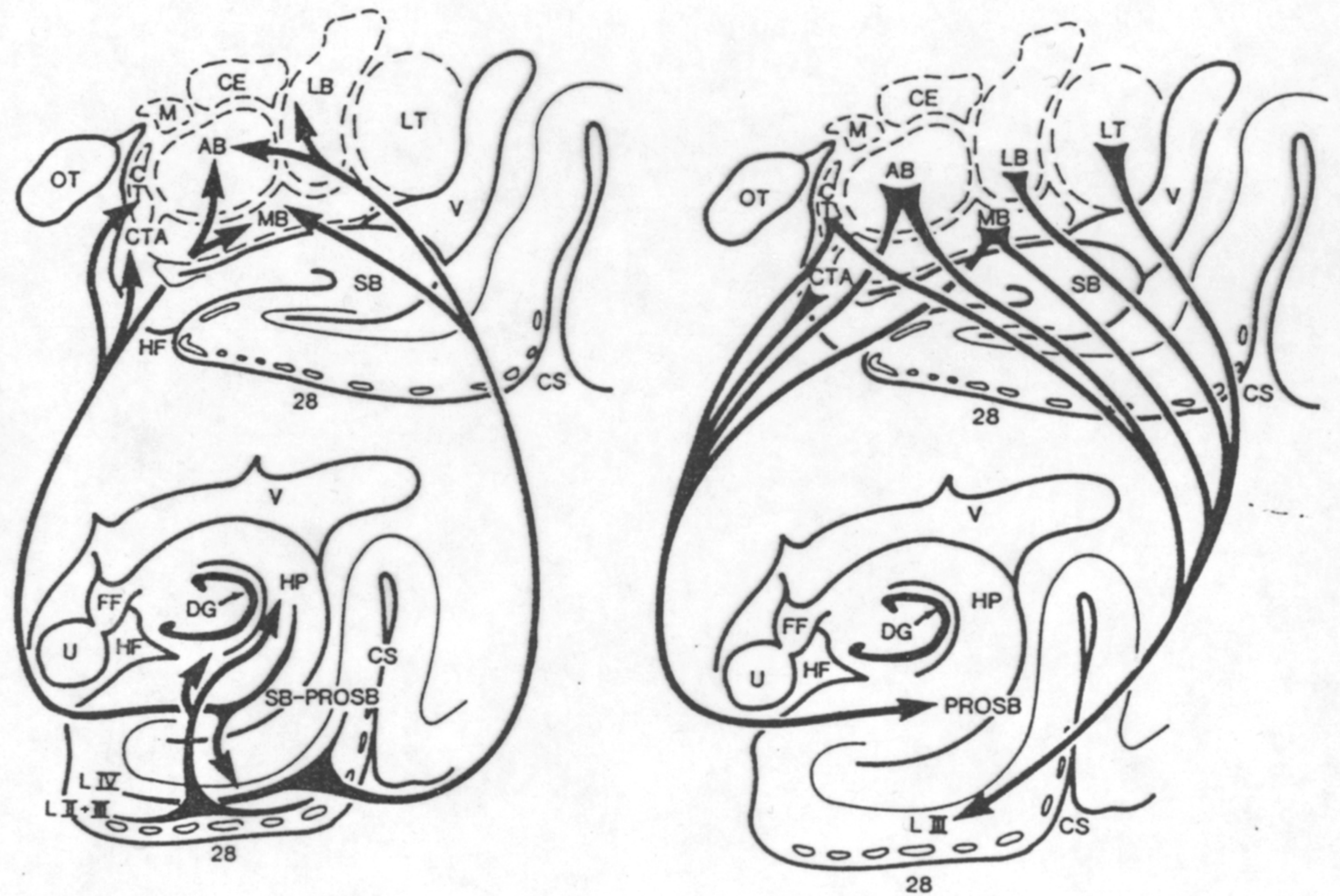
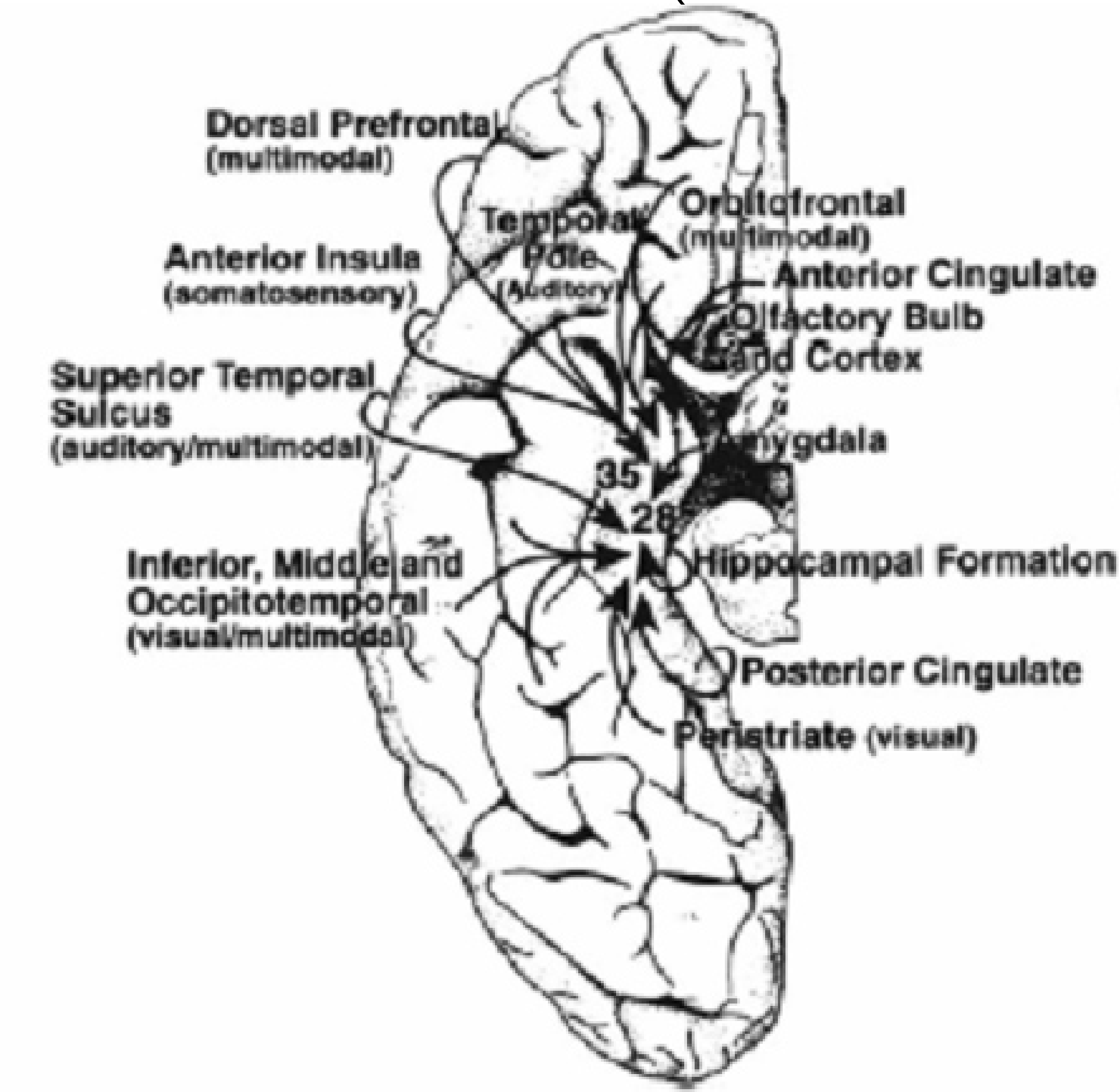


Figure 1. Connectional anatomy of the ventromedial lobe. Some probable hippocampal formation and entorhinal cortex (area 28) efferents to the amygdala (left) and some probable amygdaloid efferents to the hippocampal formation and entorhinal cortex (right) in the human are illustrated based on projections 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.

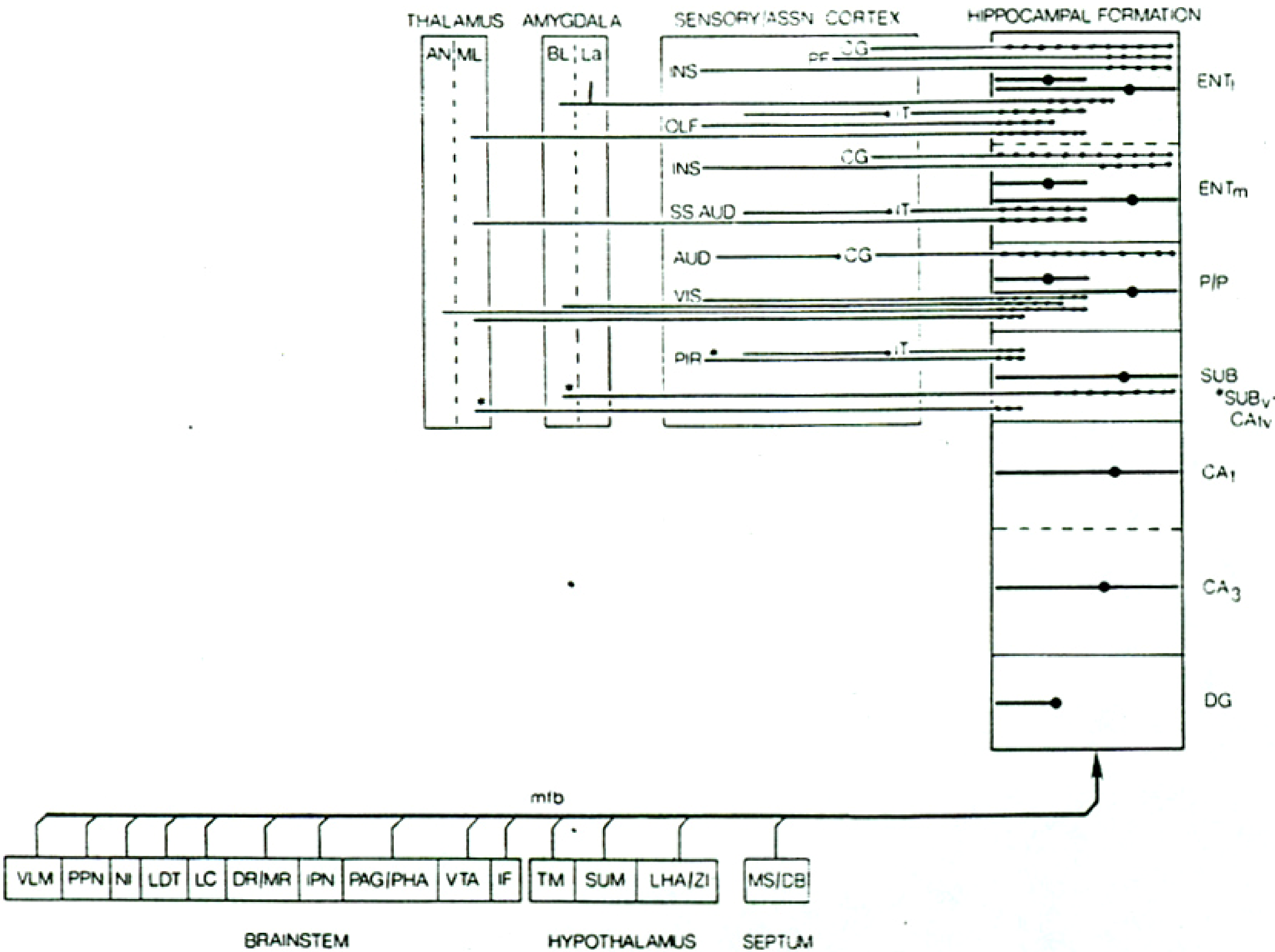
G. Van Hoesen

SUMMARY OF CORTICAL AND AMYGDALOID INPUT TO THE HIPPOCAMPUS

Projected on the human basal cortical surface (Heimer and G. van Hoesen, 2005)

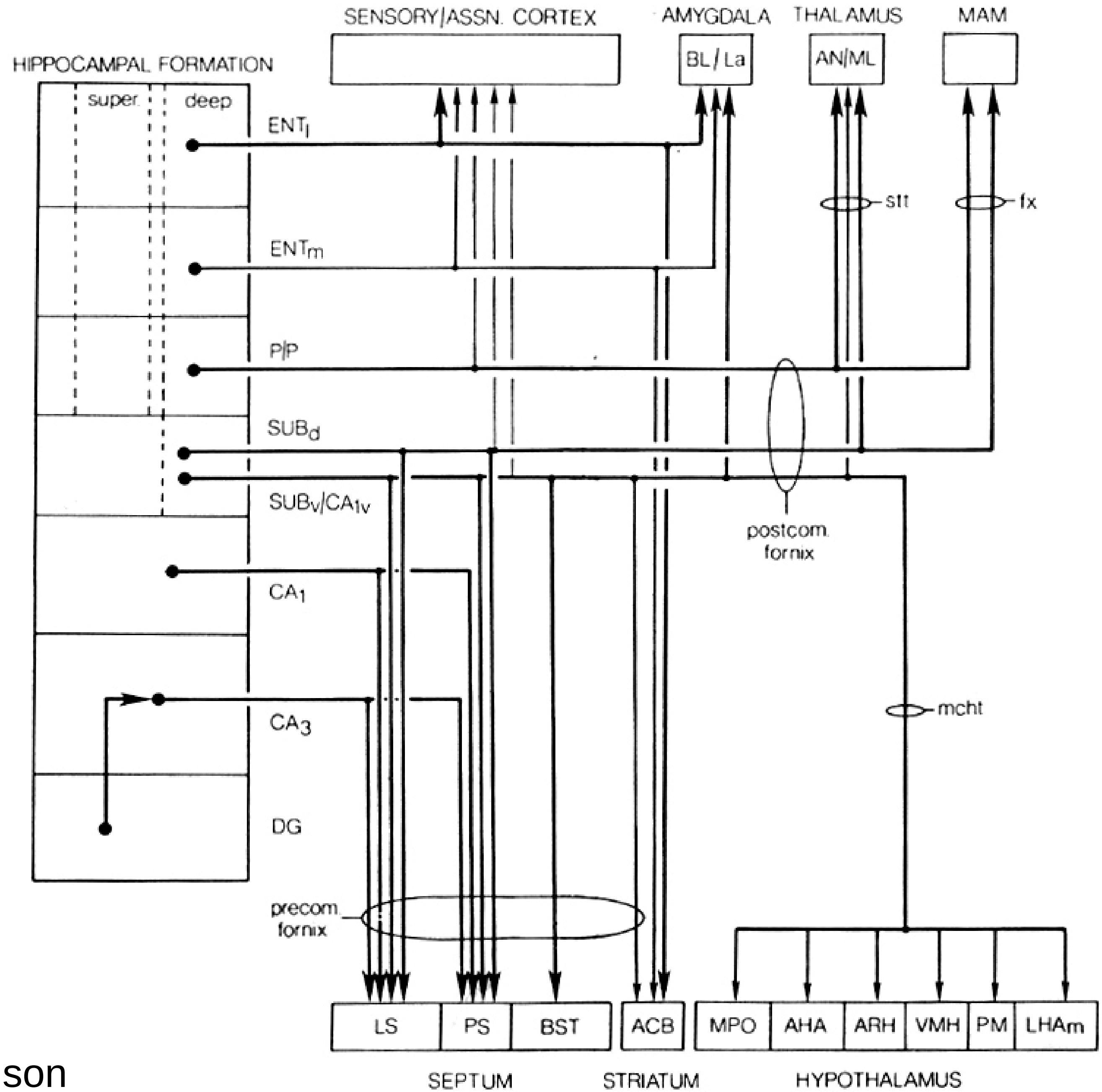


MAJOR HIPPOCAMPAL INPUTS



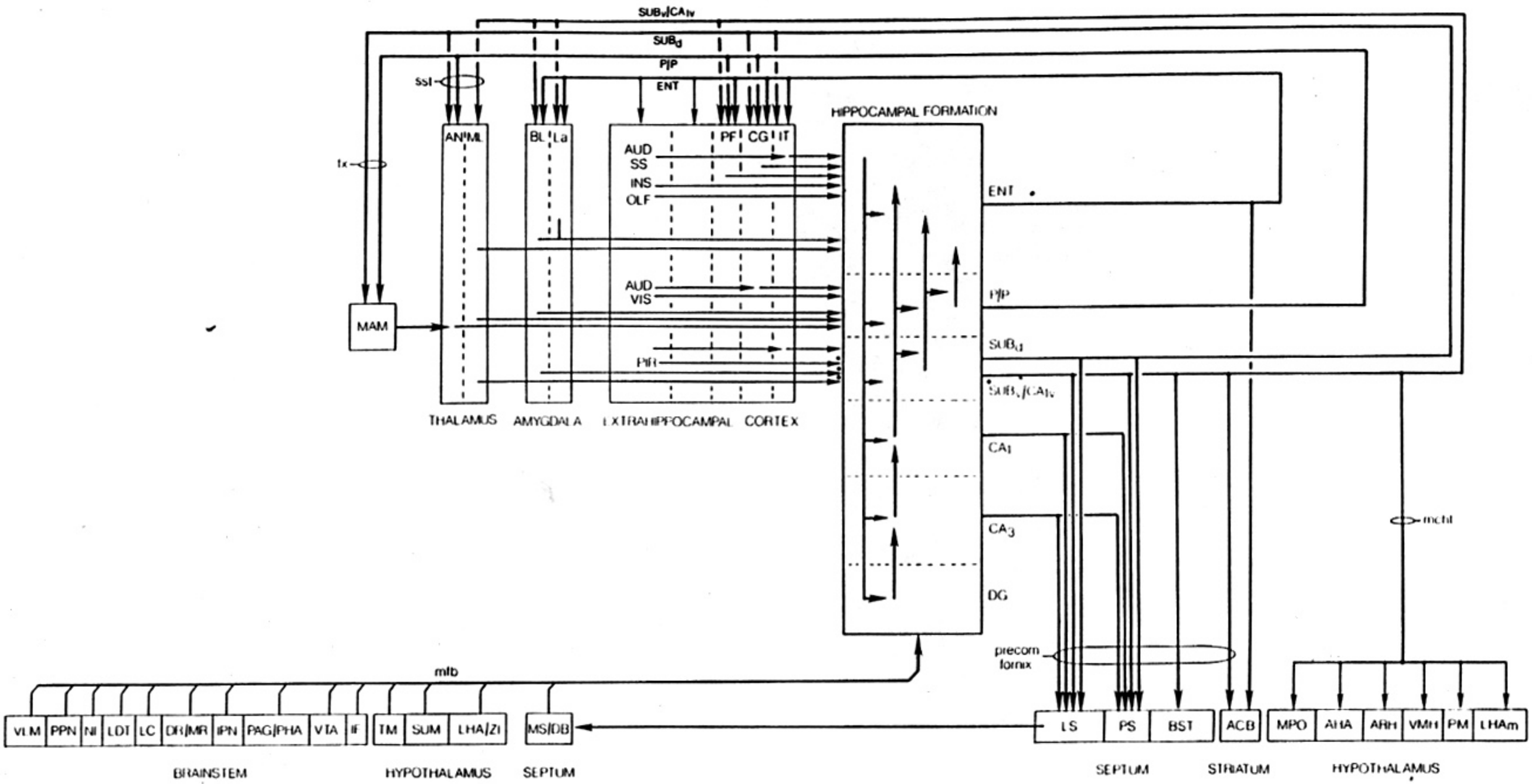
Swanson

MAJOR OUTPUTS OF THE HIPPOCAMPUS



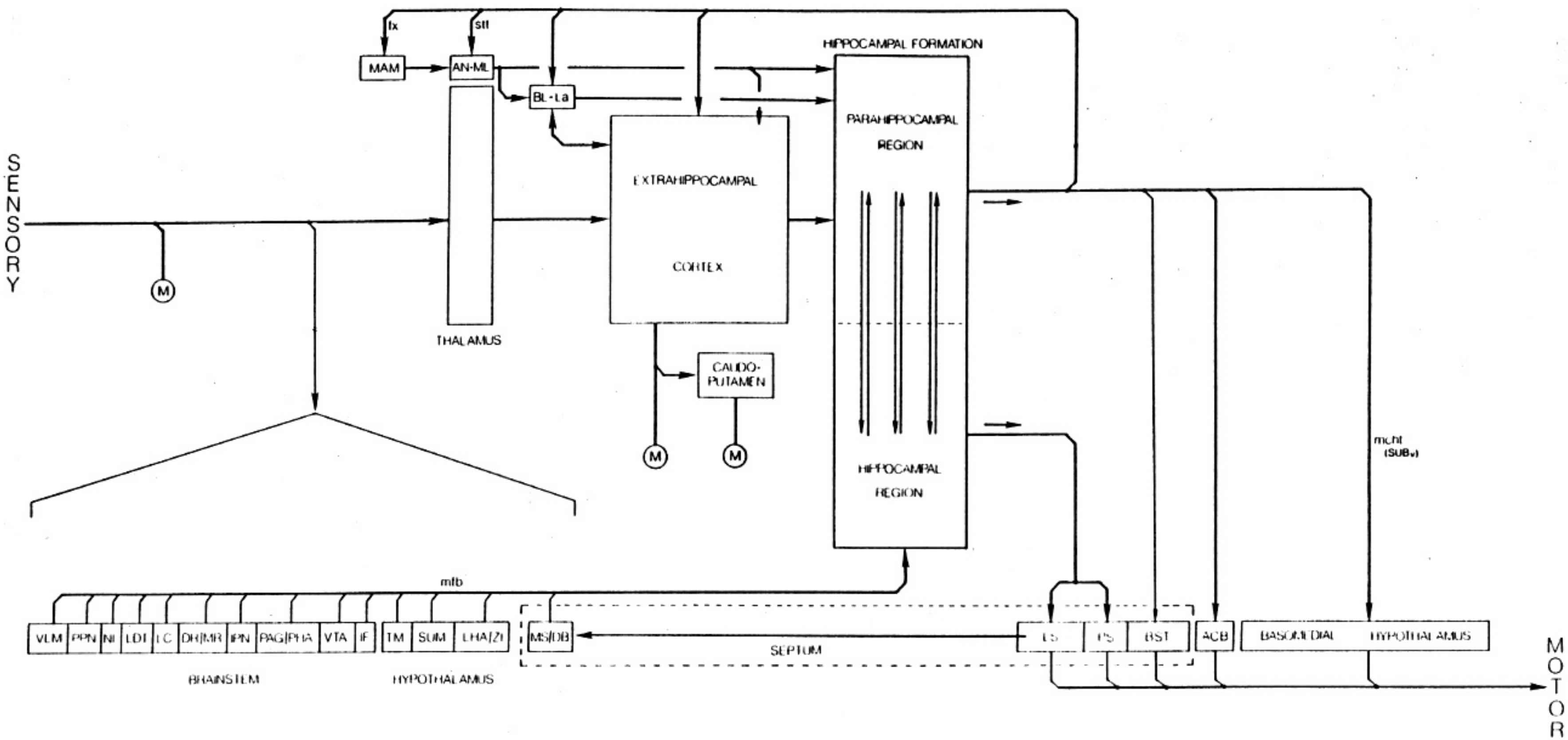
From Swanson

OVERVIEW OF MAJOR INPUT-OUTPUT RELATIONSHIP OF THE HIPPOCAMPUS

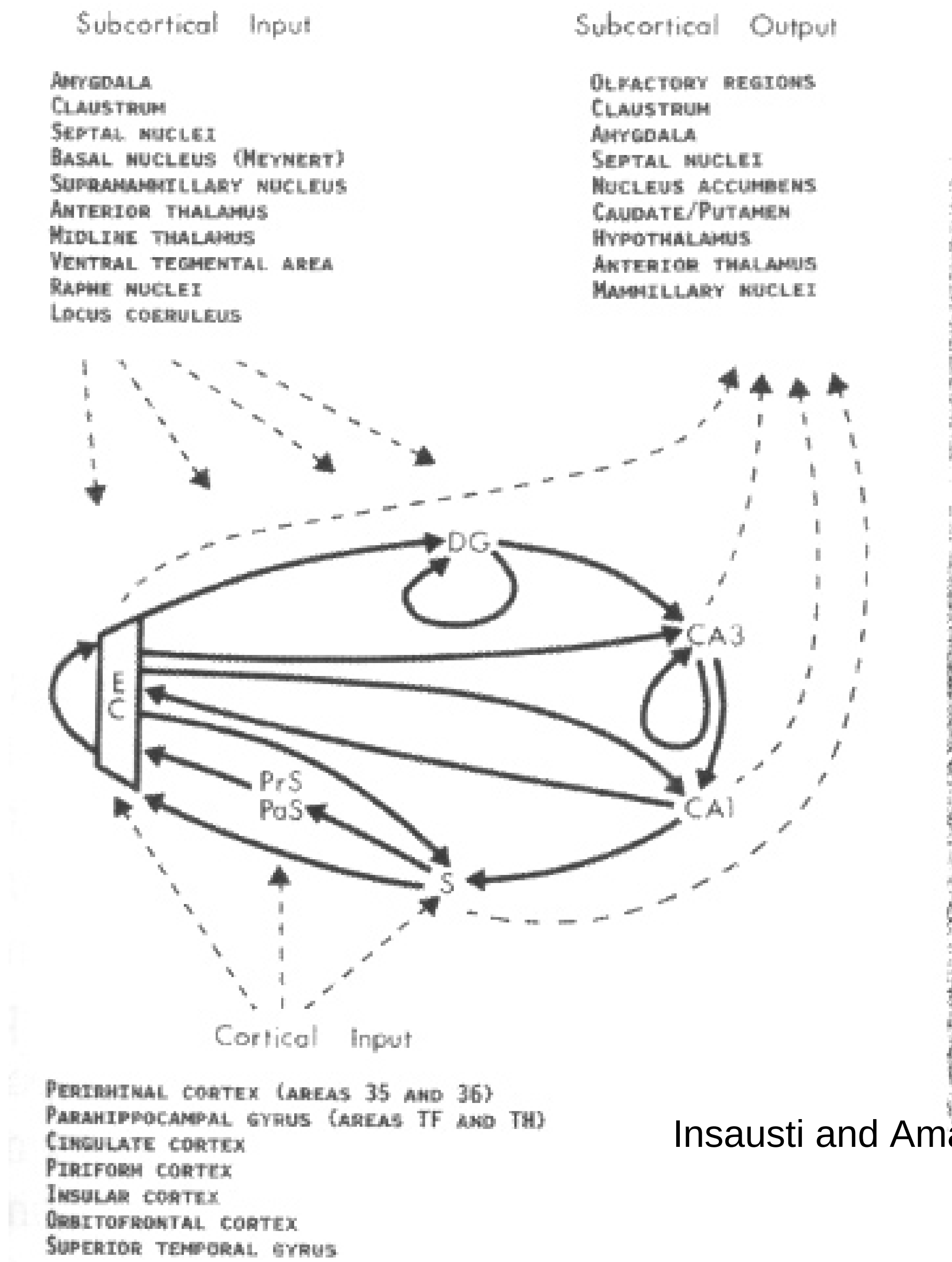


Swanson

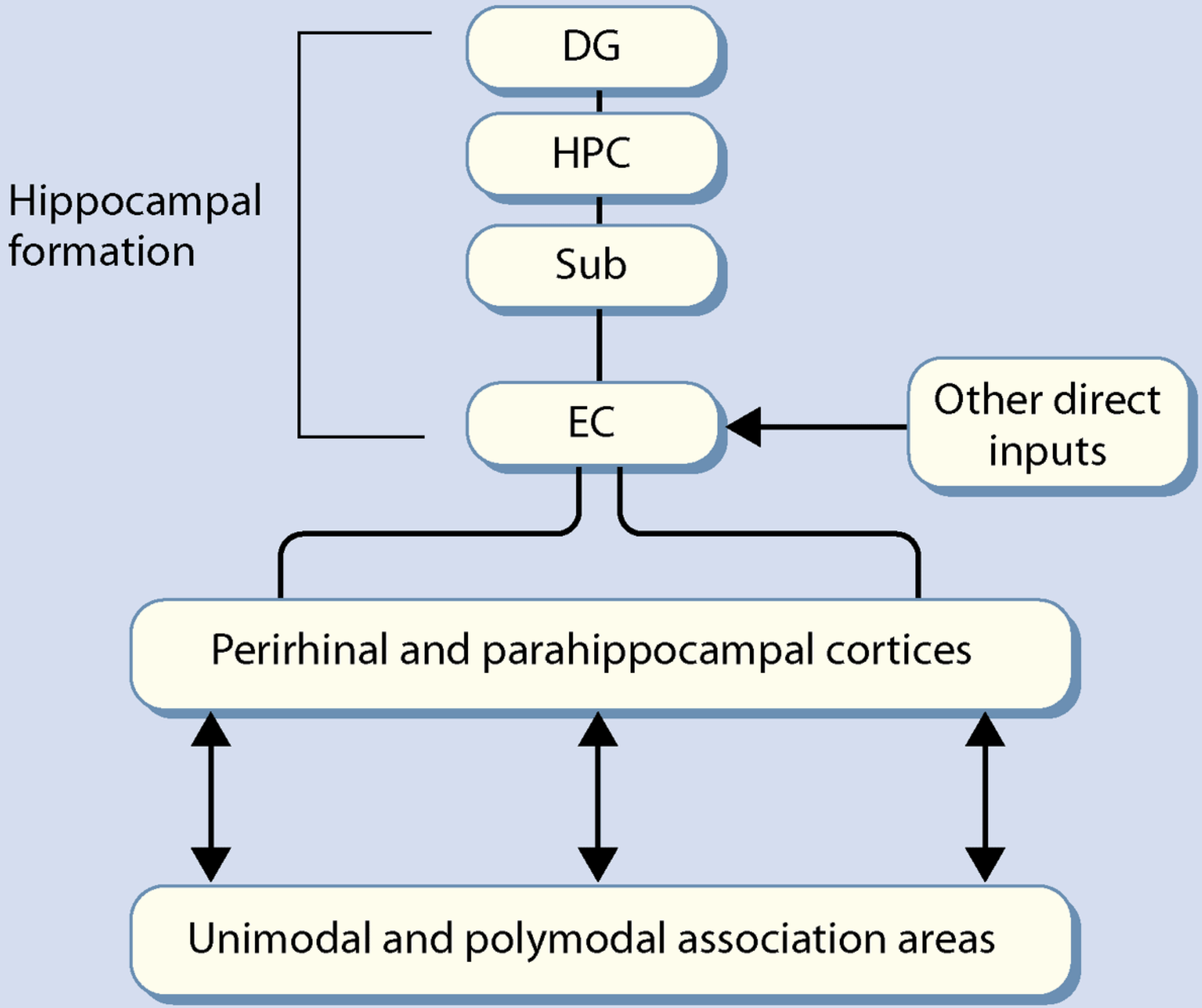
OVERVIEW OF MAJOR INPUT-OUTPUT RELATIONSHIP OF THE HIPPOCAMPUS



Swanson

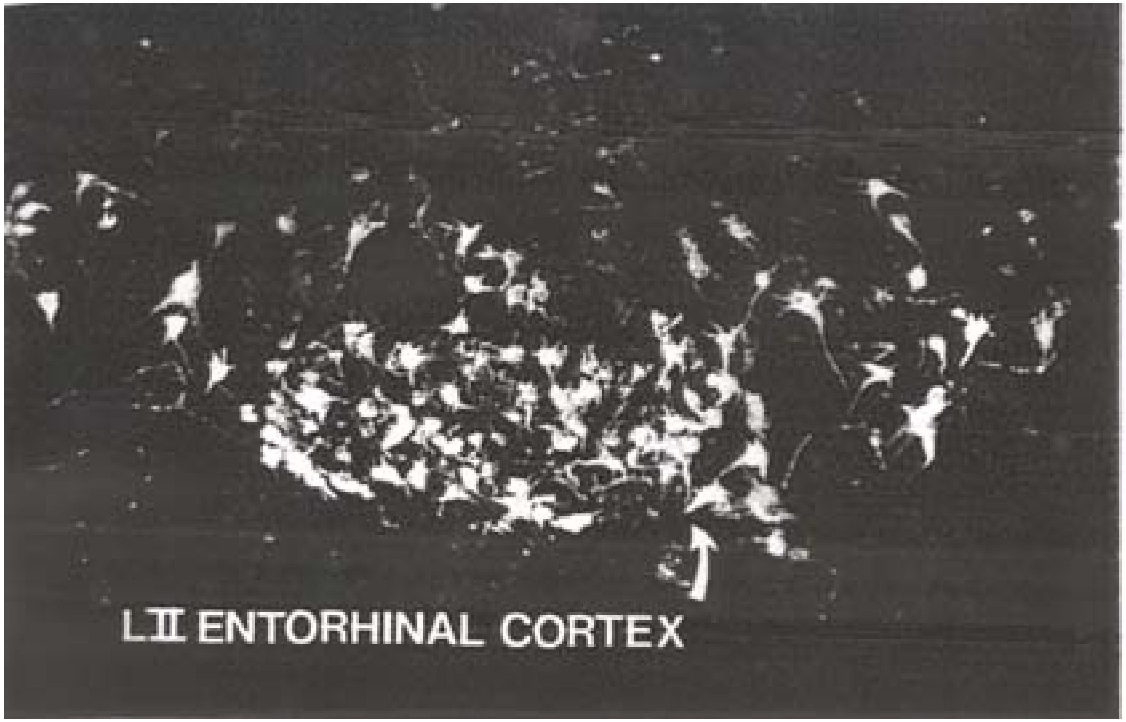


Insausti and Amaral, 2004



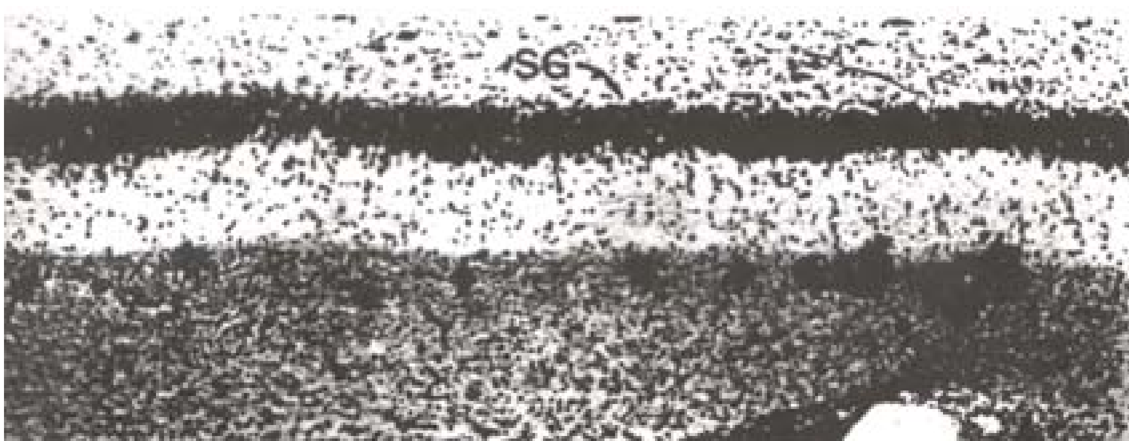
DG
HPC
Sub
EC
Hippocampal formation
Other direct inputs
Perirhinal and parahippocampal cortices
Unimodal and polymodal association areas

In Alzheimer’s disease , there is a prominent neurofibrillary degeneration of LII cells in the EC and their terminals in the DG show neuritic plaques.



A

Thioflavin S-stained neurofibriallary tangles in layer II of the entorhinal cortex in AD. These neurons give rise to major component of the perforant pathway that links the cortex with the dentate gyrus.

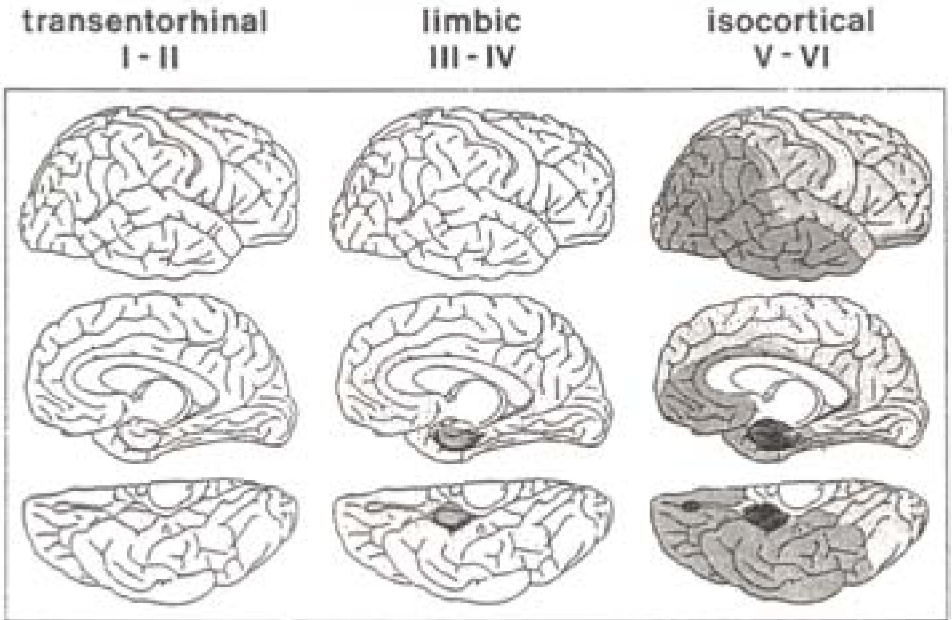


B

Alz-50 terminal immunoreactivity in the outer two thirds of the molecular layer of the dentate gyrus in an area that would correspond to the terminal zone of the perforant pathway. This pattern of immunoreactivity suggests that the AD antigen recognized by Alz-50 is located in the terminals of LII entorhinal neurons. Note the presence of Alz-50 immunoreactive neuritic plaques in the immunoreqactive zone. The vessel marks the location of the hipp. Fissure. The granule cells of the dentate gyrus (SG) have been stained with thonin.

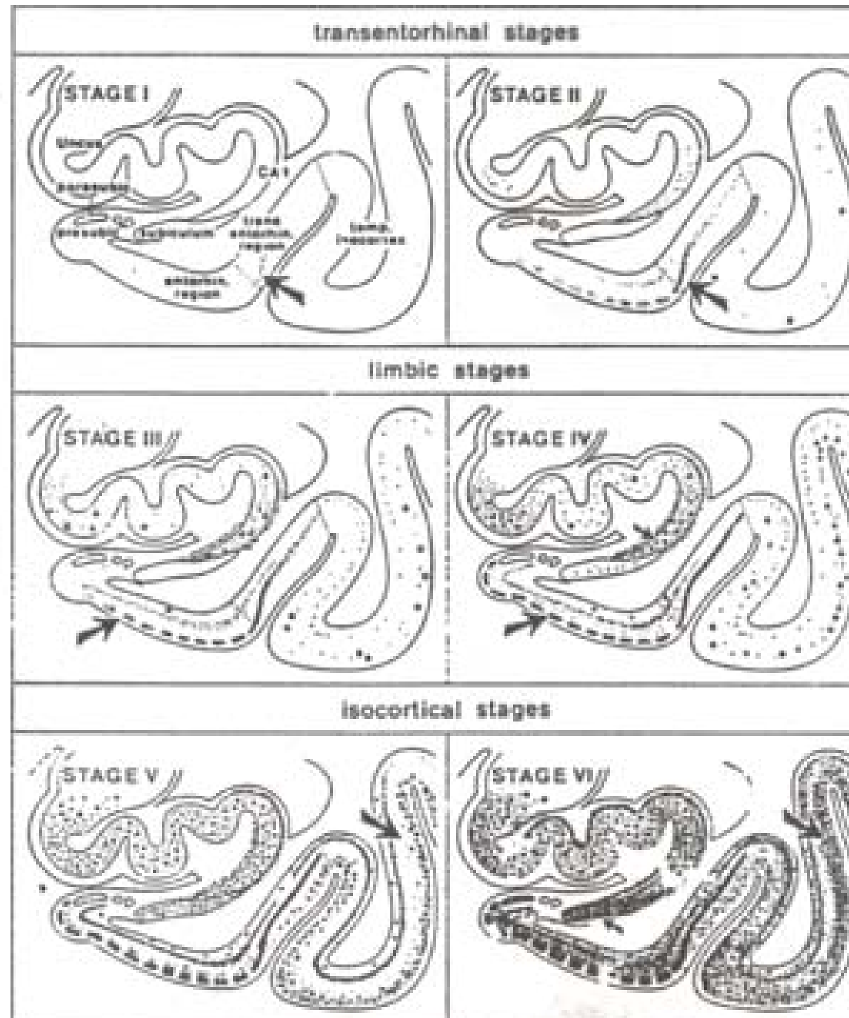
(G. van Hoesen)

Development of neurofibrillary tangles and neuropil threads from transentorhinal to isocortical stages.



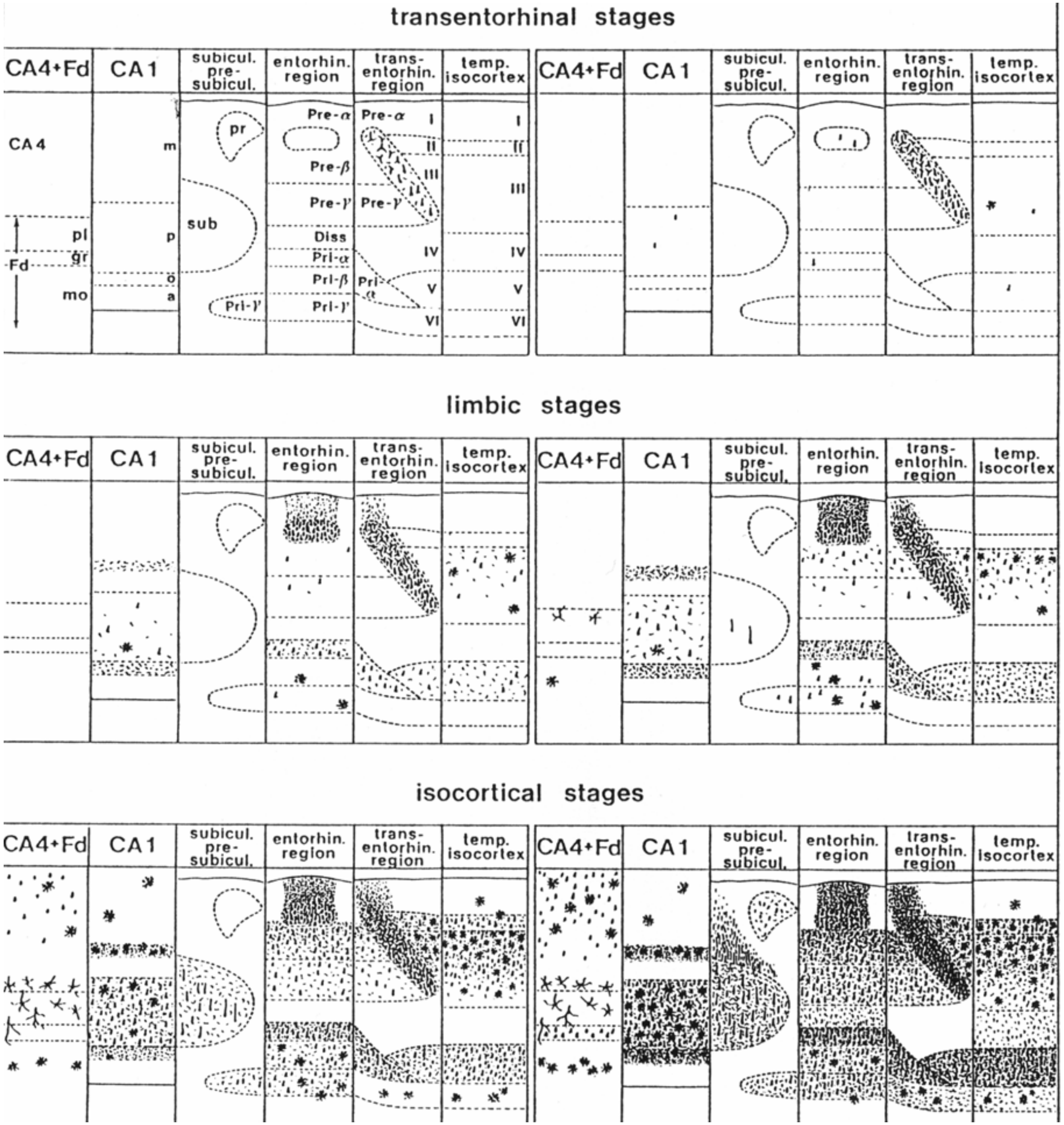
Neurofibrillary changes

Increasing density of shading indicates increasing severity of the pathological changes. (Braak and Brrak, 1994)



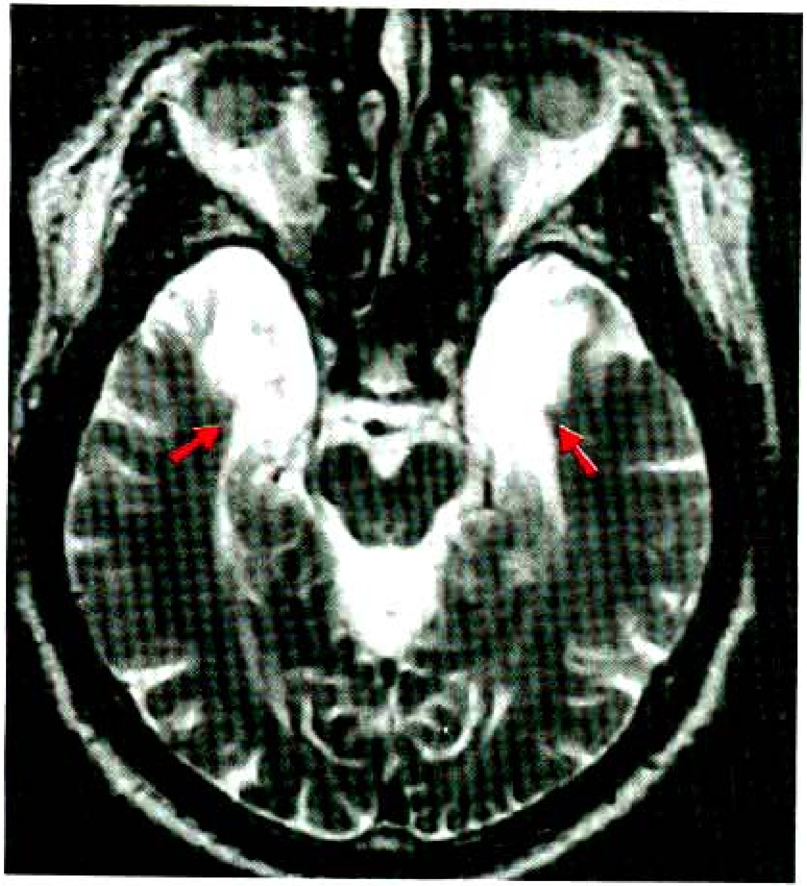
Neuropathological staging of AD-related changes in the anteromedial portion of the temporal lobe, (Braak and Braak, 1994).

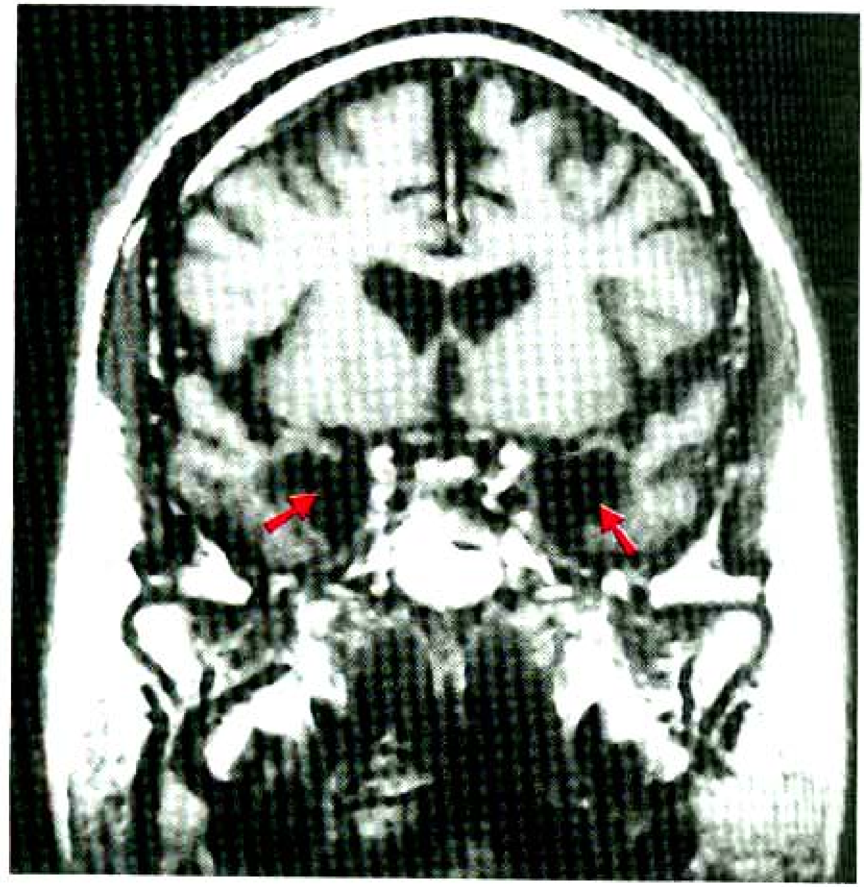
Neurofib. changes seen in anteromedial portions of the temporal lobe



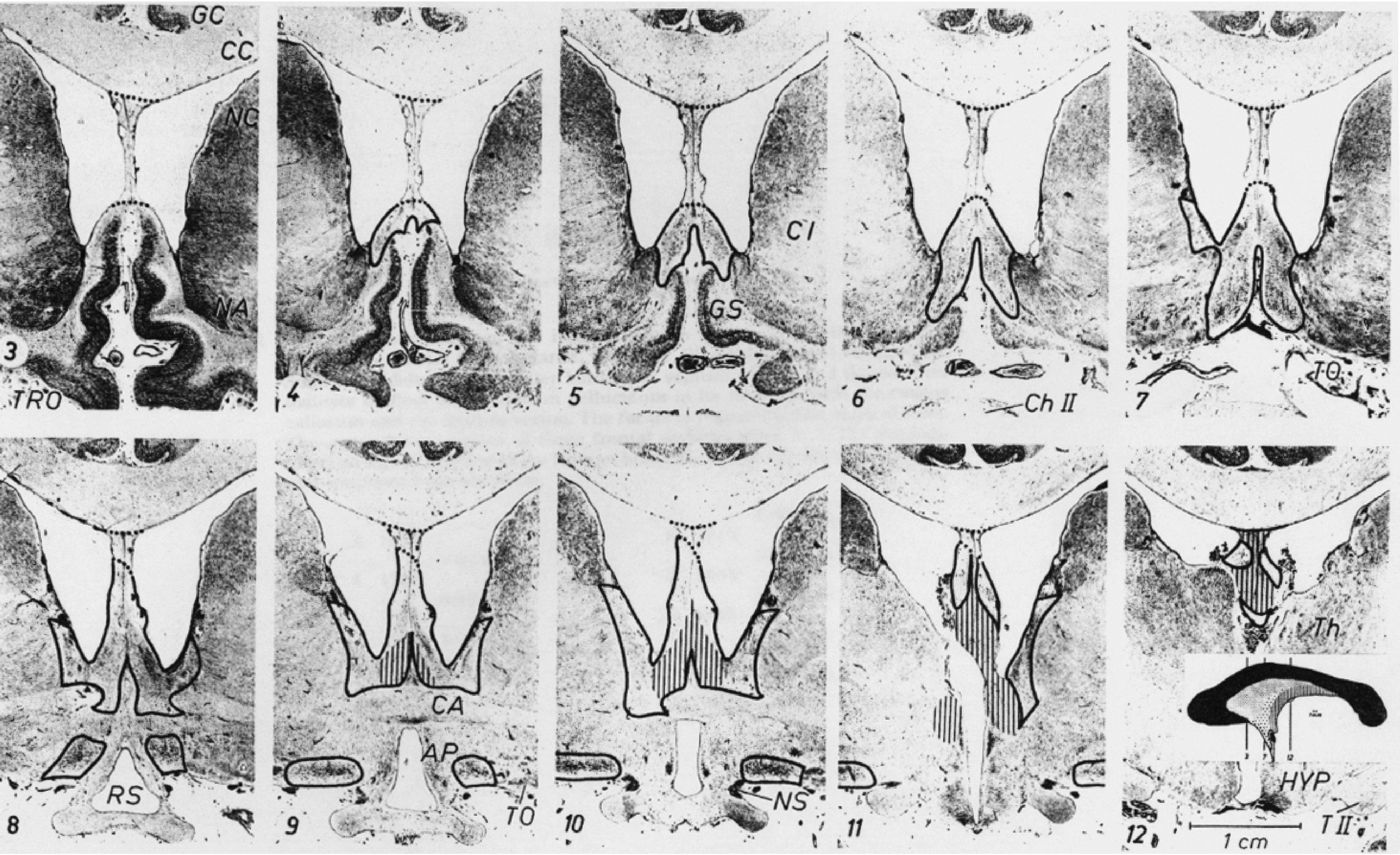
Summary development of changes from stage I to stage VI of AD. Fd=fascia dentata; gr=granula, mo=molecular layer. CA1: m=molecular; p=pyramidal; o=oriens; a=alveus. (Braak and Braak, 1994)

MRI of patient HM

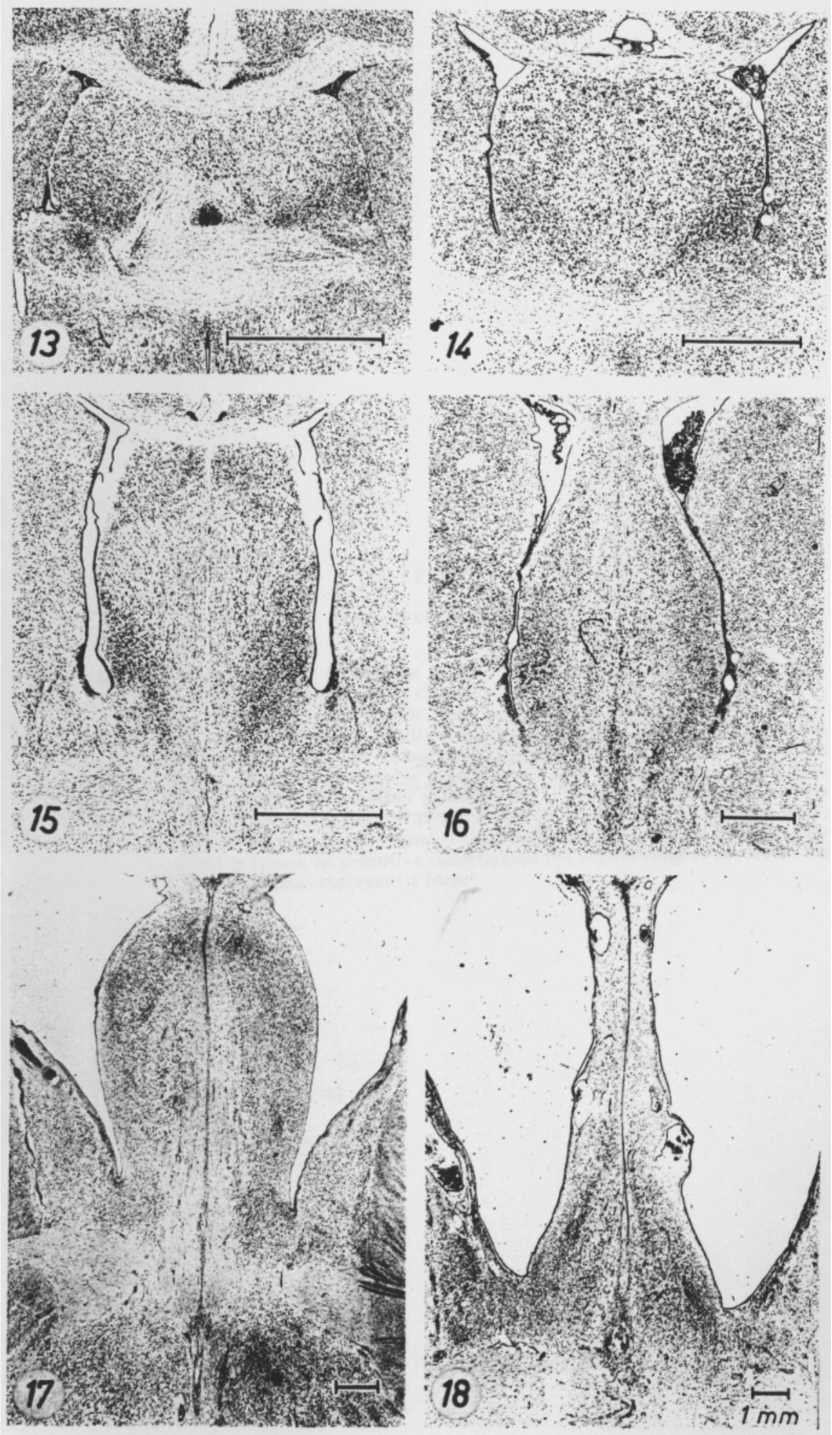




HUMAN SEPTUM



Solid lines delineate the outer borders of the septum verum and dotted lines indicate borders of the septum pellucidum at its junction with the corpus callosum and the septum verum. The fornix is represented by vertical lines (Andy and Stephan)



FRONTAL VIEW OF THE SEPTUM AT THE LEVEL OF THE ANTERIOR COMMISSURE

13: PRIMITIVE INSECTIVORE

14:LOW PROSIMIAN (Tupaia)

15:MIDDLE PROSIMIAN (Galago)

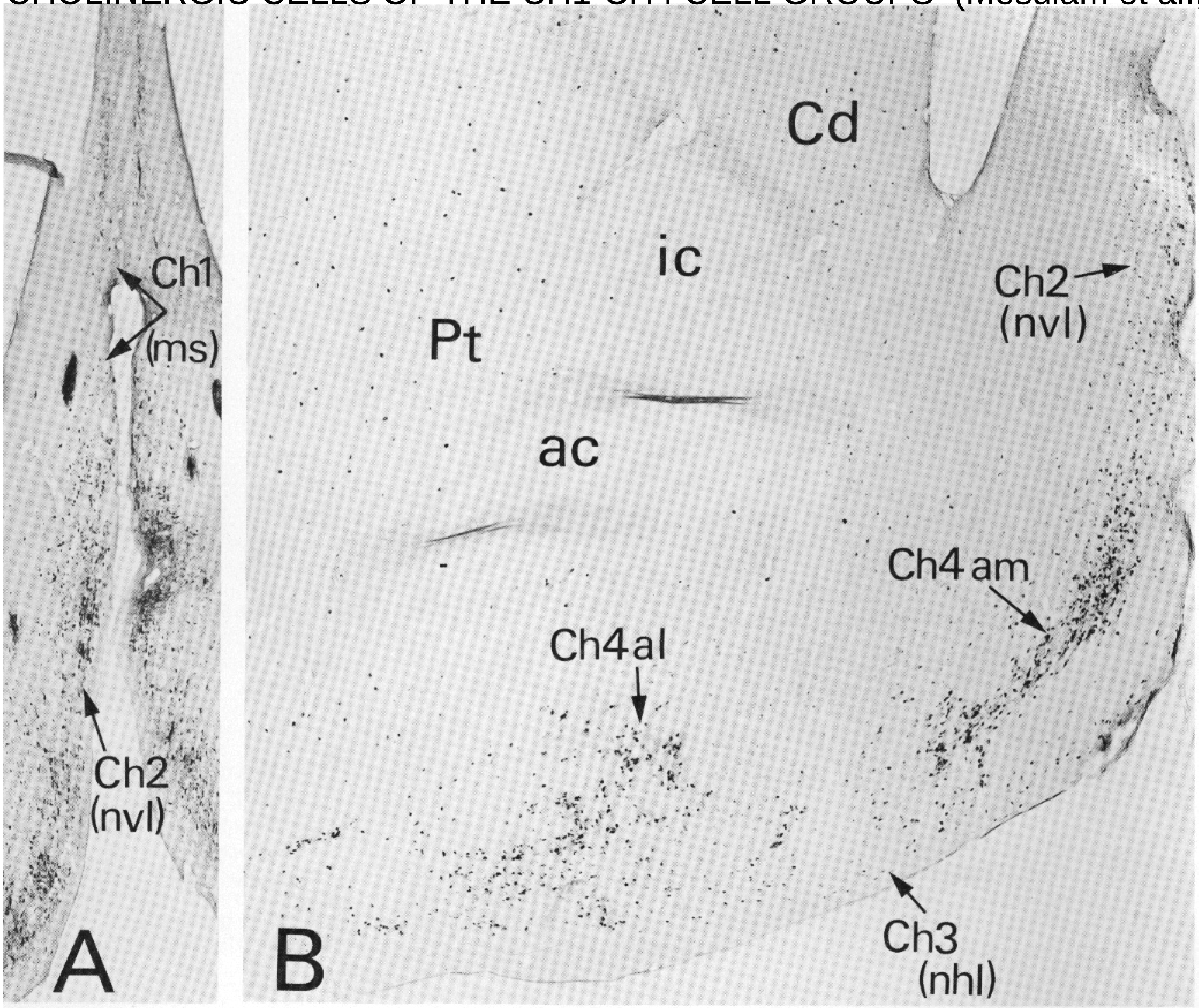
16: Middle PRIMATE (Cercopithecus)

17: HIGHER PRIMATE (Gorilla)

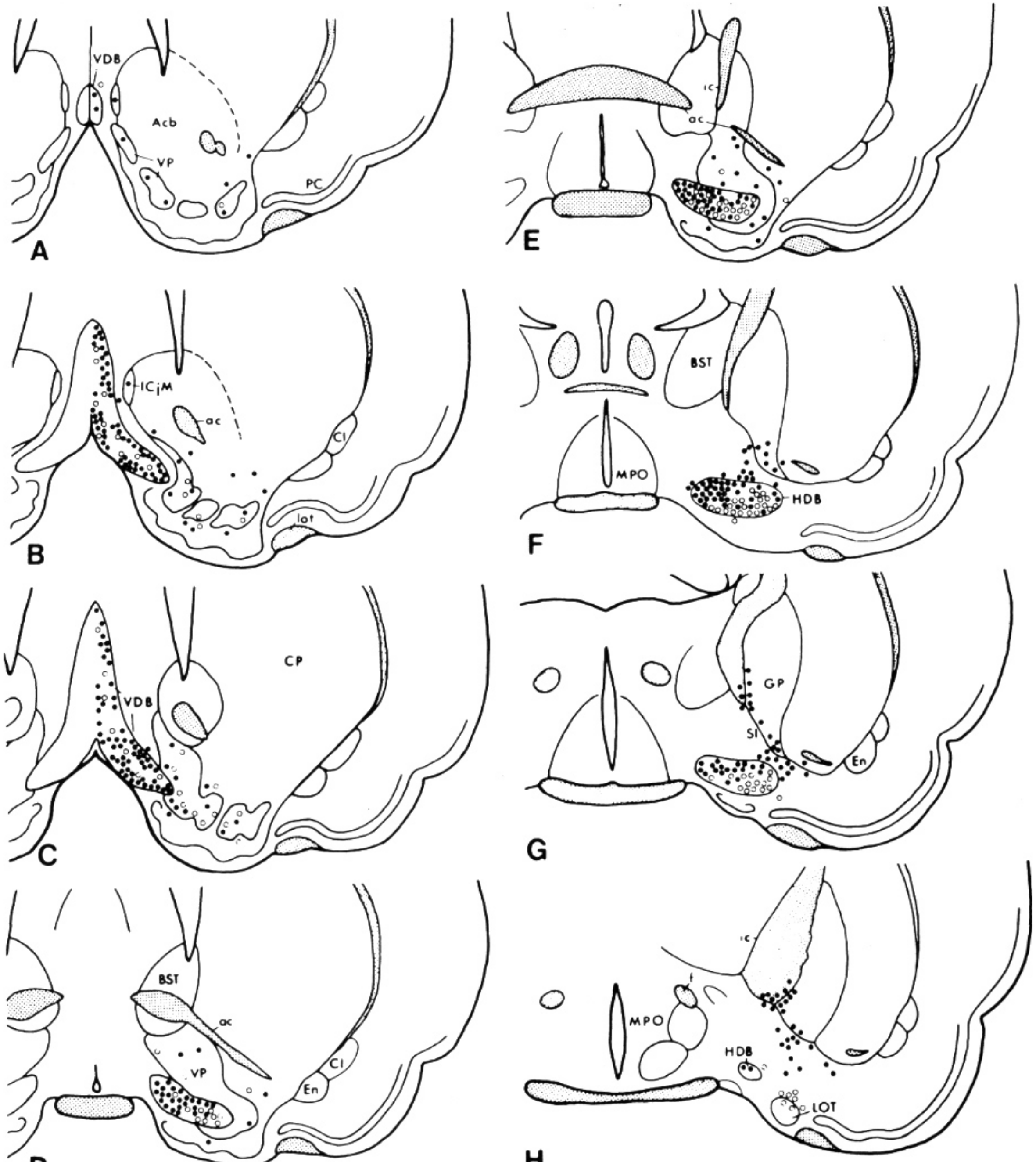
18: Homo

Andy and Stephan

CHOLINERGIC CELLS OF THE CH1-CH4 CELL GROUPS (Mesulam et al., 1983)



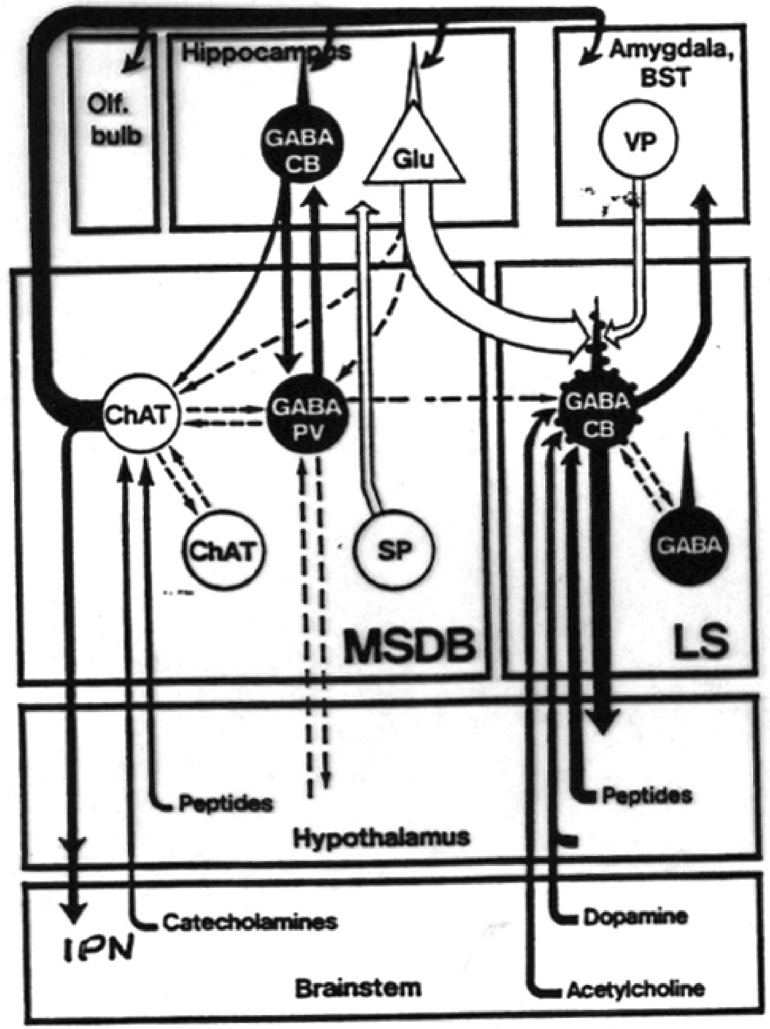
CHOLINERGIC AND GABAERGIC NEURONS IN THE SEPTUM IN RAT



Brashear, Zaborszky, Heimer, 1986

Septohippocampal circuitry in rat

(Jakab and Leranth, 1995)



A simplified diagram outlines the bidirectional connections of neurochemically identified neurons of the medial and lateral septal divisions with other brain regions, in particular, telencephalic, hypothalamic, and brain stem areas. Dashed lines represent putative connections (based on indirect evidence). BST, bed nucleus of the stria terminalis; CB, calbindin D28k; ChAT, choline acetyltransferase; GABA, γ-aminobutyric acid; Glu, glutamate; LS, lateral septum; MSDB, medial septum/diagonal band complex; PV, parvalbumin; SP, substance P; VP, vasopressin.