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Review Article

Retrosplenial and Cingulate Cortex of The Rat Brain – Cyto- And Chemoarchitectonics

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Abstract

The retrosplenial cortex of rats is divided into granular and agranular regions. The difference in the granular region of the retrosplenial cortex is that layers II-III consist of large neurons. The cingulate cortex, which lies above the corpus callosum, on the medial wall of the hemisphere, is an intermediate formation between the paleocortex and neocortex; in its complex cellular composition, it is similar to the neocortical formation. It contains five layers of neurons: molecular, small cell, mediopyramidal, large cell and multiform. The data presented in the article can serve as a fundamental basis for further study of the parts of the rat brain in normal and pathological conditions with further extrapolation of the obtained data to humans.

Keywords: retrosplenial cortex, cingulate cortex, rat, cytoarchitectonics, chemoarchitectonics

Retrosplenial cortex

The retrosplenial cortex is located on the medial surface of the cerebral hemispheres of the rat brain [13] (Figure 1).

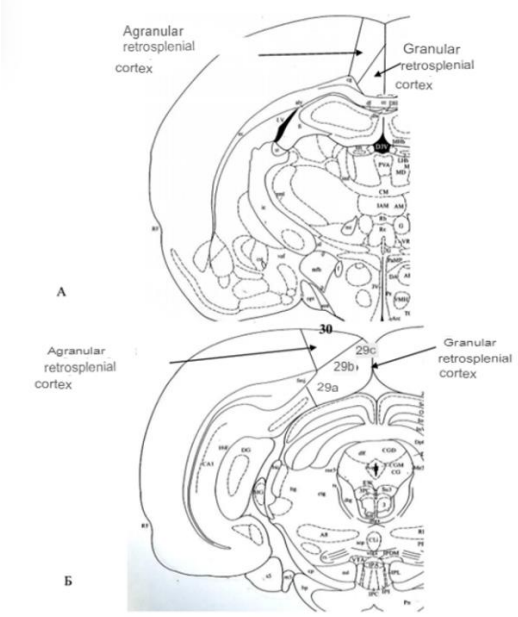

Figure 1: Location of the granular (fields 29a, 29b, 29c) and agranular (30) retrosplenial cortex in the scheme of frontal sections of the rat brain. A - Bregma - 2.12 mm, B - Bregma - 6.72 mm

It includes seven layers: molecular, stellate, granular, reticular, mediopyramidal, large pyramidal, and multiform layer [13]. The fourth layer in rats is usually weakly expressed (table 1).

Name of neuron	Cortical layer	Mediator
Horizontal neurons	molecular, multiform	GABA
Stellate neurons	stellate, multiforme	calretinin
Pyramidal neurons	mediopyramidal, large pyramidal and multiform	aspartate, glutamate, calretinin, calbindin
Basket neurons	stellate, mediopyramidal, large pyramidal and multiform	GABA, parvalbumin
Candelabra cells	stellate, mediopyramidal, large pyramidal and multiform	GABA, parvalbumin
Granular neurons	granular	glutamate, dynorphin
Bipolar neurons	small cell, multiforme	calretinin, calbindin, somatostatin, substance P
Polymorphic neurons	stellate, mediopyramidal, large pyramidal and multiforme	calretinin, calbindin, somatostatin, substance P
Fusiform neurons	mediopyramidal, large pyramidal and multiform	GABA, parvalbumin
Stellate pyramidal neurons	stellate, mediopyramidal, and multiform	aspartate, glutamate, calretinin

Table 1: Neuronal and transmitter organization of the retrosplenial cortex [8,10,15,16,18]

The retrosplenial cortex of rats is divided into granular and agranular regions [3,9]. The difference in the granular region of the retrosplenial cortex is that layers II-III consist of large neurons.

The granular retrosplenial cortex includes the following fields: 29a, 29b and 29c. The classification is based on the features of cytoarchitectonics, mainly of the mediopyramidal and large-pyramidal layers. In field 29a, layers II, III, and VII are thin, and the mediopyramidal layer is barely visible. Field 29b, on the contrary, has a well-defined layer II, formed by densely located bodies of stellate neurons [19], the granular and mediopyramidal layers are less pronounced, the neuron perikarya are more dispersed in them. Layer VI contains the bodies of large typical pyramidal neurons. The multiform layer, although thin, is clearly defined. In field 29c, the granular layer is most pronounced and, in general, the neurons of other layers are smaller in size compared to fields 29a and 29b. The predominant types of neurons are fusiform neurons and the transitional type of neurons - stellate pyramids. The apical dendrites of these neurons form bundles reaching the molecular layer [15, 19]. The stellate pyramidal neurons of old rats form noticeably fewer branches than in young animals [11]. The mediopyramidal and macropyramidal layers are well expressed, their organization is similar to the organization of the pyramidal layer of the frontal (frontal) isocortex cortex. The agranular area of the retrospenny cortex is represented by field 30. Microscopic examination of this area reveals a narrow granular layer. For this reason, field 30 cannot be called agranular in the full sense of the term. The retrosplenial cortex forms connections with the thalamic nuclei [12,17], the raphe nuclei, the nuclei of the medial geniculate body, and the motor cortex [2,3,5]. It is involved in the processes of visual memory [2,6,9,14] and regulation of behavior to predict and prevent situations that lead to painful sensations [3,5,6].

Cingulate cortex

The cingulate cortex, which lies above the corpus callosum, on the medial wall of the hemisphere, is an intermediate formation between the paleocortex and neocortex; in its complex cellular composition, it is similar to the neocortical formation [12]. It contains five layers of neurons: molecular, small cell, mediopyramidal, large cell and multiform [7] (Table 2).

Horizontal neurons	molecular, small cell, multiform	GABA
Stellate neurons	multiforme	calretinin
Pyramidal neurons	mediohyramidal, small cell	aspartate glutamate calretinin calbindin
Basket neurons	stellate, pyramidal	GABA, parvalbumin
Candelabra cells	stellate, pyramidal	GABA, parvalbumin
Pyramidal neurons	large cell	GABA neuropeptide Y calretinin calbindin somatostatin
Fusiform neurons	–//–	–//–
Bipolar neurons	small cell, multiforme	Calretinin calbindin somatostatin substance P
Polymorphic neurons	pyramidal, small cell, multiforme	calretinin calbindin somatostatin substance P

Table 2: Neuronal and transmitter organization of the cingulate cortex [16,18]

Predominantly small cells are densely located in the upper layers [7]. In the second layer, two types of cells are distinguished: bipolar neurons and multipolar neurons with spherical branching of dendrites. The cingulate cortex receives afferent connections from the neocortex [17], mainly from the association zones of the posterior hemispheres and the frontal cortex [12], sending projections to the hippocampus through the entorhinal region [1,4,5].

The cingulate cortex is involved in the regulation of autonomic and endocrine functions, in the processes of emotional learning [20], vocalization, assessment of the motivational content and emotional valence of internal and external stimuli [5,6], and in interactions between mother and offspring.

The data presented in the article can serve as a fundamental basis for further study of the parts of the rat brain in normal and pathological conditions with further extrapolation of the obtained data to humans.

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