

PECULIARITIES OF STRUCTURAL AND FUNCTIONAL ORGANIZATION OF DOMESTIC BULL'S LYMPH NODES PARENCHYMA (BOS PRIMIGENIUS TAURUS L.)

***Pavel N. Gavrilin, Sc.D. in veterinary sciences, Professor
Elena G. Prokushenkova, Ph.D., senior research worker
Dmitrij N. Masjuk, Ph.D., senior research worker
Natalia G. Perepechaeva, veterinary doctor***

From the Scientific Research Center for Biosafety and Environmental Control of Agro-Industrial Complex (Department of Histology, Immunohistochemistry and Pathomorphology), Dnipropetrovs'k State Agrarian University, Ukraine

Встановлено, що паренхіма лімфатичних вузлів бика домашнього має дискретний характер будови і представлена комплексом структурно-функціональних сегментів і компартментів. Субодиниці (сегменти) паренхіми вузлів мають ідентичну гістоархітектоніку і складаються з декількох компартментів, кількість яких залежить від ступеня розвитку сегментів. Компартменти є сукупністю структурно-функціональних зон, основними з яких є одиниці глибокої кори і лімфатичні вузлики. Одиниці глибокої кори утворюють основу компартмента, мають сфероподібну просторову конфігурацію і в комплексі з лімфатичними вузликами формують характерну мозаїчну гістоархітектоніку паренхіми. Локалізація лімфатичних вузликів у межах сегментів вузлів бика домашнього вирізняється різномірним (тотальним) розподілом (від крайового до ворітного синусів), що може свідчити про структурно-функціональну ідентичність кіркового плато, периферичних ділянок одиниць глибокої кори і мозкових тяжів.

Лімфатичний вузол, паренхіма, компартмент, одиниця глибокої кори, лімфатичний вузлик.

Introduction. Structural characteristics of mammal lymph nodes parenchyma are one of the most informative criteria formation and nonspecific and immunological reactivity state. And also they are markers of different immunopathological processes [6, 7, 8, 19, 23, 27].

In general modern conceptions of morphofunctional organization features of mammal lymph nodes lymphoid tissue are based on immunocytochemical study results of the laboratory animals and human beings' given organs [10, 11, 15, 16, 17].

Nowadays, generally accepted cases are: discreteness (segmentability) of lymph nodes parenchyma; the presence of lymphoid tissue of two main

populations of lymphocytes (T- and B-lymphocytes), which form appropriate T- and B-dependent zones; multilayer stereotypic position of functional zones in the range of the segments, with the "concentration" in the line of afferent lymph nodes orifice. Predominately, peripheral character of lymph nodes localization in the range of the segments (in the line of marginal sinus) and specific for each functional zone architectonics of reticular fibers net and vessels of micro-circulatory bloodstream are also indicated [6, 12, 18, 20, 21].

The mentioned above principles are automatically transferred to morphology of productive animals and are based for the description of the relevant organs of almost all species of domestic mammals. At the same time, according to some zoologists [1, 2, 14], all morphofunctional systems of the hollow-horned ruminants (among the productive animals domestic bull is to be referred here first of all) are the most perfect and much more complexly organized. However, at present, the conception of peculiarities and regularities of structural and functional organization of peripheral lymphoid organs parenchyma in the hierarchy of several species is practically not developed, what is utterly unfavorably reflected on the informative extent of findings in the analysis of different aspects of their morphology and morphogenesis.

Material and methods. Somatical (superficial cervical, subiliac, axillary) and visceral (mediastinal caudal, jejunal) lymph nodes of domestic bull (*Bos primigenius taurus* L.). The material was collected from clinically healthy and sexually mature animals in killing departments of meat-processing enterprises. Altogether 120 organs (superficial cervical – 30, subiliac – 30, axillary – 30, mediastinal caudal – 15, jejunal – 15) were selected and examined. Nodes were exposed with their connective tissue; they were being fixed for 10-14 days in 10% formalin solution (organs and solution correlation is 1:20). Median fragments of organs (perpendicularly cut to their entry) were used to produce serial histological sections. Total segmental serial histological sections of lymph nodes (20–30 microns in thickness), were produced in microtome-cryostat. Glycerin and gelatin mixture (glycerin – 3 g, gelatin – 20 ml, distilled water – up to 100 ml) was applied to frozen organ surface before the production of each section to prevent destruction during the process. Gelatin was preliminarily dissolved in 50 ml of warm water (35–45°C), then freezed at –18°C, whereupon it was warmed up on boiling water bath during 20–30 min, then glycerin and the rest portion of water were added.

Sections were received after solidification, but not after entire freezing of the above mentioned mixture which needs to have, soft and elastic consistency (form of "melting snow") and don't need to crumble when pressed.

The received sections were carried into glass container with distilled water (30–35°C temperature), where the glycerin and gelatin mixture was dissolved. Then the sections liberated from the mixture were carried to another container to be flushed during 3–6 hours.

Localization peculiarities of parenchyma collocation of lymph nodes functional zones (cortical plateau, deep cortex unit, (paracortex zone), lymph nodes, medulla cords) were defined using author's modified method of frozen sections impregnation with silver-nitrate by Fut [9]. It provides single-stage distinct visual-

ization of the appropriate zones according to representative architectonics of reticular fibers net. In cortical plateau reticular fibers net has representative close-meshed locate architectonics (interlacement of two fundamental fiber groups, one of which is located predominantly parallel to marginal sinus and the other one is perpendicular) (Fig. 1). In deep cortex units architectonics of the reticular fibers nets is wide-meshed honeycomb, in medulla cord it is close-meshed and felt-like. In lymph nodes it is even, close-meshed, mesobrochate and wide-meshed, depending on stage of their development to rarefaction and reduction of fibrous frame according to the formation of germinal centers (fig. 1).

Above mentioned modification has such peculiarity that preliminary treatment of lymph nodes tissues with glycerin and gelatin mixture obtains significant contraction of time needed for the sections to be in some reagents during the impregnation procedure. So, the treatment in potassium permanganate solution contracts up to 3–5 min, the one in oxalic acid solution contracts to 10 min. For the sections 30–40 min are enough for the silver nitrate solution, not more than 30 seconds are sufficient for ammoniacal silver solution, until little icteric tint appears. In 10–15 seconds reticular fibers get evident in sections in the formalin solution. After sections fixation in hyposulphite sodium solution the sections are carried to the plates with water. They are placed on the glass slide by means of a dissecting needle, brought to full drying up, cleared in fluid balm solution (xylol-balsam 10:1) and enclosed in balm. The research of the serial total sections, their photos and comparative analysis were conducted with System Microscope CX41 (Olympus).

Results and discussion. The research results indicate that the domestic bull's lymph nodes, as well as the appropriate human and laboratory animals' organs, are up built as per segmental principle. Beside this, particular segments or subunits of lymph nodes parenchyma accrete into single compact organ; and the segment boundaries are presented in histological sections in capsular trabecula-form (fig. 2).

Polar principle of parenchyma localization is also representative for the domestic bull's lymph nodes segments. It consists in volume rise of lymphoid tissue in direction of afferent lymph vessel entry, flowing into the marginal sinus. In consideration of lymphoid parenchyma concentration along the marginal sinus nodes in the range of each segment distinctly differentiate cortical substance in more replete lymphocytes and lighter medullary substance.

The analysis of development extent of particular segments in total segmental nodes sections indicates that the largest ones are the most remote from the organs collar and they are located on the convex nodes surface in central parenchyma areas, and their amount in the nodes of different groups varies drastically; what can depend on the number of afferent lymph vessels and on lymph flow intensity in the nodes in general.

The histo-architectonics of different segments of domestic bull's lymph nodes parenchyma is substantially identical. Beside this, spatial configuration of particular functional zones and the character of their collocation does not correspond fully to prevalent conventional conceptions of structural and functional organization of domestic bull's lymph nodes parenchyma.

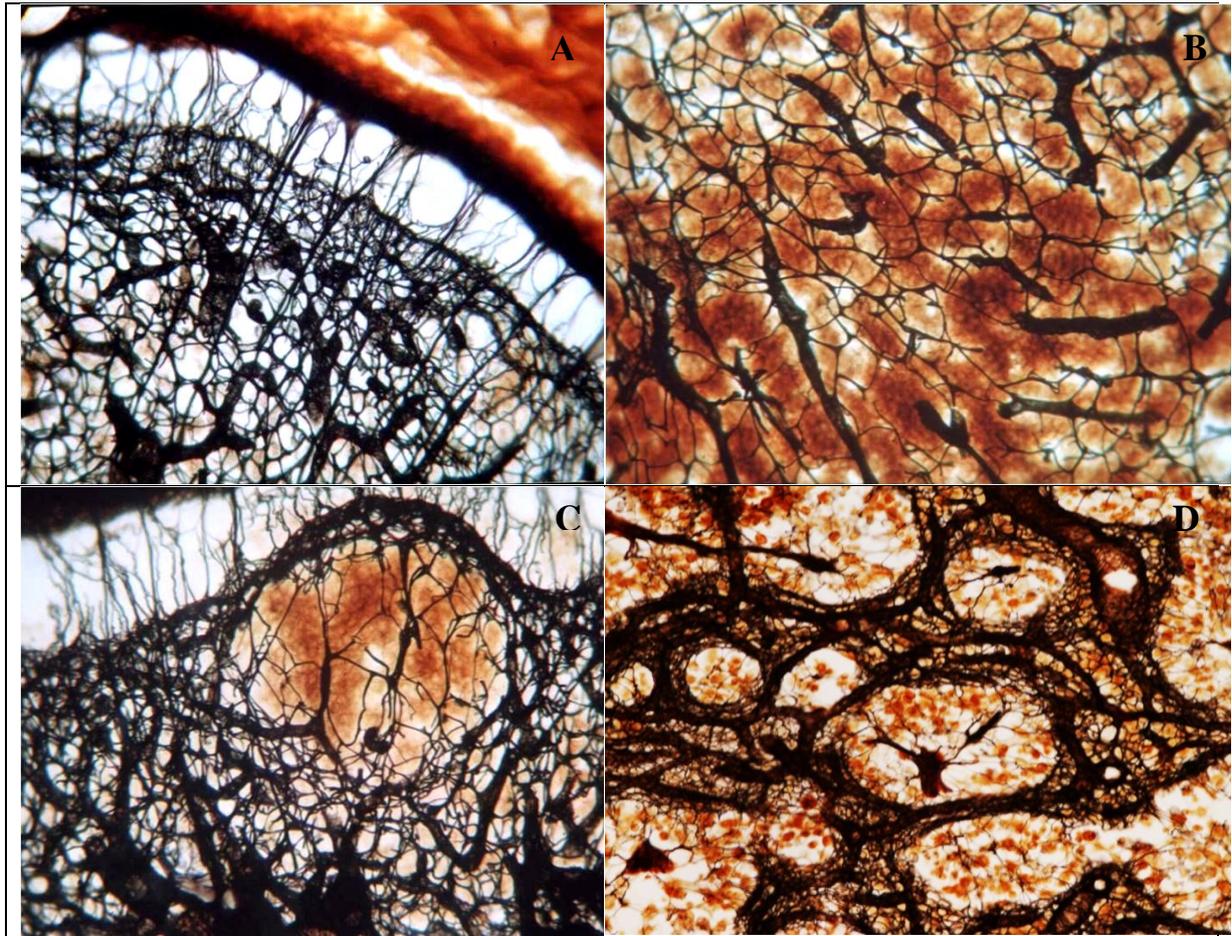


Fig. 1. Architectonics of the reticular fibers nets and some parts of the microvasculature in different zones of the parenchyma of lymph nodes:

A – cortical plateau; B – deep cortex units; C – lymph nodule; D – medulla cords.
(Impregnated with silver-nitrate by Fut, AC $\times 100$; BD $\times 400$)

In each segment lymphoid tissue, by-turn, is subdivided into several compartments – amount of which directly depends on the segment size (fig. 2). Compartments present a complex of zones, located in particular regularity; their utmost geometrical form is to spheroidal one, as well as the compartment itself which has form of asymmetrical ellipse with dilatation in direction of marginal sinus.

The basis of each compartment is a spheroidal paracortex area, defined in some works as deep cortex unit [3, 13, 24, 26], which is objected outside with a “cortex” in a form of cortex plateau, with nodes developing on the plateau basis (fig. 3).

Opposite compartment pole transfers without evident boundaries into very similar medullary substance, consisting of cylindrical cord of lymphoid tissue (medulla cord), cut by medulla sinuses. It is significant that cortex plateau areas, located around the deep cortex units, verge not only on marginal, but also on cortex intermediate sinuses, transferring without any evident boundaries into medulla cord. As a result in general the spatial configuration of cortex plateau presents not completely closed hollow sphere with “nucleus” in a form

of deep cortex unit (fig. 3). The spatial configuration of the cortex plateau also determines the lymph nodes localization character, which are formed on its basis on different levels and they completely “surround” deep cortex units; this gives representative mosaic pattern to segment parenchyma, in consequence of combination of large spheroidal deep cortex units surrounded by great amount of smaller lymph nodes.

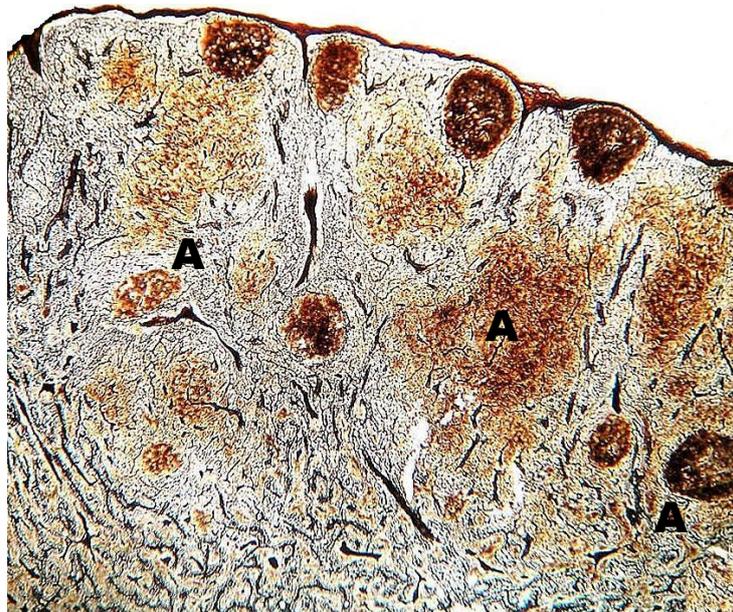


Fig. 2. Compartments (A) of the parenchyma of the superficial cervical lymph node. Impregnated with silver-nitrate by Fut, ×40

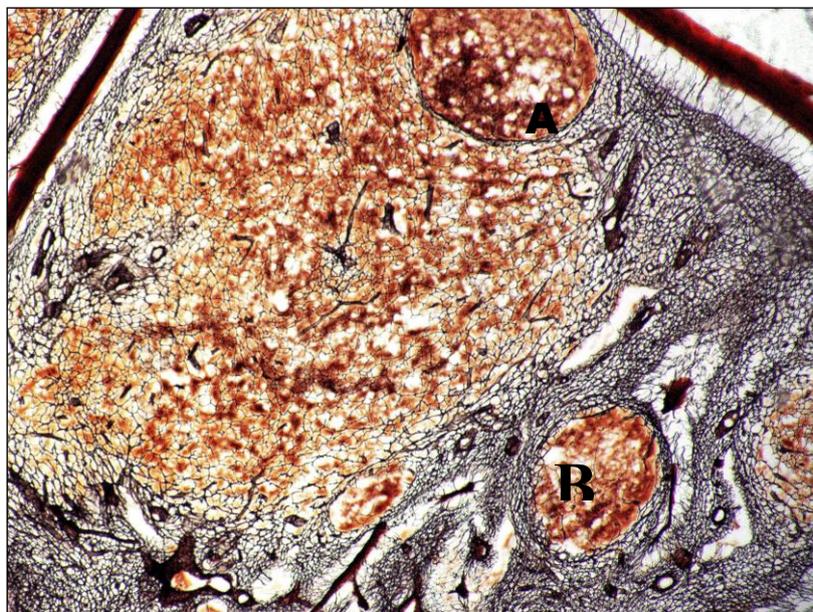


Fig. 3. The development of lymphatic nodules on various parts of the cortical plateau subiliac lymph node: A – on the boundary with the marginal sinuses; B – on the boundary with the cortex intermediate sinuses. Impregnated with silver-nitrate by Fut, ×100

It should be mentioned that in visceral lymph nodes the ones are formed not only on the cortex plateau basis, but also in medulla cord (fig. 4). The development of numerous lymph nodes in medulla cord of visceral lymph nodes in aggregate with multilayer character of their localization in cortex plateau allows to speak about through and total lymph nodes distribution in domestic bull's visceral lymph nodes parenchyma.

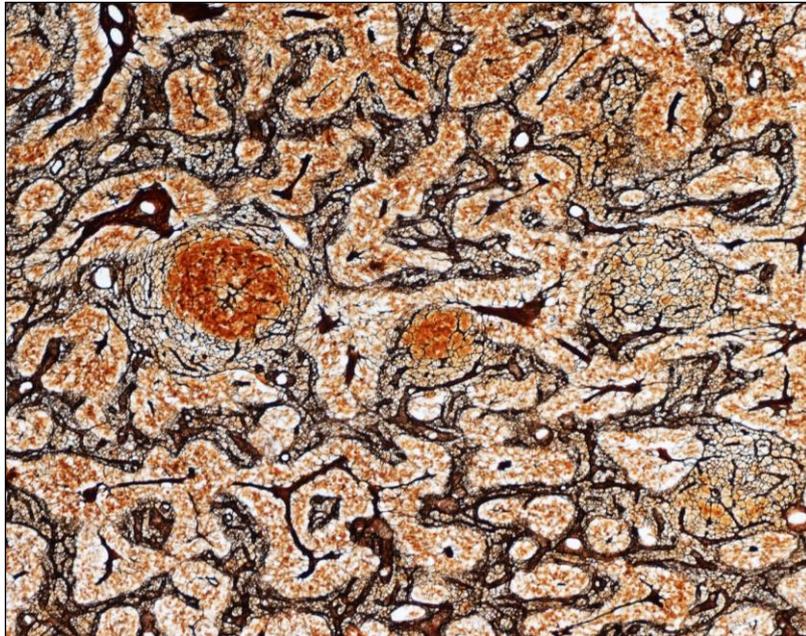


Fig. 4. The development of lymphatic nodules on the basis of medulla cords in the jejunal lymph node. Impregnated with silver-nitrate by Fut, $\times 100$

The deep cortex units form intermittent chain, which consists of isolated spheroidal structure on total medial sections of lymph nodes, in area of which several segments and respectively bigger number of compartments are located (fig. 5). It is necessary to mention that particular segment areas in the range of domestic bull's lymph nodes differentiate in their consolidation extent. So, the boundaries between complex of medulla cord segments in the medullary substance region, while segment areas, directed to the marginal sinus and include deep cortex units, as a rule distinctly detached by capsular trabeculas.

The received results allow us to make a conclusion that structural and functional organization of domestic bull's lymph nodes parenchyma substantially corresponds to the principles, which are representative for mammal class in general. The main principles are: 1) discrete (segmental and compartmental) character of which are discrete (segmental and compartment) character of lymphoid tissue constitution; 2) identical histo-architectonics of appropriate subunits. It is necessary to mention that established facts about variability of amount and extent of development of segments and compartments of nodes parenchyma require supplemental researches. These researches could be directed at: 1) distribution character study of afferent lymph vessels along nodes "surface"; 2) interconnection of extent of segment and compartments

development with diameter of afferent lymph vessels and lymphodynamics intensity in particular organs and their areas.

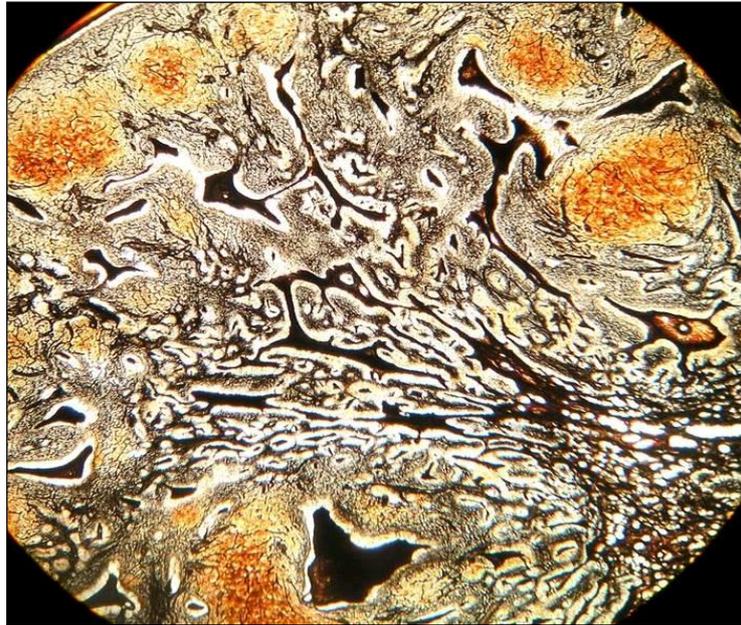


Fig. 5. Complex spheroidal units deep cortex in the parenchyma of the superficial cervical lymph node. Impregnated with silver-nitrate by Fut, $\times 40$

We established the fact that fundamental functional parenchyma zones (deep cortex units and lymph nodulus) have spheroidal spatial configuration, resulting that it has mosaic not layerwise character of histo-architectonics, demands supplemental researches, updating and substantiation using methods of immunocytochemistry. Domestic bull's lymph nodes, due to their size and possibility to receive of drastic amount of serial medial sections, are ideal objects for the research of histoarchitectonics peculiarities of the mammal given organs. This fact differentiates substantially the given organs from the human ones and, particularly, from animal lymph nodes, which sizes are extremely small, but the risk of mistake while trying to get total medial, perpendicular to organs collars sections is substantial.

In connection with the above mentioned we consider necessity of research about behavior of different mammals lymph nodes from the position of possible universality of their formation. We should also note that there is reference to the fact of discreteness and hemispherical spatial organization of albino rats' deep cortex units in several works [3, 13]. Confirm the universal fact of structural and functional organization of mammals' lymph nodes parenchyma we can mention identical character of lympho- and haemodynamics and also the lymphocytes recycling mechanism, that must be the fundamental factors of formation of the lymph parenchyma zonal structure.

According to Y. Törö, J. Csabs [22] and Y.I. Borodin, V.N. Grigoriev [5], the development of numerous lymph nodes in lymph nodes parenchyma depth, is a representative reaction on their intensive antigen stimulation. At the same time, there is no distinct morphological confirmation of the given process

and explanation of the contradictions with generally accepted conceptions, that the lymph nodes are formed exclusively in cortex substance, as a rule along the marginal sinus. The evidence of structural and functional identity of cortex plateau, peripheral zones of deep cortex units and medulla cord can be solution to the given problem. In terms of this, the “depth” factor of lymph nodes penetration into the parenchyma depth is likely to be considered as criteria for antigenic action strength and extent of this or that lymph participation in realization of immunoresponsiveness function.

Nowadays, established conceptions about the regularity of structural and functional organization of domestic bull's lymph nodes parenchyma has been comprised on the early stages of immunology and immuno-morphology development, when the heterogeneity aspects of lymphoid cells populations in peripheral lymphoid organs and, respectively, the mechanisms of their interactions during secondary phase of immune response formation weren't fully uncovered. According to the above mentioned, developing of new conception of morphological and functional parenchyma organization of organs lymphocytopoiesis and different species of animals' immunogenesis will lead to more adequate and resultant interpretation of the given organs structural alteration during morphogenesis process, normal, during experiment, and also during pathological states.

Conclusions

1. Parenchyma of a lymph node of a domestic bull is totality of identical subunits. The identical subunits are segments and compartments that have their structure functional relation.

2. Parenchyma segments are delimited from each other by capsular trabeculas and consist of several compartments that number depends on a degree development (size) of segment.

3. Basic principles compartment structure are ball-shaped, spatial configuration of functional areas; different (“through”) locating of lymph of nodes in their range; mosaic histo-architectonics nature.

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Установлено, что паренхима лимфатических узлов быка домашнего имеет дискретный характер строения и представлена комплексом структурно-функциональных сегментов и компартментов. Субъединицы (сегменты) паренхимы узлов имеют идентичную гистоархитектонику и состоят из нескольких компартментов, количество которых зависит от степени развития сегментов. Компартменты являются совокупностью структурно-функциональных зон, основными из которых являются единицы глубокой коры и лимфатические узелки. Единицы глубокой коры образуют основу компартмента, имеют сферообразную пространственную конфигурацию и в комплексе с лимфатическими узелками формируют характерную мозаичную гистоархитектонику паренхимы. Локализация лимфатических узелков в пределах сегментов узлов быка домашнего отличается разноуровневым (тотальным) распределением (от краевого до воротного синусов), что может указывать на структурно-функциональную идентичность коркового плато, периферических участков единиц глубокой коры и мозговых тяжей.

Лимфатический узел, паренхима, компартмент, единица глубокой коры, лимфатический узелок.

It is determined that domestic bull's lymph nodes parenchyma possesses discrete character of structure; and it is represented by a complex of structural and functional segments and compartments. Subunits (segments) of nodes parenchyma have identical hystoarchitectonics and consist of several compartments, the amount of which depends on the level of segment development. Compartments present constellation of structural and functional zones. Deep cortex units and lymph nodes are the main zones. Deep cortex units form the compartment base. They have spheroidal spatial configuration and form representative mosaic hystoarchitectonics parenchyma in combination with lymph nodules. Localization of lymph nodules in the range of domestic bull's nodes segments (differ in total split-level distribution (from marginal to portal sinus). This may denote that cortical plateau, peripheral areas of deep cortex units and medulla cords are structurally and functionally identical.

Lymph nodes, parenchyma, compartment, deep cortex units, lymph nodules.