

## Histotopographic Structure And Morphometric Parameters Of Deep Lymph Nodes In The Neck Of Rats

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**Abstract.** In this scientific study, the features of the histotopographic structure and morphometric parameters of deep lymph nodes in the neck of baby rats born from female rats receiving a research diet were studied. The results of the study show that rats born from rats that were fed a low-fat diet daily have deep lymph nodes. The dead formation occupies 58.1 % of the area, the primary lymphoid follicular zone – 14.7 %, the medulla – 22.3 %, the paracortical zone – 8.5 %. By the 20-day period, the area of the cavity decreased by 2 times, the primary follicular zone increased (18.3 %), the secondary follicular zone increased (11.6 %), and the paracortical area also expanded (13.4 %). By the 4-month period, it was observed that follicles have the same area, the area of secondary follicles increased (19.6 %) compared to primary follicles, and the paracortical follicle occupied 12.1 % of the area.

**Keywords:** rat; nutrition; baby rat; postnatal period; lymph node; morphology; morphometry.

## Kalamush Bo‘Yin Chuqur Limfa Tugunlarining Gistotopografik Tuzilishi Va Morfometrik Parametrlari.

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**Annotatsiya.** Ushbu ilmiy ishda tadqiqot ratsioni bilan oziqlantirilgan urg‘ochi kalamushlardan tug‘ilgan kalamush bolalari bo‘ynidagi chuqur limfa tugunlarining gistotopografik tuzilishi va morfometrik parametrlarining o‘ziga xos xususiyatlarini aniqlashga bag‘ishlangan. Tadqiqot natijalari shuni ko‘rsatadiki, har kuni kam yog‘li ozuqa bilan boqilgan kalamushlardan tug‘ilgan kalamushlarda chuqur limfa tugunlari mavjud. O‘lik formatsiya 58,1% maydonni egallaydi, birlamchi limfoid follikulalar zona - 14,7%, miya qatlami - 22,3%, parakortikal zona - 8,5%. 20 kunlik davrga kelib, bo‘shliq maydoni 2 baravar kamaygani, birlamchi follikulalar zona kattalashgani kuzatildi. 4 oylik davrga kelib, follikulalar bir xil maydonga ega ekanligi, ikkilamchi follikulalar maydoni birlamchi follikulalar maydoniga nisbatan oshganligi (19,6%), parakortikal follikulalar esa 12,1% maydonni egallaganligi kuzatildi.

**Kalit so‘zlar:** kalamush, ovqatlanish, kalamush bolasi, postnatal davr, limfa tuguni, morfologiya, morfometriya.

The nature of nutrition plays a significant role in the formation of various body systems. Insufficient intake of high-grade protein, vitamins, macro- and microelements, especially common in recent years, leads to significant metabolic disorders and the development of pathology [1, 2].

Of particular interest is the study of the features of the development, depending on the quality of the diet, of deep cervical lymph nodes draining the head area, including the brain and organs of the oral cavity.

This is due to the fact that the homeostasis of the organs of the central nervous system is determined by the effectiveness of the drainage function of the deep cervical lymph nodes. On the other hand, the immune function of these lymph nodes determines the usefulness of the local immunity of the oral cavity organs in direct contact with the external environment and exposed to increased antigenic load [3-5].

Currently, an increasing number of pathological conditions are being discovered, the origins of which go back to the embryonic period of life. The pathology of the newborn, childhood, and even the entire period of life may be due to adverse effects during intrauterine development [6], since it is known that during pregnancy there is a close connection between the eponymous organs of the mother and fetus [7]. An analysis of the literature data shows that many issues of lymph node morphology, especially in the mother–child system, have not been studied enough, and a number of data are even contradictory [6, 8]. In this regard, the effect of the low-protein diet of the maternal organism on the functional morphology of the cervical lymph nodes is of interest.

**The aim of the study** was to evaluate the dynamics of cellular transformations of deep cervical lymph nodes in the postnatal period in baby rats born from female rats with protein deficiency during pregnancy and lactation.

**Research materials and methods.** 96 animals were used in the work, including 40 female rats weighing 200-250 g from the Tomsk nursery and their offspring – 56 baby rats. 20 pregnant female rats received a standard vivarium diet (control group), and 20 were kept on a low–protein diet (excluding the meat component) (experimental group). The low-protein diet of these rats was also maintained during lactation. In rats, deep cervical lymph nodes were removed after decapitation under ether anesthesia on the 2nd, 10th and 20th days after birth.

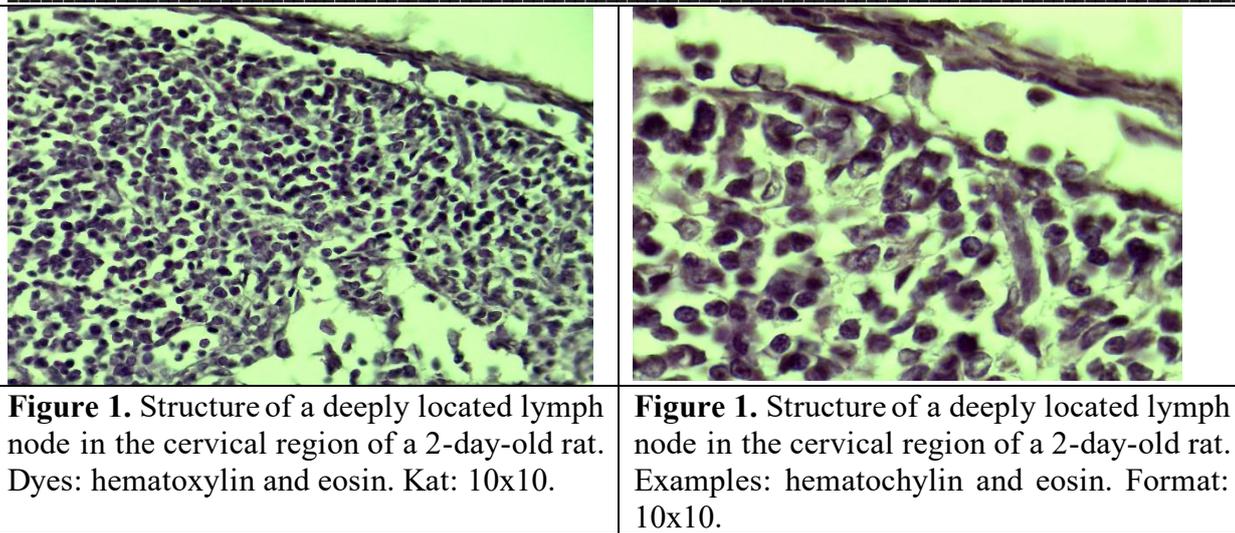
For studies, lymph nodes were fixed in 10% neutral formalin. After standard histological wiring, the material was poured into paraffin wax. Serial sections 5-6 microns thick were stained with hematoxylin-eosin and enclosed in Canadian balsam. Cellular elements in various structural and functional zones of lymph nodes were counted in 10 fields of view at magnification  $\times 400$ ,  $\times 600$  and  $\times 900$  on a conditional unit area of 6400 microns<sup>2</sup>. Digital data were processed statistically using the Student's t-test.

**Research Results.** A study of serial sections of deep cervical lymph nodes of 2-day-old rats born from females who received a standard vivarium diet during pregnancy showed that the node for this period of development is represented by undifferentiated lymphoid tissue located along the course of the main vessels. The parenchyma of the lymph node consisted of  $46.1 \pm 0.2\%$  of reticular cells,  $28.6 \pm 0.2\%$  were small lymphocytes,  $15.6 \pm 0.1\%$  were medium lymphocytes. The node was in the stage of primary differentiation, which is characterized by the isolation of the organ. The parenchyma of the lymph node of 2-day-old rats, whose mothers received a low-protein diet during pregnancy and lactation, consisted of  $53.8 \pm 0.2\%$  of reticular cells,  $20.1 \pm 0.1\%$  were small lymphocytes and  $8.1 \pm 0.2\%$  were medium lymphocytes.

Thus, in 2-day-old baby rats born to females receiving a low-protein diet, the content of reticular cells was increased by 16.7%. At the same time, the content of small and medium lymphocytes was lower than the control by 29.7 and 48.1%, respectively. The lymph nodes of these baby rats corresponded to the beginning of the third stage of development, when the subcapsular sinus and capsule first appear.

In the rats kept on a standard diet, the lymph nodes corresponded to the 3rd stage of development with a pronounced marginal sinus and subcapsular septa. From this, it can be concluded that the low-protein diet of female rats during pregnancy and lactation caused a slowdown in the development of deep cervical lymph nodes in embryogenesis.

A study of the cellular composition of the parenchyma of the primary follicles of the deep cervical lymph node of 10-day-old rats born to females receiving a low-protein diet revealed an increase in the content of reticular cells by 49.2% compared with the control (Table 1). No plasma cells were found in these rats. The content of mast cells was  $0.8 \pm 0.29\%$ . The content of degenerating cells was increased by 127.3%. The number of plasmoblasts was reduced by 68.8%. The content of small and medium lymphocytes was reduced by 14.6 and 39.3% compared to the control, respectively. No large lymphocytes were found in rat pups born to females who received a low-protein diet. In the same rats, mitoses were found to be 38.1% lower than in the control.



**Figure 1.** Structure of a deeply located lymph node in the cervical region of a 2-day-old rat. Dyes: hematoxylin and eosin. Kat: 10x10.

**Figure 1.** Structure of a deeply located lymph node in the cervical region of a 2-day-old rat. Examples: hematoxylin and eosin. Format: 10x10.

Table 1 – Cellular composition of deep cervical lymph nodes in the postnatal period in baby rats born from female rats who received a normal and low-protein diet during pregnancy

Terms of experience	Zone	Control, experienced	Cells				Plasmoblasts	Lymphocytes			Mitoses
			reticular	plasma	obese	degenerating		small	medium	big	
10th day	PF	K	25,4±0,16	1,0±0,08	0*	1,1±0,08	1,6±0,15	45,2±0,11	8,4±0,09	0,5±0,14	0,42±0,05
		O	37,9±0,18*	0*	0,8±0,29	2,5±0,22*	0,5±0,07*	38,6±0,47*	5,1±0,18*	0*	0,26±0,03*
	VLF	K	37,5±0,15	0*	0*	0*	0,8±0,12	42,1±0,16	7,1±0,57	0*	1,2±0,09
		O	0*	0*	0*	0*	0*	0*	0*	0*	0*
	PP	K	52,1±0,13	0*	0*	0*	0*	63,1±0,15	4,2±0,22	0*	0,4±0,06
		O	33,1±0,46*	0*	0*	1,7±0,09	0*	56,3±0,12*	5,5±0,09*	0*	0,2±0,06*
	MT	K	44,8±0,32	7,6±0,14	0,1±0,08	0,3±0,09	2,1±0,18	26,7±0,15	3,1±0,12	2,8±0,11	0,4±0,07
		O	52,1±0,68*	2,5±0,08*	0,5±0,16*	0,6±0,05*	0,9±0,08*	15,6±0,32*	3,8±0,17*	0,5±0,23*	0,2±0,02*
20th day	ΠΦ	K	12,7±0,19	2,0±0,16	0*	2,2±0,09	3,5±0,02	59,6±0,15	15,2±0,07	0,7±0,19	0,95±0,07
		O	14,2±0,22*	1,8±0,15	1,2±0,56	3,4±0,06*	3,2±0,09	52,4±0,25*	3,3±0,11*	0,6±0,15	0,69±0,08*
	VLF	K	30,8±0,29	0*	0*	0*	1,4±0,11	30,4±0,12	14,5±0,16	0*	4,3±0,05
		O	35,1±0,42*	0*	1,7±0,16	2,3±0,46	1,3±0,18	25,7±0,08*	2,2±0,11*	0*	3,9±0,12*
	PP	K	12,6±0,22	0*	0*	0*	0*	78,4±0,11	7,5±0,18	0*	0,8±0,1
		O	14,3±0,69*	0*	0*	2,6±0,08	0*	65,7±0,27*	3,8±0,07*	0*	0,5±0,08*

MT	K	23,9±0,16	16,4±0,25	50,2±0,05	0,2±0,07	5,2±0,16	30,5±0,11	9,2±0,15	5,3±0,18	0,6±0,09
	O	27,2±0,46*	14,7±0,58*	0,4±0,05*	0,5±0,09*	4,8±0,47	22,3±0,28*5	7,7±0,23*	7,6±0,34*	0,3±0,05*

Note. PFL – primary follicles; VLF – secondary follicles; PP – paracortical zone; MT – cerebral cords; K – control; O – experience; 0 – absence of cells; \* – significant differences from the control.

In rats born to females who received a low-protein diet during pregnancy and lactation, secondary follicles were not found at all during the 10-day period of life.

The study of the cellular composition of the parenchyma of the paracortical zone of the deep cervical lymph node of 10-day-old rats born to females receiving a low-protein diet revealed a decrease in the content of reticular cells by 36.5% compared with the control.

Plasma and mast cells were not found in these rats. The content of degenerating cells was  $1.7 \pm 0.09\%$ . Plasmoblasts were missing. The content of small and medium lymphocytes was reduced by 10.8 and 64.3% compared to the control, respectively. No large lymphocytes were found in this area in rats born to females who received a low-protein diet. In the same rats, mitoses were found to be 2 times lower than in the control.

When studying the cellular composition of the parenchyma of the cerebral cords of the deep cervical lymph node of 10-day-old rats born to females receiving a low-protein diet, an increase in the content of reticular, obese and degenerating cells was revealed by 16.3, 400.0 and 100.0% compared with the control, respectively. The content of plasma cells, on the contrary, was reduced by 67.1%. The number of plasmoblasts was reduced by 57.1%. The content of small, medium and large lymphocytes was reduced by 41.6, 74.2 and 82.1% compared to the control, respectively. In these rats, mitoses were 50.0% lower than in the control.

Thus, in the structure of the deep cervical lymph nodes of 10-day-old baby rats born to females who received a low-protein diet during pregnancy and lactation, a lag in the development of all structural elements of the organ was noted. Secondary follicles and intermediate sinuses were not formed. The cellular composition of the primary follicles, the paracortical zone and the cerebral cords indicates an insufficient development of the immune function of the nodes for this period of life.

The study of the cellular composition of the parenchyma of the primary follicles of the deep cervical lymph node of 20-day-old rats born to females receiving a low-protein diet revealed an increase in the content of reticular and degenerating cells by 11.8 and 54.6% compared with the control, respectively. The number of plasma cells in these rats did not differ statistically significantly from the control values. The content of mast cells was  $1.2 \pm 0.56\%$ . The number of plasmoblasts was also at the control level. The content of small and medium lymphocytes was reduced by 12.1 and 38.8% compared to the control, respectively. The number of large lymphocytes in rat pups born to females receiving a low-protein diet turned out to be at the control level at this time of the study. In the same rats, mitoses were found to be 27.4% lower than in the control.

The study of the cellular composition of the parenchyma of the secondary follicles of the deep cervical lymph node of 20-day-old rats born to females receiving a low-protein diet revealed an increase in the content of reticular cells by 14.0% compared with the control. These rats had no plasma cells in this zone. The content of obese and degenerating cells was  $1.7 \pm 0.16$  and  $2.3 \pm 0.46\%$ , respectively. The number of plasmoblasts turned out to be at the control level. The content of small and medium lymphocytes was reduced by 15.5 and 36.6% compared to the control, respectively. Large lymphocytes were not detected. In these rats, mitoses were found to be 9.3% lower than in the control.

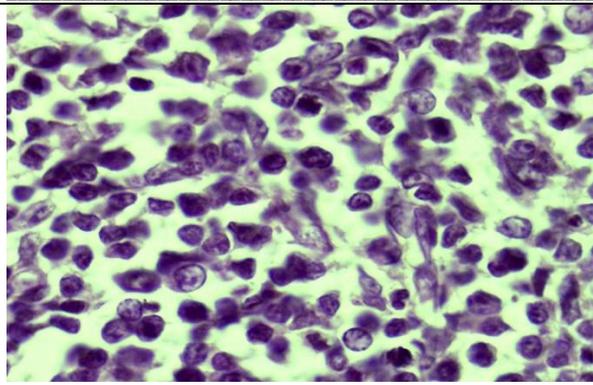


Figure 3. In a 2-day-old rat, the lymphoid tissue of the deeply located lymph nodes of the cervical region, reticular cells, and lymphocytes are sparse and randomly distributed. Paint: G-E. Format: 10x40.

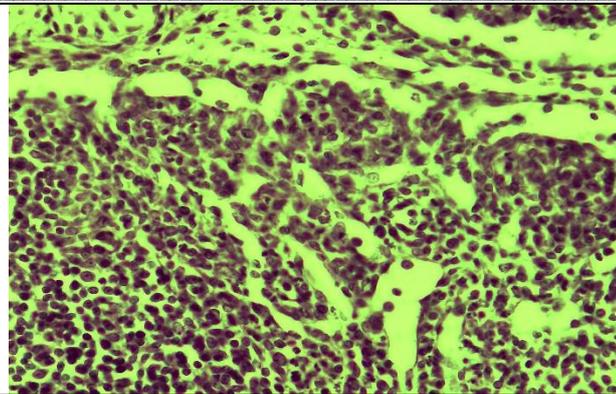


Figure 4. Intrapening of sinuses from the peripheral sinus into the parenchyma of a deeply located lymph node in the neck of a 10-day-old rat. Paint: G-E. Kat: 10x10.

The study of the cellular composition of the lymphoid parenchyma of the paracortical zone of the deep cervical lymph node of 20-day-old rats born to females receiving a low-protein diet revealed an increase in the content of reticular cells by 13.5% compared with the control. Plasma and mast cells were not found in these rats in this zone and during this period of the study. The content of degenerating cells was  $2.6 \pm 0.08\%$ . Plasmoblasts were missing. The content of small and medium lymphocytes was reduced by 16.2 and 22.7% compared to the control, respectively. Large lymphocytes in this area and at this time of the study were also not detected. In the same rats, mitoses were found to be 37.5% lower than in the control.

A study of the cellular composition of the lymphoid parenchyma of the cerebral cords of the deep cervical lymph node of 20-day-old rats born to females receiving a low-protein diet revealed an increase in the content of reticular, obese and degenerating cells by 13.8, 100.0 and 150.0% compared with the control, respectively. The number of plasma cells in these rats turned out to be 10.4% lower than in the control. The content of plasmoblasts did not differ statistically significantly from the control. The content of small and medium lymphocytes was reduced by 26.9 and 38.0% compared to the control, respectively. The number of large lymphocytes in rat pups born to females receiving a low-protein diet was 43.4% higher at this time of the study compared with the control. In these rats, mitoses were found to be 2 times lower than in the control.

Thus, in 20-day-old baby rats born to females who received a low-protein diet during pregnancy and lactation, structural signs of decreased immune function remained in the parenchyma of the deep cervical lymph nodes.

**Conclusion.** Low-protein nutrition of female rats during pregnancy causes a slowdown in the development of deep cervical lymph nodes in embryogenesis. This, in turn, leads to a violation of the cellular composition of the deep cervical lymph nodes, which in the future will certainly affect their immune function.

### References

1. Бородин Ю.И., Григорьев В.Н. Лимфатический узел при циркуляторных нарушениях // Новосибирск: Наука, Сиб. отделение. 1986; 286 стр.
2. Бородин Ю.И., Горчакова О.В., Горчаков В.Н. Периферические лимфоидные структуры: образование и функция. // Морфология. 2016;(4):90-6.
3. Поддубная И.В., «Лечение индолентных неходжкинских лимфом», Практическая онкология, 2004;5(3).
4. Сапин М. Р., Этинген Л. Е. Иммунная система человека. — М.: Медицина, 1996; 304 стр.
5. Сапин М.Р. Лимфатическая система и ее роль в иммунных процессах/Морфология: Материалы докладов XI конгресса международной ассоциации морфологов. г. Самара, 29–31 мая 2012 г. – СПб,

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2012;3(141):139.

6. Bartlett P. C. Current developments in the epidemiology and control of enzootic bovine leukosis as caused by bovine leukemia virus [Электронный ресурс]/ P. C. Bartlett, V. J. Ruggiero, H. C. Hutchinson et al. // Pathogens. 2020;9(12):10-58.

7. Bennett JE, Dolin R, Blaser MJ, eds. Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases. th ed. Philadelphia: Elsevier; 2015; 35-77 p.

8. Bento D.C., Jones E., Junaid S., Tull J., Williams G.T., Godkin A., et al. High endothelial venules are rare in colorectal cancers but accumulate in extra-tumoral areas with disease progression. // Oncoimmunology. 2015;4(3):974374.

9. Saidova A.A. Bovine stem cells: methodology and applications / A.A. Saidova // SOJ Veterinary Sciences. 2019;5(1):1-9.

10. Song I.H., Heo S.-H., Bang W.S., Park H.S., Park I.A., Kim Y.A., et al. Predictive value of tertiary lymphoid structures assessed by high endothelial venule counts in the neoadjuvant setting of triple-negative breast cancer. // Cancer Res Treat. 2017;49(2):399-407.

11. Turner, V. M. Influence of ageing on the microarchitecture of the spleen and lymph nodes [Электронный ресурс] / V. M. Turner, N. A. Mabbott // Biogerontology. 2017;18(5):723-738.

12. García-Hernández M.L., Uribe-Uribe N.O., Espinosa-González R., Kast W.M., Khader S.A., Rangel-Moreno J. A unique cellular and molecular microenvironment is present in tertiary lymphoid organs of patients with spontaneous prostate cancer regression. // Front Immunol. 2017;8:563.