

## Реферати

**ЕНЕРГЕТИЧНА ЦІННІСТЬ ХАРЧОВОГО РАЦІОНУ ТА ЇЇ ВІДПОВІДНІСТЬ ДОБОВИМ ПОТРЕБАМ У МОЛОДИХ ОСІБ**

Колинько Л.М., Весніна Л.Е.

У роботі визначено енергетичну цінність харчового раціону осіб із різною масою тіла та її відповідність добовим потребам в енергії. Обстежено 96 осіб обох статей 18-25 років. У групах з нормальною масою тіла, з підвищеною (індекс маси тіла 25,00-29,99 кг/м<sup>2</sup>) та ожирінням I ступеня (індекс маси тіла 30,00-34,99 кг/м<sup>2</sup>) вивчався харчовий статус методом 24-годинного відтворення харчування, основний обмін та рекомендоване добове споживання енергії. Енергетична цінність харчового раціону осіб із підвищеною масою тіла та ожирінням I ступеня обох статей достовірно перевищувала енергетичну цінність раціону осіб контрольної групи. Рівень позитивного енергетичного балансу в групі з підвищеною масою тіла у робочий день становив 16,02% у чоловіків, у вихідний день 26,47% у чоловіків, 24,46% у жінок. У чоловіків з ожирінням рівень позитивного енергетичного балансу у робочий день становив 20,09%, у вихідний 33,92%, у жінок у робочий день 10,48%, у вихідний 37,28%. Між показниками антропометрії та енергетичного обміну виявлені сильні та середньої сили зв'язки.

**Ключові слова:** підвищена маса тіла, ожиріння I ступеня, енергетична цінність харчового раціону, енергетичний обмін, позитивний енергетичний баланс.

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**ЭНЕРГЕТИЧЕСКАЯ ЦЕННОСТЬ ПИЩЕВОГО РАЦИОНА И ЕГО СООТВЕТСТВИЕ СУТОЧНЫМ ПОТРЕБНОСТЯМ У МОЛОДЫХ ЛИЦ**

Колинько Л.М., Веснина Л.Э.

В работе определена энергетическая ценность пищевого рациона лиц с разной массой тела и ее соответствие суточным потребностям в энергии. Обследовано 96 человек обоего пола 18-25 лет. В группах с нормальной массой тела, с повышенной (индекс массы тела 25,00-29,99 кг/м<sup>2</sup>) и ожирением I степени (индекс массы тела 30,00-34,99 кг/м<sup>2</sup>) изучался пищевой статус методом 24-часового воспроизведения питания, основной обмен и рекомендованное суточное потребление энергии. Энергетическая ценность пищевого рациона лиц с повышенной массой тела и ожирением I степени обоих полов достоверно превышала энергетическую ценность рациона лиц контрольной группы. Уровень положительного энергетического баланса в группе с повышенной массой тела в рабочий день составлял 16,02% у мужчин, в выходной день 26,47% у мужчин, 24,46% у женщин. У мужчин с ожирением уровень положительного энергетического баланса в рабочий день составлял 20,09%, в выходной 33,92%, у женщин в рабочий день 10,48%, в выходной 37,28%. Между показателями антропометрии и энергетического обмена выявлены сильные и средней силы связи.

**Ключевые слова:** повышенная масса тела, ожирение I степени, энергетическая ценность пищевого рациона, энергетический обмен, положительный энергетический баланс.

Рецензент Костенко В.О.

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Y.Y. Kuzmenko, L.O. Stechenko, S.M. Chuhrai, H.I. Kozak, T.M. Oliinyk<sup>1</sup>

Bogomolets National Medical University, Kyiv

<sup>1</sup>National University of Ukraine on Physical Education and Sport, Kyiv**MORPHOFUNCTIONAL FEATURES OF RENAL GLOMERULAR CAPILLARIES IN CONDITIONS OF CONGENITAL HYPOTHYROIDISM IN THE AGE ASPECT**

e-mail: lostechenko@gmail.com

Blood capillaries of rat renal glomeruli were studied 14, 50 and 100 days after the development of congenital hypothyroidism. It was found that on day 14 after the onset of hypothyroidism 7-day-old rats had a decrease in morphometric parameters of the number of capillaries and their area in comparison with age control in the absence of any marked morphological changes. In 45-day-old rats 50 days after the development of this pathology in glomerular blood capillaries changes in quantitative indicators had not reached critical values, while the presence of both destructive-dystrophic and compensatory processes were noted morphologically. 100 days after the development of pathology changes in blood capillaries became more pronounced than in the previous period. Destructive-dystrophic changes of a part of capillaries and the phenomena of necrosis and apoptosis were observed in the presence of compensatory-adaptive processes.

**Key words:** blood capillaries, kidneys, rats, congenital hypothyroidism.

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Congenital hypothyroidism is one of the most complex and important problems among endocrinological pathology in children leading to a dangerous developmental disorder of almost all organs and systems, and without timely diagnosis and treatment to severe disability of a child. According to neonatal screening data incidence of congenital hypothyroidism in Ukraine ranges from 1/2500 to 1/4000 of newborns and peaks in the regions with severe iodine deficiency [2]. At present fatal changes in the body, growth and development retardation of a child can be prevented by timely prescription of thyroid hormone replacement therapy, therefore the study of this pathology is relevant [4,5,12]. It is known that during embryogenesis thyroid hormones directly or indirectly affect the development and physiology of kidneys causing significant changes in renal function, such as decreased sodium reabsorption in the proximal tubules, impaired concentrating capacity of distal tubules, decreased uric acid excretion,

decreased renal circulation and glomerular filtration [7-8]. In our earlier studies we found that thyroid hormone deficiency significantly affects the weight of the rats kidney at different ages and leads to impaired maturation of all its structural components [3].

Given the above, the study of morphogenesis, regeneration, viability of the kidneys as the main organ body homeostasis maintaining in conditions of thyroid hormone deficiency is relevant and up-to-date.

**The purpose** of the study was to reveal the peculiarities of the structure of renal glomerular blood capillaries in conditions of congenital hypothyroidism in the course of the experiment.

**Materials and methods.** Kidneys of Wistar rats which were kept in standard conditions of Bogomolets NMU vivarium were studied. In keeping, animal care, and procedures the provisions of the European Convention for the Protection of Vertebrate Animals Used for Experimental and Scientific Purposes (Strasbourg, 1985) and the General Ethical Principles for Animal Experiments, approved by the 1st National Congress on Bioethics were observed. (Kyiv, 2001). Congenital hypothyroidism in experimental animals was simulated by thyroid suppression with a thyrostatic drug mercazolil, which has been administered daily at a dose of 20 mg / kg of body weight dissolved in water throughout the experiment. Pregnant females were administered the drug orally from the 14th day of prenatal fetal development and after birth the experimental animals had been receiving it with breast milk and then with their food. Peculiarities of thyroid hormone deficiency effect were determined in rats 7, 45 and 100 days old. Juvenile 7-day-old rats; young sexually and physiologically immature 45-day-old rats; sexually and physiologically mature 100 day-old rats served the control for experimental animals. The hypothyroidism condition was determined by enzyme-linked immunosorbent assay by the content of free thyroxine in blood plasma on the device "Sunrise RC" TEKAN company at the time when the animals were sacrificed. The cortical substance of the kidney was used as the material for electron microscopic examination. Kidney pieces were fixed with 2.5% glutaraldehyde solution on phosphate buffer with postfixation in 1% osmium tetroxide solution and treated following the conventional procedures. Sections were made on an LKB III (Sweden) ultramicrotome. The preparations were studied and photographed on an electron microscope PEM-125K. Morphometry of blood capillaries (bulk density, quantitative density and area) was done on a PEM-125K electron microscope using «KAPPA» software. The mean value, the mean value error, the standard deviation, and the accuracy factor were calculated for each indicator. Statistical processing of the obtained data was performed using the parametric Student's t test and the non-parametric Kolmogorov-Smirnov test according to the principles of variation statistics.

**Results of the study and their discussion.** 14 days after the beginning of the experiment thyroid hormone deficiency was confirmed in 7-day-old rats by a decrease in plasma thyroxine levels up to  $3.44 \pm 0.49$  pmol / L versus  $7.98 \pm 0.71$  pmol / l in the age control.

A decrease in the number of capillaries alongside the increase of their size was observed in this age group of rats, making the volume they occupy in the renal corpuscle equal to that in the statistically identical age control, i.e.  $5.79 \pm 82\%$  of corpuscle volume (table 1).

The lumens of the capillaries were often obturated with formed elements of blood: erythrocytes, lymphocytes, and leukocytes. In renal corpuscles with incomplete differentiation processes the glomerular capillaries were lined with endothelial cells with large nuclei and there was no differentiation into the nucleus-containing and peripheral zones. This seems to be the reason for the increased size of the capillaries in comparison with the control. A few glomerular capillaries have dilated lumens and endothelial cells cytoplasm differentiated into the nucleus-containing and peripheral zones (fig. 1. A). The basal membrane of endothelial cells in immature glomeruli still remains incompletely formed and quite thinned even at the sites of bifurcations (fig. 1B).

Table 1

**Morphometric parameters of the renal glomerular capillaries in rats with CHT,  $M \pm m$** 

Groups of animals	Bulk density of the capillaries %	Quantitative density * $10^{-6} \mu\text{m}^3$	Area of capillaries * $10^2 \mu\text{m}^2$
7 days	$5.79 \pm 1.82$	$15.95 \pm 1.49^*$	$4.16 \pm 0.23^*$
control	$6.82 \pm 0.97$	$19.42 \pm 1.61$	$3.60 \pm 0.21$
45 days	$9.56 \pm 1.92^*$	$29.51 \pm 2.63$	$3.16 \pm 0.28$
control	$14.74 \pm 2.20$	$33.35 \pm 4.34$	$3.64 \pm 0.32$
100 days	$9.15 \pm 1.09^*$	$20.17 \pm 2.16^*$	$2.21 \pm 0.18^*$
control	$16.9 \pm 0.9$	$33.69 \pm 1.9$	$3.15 \pm 0.17$

\*significant difference in comparison with the control ( $P \geq 0.05$ )

According to enzyme-linked immunosorbent assay findings the level of free thyroxine in blood plasma of 45-day-old rats 50 days after the initiation of the experiment was significantly lower than in the

age control ( $3.96, \pm 0.46$  pmol / L vs  $7.63 \pm 0, 99$  pmol / L, respectively.). The morphometric characteristics of the glomerular capillaries indicate a decrease in the bulk density of the capillaries, with the absolute number of glomerular capillaries and their area decreasing to a lesser extent (table 1).

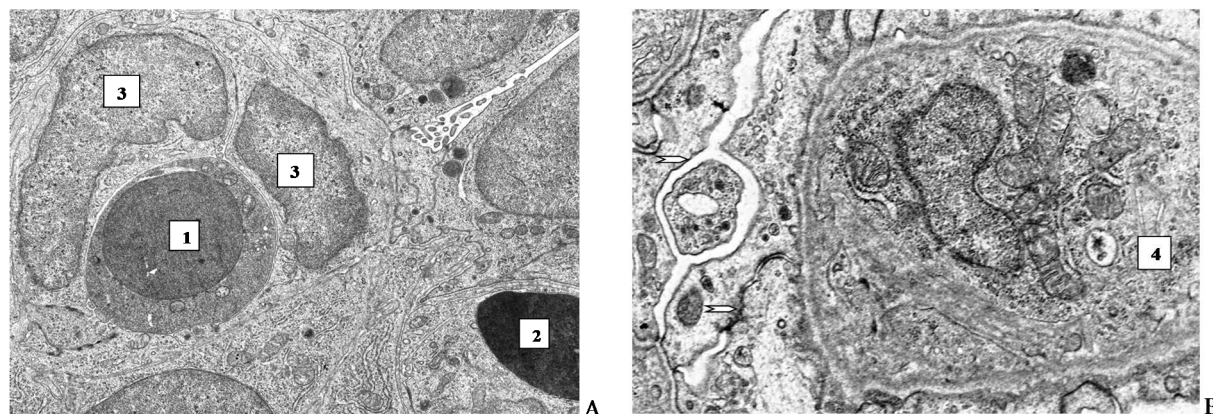


Fig. 1. Glomerular blood capillaries of a 7-day-old rat 14 days after the onset of CHT. Erythroblast (1), erythrocyte (2) in the lumen of the glomerular capillaries. Endothelial cell nuclei (3), peripheral areas (↑) of endothelial cells, mesangial cell (4). Electron microscope images. Magnification: A-10000, B-16000.

At the electron microscopy level heteromorphic structure in the endothelium of blood glomerular capillaries is noted: in some glomeruli endotheliocytes do not differ from those in control animals, but most of them contain a significantly thinned peripheral zone with a large number of fenestrae, which may indicate the development of adaptive processes in the endothelium (fig. 2. A, B). It should be noted that such a thinning of the cytoplasm leads to a decrease in the number of organelles and a disorder of metabolic processes in the endothelium.

Nuclear-containing zones are quite rare, but there occur cells with a pyknotically changed nucleus, extremely few organelles and a partially lysed plasma membrane, which may indicate the development of apoptotic changes in the endothelium (fig. 2 A). Some endothelial cells have signs of biosynthetic activity, namely: nuclei with predominance of euchromatin, endoplasmic reticulum tubules, Golgi complex, and polysomes not only around the nucleus, but also in the peripheral areas that have moderately or slightly increased thickness with no fenestra (fig. 2A, B). Others have signs of dystrophic and destructive processes: such as, local edema of the endothelial cells cytoplasm and their mitochondria with formation of vacuoles containing edematous fluid or microclasmatous outgrowths with their subsequent separation into the lumen (fig. 2. A).

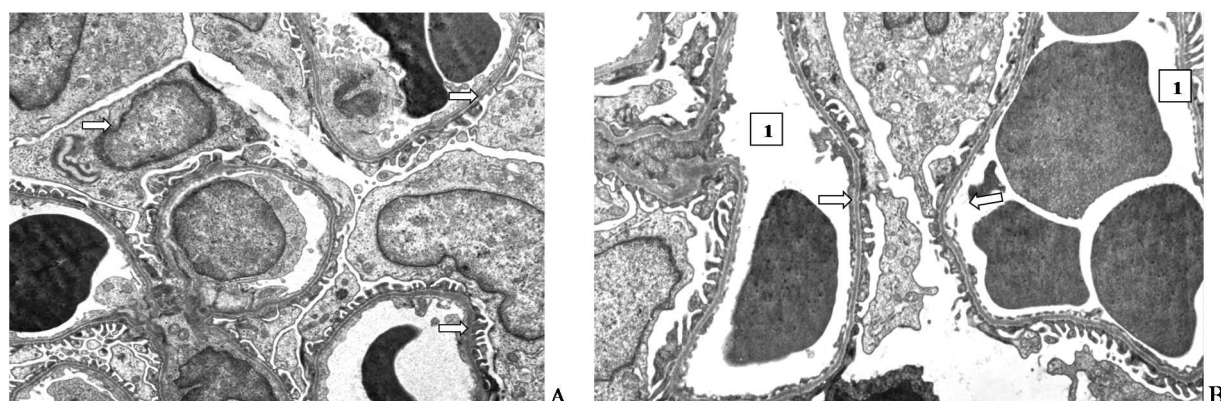


Fig. 2. Blood capillaries of a 45-day-old rat 50 days after the onset of CHT. Lumens of glomerular capillaries (1). Peripheral areas (↑) of endothelial cells. Electron microscopic images. Magnification: A, B-10000.

100 days after the development of CHT significantly less free thyroxine in comparison with the previous observation periods was found in the blood plasma of experimental rats, i.e.  $2.77 \pm 0.76$  pmol / L, which is three times lower than in the age control ( $8.58 \pm 0.72$  pmol / L).

The lumens of the glomerula capillaries are slightly dilated and contain formed blood elements. The endothelial cells that line them have a clear division into the nuclear-containing and peripheral zones (fig. 3 A, B). As a rule, the karyoplasm of endothelial cells has high electron density, which makes them dark (fig. 3 A). In cases of the greatest compaction of karyoplasm the nuclei are reduced in sizes, pyknomorphic and flattened (fig. 3 B). The shrinkage of the nuclei can explain the detachment of endothelial cells from the basement membrane. In some capillaries, endothelial desquamation is also found

in the peripheral areas. Cells with pyknomorphic nuclei are significantly thinned, have single organelles, mainly lysosomes and the Golgi complex, in which autophagosomes are formed (fig. 3A).

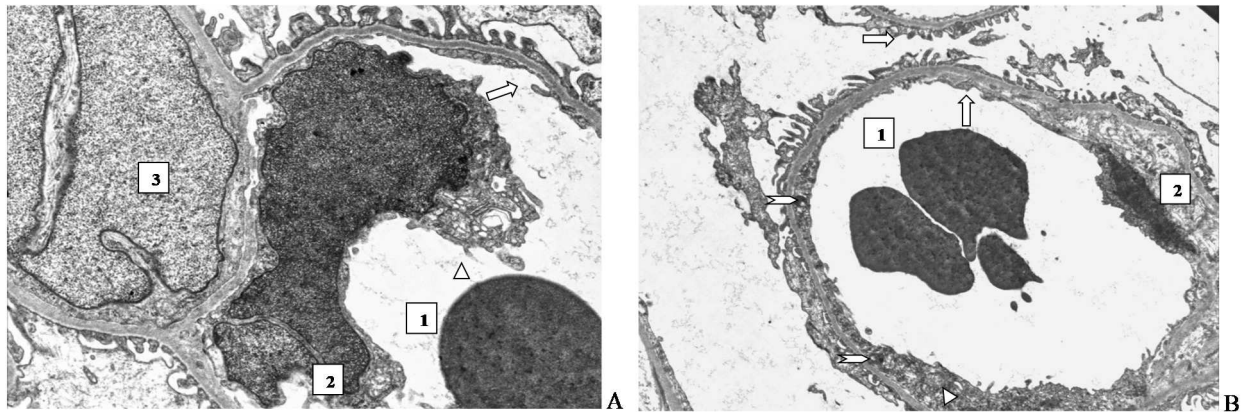


Fig. 3. Fragments of the renal corpuscle glomerular capillaries of 100 days old rats 100 days after the onset of CHT. Lumen of capillaries (1), pyknomorphic nucleus (2), peripheral areas (↑) of endotheliocytes, lysosome (△) mitochondria (†). Electron microscopic images. Magnification: A-14000, B-8000.

Regarding the indicators characterizing the glomerula capillaries, noteworthy is a decrease in all their values studied in comparison with age control. The degree of differences from control during the development of CHT is the greatest in 100-day-old rats (fig. 4).

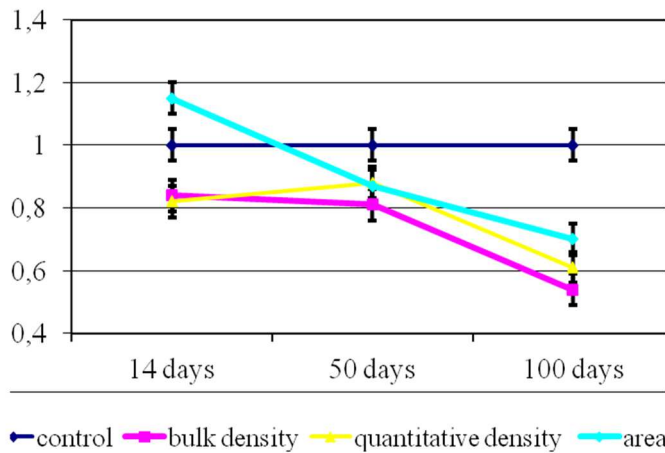


Fig. 4. Dynamics of changes in the indicators characterizing the glomerular capillaries of the renal corpuscles in rats with CHT in conventional units in relation to the control taken as 1.

In 45-day-old rats after 50 days of development of congenital hypothyroidism qualitative differences from age control in the glomerular blood capillaries are not widespread, and changes in quantitative indicators do not reach critical values. This gives grounds to believe that in the glomerular blood capillaries both destructive-dystrophic and compensatory processes are observed at the same time, with the latter prevailing. It should be noted, however, that apoptosis in the kidney of 45-day-old rats 50 days after the onset of CHT is not significantly pronounced. This statement is based on the absence of apoptotic bodies and cell compaction can be reversible.

100 days after the CHT development, changes in the kidney become more pronounced in comparison with the previous terms. In glomerular blood capillaries against the background of active destructive processes there is a failure of the compensatory ones.

## Conclusion

In the course of the experiment, under the conditions of thyroid hormone deficiency, a number of morpho-functional changes develop in the glomerular blood capillaries.

At the early stages of hypothyroidism development in case of its congenital form, the main feature of the kidney is the retarded maturation of both the entire kidney and the differentiation of its components, in particular the glomerular blood capillaries. Prevailing in the glomerulus in the presence of the formed capillaries are the capillaries, whose endotheliocytes have a large nucleus, surrounded mainly by ribosomes and single mitochondria and almost no peripheral thinned area. Morphometrically, a decrease in the number of capillaries compared to control animals was found.

In 45-day-old rats after 50 days of CHT development, changes in quantitative parameters (number of capillaries and their area) do not significantly exceed those in control animals, which may indicate the predominance of compensatory changes in the internal lining of capillaries over the destructive-dystrophic ones.

100 days after CHT development, the changes in the kidney become more pronounced than in the previous period. Destruction of glomerular capillaries is observed, which leads to a decrease in both quantitative and bulk densities. These changes are based on apoptosis and necrosis of endothelial cells of the part of glomerular capillaries; desquamation of the endothelial lining, local expansion and loosening of the basement membrane, which leads to the damage to their integrity in particular and trophic disorders in general are observed in the other part of the capillaries.

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### Реферат

#### МОРФОФУНКЦИОНАЛЬНІ ОСОБЛИВОСТІ КАПЛІАРІВ СУДИННОГО КЛУБОЧКА НИРОК В УМОВАХ ВРОДЖЕНОГО ГІПОТИРЕОЗУ У ВІКОВОМУ АСПЕКТІ

Кузьменко І.І., Стеченко Л.О., Чухрай С.М., Козак Г.І., Олійник Т.М.

У щурів досліджено кровоносні капіляри судинних клубочків нирок через 14, 50 і 100 днів розвитку вродженого гіпотиреозу. Встановлено, що на 14 добу від початку розвитку гіпотиреозу в 7-ми денних щурів на тлі відсутності виражених морфологічних змін відзначається зменшення морфометричних показників кількості капілярів і їх площі в порівнянні з віковим контролем. У 45-ти добових щурів через 50 днів розвитку цієї патології в кровоносних капілярах судинних клубочків зміни кількісних показників не набувають критичних величин, а морфологічно відзначаються як деструктивно-дистрофічні, так і компенсаторні процеси. Через 100 днів розвитку патології зміни в кровоносних капілярах набувають більшої виразності в порівнянні з попереднім терміном. На тлі компенсаторно-приспосувальних процесів відзначаються деструктивно-дистрофічні зміни частини капілярів та явища некрозу і апоптозу.

**Ключові слова:** кровоносні капіляри, нирки, щури, вроджений гіпотиреоз.

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#### МОРФОФУНКЦИОНАЛЬНЫЕ ОСОБЕННОСТИ КАПИЛЛЯРОВ СОСУДИСТЫХ КЛУБОЧКОВ ПОЧЕК В УСЛОВИЯХ ВРОЖДЕННОГО ГИПОТИРЕОЗА В ВОЗРАСТНОМ АСПЕКТЕ

Кузьменко І.І., Стеченко Л.О., Чухрай С.М., Козак Г.І., Олійник Т.М.

У крыс исследованы кровеносные капилляры сосудистых клубочков почек через 14, 50 и 100 суток развития врожденного гипотиреоза. Установлено, что на 14 сутки от начала развития гипотиреоза в 7-ми дневных крыс на фоне отсутствия выраженных морфологических изменений отмечается уменьшение морфометрических показателей количества капилляров и их площади в сравнении с возрастным контролем. У 45-ти суточных крыс через 50 суток развития этой патологии в кровеносных капиллярах сосудистых клубочков изменения количественных показателей не приобретают критических величин, а морфологически отмечаются как деструктивно-дистрофические, так и компенсаторные процессы. Через 100 суток развития патологии изменения в кровеносных капиллярах приобретают большую выразительность по сравнению с предыдущим сроком. На фоне компенсаторно-приспособительных процессов отмечаются деструктивно-дистрофические изменения части капилляров и явления некроза и апоптоза.

**Ключевые слова:** кровеносные капилляры, почки, крысы, врожденный гипотиреоз.

Рецензент Єрошенко Г.А.