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Features of the Functional Development of the Gastrointestinal Tract

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Abstract: The review presents materials reflecting the functional formation of the digestive organs, that is, the "maturation" of their enzymatic activity. It has been established that the alimentary factor plays the main role in the "ripening" of the digestive system. Cases of maternal pathology adversely affect the development of the digestive system.
Key words: intestines, pancreas, development, ontogeny, lactotropic nutrition.

Relevance. It has now been established that the ontogenesis of the structure and function of the gastrointestinal tract is realized due to the interaction of four main determinants, namely: genotype, biological clock, neuroendocrine regulatory systems and environmental factors.

In our article, we decided to discuss in more or less detail the literature regarding the restructuring of the gastrointestinal tract when this restructuring is influenced by viral and bacterial infections transmitted from a pregnant and/or lactating mother to developing offspring.

The role of the genetic factor. The genetic program is laid down in the form of a sequence of nucleotides in a DNA molecule. It controls the development of various organs and systems of the body as a whole. The role of the genetic program in the development of pancreatic exocrine cells has been shown in cell culture in vitro [1, 4]. It has been demonstrated that in the pancreatic explant, the time of the increase in the activity of α-amylase, lipase and chymotrypsinogen and the appearance of zymogen granules is very similar to that in fetal development. In a similar way, the fetal intestine of rats transplanted into the kidney or into the subcutaneous space of an adult, or when cultivated in vitro, develops. In addition, there are many works indicating that, for example, the disaccharidase activity of the small intestine mucosa develops in exactly the same way in vitro and in sito [4, 5].

However, it should be noted that the genotype is not always the same. It can undergo mutation, which manifests itself in the form of congenital malformations of metabolism. Thus, hereditary diseases of the exocrine function of the pancreas such as fibrous cyst and rare deficiency of lipase, trypsinogen or amylase [10, 12, 15] are typical examples of mutation of the corresponding gene loci. Insufficiency of some intestinal disaccharidases, the inheritance of which obeys Mendel's laws, is also the result of a mutation [4]. These genetic disorders are so specific that they are often used as a model for studying the molecular mechanisms involved in digestion.

It has been shown that the insufficiency of the lipolytic activity of the pancreas is associated with the suppression of the rate of synthesis of this enzyme in acinar cells by approximately half. In children with congenital sucrase-isomaltase deficiency, the sucrase-isomaltase complex is sharply reduced or this enzyme is completely absent [31] on the brush border of mature enterocytes. With this disorder, an atypical protein is synthesized in the cytoplasm of enterocytes,

which is a modified sucrase-isomaltase complex, which is not transported to the brush border [37, 38], possibly due to the lack of an appropriate affinity of molecules for transporters.

In general, there are many examples of impaired function of the enzyme systems of the gastrointestinal tract associated with damage to an adult [32, 57] or during in vitro cultivation. In addition, there are many works indicating that, for example, the disaccharidase activity of the small intestine mucosa in vitro and in sito develops in exactly the same way.

However, it should be noted that the genotype is not always the same. It can undergo mutation, which manifests itself in the form of congenital malformations of metabolism. Thus, hereditary diseases of the exocrine function of the pancreas such as fibrous cyst and rare deficiency of lipase, trypsinogen or amylase [32, 46, 52, 53] are typical examples of mutation of the corresponding gene loci. Insufficiency of some intestinal disaccharidases, the inheritance of which obeys the laws of Mendel, is also the result of a mutation. These genetic disorders are so specific that they are often used as a model for studying the molecular mechanisms involved in digestion.

It has been shown that the insufficiency of the lipolytic activity of the pancreas is associated with the suppression of the rate of synthesis of this enzyme in acinar cells by approximately half [45]. In children with congenital sucrase-isomaltase deficiency, the sucrase-isomaltase complex is sharply reduced [43] or this enzyme is completely absent on the brush border of mature enterocytes. With this disorder, an atypical protein is synthesized in the cytoplasm of enterocytes, which is a modified sucrase-isomaltase complex, which is not transported to the brush border [44], possibly due to the lack of an appropriate affinity of molecules for transporters.

In general, there are many examples of dysfunction of the enzyme systems of the gastrointestinal tract associated with damage to the genetic control of the ontogeny of enzyme-producing systems. We will confine ourselves to the above examples and note that the current level of our knowledge allows us to state the following: a mutation of the regulatory gene leads to a delay in the development or elimination of a programmed reduction, for example, lactase activity. The correctness of this point of view seems to us the most probable, since the emergence of an entirely new enzymatic system in ontogenesis is much more complicated than a simple modification of an existing one.

The role of the biological clock. The biological clock is a programmed temporal sequence of events in ontogeny. They are under genetic control and therefore species-specific. For example, the pattern of development of pancreatic enzyme activity in humans is significantly different from that in rats. In the latter, the accumulation of pancreatic enzymes begins a few days before birth [57]. In humans, for example, pancreatic lipase appears at 34 weeks of gestation [52], α-amylase is absent in the fetal pancreas and appears in very small amounts during the neonatal period. This difference between rat and human in the functional development of the pancreas raises some caution against directly extrapolating animal data to explain the development of the human gastrointestinal tract. However, the development of the digestive system in different species of mammals, in general, occurs in a certain sequence. According to published data, it starts from the division of the zygote and the formation of endo-, meso- and ectoderm. As a result of the interaction of these three primary germ layers, a pattern of differentiation arises, according to which anatomical specialization of various parts of the gastrointestinal tract occurs with a known sequence of characteristic species specificity and biological variability. It has been established that in the human fetus at the 20th week of gestational development, the anatomical differentiation of the gastrointestinal tract is similar to that in newborns [57].

The development of the secretory function of the digestive glands and the absorption function of the gastrointestinal tract do not always occur synchronously. The mechanisms of

absorption from the small intestine in relation to individual substances are formed already at the 26th week of gestation, while stimulated pancreatic secretion is not observed even in the neonatal period. In addition, within intrauterine life, different sections of the gastrointestinal tract develop at different times.

In the aspect of the scientific problems discussed in this review and for the subsequent analysis of the results obtained in the work, it seems important to us to clarify the question of whether morphogenesis and cytodifferentiation begin simultaneously in ontogenesis and whether these processes are regulated by the same factors or whether they develop to some extent, do not dependent on each other. In the studies of some authors, the possibility of conjugation between cytodifferentiation and morphogenesis in the development of the pancreas in mice was studied [2, 3, 11, 19, 20, 22, 24, 28]. These authors isolated the protodifferentiated pancreatic epithelium from the mesoderm and cultured it on a plastic substrate. Within 24 hours, the epithelium grew to a monolayer, but under these conditions, acinar cells did not form and cellular mitosis was not observed. Therefore, there were no mesenchymal cells or mesenchymal factors in this culture. However, despite the absence of morphogenesis, cytodifferentiation occurred, as evidenced by a 100-fold increase within 5-7 days in these cultures of the specific activity of amylase and the appearance of zymogenic granules in the cells. The changes observed in mice were similar to those found by other authors in the chicken pancreas in sito [28, 38]. The generalization of these data indicates the presence of a clear dissociation between the regulation of cytodifferentiation, on the one hand, and morphogenesis, on the other hand, at least in relation to the pancreatic acinar tissue of mice during the second transitional period of fetal development.

In general, turning to the conclusion of this section of the literature review, we note that the role of the biological clock in the structural and functional development of the digestive organs has been studied quite fully at present. It has been noted that the transition of the structural and functional characteristics of the gastrointestinal tract from one state to another at different stages of ontogenesis (for example, from juvenile to adulthood) is realized due to various regulatory mechanisms, among which the biological clock is of no small importance [5, 9, 29 , 30, 42, 43, 51]. The role of hormonal control. It has now been established that neuroendocrine regulatory systems play a huge role in the implementation of the genetic program of ontogenetic morphofunctional changes in the gastrointestinal tract. Indeed, studies have shown that the administration of hydrocortisone to suckling mice induces the synthesis of certain enteral enzymes. Many other authors have found that when hydrocortisone is administered to suckling rats or mice, they soon induce the synthesis of sucrase, which is usually absent during the first two weeks of postnatal development. The same data were obtained for alkaline phosphatase, maltase, and various peptide hydrolases [45, 46, 56]. The physiological mechanisms of action of glucocorticoids on the enzymatic system of the digestive organs in ontogenesis are quite complex, but they obey the following patterns. First, the small intestine of rat pups after the injection of hormones becomes similar in many respects to that of rat pups during the transition from milk to definitive nutrition. Secondly, the process of morphofunctional transformation of the intestine is not carried out quickly, but at least within 72 hours. Thirdly, changes in the enzymatic spectrum of enterocytes of the cryptovillous axis, after injection of glucocorticoids, persist for many generative cycles of the cell [15]. From this last fact, it can be concluded that the changes start from the cells of the crypts and are detected during the entire process of cell migration from the base of the crypts to the top of the villi [17, 19, 22, 59]. The validity of this assumption has been proven by various methods. So, Doell, Rosen, Kretchmer (1965), using fluorescence technique, showed that approximately 24 hours after the administration of hydrocortisone to suckling rats,

sucrase activity initially appears at the base of the intestinal villi and only then gradually spreads to their top. This conclusion was confirmed in the works of other authors, who determined the enzymatic activity of thin-layer sections along the cryptovillous axis by biochemical methods [23]. It turned out that in 9-day-old rat pups, 24 hours after the administration of hydrocortisone, sucrase was not detected in villus sections, but its slight activity appeared at this time at the base of the crypts. By 48 hours, it is already found in the lower half of the villi, and by 96 hours it reaches its top.

The authors of the radiographic study showed that when rat pups were injected with hydrocortisone, the rate of enterocyte migration from the base of the crypts to the top of the villi did not change significantly. This indicates that the premature appearance of sucrase after the administration of glucocorticoids occurs in cryptal cells, and not in cells that have already reached the region of the villi. This localization of the hormone action is consistent with the observations of some authors, who showed the cessation of pinocytosis in the small intestine of growing animals after hydrocortisone injection [16, 57]. It is believed that the termination of pinocytosis is associated not with a change in the permeability of epithelial cell membranes, but with their replacement with new ones that do not have permeability for large molecular proteins [60].

It has now been proven that the inducing effect of glucocorticoids on sucrase synthesis can be reproduced by injection of ACTH, thyroxine (T4), gastrin, insulin, and also sex steroid hormones [16, 57, 60].

Of the hormonal factors, thyroxine plays an important role in the regulation of the ontogenesis of the digestive function, since the concentration of this hormone in the blood of rats increases sharply during the second postnatal week. The introduction of T4 or triiodothyronine (T3) leads to a premature decrease in the activity of lactase in the jejunum and lysosomal hydrolases in the ileum, as well as an increase in sucrase and maltase [16]. In contrast, hypothyroidism prevents the commonly observed decrease in lysosomal hydrolase activity and the natural increase in sucrase and maltase activity. Numerous data convince us that the introduction of T4 leads to a premature increase in the content of corticosterone in the blood [54] and that hypothyroidism significantly suppresses the age-related increase in the basal level of corticosterone [55].

It is quite possible that the effect of thyroid hormone on sucrase and maltase activities is secondary, resulting from changes in the concentration of corticosterone in the blood [32]. The specific inhibitory effect of hypothyroidism on the development of sucrase and maltase can be prevented by administration of T4. In contrast, with the introduction of T4, during the first two postnatal weeks, in rats, stimulation of sucrase and maltase activity is not observed, despite the increase in corticosterone. Therefore, T4 does not affect the development of sucrase and maltase. This is consistent with data showing that T4, the opposite of corticoids, is unable to induce the activity of these enzymes in transplanted pieces of small intestine in rat pups. Thyroxin apparently regulates the activity of those enzymes that are usually reduced during development. This was confirmed in experiments with the determination of neuraminidase and acid galactosidase, which, with the introduction of corticosterone acetate, show premature repression. For lactase, the effect of hypophysectomy, that is, a decrease in enzyme activity after removal of the pituitary gland, is restored with the introduction of T4, which is not observed with the introduction of cortisone [32]. The regulatory effect of T4 in the ontogenetic decrease in the activity of these enzymes is manifested in the fact that this hormone, together with insulin, is a powerful stimulator of the mitotic activity of the intestinal epithelium [57]. It has been proven that the decrease in lactase activity at the end of the 3rd week of life in rat pups is due to the influence of thyroxine.

Significant data have also been accumulated on the role of other hormones in the regulation of the ontogeny of the digestive system. The administration of pancreatic glucagon to suckling rats did not lead to an increase in sucrose activity, and on the basis of this it was concluded that this hormone had little or no effect on the maturation of intestinal enzymatic activities. Treatment of suckling rat pups with prostaglandin (PGI2) daily for 4 days was accompanied by a premature increase in specific sucrase and maltase activity. However, according to the authors themselves, such an effect of prostaglandin can be mediated through changes in corticosteroids, which, obviously, respond to the introduction of a biologically active substance. This is consistent with the fact that PGI2 does not alter sucrase and maltase activity in rat pups after 23 days of age [21, 22], which are glucocorticoid-insensitive (H4) during this period.

Administration of epidermal growth factor to mice during the 2nd postnatal week results in premature onset of intestinal sucrase activity and premature elevation of various other membrane-bound hydrolases. These effects are significantly different quantitatively from the effect of glucocorticoids, but, nevertheless, they are quite pronounced [32, 23].

Exogenous insulin leads to premature maturation of small intestine function in mice [5, 6, 7, 57]. These effects cannot be secondary and associated with an increase in the concentration of endogenous corticosterone, since: a) the effect of insulin has a shorter latent period than the effect of corticosteroids; b) after administration of insulin to sucking rats together with cortisone, the response of sucrase and maltase is more pronounced than that of cortisone alone [12, 13, 14]; c) the inducing effect of insulin on the sucrase activity of the intestines of sucking mice also manifests itself in in vitro culture. The role of endogenous insulin in the development of intestinal function is also proved by the fact that the concentration of this hormone in the circulating blood begins to increase in rats from 10 to 25 days after birth, that is, precisely by the period of transition of animals from dairy to definitive nutrition, when an increase in α activity should occur. -glucosidase.

The role of environmental factors. With regard to the role of the elementary factor in the regulation of the enzyme spectrum of the gastrointestinal tract in ontogenesis, it has been established that the presence of a food substrate is one of the important attributes of modifying the pattern of development of intestinal and pancreatic enzymes. Intragastric administration of sucrase to 9-day-old rat pups for three days increases the activity of sucrase and isomaltase, but not lactase [4]. At the same time, if suckling rat pups continue to be fed with lactose, then a selective increase in lactase activity is observed with a slowdown in its natural decrease in the usual terms [5]. Feeding premature babies with food high in starch for 30 days leads to an increase in amylase activity in the duodenal contents, while feeding a high-protein diet leads to an increase in the activity of trypsin and lipase in pancreatic juice [9, 21].

An analysis of the literature showed that the main functional development of the intestine, due to the activation of its enzymatic activity and the development of cryptovillous structures and the formation of a glycocalyx layer, is associated with the alimentary factor [6, 7, 23, 31]. After childbirth, the newborn enters the world of microbes, and the food itself that enters the baby's body is also genetically alien, so mother's milk is a source of not only nutrients [34, 56, 58, 60], but also sources of immunoglobulins, cellular components and other immunomodulatory drugs that provide adoptive immunity for the newborn [33, 35, 36, 39, 40, 41, 47]. Naturally, this harmonious genetic deterministic mechanism of protection of the newborn is violated in maternal pathology [48, 49, 50].

Thus, it has now been established that the alimentary factor is essential in the regulation of the digestive-transport function of the digestive organs in ontogeny. So, from our brief review it is clear that the gastrointestinal tract of mammals, including humans, undergoes regular changes in

the process of ontogenesis. Thanks to these changes, the developing organism acquires the ability to adapt to the changing composition of food. The development of the gastrointestinal tract in ontogenesis occurs due to the interaction of the genotype, biological clock, neuroendocrine regulation and the influence of external factors. Among the latter, nutrition is a very important factor. It should be emphasized that various pathological changes in the developing organism significantly affect the formation of the digestive and transport functions of the digestive organs in ontogenesis.

List of used literature

1. Аксенова, В.М. Физиология системы пищеварения: учебное пособие /В.М. Аксенова, А.П. Осипов; ФГБОУ ВПО Пермская ГСХА. - Пермь: Изд-во ФГБОУ ВПО Пермская ГСХА, 2013. - 104 с.
2. Андреева, С.Д. Морфометрическая характеристика поджелудочной железы свиней в пренатальном и раннем постнатальном онтогенезе / С.Д. Андреева // Иппология и ветеринария. – 2011. – № 1. – С. 58-62.
3. Аршавский И.А. Очерки по возрастной физиологии. "Медицина". -1967. -474с.
4. Иванов А.А., Войнова О.В., Ксенофонтов Д.А. и др. Сравнительная физиология животных. СанктПетербург: Лань, 2010.
5. Камилова А. Т., Кучкарова Л. С., Солиева А. А. Ферментативная активность поджелудочной железы и гидролиз углеводов в модели хронической энтеральной недостаточности у растущих крыс // Педиатрия и детская хирургия (Казахстан). — 2013. — № 4. — С. 35–39.
6. Коротько Г. Ф. Секреция поджелудочной железы. — Краснодар: Кубанский гос. мед. университет, 2005. — 312 с.
7. Кудешова Г. Т., Иномов А. У., Жабборов А. М. Влияние некоторых экотоксикантов на ассимиляцию углеводов в пищеварительной системе крыс // Инфекция, иммунитет и фармакология (Ташкент). — № 1. — 2014. – С. 47–50.
8. Кучкарова Л. С., Эргашев Н. А., Дустматова Г. А. Роль стероидных, тиреоидных и пептидных гормонов в развитии активности энтеральных карбогидраз // Матер. межд. конф. «Актуальные проблемы пищеварения и питания», посв. 80-летию А. М. Уголева, Санкт-Петербург, 2006, 3–5 окт. — С. 187.
9. Кучкарова Л.С. Развитие ферментных систем кишечного пищеварения в зависимости от тиреоидного статуса матери в период лактации. Автореф. дисс... канд. биол. наук.- Ташкент, - 1989. - 24с.
10. Кучкарова Л.С., Кудешова Г.Т., Дустматова Г.А. ГОРМОНАЛЬНАЯ РЕГУЛЯЦИЯ АССИМИЛЯЦИИ УГЛЕВОДОВ В ТОНКОЙ КИШКЕ КРЫС ПЕРИОДА МОЛОЧНОГО ПИТАНИЯ // Научное обозрение. Биологические науки. – 2017. – № 2. – С. 108-116; URL: https://science-biology.ru/ru/article/view?id=1057 (дата обращения: 07.06.2023).
11. Мирзарахимова, М. А. Ферментный гомеостаз и секреция ферментов поджелудочной железы у крыс при сочетанном влиянии гипокинезии, высокой температуры и инсоляции / М. А. Мирзарахимова, Ш. К. Кадиров. — Текст : непосредственный // Молодой ученый. — 2018. — № 5 (191). — С. 52-55. — URL: https://moluch.ru/archive/191/48192/ (дата обращения: 07.06.2023).
12. Развитие кишечного пищеварения в раннем онтогенезе при воздействии ксенобиотиков / Б. М. Мирзаев, Н. Ф. Киёмова, Г. Т. Кудешова [и др.]. — Текст : непосредственный // Молодой ученый. — 2016. — № 14 (118). — С. 209-212. — URL:

https://moluch.ru/archive/118/32770/ (дата обращения: 07.06.2023).
13. Романова, Т. А. Особенности дифференцировки клеток эпителиального слоя слизистой оболочки тонкой кишки / Т. А. Романова, Л. А. Хохлова. — Текст : непосредственный // Молодой ученый. — 2015. — № 11.1 (91.1). — С. 87-89. — URL: https://moluch.ru/archive/91/19383/ (дата обращения: 07.06.2023).
14. Садыков Б. А., Кучкарова Л. С., Каримова И. И., Эргашев Н. А. Влияние стрессорных воздействий в поздние периоды гестации на активность пищеварительных гидролаз матери и плода. // Узб. биол. журн. — 2004. — № 3. — С. 24–27.
15. Садыков Б. А., Кучкарова Л. С., Эргашев Н., Каримова И., Дустматова Г.Экологические факторы и формирование пищеварительной системы // Узб. биол. журн. – 2006. – № 4. – С. 8–10.
16. Садыков Б. А., Кучкарова Л. С., Эрматова С. А., Эргашев Н. А. Активность пищеварительных ферментов у потомства крыс, получавших во время лактации рацион, контаминированный тяжёлыми металлами // Вопросы питания. (Россия). – 2009. — №.2 – С. 47–50.
17. Солиева М. Г., Киѐмова Н. Ф., Мирзаев Б. М., Кудешова Г. Т., Зокирова Ш. А. Активность α-глюкозидазных и β-галактозидазных ферментов тонкой кишки при экспериментальной метгемоглобении растущих крыс // Актуальные проблемы физико-химической биологии и токсикологии // Матер. научн. конф. посв. 70-летию проф. Мирходжаева У. З. — Ташкент, 2016. – С. 205–206.
18. Стожаров А. Н. Медицинская экология: учеб. пособие. — Минск: Высш. шк., 2007. — 368 с.
19. Стожаров А. Н. Медицинская экология: учеб. пособие. — Минск: Высш. шк., 2007. — 368 с.
20. Хасанов, Б. Б. (2022). ИММУНОГЕННЫЕ СВОЙСТВА МОЛОЧНЫХ ЖЕЛЕЗ И ГРУДНОГО МОЛОКА. Re-health journal, (3 (15)), 21-30.
21. Хасанов, Б. Б. (2022). Морфология молочной железы при беременности и лактации. Бухара. Типография" Sadriddin Salim Buxoriy" при Бухарском государственном университете, 120.
22. Хасанов, Б. Б. (2022). Особенности процессов лактации при экспериментальном токсическом гепатите. Re-health journal, (2 (14)), 49-54.
23. Хасанов, Б. Б., & Тухтаев, К. Р. (2001). Морфометрическая характеристика иммунокомпетентных клеток молочной железы при беременности и лактации. Проблемы биологии и медицины.
24. Шахмуров Г. А., Кучкарова Л. С. Влияние нитратов и нитритов на активность панкреатической амилазы у крыс // 18 междунар. Пущинская школа-конференция молодых ученых «Биология наука XXI века». — Пущино, 21- 25 апреля, 2014. — С. 125.
25. Azizova, F. X., Tuxtaev, K. R., & Khasanov, B. B. (1997). at al. Structural and functional properties of mesenteric lymph nodes under antigenic influence in early postnatal ontogeny. Uzbekistan Medical Journal, (10-11), 14-16.
26. Burtkhanovich, K. B. (2022). Extragenital Pathology and Immunocompetent Cells Relations of Lactating Breast Gland and Offspring Jejunum. American Journal of Internal Medicine, 10(2), 28-33.
27. Burtkhanovich, K. B. Artificial feeding, posterity development features and adrenal gland formation in early postnatal ontogenesis. Problems of biology and medicine, 119, 160-164.

28. Chemyshevich YU.N. Morphofunctional analysis of the jejunum of rat pups developing under conditions of maternal cholestasis. Zhurnal Grodnenskogo gosudarstvennogo meditsinskogo universiteta № 3, 2014 g. C. 33-37.
29. DeSesso J.M., Jacobson C.F. Anatomical and physiological parameters affecting gastrointestinal absorption in humans and rats. Food Chem. Toxicol. 39(3): 209–228. 2001.
30. Elnif J., Buddington R.K., Hansen N.E., Sangild P.T. Cortisol increases the activities of intestinal apical membrane hydrolases and nutrient transporters before weaning in mink (Mustela vison). J. Comp. Physiol. B. 176(3): 233–241. 2006.
31. Ji B., Bi Y., Simeone D. et al. Human pancreatic acinar cells lack functional responses to cholecystokinin and gastrin // Gastroenterology. — 2001. — Vol. 121, No. 6. — P. 1380 – 1390.
32. Kampa M., Castanas E. Human health effects of air pollution // Environmental Pollution. — 2008 – V. 151. – P. 362–367.
33. Khasanov B. B. Morphology of the mammary gland during pregnancy and lactation // Bukhara. Printing house “Sadriddin Salim Buxoriy” at the Bukhara State University - 2022. - S. 120.
34. Khasanov, B. B. (2022). The influence of extragenital pathology of the mother on the processes of fertility and the formation of the immune system of the offspring. German International Journal of Modern Science, 37, 17-24.
35. Khasanov, B. B., Azizova, F. K., Sobirova, D. R., Otajonova, A. N., & Azizova, P. K. (2022). Toxic hepatitis of the female and the structural and functional formation of the lean intestine of of the offspring in the period breastfeeding.
36. KhIa, K., Tukhtaev, K. R., & Khasanov, B. B. (2004). Effect of maternal toxic hepatitis on the functional characteristics of the lactation process. Likars' ka sprava, (5-6), 68-71.
37. Mildred Maisonet M., Correa A., Misra D., Jaakkolaf J. K. J. A review of the literature on the effects of ambient air pollution on fetal growth // Environmental Research. — 2004. – V. 95, I.1. — P. 106–115.
38. Rakhimov K.R., Demidova A.I., Salik- hov G.A. Enzymatic systems of cavitary and membrane hydrolysis of nutrients in growing, adult and old rats. Physiol. J. USSR I.M. Sechenov. 8: 998–1004. 1985. (In Russ.)].
39. Rakhimov K.R., Likhovid L.V., Shinder D.A. Formation of enzyme systems of the initial and final stages of protein hydrolysis in the postnatal ontogenesis of rats. Physiol. J. of the USSR. I.M. Sechenov. 10: 127–132. 1991. (In Russ.)].
40. Tukhtaev, K. R. (2003). other. Structural and functional relationships of immunocompetent cells of the mammary gland of lactating rats and small intestine of rat rats during breastfeeding. Morphology, (6), 70.
41. Ugolev A.M., Egorova V.V., Yezuitova N.N., Timofeeva N.M., Gromova L.V., Zaripov B.Z. Enzymatic-transport characteristics of the small intestine of rats during aging. Physiol. J. I.M. Sechenov. 8: 29–37. 1992. (In Russ.)].
42. Yaglova N.V., Obernikhin S.S. Influence of activation of the immune system of the maternal organism in early pregnancy on the postnatal morphogenesis of the organs of the immune system of the offspring. Problemy reproduktsii, 1, 2013. - C. 73-77.
43. Zaiko N.N., Byts' Yu.V., Kryshtal' N.V. Patofiziologiya. Narushenie uglevodnogo obmena. — Kiev: VSI «Meditsina»; 2015. 212 s.
44. Zufarov, K. A. and other. (2003). Quantitative and ultrastructural characteristics of immunocompetent cells in the mammary gland during pregnancy and lactation.

Morfologiia (Saint Petersburg, Russia), 124(4), 74-79.