AJPMHS GLOBAL RESEARCH NETWORK

AMERICAN Journal of Pediatric Medicine and Health Sciences
Volume 01, Issue 10, 2023 ISSN (E): 2993-2149

Pathophysiological Features of Glucose Metabolism in the Fetus with Diabetes Mellitus

Kadirova Lailo Valizhanovna
Assistant at the Department of Pathological Physiology, Bukhara State Medical Institute

Abstract: During pregnancy with diabetes mellitus (DM), the fetus undergoes many metabolic changes. The extent of these changes depends not only on the level of maternal glycemia, but also on the level of fetal glycemia. Other important alternating factors are fetal hyperinsulinemia and disturbances in the functioning of transporters of various substances. Most structural changes occur in the fetal part of the placenta. This is manifested by a thickening of the basement membrane, a decrease in the number of syncytiotrophoblast microvilli, disruption of the activity of various transport proteins and, as a consequence, a change in the cascade of all metabolic reactions. Literature data on the pathophysiological features of glucose metabolism in the fetus with diabetes mellitus were analyzed.

Keywords: fetus, diabetes mellitus, placenta, metabolism.

Relevance. The main nutrients for the fetus are glucose and amino acids. Glucose, including its metabolic product lactate, is the main energy substrate for the fetus, participating in maintaining basal metabolism and storing energy reserves necessary for protein synthesis and growth. Amino acids provide both a structural basis for protein synthesis and an oxidative substrate in energy production during glucose deficiency. Fatty acids are used by the fetus as structural components of membranes and also for the growth of adipose tissue. In humans, FA oxidation begins immediately after birth. This process occurs primarily in the fetus, in contrast to the oxidation of glucose. Hormonal regulation of the utilization of metabolic substrates and the effect of insulin and insulin-like factors (IGF) on the fetus are of secondary importance in the provision of nutritional substrates. When the fetal glycemic level decreases, glucose consumption decreases in direct proportion [17]. In a short period of time, fetal oxygen consumption remains at a level close to normal, which is ensured by active reciprocal oxidation of other substrates, such as glycogen, lactate, amino acids, fatty acids and ketone bodies. With a longer period of insufficient glucose supply (> 2 weeks), fetal oxygen consumption is reduced by 25–30%. A decrease in the degree of oxygenation of the fetus with prolonged nutrient deficiency reflects the dependence of the reduced level of synthesis of proteins and metabolites necessary for fetal growth. On the other hand, excessive delivery of nutrients to the fetus in maternal diabetes leads to a decrease in amino acid oxidation. The level of glucose transport to the fetus, as well as the amount of glucose uptake by the fetus, directly depends on maternal glycemia [18]. The growth rate, glycogen deposition, and fat formation also depend on the amount of glucose supplied to the fetus and the degree of its uptake. Not surprisingly, fetuses from mothers with diabetes have more liver glycogen, muscle glycogen, and fat than those from mothers with normal glycemic levels. The processes of glucose accumulation in the uterus and placenta are directly regulated by the level of glycemia in the fetus [19]. The relatively high concentration of fetal glucose reduces the degree of its transplacental transfer in favor of its consumption by the placenta. At the same

time, a relative decrease in fetal glucose concentration will limit glucose uptake by the placenta and increase glucose transport to the fetus. The glucose content in the fetal plasma is slightly reduced compared to that in the mother. This increases the concentration gradient, providing a steady flow of glucose to the growing fetus. Several physiological mechanisms underlie the maintenance of adequate transplacental glucose transfer to the fetus. First, increased cellular metabolism and growth of brain tissue requiring adequate glycemic levels. Secondly, an increase in the secretion of fetal insulin due to an increase in the number of pancreatic islets and beta cells of the pancreas. Thirdly, increased growth of insulin-sensitive tissues (skeletal muscle, cardiac and adipose tissue). The dependence of transplacental transport of glucose and its consumption by the tissue of the uterus and placenta was shown in studies on pregnant sheep, which were introduced into a state of chronic hypoglycemia. In this experiment, fetal gluconeogenesis increased, which maintained glucose consumption at the required level [20]. Thus, fetal glucose production can compensate for its deficiency during maternal hypoglycemia. There are a number of factors that can affect transplacental glucose transport: placental surface area, insufficiency of the barrier between maternal and fetal blood flow, changes in the speed of uterine and fetal blood flow, imbalance of glucose consumption by the placenta. The role of placental thickness in glucose transport has not yet been fully studied, but a direct correlation has been found between the gradient of glucose concentration in the arterial blood of the mother and fetus and the thickening of the fetoplacental membrane [29]. The rate of glucose absorption by fetal organs depends on the level of glycemia. It is still unknown to what extent basal insulin concentration affects glucose uptake by individual tissues and organs in the fetus. Fetal hyperglycemia stimulates increased insulin production by the fetus. In contrast to a sharp increase in the concentration of fetal insulin, which increases the rate of glucose utilization and decreases its concentration in plasma, a sudden decrease in the level of this hormone (with somatostatin infusion) has no effect on the concentration of fetal glucose or the rate of its use [31]. It is possible that decreased insulin concentrations promote fetal gluconeogenesis, which limits the transfer of glucose to the fetus from the placenta, thereby preventing an increase in fetal plasma glucose concentrations. However, in experiments, chronic hypoinsulinemia in fetuses (during pancreatectomy or streptozotocin injections) leads to an increase in the level of glycemia in the fetus [32]. During hypoglycemia, as a result of a compensatory increase in fetal gluconeogenesis and a relative increase in glucose concentration, the degree of glucose transfer across the placenta and the synthesis of fetal insulin decreases. This confirms the somatotropic effect of insulin. GLUT1, being the main transporter of plasma glucose, is expressed in all fetal tissues. GLUT4 is found in the heart, adipose tissue, and skeletal muscle. In an experiment on pregnant sheep, the concentration of GLUT1 increases under conditions of hypoglycemia and hypoinsulinemia in skeletal muscle and adipose tissue, while remaining unchanged in nervous tissue. In contrast, hyperglycemia causes a decrease in GLUT1 concentrations in most tissues. GLUT4 activity is regulated by glycemic levels in fetal skeletal, muscle, and adipose tissue. In response to hyperglycemia, its concentration initially increases and then decreases to normal levels [33]. A sharp increase in insulin levels leads to an increase in glucose consumption by skeletal and cardiac muscle tissue of the fetus, while its plasma content decreases. Also, hyperinsulinemia in fetuses increases the concentrations of both GLUT1 and GLUT4 [32]. Various studies of tissue, gestational age, glycemic and insulinemic levels show significant variability in glucose transporter concentrations during pregnancy [34].

In sheep fetuses in the second half of pregnancy, glucose-stimulated insulin secretion increases more than fivefold [25]. It is assumed that the same thing happens in human fetuses. Such results were obtained in in vitro studies of pancreatic islets from human embryos and premature newborns [26]. Fetal insulin secretion can be characterized by the duration and pattern of changes in fetal plasma glucose concentrations. Experiments in fetal sheep have shown that sustained hyperglycemia actually reduces basal and glucose-stimulated insulin secretion [27]. In addition, sensitivity to amino acids (arginine) decreases. Similar results were found in sheep embryos that received a course of glucose bolus administration [38]. Thus, the main reason for

the increased secretion of fetal insulin is a change in the glucose concentration under conditions of wave-like hyperglycemia. Fatty acids also stimulate insulin secretion in the fetus. Their concentration increases in pregnant women with diabetes and in fetuses in late gestation [29]. Acute and chronic hypoglycemia, as well as a decrease in the concentration of amino acids in the blood plasma, cause a decrease in insulin secretion by the fetus [30]. The mechanisms for this effect are unknown, but it is believed that glucose directly affects the insulin gene. Interestingly, in late pregnancy sheep fetuses, insulin infusion-induced hypoglycemia leads to an increase in fetal blood insulin levels but decreases glucose-stimulated insulin secretion [39]. Sharp changes in the concentration of IGF-1 in fetal plasma have virtually no effect on glucose metabolism [40]. However, the effect of glucose is realized at the level of gene transcription by regulating the production of IGF-1 and IGF-2 [50]. Insulin also independently promotes IGF-1 synthesis. These data indicate that cellular glucose transport and concentration influence IGF-1 production in the fetus. In turn, increasing plasma concentrations of IGF-1 and insulin may inhibit protein dissimilation. Thus, insulin and IGF-I indirectly increase the ability of glucose to stimulate AA synthesis and fetal growth. In fetal sheep, a sharp increase in insulin concentration triggers an intracellular cascade of mitogen-dependent proteins, which can have a direct effect on protein synthesis, cell growth and division. A sudden increase in insulin concentration in fetal sheep enhances AA utilization. These effects are short-lived, since the constant supply of insulin into the fetal plasma slightly increases tissue growth. In addition, insulin has a positive effect on the production and storage of lipids in adipose tissue.

In the presence of diabetes, increased transplacental glucose transport results from hyperglycemia and a large concentration gradient between the maternal and fetal bloodstreams. Another mechanism for the active transfer of glucose to the fetus may be an imbalance in the synthesis and activity of the main glucose transporters - GLUT 1, 3, 4, 12. A compensatory decrease in fetoplacental blood flow can counteract the excess supply of glucose to the fetus. An additional mechanism for protecting the fetus from hyperglycemia may be the accumulation of glycogen by the placenta. In response to hyperglycemia, the synthesis of fetal insulin naturally increases. Pathological hyperinsulinemia has a somatotropic effect, which leads to excessive fetal growth. One of the most significant factors in the regulation of glucose metabolism in the "mother-placenta-fetus" system are transporter proteins of the GLUT family. Paradoxically, there are not many works devoted to the features of the expression of these messengers in various types of diabetes, and the data presented are scattered. However, it has been shown that in type 1 diabetes, the expression and activity of GLUT1 are decreased, and GLUT3 is increased. Apparently, this is due to adaptive reactions to maintain normal fetal homeostasis by transferring excess glucose from the fetus to the placenta. In GDM, no distinctive features of the expression of these proteins have been identified, but it is noteworthy that in women with more severe disorders of carbohydrate metabolism (who received insulin therapy), the same patterns are observed as in type 1 diabetes. Analysis of the content of various amino acids in fetal plasma showed that in type 1 diabetes and GDM, the main pool of amino acids decreases on insulin therapy. In GDM on diet therapy, on the contrary, there is an increase in the content of various amino acids in the fetus. Assessing the transport activity of AK carrier proteins is difficult due to the small number of studies. Transplacental transfer and exchange of various lipids in diabetes have not been fully studied. Changes in FA uptake and metabolism have been described, but such data are lacking for triglycerides, phospholipids and cholesterol. It has been shown that the transport and distribution of lipids derived from arachidonic acid are impaired during pregnancy under conditions of type 1 diabetes [29]. Linolenic acid accumulates in the placenta, which is one of the main sources of arachidonic acid synthesis. In addition to this, the balance of the synthesis of other eicosanoids is disrupted towards an increase in thromboxane and a decrease in prostacyclin. The above disorders lead to vasoconstriction and more frequent development of preeclampsia in pregnant women with diabetes. GDM affects changes in maternal cholesterol levels and leads to maternal and fetal hypertriglyceridemia, especially in the VLDL and HDL fractions. In contrast to the placenta, plasma levels of arachidonic acid and docosahexaenoic acid

in fetuses from mothers with diabetes are lower than in normal pregnancies. As is known, diabetes is a “metabolic disease” that determines unfavorable fetal development and the development of perinatal complications. Based on this, it was extremely interesting to assess the degree of change in the metabolic activity of various nutrients in the “mother-placenta-fetus” system specifically in diabetes. Based on a review of the literature, it was established that women with various types of diabetes have disturbances in the fetoplacental complex, which not only cause dysmorphogenesis of the placenta, but also cause various changes in the fetus. A deeper understanding of these processes will further clarify the fundamental principles of these processes and will contribute to the possible prediction and prevention of perinatal complications associated with diabetes.

Literature

1. Кадырова Л. В., Рахимова Г. Ш. Некоторые Аспекты Состояния Эндокринных Желёз Белых Крыс После Черепно-Мозговой Травмы //Central Asian Journal of Medical and Natural Science. – 2021. – С. 254-257.
2. Кадирова Л. В. ОСОБЕННОСТИ МАКРОСКОПИЧЕСКОЙ ХАРАКТЕРИСТИКИ НАДПОЧЕЧНИКОВ 3-МЕСЯЧНЫХ БЕЛЫХ КРЫС ПОСЛЕ ТЯЖЕЛОЙ ЧЕРЕПНОМОЗГОВОЙ ТРАВМЫ //ЎЗБЕКИСТОН РЕСПУБЛИКАСИ СОҒЛИҚНИ САҚЛАШ ВАЗИРЛИГИ ТОШКЕНТ ТИББИЁТ АКАДЕМИЯСИ. Вестник ТМА. – 2022. – Т. 3. – С. 80.
3. Valizhanovna K. L. Rational application of new pedagogical methods of teaching in a modern university, results and effects of interactive learning //BARQARORLIK VA YETAKCHI TADQIQOTLAR ONLAYN ILMIY JURNALI. – 2022. – Т. 2. – №. 2. – С. 33-38.
4. МЕТОД Л. В. К. И. БЛИЦ ОПРОС //ПРИ ПРЕПОДАВАНИИ ПРЕДМЕТА ПАТОЛОГИЧЕСКАЯ ФИЗИОЛОГИЯ, НА ПРИМЕРЕ ТЕМЫ:«ВОСПАЛЕНИЕ»//Scientific progress. – 2022. – Т. 2.
5. Кадирова Л. В., Темиров Т. И., ПАТОФИЗИОЛОГИЧЕСКИЙ П. И. Э. ORIENSS. 2022. № Special Issue 4-2 //URL: https://cyberleninka. ru/article/n/patofiziologicheskiy-podhod-izucheniya-elektrotravmy(дата обращения: 05.11. 2022).
6. Кадирова Л. В., Нодирддинов Д. М. Особенности патофизиологического течения синдрома длительного сдавливания //BARQARORLIK VA YETAKCHI TADQIQOTLAR ONLAYN ILMIY JURNALI. – 2022. – Т. 2. – №. 4. – С. 13-17.
7. Кадирова Л. В. Нодирддинов Достон Мирзохидович //ОСОБЕННОСТИ ПАТОФИЗИОЛОГИЧЕСКОГО ТЕЧЕНИЯ СИНДРОМА ДЛИТЕЛЬНОГО СДАВЛИВАНИЯ, BARQARORLIK VA YETAKCHI TADQIQOTLAR ONLAYN ILMIY JURNALI. – 2022. – Т. 2. – №. 4. – С. 13-17.
8. Kadirova L. V. The Role of Cellular Immunity in Formation of Endothelium Disfunction in Patients with Nonspecific Aortoarteriitis //The pharmaceutical and chemical journal. – 2021. – Т. 8. – №. 2. – С. 43-46.
9. Кадирова Л. В., Рахимова Г. Ш., Абдуллаева М. А. Нарушение иммунного статуса, функционального состояния эндотелия сосудистого русла и их коррекция у больных артериальной гипертензией, при неспецифическом аортоартериите //Новый день в медицине. – 2020. – №. 2. – С. 131-134.
10. Кадирова Л. В., Махмудов Ш. С. ПАТОФИЗИОЛОГИЧЕСКИЙ ПОДХОД ИЗУЧЕНИЯ ГОРНОЙ БОЛЕЗНИ //BARQARORLIK VA YETAKCHI TADQIQOTLAR ONLAYN ILMIY JURNALI. – 2022. – Т. 2. – №. 4. – С. 8-12.
11. Кадирова, Лайло Валижановна, Темиров, Тимур Ихтиярович ПАТОФИЗИОЛОГИЧЕСКИЙ ПОДХОД ИЗУЧЕНИЯ ЭЛЕКТРОТРАВМЫ //

ORIENSS. 2022. № Special Issue 4-2. URL: https://cyberleninka.ru/article/n/patofiziologicheskiy-podhod-izucheniya-elektrotravmy (дата обращения: 21.12.2023).

12. Кадирова Л. В. ТОПОГРАФО-АНАТОМИЧЕСКИЕ ОСОБЕННОСТИ НАДПОЧЕЧНИКОВ РАЗЛИЧНЫХ ЖИВОТНЫХ //AMALIY VA TIBBIYOT FANLARI ILMIY JURNALI. – 2023. – Т. 2. – №. 5. – С. 326-331.
13. Кадирова Л. В. Морфологические Параметры Надпочечников При Различных Воздействиях //AMALIY VA TIBBIYOT FANLARI ILMIY JURNALI. – 2023. – Т. 2. – №. 5. – С. 182-187.
14. Valizhonovna K. L. Anatomo-Topographic Features of the Adrenal Gas in Various Animals //Scholastic: Journal of Natural and Medical Education. – 2023. – Т. 2. – №. 5. – С. 281-287.
15. Valizhonovna, K. L. (2023). Morphofunctional Features of the Adrenal Structure in Norm and Under Various Impacts. *American Journal of Pediatric Medicine and Health Sciences (2993-2149)*, *1*(3), 69–74. Retrieved from http://grnjournal.us/index.php/AJPMHS/article/view/187
16. Rakhimova, Gulnoz Shamsievna, Kadirova, Laylo Valijonovna THE USE OF INTERACTIVE METHODS TO ASSESS THE LEVEL OF ASSIMILATION OF THE MATERIAL STUDIED IN PATHOLOGICAL PHYSIOLOGY // ORIENSS. 2022. №1. URL: https://cyberleninka.ru/article/n/the-use-of-interactive-methods-to-assess-the-level-of-assimilation-of-the-material-studied-in-pathological-physiology (дата обращения: 21.12.2023).
17. Rakhimova, Gulnoz Shamsievna, Kadirova, Laylo Valijonovna THE INTERACTIVE USAGE OF METHODS TO ASSESS THE LEVEL OF ASSIMILATION OF THE MATERIAL STUDIED IN PATHOLOGICAL PHYSIOLOGY // ORIENSS. 2022. №1. URL: https://cyberleninka.ru/article/n/the-interactive-usage-of-methods-to-assess-the-level-of-assimilation-of-the-material-studied-in-pathological-physiology (дата обращения: 21.12.2023).
18. Abdullaeva M. A., Kadirova L. V., Turaev U. R. Changes of Indicators of Immune Status in Patients with Nonspecific AortoArteritis on the Base of Combined Therapy //The Pharmaceutical and Chemical Journal. – 2020. – Т. 7. – №. 1. – С. 35-38.
19. Кадирова Л. В. РОЛЬ АВИЦЕННЫ В СОВРЕМЕННОМ ОБРАЗОВАНИИ //Преподаватель года 2022. – 2022. – С. 329-337.
20. Лайло Валижановна Кадирова ИНТЕРАКТИВНЫЙ МЕТОД « БЛИЦ ОПРОС » ПРИ ПРЕПОДАВАНИИ ПРЕДМЕТА ПАТОЛОГИЧЕСКАЯ ФИЗИОЛОГИЯ, НА ПРИМЕРЕ ТЕМЫ: «ВОСПАЛЕНИЕ» // Scientific progress. 2022. №2. URL: https://cyberleninka.ru/article/n/interaktivnyy-metod-blits-opros-pri-prepodavanii-predmeta-patologicheskaya-fiziologiya-na-primere-temy-vospalenie (дата обращения: 21.12.2023).
21. Олимова А. З., Шодиев У. М. Репродуктив Ёшдаги эркакларда бепуштлик сабаблари: Бухоро тумани эпидемиологияси //Scientific progress. – 2021. – Т. 2. – №. 7. – С. 499-502.
22. Zokirovna O. A., Abdurasulovich S. B. Ovarian Diseases in Age of Reproductive Women: Dermoid Cyst //IJTIMOIY FANLARDA INNOVASIYA ONLAYN ILMIY JURNALI. – 2021. – Т. 1. – №. 6. – С. 154-161.
23. Olimova A. Z. ECHINOCOCCOSIS OF LIVER OF THREE MONTHLY WHITE RAT //Scientific progress. – 2022. – Т. 3. – №. 3. – С. 462-466.

24. Олимова А. З. Морфологические и морфометрические особенности печени белых беспородных трех месячных крыс после тяжёлой черепно-мозговой травмы вызванной экспериментальным путём //BARQARORLIK VA YETAKCHI TADQIQOTLAR ONLAYN ILMIY JURNALI. – 2021. – Т. 1. – №. 6. – С. 557-563.

25. Oglu M. Z. M., Zokirovna O. A. МОРФОЛОГИЧЕСКИЕ И МОРФОМЕТРИЧЕСКИЕ ПАРАМЕТРЫ ПЕЧЕНИ БЕЛЫХ БЕСПОРОДНЫХ КРЫС, ПЕРЕНЕСШИХ ЭКСПЕРИМЕНТАЛЬНУЮ ЧЕРЕПНО-МОЗГОВУЮ ТРАВМУ ПОСЛЕ МЕДИКАМЕНТОЗНОЙ КОРРЕКЦИИ //JOURNAL OF BIOMEDICINE AND PRACTICE. – 2023. – Т. 8. – №. 1.

26. Олимова А. З., Турдиев М. Р. БУХОРО ШАҲРИДА МЕЪДА ВА ЎН ИККИ БАРМОҚЛИ ИЧАК ЯРАСИ УЧРАШ ЭПИДЕМИОЛОГИЯСИ //Oriental renaissance: Innovative, educational, natural and social sciences. – 2022. – Т. 2. – №. 4. – С. 642-647.

27. Zokirovna O. A. Modern Concepts of Idiopathic Pulmonary Fibrosis //American Journal of Pediatric Medicine and Health Sciences. – 2023. – Т. 1. – №. 3. – С. 97-101.

28. Zokirovna O. A. Pathology of Precancerous Conditions of the Ovaries //American Journal of Pediatric Medicine and Health Sciences. – 2023. – Т. 1. – №. 3. – С. 93-96.

29. Зокировна, Олимова Азиза и Тешаев Шухрат Джумаевич. «Морфологические аспекты печени белых беспородных крыс после тяжелой черепно-мозговой травмы, вызванной экспериментально в виде дорожно-транспортного происшествия». *Scholastic: Journal of Natural and Medical Education* 2.2 (2023): 59-62.

30. Zokirovna O. A. Comparative characteristics of the morphological parameters of the liver at different periods of traumatic brain injury //Euro-Asia Conferences. – 2021. – С. 139-142.

31. Zokirovna O. A. Macroand microscopic structure of the liver of threemonthly white rats //Academic research in educational sciences. – 2021. – Т. 2. – №. 9. – С. 309-312.

32. Олимова А. З. Частота Встречаемости Миомы Матки У Женщин В Репродуктивном Возрасте //BARQARORLIK VA YETAKCHI TADQIQOTLAR ONLAYN ILMIY JURNALI. – 2021. – Т. 1. – №. 6. – С. 551-556.

33. Zokirovna O. A., Abdurasulovich S. B. Ovarian Diseases in Age of Reproductive Women: Dermoid Cyst //IJTIMOIY FANLARDA INNOVASIYA ONLAYN ILMIY JURNALI. – 2021. – Т. 1. – №. 6. – С. 154-161.

34. Zokirovna O. A. Cytological screening of cervical diseases: pap test research in the bukhara regional diagnostic center for the period 2015-2019. – 2022.

35. Zokirovna O. A., PREVALENCE R. M. M. EPIDEMIOLOGY OF CANCER OF THE ORAL CAVITY AND THROAT IN THE BUKHARA REGION //Web of Scientist: International Scientific Research Journal. – 2022. – Т. 3. – №. 11. – С. 545-550.

36. Olimova A. Z. The frequency of occurrence of my uterus In women of reproductive age //JOURNAL OF ADVANCED RESEARCH AND STABILITY (JARS). – 2021. – Т. 1. – №. 06. – С. 551-556.

37. Olimova Aziza Zokirovna. (2023). MODERN PRINCIPLES OF THE EFFECT OF HEMODIALYSIS THERAPY ON HEART RATE. *International Journal of Integrative and Modern Medicine*, *1*(1), 80–85. Retrieved from http://medicaljournals.eu/index.php/IJIMM/article/view/28

38. Olimova Aziza Zokirovna. (2023). PATHOMORPHOLOGICAL CHARACTERISTICS OF THE EPIDIDYMIS UNDER IRRADIATION. *International Journal of Integrative and Modern Medicine*, *1*(1), 96–100. Retrieved from http://medicaljournals.eu/index.php/IJIMM/article/view/31

39. Olimova Aziza Zokirovna. (2023). THE INCIDENCE OF CANCER OF THE ORAL CAVITY AND PHARYNX IN THE BUKHARA REGION. *International Journal of Integrative and Modern Medicine*, *1*(1), 86–89. Retrieved from http://medicaljournals.eu/index.php/IJIMM/article/view/29

40. Olimova Aziza Zokirovna. (2023). INFLUENCE OF ALCOHOL INTOXICATION ON THE HEART TISSUE OF RATS IN THE EXPERIMENT. *International Journal of Integrative and Modern Medicine*, *1*(1), 90–95. Retrieved from http://medicaljournals.eu/index.php/IJIMM/article/view/30

41. Olimova Aziza Zokirovna. (2023). Modern Aspects of the Etiology of Gastric Ulcer and Its Complications. *American Journal of Pediatric Medicine and Health Sciences (2993-2149)*, *1*(3), 163–166. Retrieved from http://grnjournal.us/index.php/AJPMHS/article/view/208

42. Zokirovna O. A., Jumaevich T. S. Morphological Aspects of the Liver of White Outbred Rats After Severe Traumatic Brain Injury Caused Experimentally in the Form of a Road Accident //Scholastic: Journal of Natural and Medical Education. – 2023. – Т. 2. – №. 2. – С. 59-62.

43. Aziza Zokirovna Olimova GASTRIC ULCER AND ITS COMPLICATIONS // Scientific progress. 2022. №3. URL: https://cyberleninka.ru/article/n/gastric-ulcer-and-its-complications (дата обращения: 28.09.2023).

44. Olimova Aziza Zokirovna. (2022). TECHNIQUE FOR CUTTING BIOPSY AND SURGICAL MATERIAL IN THE PRACTICE OF PATHOLOGICAL ANATOMY AND FORENSIC MEDICINE. *Web of Scientist: International Scientific Research Journal*, *3*(7), 116–120. https://doi.org/10.17605/OSF.IO/PSQ59

45. Zhumayevich N. F., Zokirovna O. A. PATHOMORPHOLOGY OF GASTRIC CANCER //BARQARORLIK VA YETAKCHI TADQIQOTLAR ONLAYN ILMIY JURNALI. – 2022. – С. 330-333.

46. Zokirovna O. A. Epidemiological and Etiological Data of Morphogenesis and Pathomorphology of Congenital Heart Diseases in Children //American Journal of Pediatric Medicine and Health Sciences. – 2023. – Т. 1. – №. 4. – С. 88-91.