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REGULARITIES OF LECTINOGISTOCHEMICAL DIFFERENTIATION OF HUMAN THYMUS GLAND BUD IN PRENATAL ONTOGENESIS

Summary

In this study of the material taken from 108 human embryos (Em), pre-feti (Pf) and feti (Ft), we have first described the arrangement of glycopolymers and proved the effect of successive redistribution of glycopolymers – the lectin receptors in cells on their surface and in the extracellular tissue structures during organ-specific differentiation of epithelial and mesenchymal human thymus gland buds, and the role of these molecules in epithelial-mesenchymal interaction depending on heterogeneous origin of the buds. We have proved that fibrylogenesis of embryonic connective tissues is associated with expression of receptors and reduction of various lectins (Lc). Organ-specific differentiation of mesenchymal cells in fibroblasts is also accompanied by redistribution of lectin-reactive glycoconjugate. We have studied the sequence of biosynthesis and the activity of polysaccharide complexes, and confirmed their role in the differentiation and structural transformation of thymus gland in prenatal ontogenesis phase.

Introduction

In the last ten years, morphological sciences (anatomy, histology, and embryology) have paid significant attention to the developmental anatomy, the findings of which are highly demanded by physiologists, psychologists and clinicians. However, anatomical (histologic) structures of children and elderly people are among the least studied ones today in the context of developmental morphology. Even less studied are developmental features of prenatal ontogenesis, which, according to M.P. Sapin [1], should be

subdivided into monthly and even weekly ones in the most important (critical) periods.

The significance of comparative and embryological research for addressing the phylogenic and evolutional issues is beyond any doubt. At the same time, the basic knowledge of mammalian ontogenesis has been obtained from studying model objects (rats, mice, guinea pigs, etc.), commercial animals, and human embryos. Extremely rare are works devoted to the development of organs and organ systems in successive stages of prenatal human ontogenesis. The results of such studies make it possible to understand the regularities of evolutionary transformations [2–4].

Processes of embryonic morphogenesis accumulate a complex of phenomena that characterize a continuous change of human tissue and organ systems organization in a process of development. At the same time, morphogenesis explores both organogenesis and histogenesis [5].

There are embryonic and post-embryonic histogenesis. The embryonic histogenesis is considered a qualitative change of tissue, resulted in sequential approach to a definitive state [6]. The study of morphogenesis is intended to ensure the simultaneous consideration of both processes (organ- and histogenesis) as an interaction of steps or phases that change each other, by identifying a correlation between them. The fundamental group of processes for modern embryology is a spatio-temporal orderliness of development, predetermined by epithelio-mesenchymal interactions.

The works of Zaporizhia Morphological School [7–9], which have become the grounds for conceptualizing the role of intrauterine penetrating antigens in morphogenesis of the thymus gland and lymphoid organs are of revolutionary importance for those engaged in the study of prenatal morphogenesis of the thymus gland. The effect of exo- and endogenous factors on mother's body during pregnancy leads to disturbances in the morphogenesis of internal organs, manifested by an imbalance of clearly determinated spatial tissue structure. The basis of the imbalance consists in disturbance of adhesion, migration, cell proliferation, intercellular and cellular-matrix interactions.

The topicality of diagnostics, treatment and prevention of congenital or acquired syndrome of enlarged thymus gland in children is preconditioned by its high prevalence rate (3.5%–29.9% of cases), high rate of associated congenital defects (cardiovascular, nervous, respiratory, endocrine system, connective tissue, etc.), disembriogenesis stigmas, and significant predisposition of these children to infectious and inflammatory bronchopulmonary diseases [10].

All cells resemble each other [11] in a principle of structural organization, and at the same time, they are significantly different in biochemical

elements comprising their structure. This concept is easy to verify by comparing the organization and structure of pro- and eukaryotic cell surface [12]. Since the cell membrane surface is covered by a variety of hydrocarbon receptors, their detection by specific Lc is an important element of the diagnostics of physiological-and-biochemical status of the cell.

A variety of monosaccharides is very large, but the most common elements of eukaryotic cell oligosaccharides are glucose (Glc), N-acetylglycose (NAcGlc), galactose (Gal), N-acetyl galactose (NAcGal), mannose (Man), fucose (Fuc), and N- acetylnearamine or sialic acid (NAcNeu) [13].

The use of Lc as molecular probes in the study of cell physiology patterns, isolation and study of biologically active substances, bioefectors, and diagnostic reagents in isoserology, clinical laboratory and pathomorphologic studies of medicines is not a complete list of the options for application of Lc in modern biology and medicine.

Versatile options of Lc application are a visual illustration of the basic principle of biotechnology – the adaptation of mechanisms and processes used by nature in biological objects for addressing practical problems of humans. One of the promising opportunities for application of Lc as biologically active substances lies in the field of morphology [12].

There is a certain analogy between lectinogistochemistry and immunohistochemistry methods. Histochemical methods involving antibodies and Lc are characterized with approximately same sensitivity, similar mechanisms of histochemical reactions and principles of visualization of Lc and antibodies binding sites in tissues. Unlike antibodies, Lc interact only with hydrocarbon biopolymer determinants.

Histochemical methods with involvement of Lc are not inferior to immunohistochemical methods in terms of sensitivity and selectivity of detection of certain types and subpopulations of cells and even superior to the above in some cases.

Determining the role of the immune system (including thymus gland) in the morphogenesis processes and the integrity of human body is one of the topical problems of biology. According to authors [13; 14], using Lc for studying the morphogenesis processes is a promising trend in the development of morphology and molecular biology.

A number of domestic researchers [15; 16] have described redistribution of Lc receptors genetically determined in the process of differentiation, which are biologically active compounds, capable of predetermining morphogenetic and formative processes in normal development of a human body by way of lectinogistochemical study of epithelial and mesenchymal cells derived from the primary oral cavity.

According to E. Yu. Shapovalova [15], differentiation of mesenchyme into embryonic connective tissue of oral cavity organs with its derivatives,

respiratory organs and pancreatic gland cushion occurs asynchronously and alike.

Today, Lc are used as both selective and sensitive probes intended for studying a distribution of carbohydrate-containing molecules – glycoconjugates – in consecutive phases of morphogenesis [17; 18]. The latter bind with terminal unreduced mono- or oligosaccharide glycopolymer residues with high selectivity.

Glycopolymeric (GPM) compounds form the structural and functional basis of cells and tissues of a living organism. They are a part of many plasmatic cell membranes, glycocalyx, intracellular inclusions, connective tissue fibers and the main substance; are signal and receptor molecules; predetermine intercellular contacts, adhesion and cell migration; and are likely capable of triggering or inhibiting apoptosis. Recognition and binding of such GPM by endogenous Lc in ontogenesis, called lectin-receptor interactions, can trigger lectin-dependent regulation of cellular functions and cellular responses that predetermine differentiation of tissues and their structural components.

We have studied a large number of works describing the dynamics of Lc receptor variability in a postnatal formation and functioning of the salivary glands of laboratory animals [19–21] and humans [22–24].

Despite the important role of lectin-receptor interactions in the embryonic development of tissues and organs, there is still a lack of works devoted to studying a distribution of Lc receptors in human thymus gland in early prenatal ontogenesis [25; 26].

Lectinogistochemical studies of the trends in Lc receptor change in early thymus gland morphogenesis may help to clarify the issue of repression and derepression of glycopolymers with various terminal unreduced monosaccharide residues on the surface and in the cytoplasm of parenchyma and stroma, which is essential for understanding the complex processes of intercellular and inter-tissue interactions.

The distribution of GPMs that are lectin receptors (LR) in prenatal ontogenesis of thymus gland may serve a criterion of its normal or pathological development and may help to approach resolution of the problem of the thymus gland origin.

Taking into account the above mentioned, we have studied the biosynthesis trends and redistribution of carbohydrate determinants of tissues, Lc receptors, in the epithelium and mesenchyme of the human thymus gland buds in prenatal ontogenesis.

The content of Lc receptors in epithelial and mesenchymal derivatives of human thymus gland reflected in points is presented in Table 1.

Table 1

Content of lectin receptors in epithelial and mesenchymal derivatives of human thymus gland (points)

Lectin	PCL embryos and pre-feti (38 days, 45 days, 52 days, 57 days, 10 weeks, 12 weeks), mm	Epithelial bud cells 33		Peri-epithelial mesenchyme, or embryonic bud connective tissue 33	
		cytomembrane	cytoplasm	cytome-mbrane	cyto-plasm
SBA	10	0	3	3	2
	16	3	2	3	2
	23	3	2	2	2
	27	3	1	2	1
	45	3	2	2	1
	70	3	2	2	1
STA	10	0	0	0	0
	16	0	0	0	0
	23	3	2	3	2
	27	0	0	0	0
	45	0	0	0	0
	70	0	0	0	0
HPA	10	0	0	0	0
	16	0	0	0	0
	23	4	3	0	2
	27	0	0	0	0
	45	0	0	0	0
	70	0	0	0	0
WGA	10	0	0	0	0
	16	0	3	1	3
	23	3	2	1	0
	27	4	3	4	2
	45	4	3	3	2
	70	4	4	3	1
SNA	10	3	2	1	0
	16	3	2	2	1
	23	4	3	2	1
	27	3	2	1	1
	45	1	0	0	1
	70	0	0	0	1
PNA	10	4	3	3	2
	16	3	2	2	1

	23	3	2	2	1
	27	3	3	0	1
	45	2	3	2	1
	70	2	1	2	1
LCA	10	0	0	0	0
	16	0	0	0	0
	23	2	0	1	0
	27	2	0	1	0
	45	1	0	0	0
	70	0	0	0	0
LABA	10	0	0	0	0
	16	0	0	0	0
	23	2	1	1	0
	27	3	1	2	1
	45	0	0	0	0
	70	0	0	0	0

1. Patterns of binding lectins with epithelium and mesenchyme in the early prenatal ontogenesis of human thymus gland

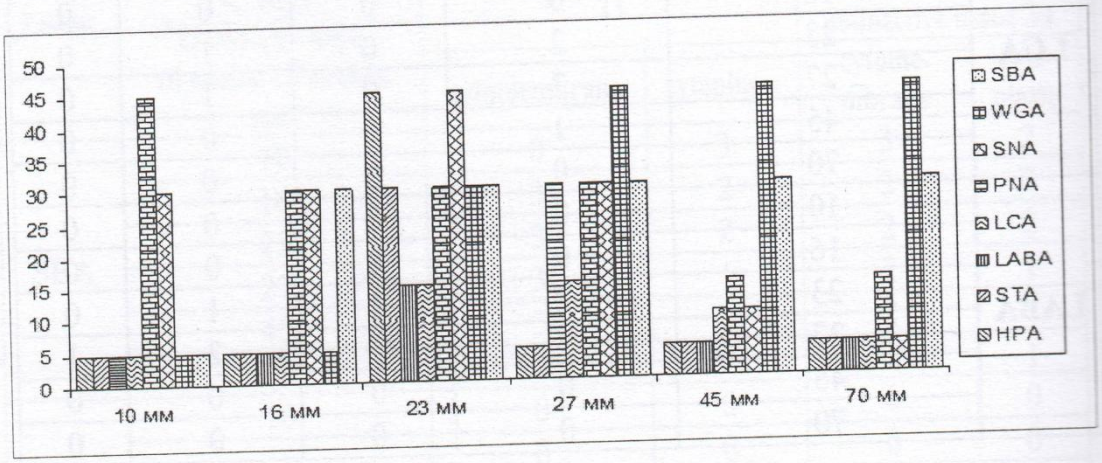
We studied changing carbohydrate structure of tissues in early embryonic histogenesis of human thymus gland by examining the thymus gland epithelial bud and adjacent mesenchyme. The content of Lc receptors in cytomembrane and cell cytoplasm is presented in Fig. 1 and Fig. 2

The absence of Lc receptors corresponds to 5 conditional units (cu). «1 point» content corresponds to 10 cu, «2 points» content corresponds to 15 cu, «3 points» content corresponds to 30 cu, and «4 points» content corresponds to 45 cu.

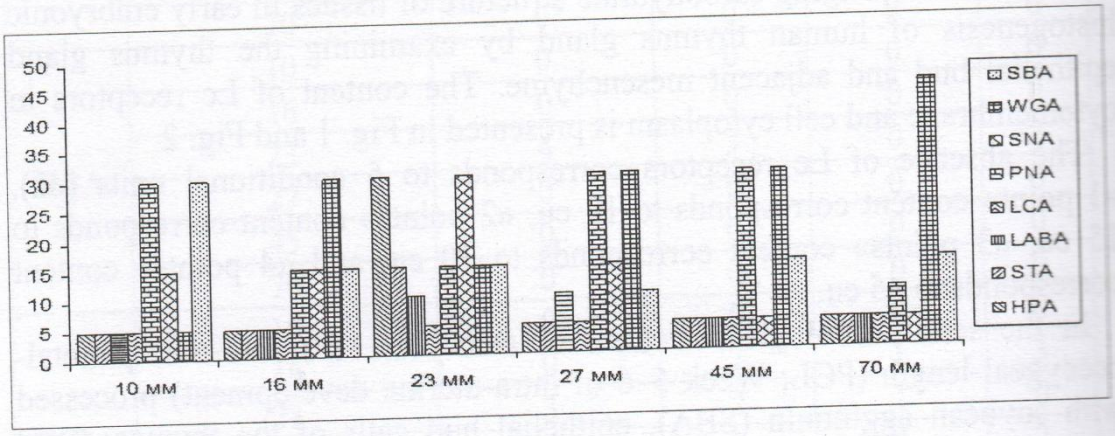
In the serial histological sections of embryos, 10.0-13.0 mm parietal-coccygeal length (PCL; Week 5–6 of intra-uterine development) processed with soybean agglutinin (SBA), epithelial bud cells of the thymus gland accumulated GPM with terminal unreduced residues of N-acetyl-D-galactosamine in the cytoplasm (coloration intensity – 3 points), while their cytomembrane remain SBA-areactive (0 points).

Starting from pre-feti with 16.0 mm PCL (Week 7) (Fig. 3) and until 70.0 mm PCL (Week 12) (Fig. 4), we were finding strong concentration (coloration intensity 3 points) of GPM specific to SBA on cytomembrane of epithelial thymus gland bud, and moderate (2 points) concentration of GPM with terminal unreduced residues of N-acetyl-D-galactosamine in the cytoplasm.

In contrast to the epithelial cells of thymus gland, cytomembrane of cells adjacent to epithelial bud of the mesenchymal thymus gland in embryos with 10.0–13.0 mm PCL (Week 5–6 of intra-uterine development) expressed a large number of SBA-positive biopolymers (coloration intensity – 3 points), and their content in the mesenchyme cell cytoplasm was moderately positive (coloration intensity – 2 points).

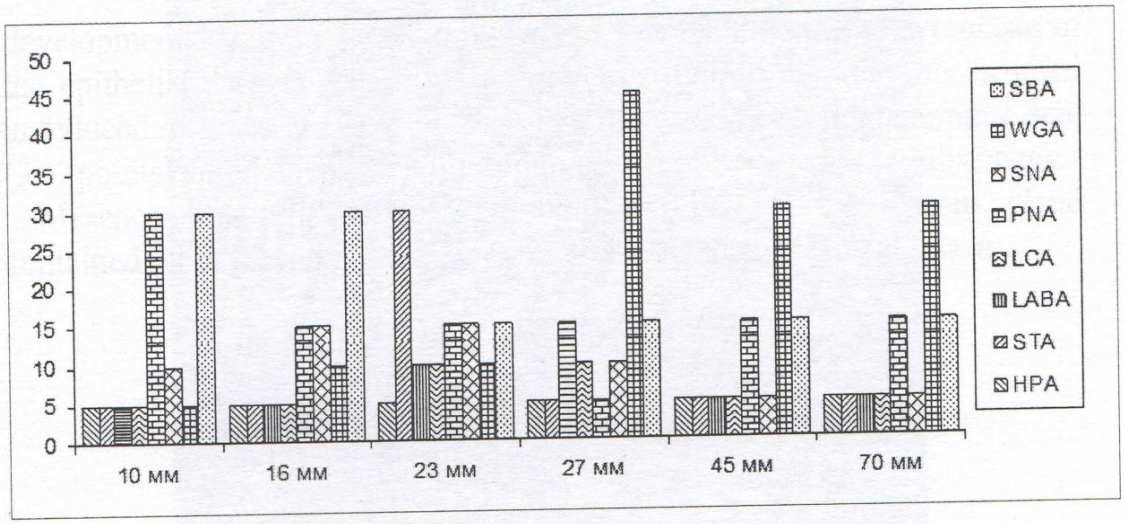


A – Cytomembrane of Epithelial Cells

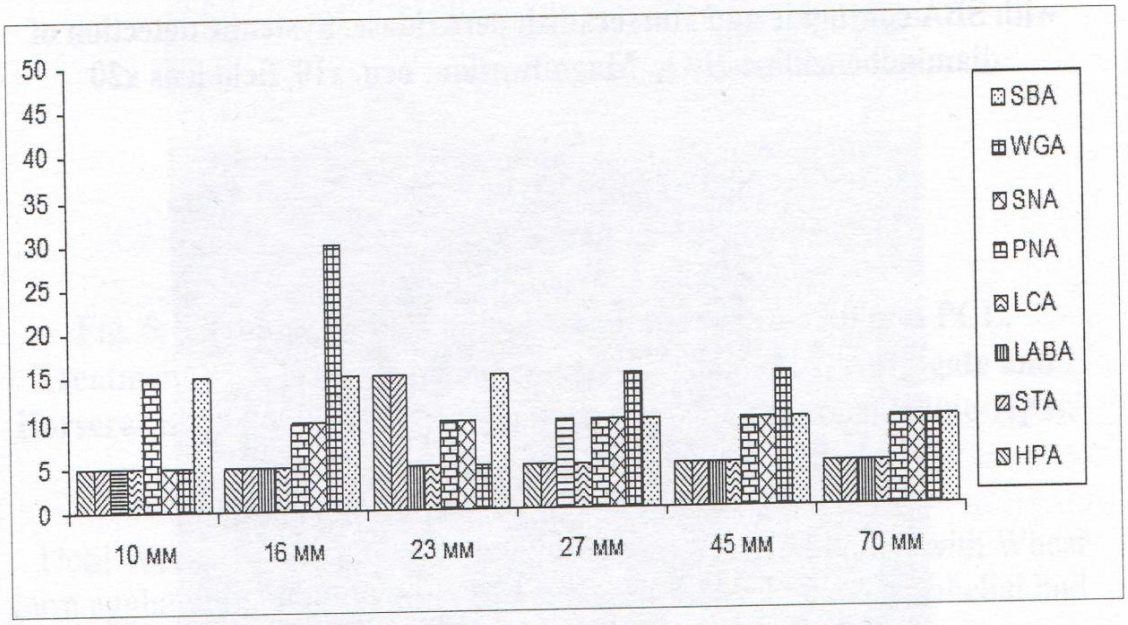


B – Cytoplasm of Epithelial Cells
Fig. 1. Content of lectin receptors in the thymus gland bud epithelial cells

In pre-feti with a 16.0–70.0 mm PCL (7–12 weeks of intra-uterine development), cells adjacent to the epithelial cushion of 33 mesenchyme both in the cytomembrane (2 points) and in the cytoplasm (1 point) reduced expression of compounds specifically bound with SBA.



A – Cytomembrane of Mesenchymal cells



B – Cytoplasm of Mesenchymal cells

Fig. 2. Content of lectin receptors in mesenchymal cells adjacent to thymus gland epithelial bud

Fig. 3. Thymus gland of human pre-fetus with a 16.0 mm PCL. Treatment with SBA conjugate and Horseradish peroxidase. Systemic detection of diaminobenzidine-H_2O_2. Magnification: ocu. x10, field lens x20

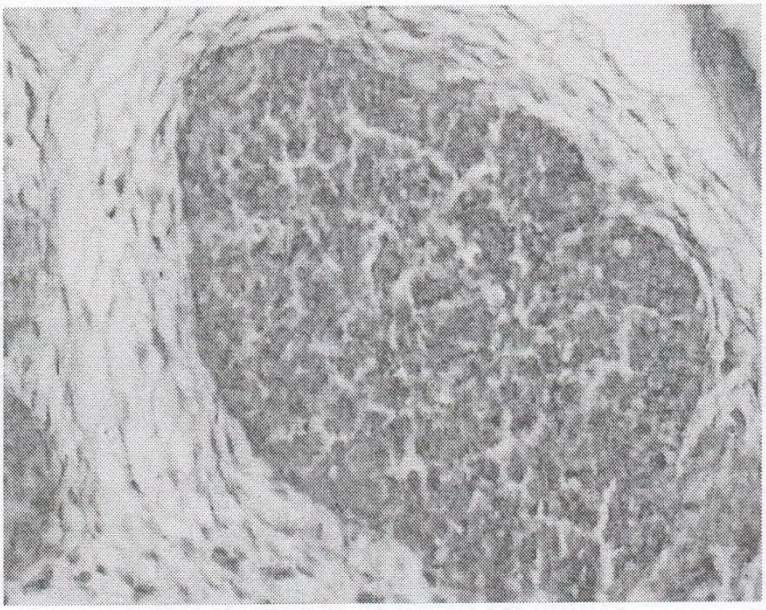


Fig. 4. Thymus gland of human pre-fetus with a 45.0 mm PCL. Treatment with SBA conjugate and Horseradish peroxidase. Systemic detection of diaminobenzidine -H_2O_2. Magnification: ocu. x10, field lens x20

In the sequential treatment of sections with a Wheat germ agglutinin (WGA) conjugate and Horseradish peroxidase, we found that in early

developmental stages of the thymus gland, cytomembrane and cytoplasm of the epithelial thymus gland bud accumulated GPM (Fig. 5) with terminal unreduced residues of N-acetyl-D-glucosamine and N-acetylneuraminic acid (3–4 points) simultaneously with accumulation of PAS-positive substances.

Mesenchymal cells, adjacent to epithelial bud of the thymus gland contained more receptors on their cytomembrane than in the cytoplasm.

Fig. 5. Thymus gland of human pre-fetus with a 13.0 mm PCL. Treatment with Wheat germ agglutinin/lectin (WGA) conjugate and Horseradish peroxidase. Systemic detection of diaminobenzidine-H_2O_2. Magnification: ocu. x10, field lens x20

Until Weeks 10–12 of intrauterine development, GPM bound with Wheat germ agglutinin (WGA) occurred mostly in cytomembrane of epithelial bud (4 points) and in adjacent mesenchyme (3 points) (Fig. 6).

In early thymus gland developmental stages, receptors of Sambucus nigra lectin (SNA) were concentrated in significant amount (Fig. 7) on cytomembrane of the thymus gland epithelial bud cells (3 points) and on cytomembrane of adjacent mesenchymal cells (2 points). Cell cytoplasm contained them in somewhat smaller amounts. By Weeks 10–12 of intrauterine development, the presence of sialal GPM subsided both on cytomembrane and in cytoplasm. Upon the end of Week 12, receptors of the Sambucus nigra lectin were found in insignificant amount both in the epithelial bud, and in the cells adjacent (0-1 point) to mesenchyme.

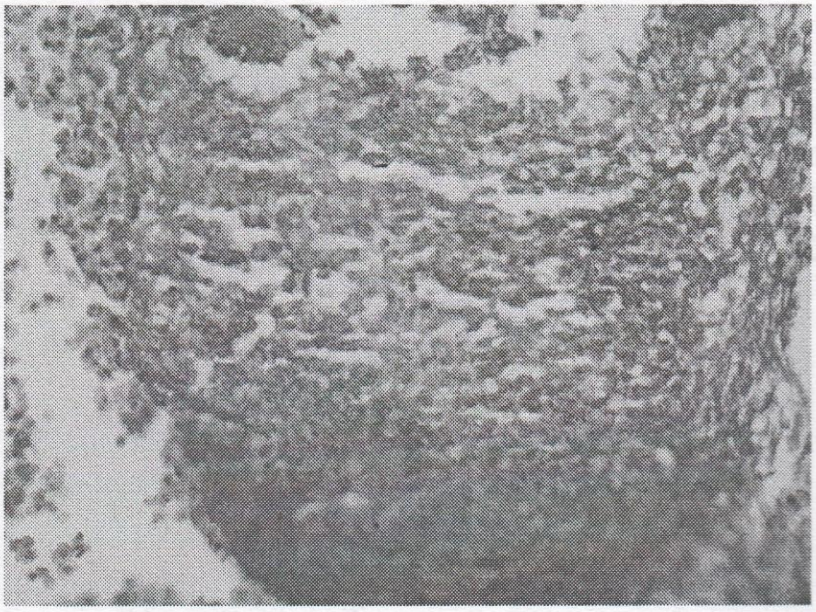


Fig. 6. Thymus gland of human pre-fetus with a 45.0 mm PCL. Treatment with Wheat germ agglutinin/lectin (WGA) conjugate and Horseradish peroxidase. Systemic detection of diaminobenzidine-H_2O_2. Magnification: ocu. x10, field lens x20

Consequent treatment of sections with Peanut agglutinin (PNA) conjugate and Horseradish peroxidase presented a consistent presence of GPM with terminal unreduced β-D galactose residues both on the surface and in the cytoplasm (Fig. 8) of epithelial bud and adjacent mesenchymal cells (3 and 2 points respectively) throughout the whole study. At the end of Week 12 of the thymus gland fetal development, the number of receptors to the above lectin in the cytoplasm of cells adjacent to the epithelial mesenchyme bud and young collagen fibers (1–2 points) somewhat subsided.

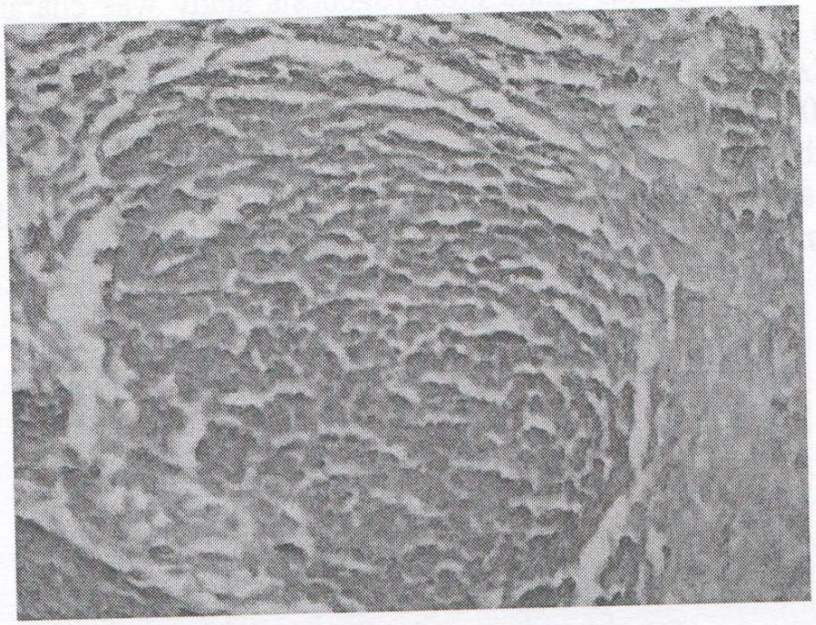


Fig. 7. Thymus gland of human pre-fetus with a 11.0 mm PCL. Treatment with Sambucus nigra lectin (SNA) conjugate and Horseradish peroxidase. Systemic detection of diaminobenzidine-H_2O_2. Magnification: ocu. x10, field lens x20

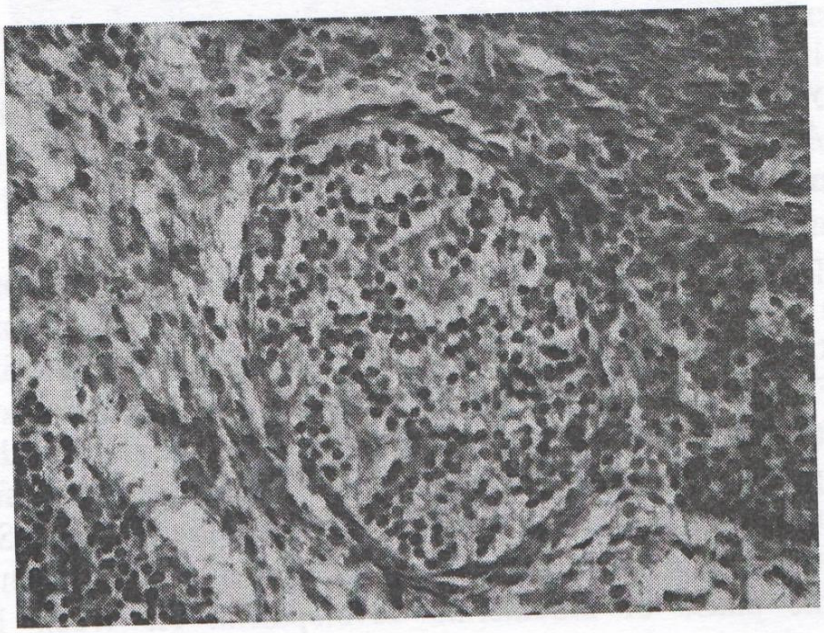


Fig. 8. Thymus gland of human pre-fetus with a 17.0 mm PCL. Treatment with Peanut lectin conjugate (PNA) and Horseradish peroxidase. Systemic detection of diaminobenzidine-H_2O_2. Magnification: ocu. x10, field lens x20

The period of thymus gland embryogenesis study was characterized by short-term emergence of insignificant number of receptors to Lens culinaris lectin (LCA) with terminal unreduced residues of α-D-mannose in pre-feti with a 23.0–45.0 mm PCL (Day 52 – Week 10 of intrauterine development) only on the surface (Fig. 9) of the thymus gland epithelial bud cells (2 points) and adjacent mesenchyme (1 point). Cytoplasm of epithelial cells and adjacent mesenchyme remained LCA-areactive (0 points).

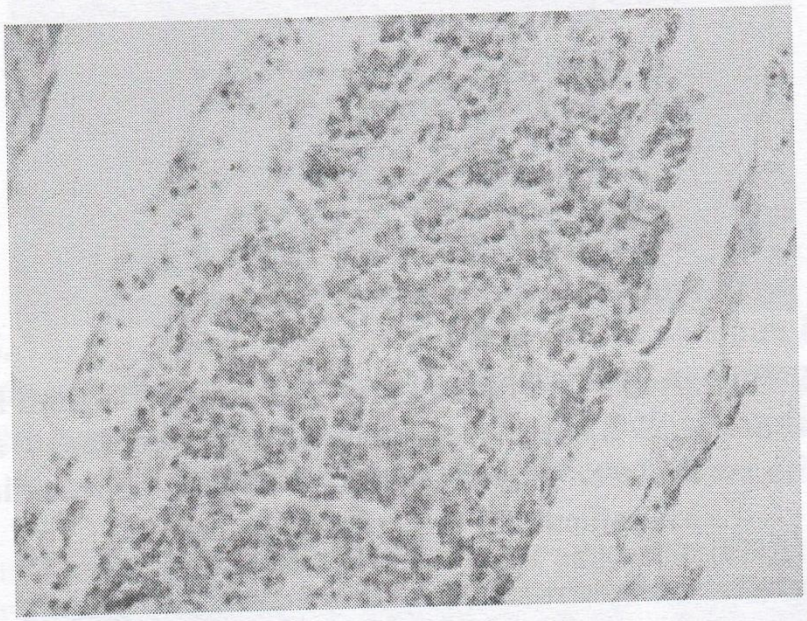


Fig. 9. Thymus gland of human pre-fetus with a 25.0 mm PCL. Treatment with LCA conjugate and Horseradish peroxidase. Systemic detection of diaminobenzidine-H_2O_2. Magnification: ocu. x10, field lens x20

No (0 points) Laburnum anagyroides lectin (LABA) receptors were present in early human embryo thymus gland cells. The process of differentiation of the epithelial bud of the thymus gland resulted in synthesis of GPM (Fig. 10) and terminal unreduced residues of α-L-fucose with their initial accumulation in a greater extent on cytomembrane of epithelial bud cells (2–3 points) and adjacent mesenchyme (1–2 points) in pre-feti with a 23.0–27.0 mm PCL (Days 52–57 of intrauterine development). Somewhat smaller amount of the above substances appeared in cell cytoplasm (1 point) in the same phase of intrauterine development. At Week 10–12 of embryogenesis, the thymus gland epithelial bud and adjacent fibrous mesenchyme did not contain these lectin receptors (0 points).

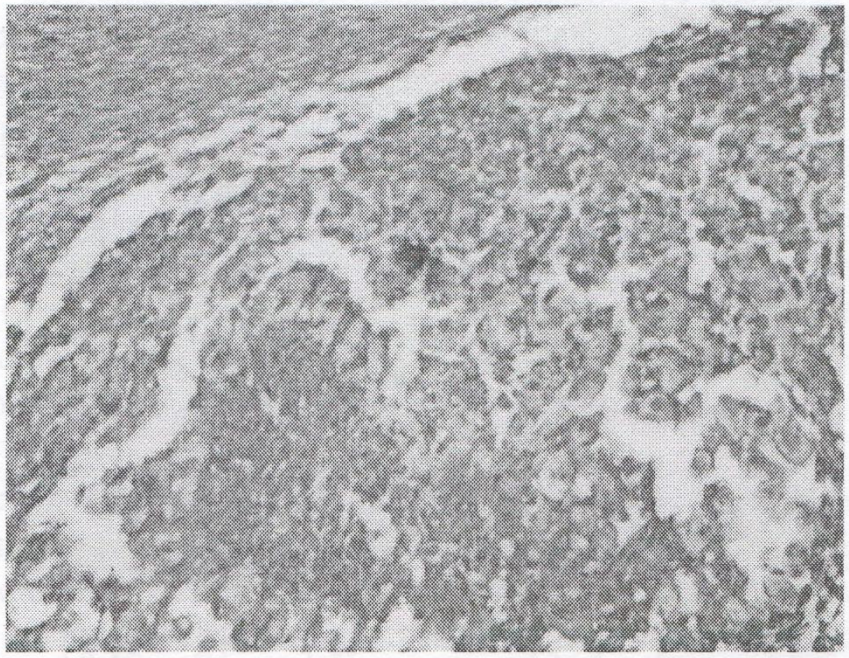


Fig. 10. Thymus gland of human pre-fetus with a 27.0 mm PCL. Treatment with LABA conjugate and Horseradish peroxidase. Systemic detection of diaminobenzidine-H_2O_2. Magnification: ocu. x10, field lens x20

In human embryos and pre-feti with a 10.0-18.0 mm PCL (Weeks 5–7 of intrauterine development), the consecutive treatment of sections with Solanum tuberosum (potato) lectin (STA) conjugate revealed complete absence of N-acetyl-hitotriozamin in cytomembrane and cytoplasm of epithelial thymus gland bud cells, and in the cells of adjacent mesenchyme (0 points). In pre-feti with a 21.0–23.0 mm PCL (7.5 weeks of intrauterine development), we observed (Fig. 11) short expression of STA-positive biopolymers in cytomembrane (3–0 points) and in cytoplasm (2–3 points) of epithelial thymus gland bud cells, cytomembrane (0-3 points) and cytoplasm (2–4 points) adjacent to the epithelial bud of mesenchymal cells. At Weeks 8–12 of embryogenesis (pre-feti with a 27.0–70.0 mm PCL), epithelial bud and adjacent mesenchymal cells were STA-areactive.

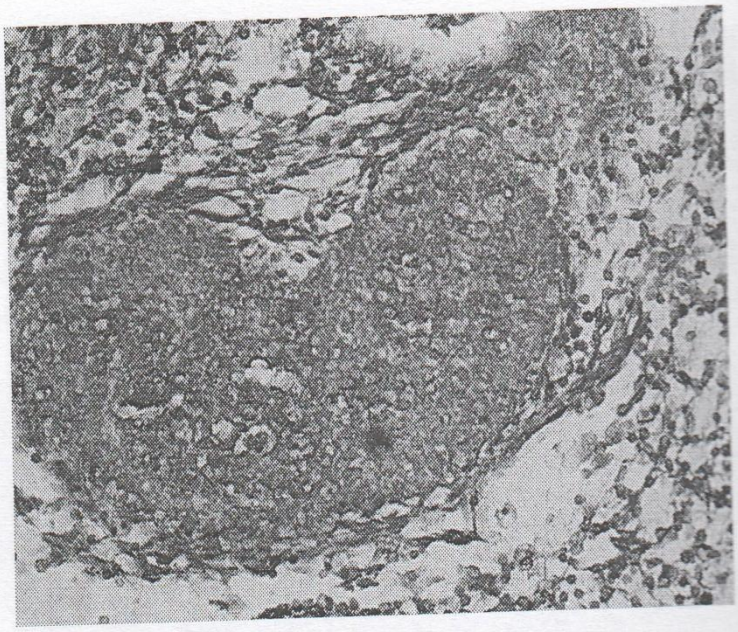


Fig. 11. Thymus gland of human pre-fetus with a 21.0 mm PCL. Treatment owith Solanum tuberosum (potato) lectin (STA) conjugate and Horseradish peroxidase. Systemic detection of diaminobenzidine-H_2O_2. Magnification: ocu. x10, field lens x20

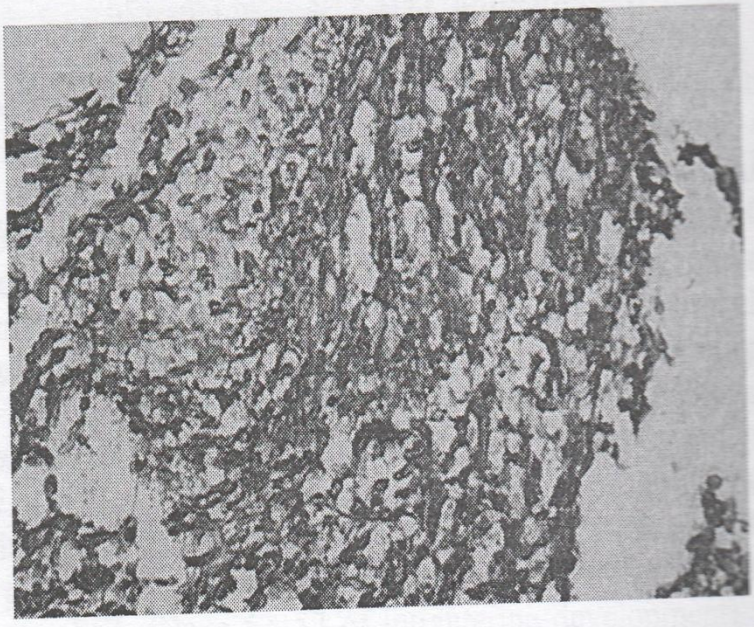


Fig. 12. Thymus gland of human pre-fetus with a 21.0 mm PCL. Treatment with Helix pomatia lectin (HPA) conjugate and Horseradish peroxidase. Systemic detection of diaminobenzidine-H_2O_2. Magnification: ocu. x10, field lens x20

During prenatal ontogenesis of human thymus gland, treatment of series of histological sections with Helix pomatia lectin (HPA) revealed a short-term emergence of HPA-positive biopolymers with terminal unreduced residues of N-acetyl-2-deoxy-2-amino-D-glucopyranose in pre-feti with a 21.0–23.0 mm PCL (Week 7 of fetal development) on cytomembrane (Fig. 12) of epithelial bud cells of the thymus gland (4 points) and in the cytoplasm (3 points). Cytomembrane of cells adjacent to the mesenchyme appeared to be HPA-areactive, and cytoplasm contained a small amount (2 points) of HPA-positive compounds.

2. Patterns of glycogen production by epithelial and mesenchymal components of thymus gland buds in human prenatal ontogenesis

Throughout the entire human ontogenesis prenatal phase, complex processes of polysaccharides synthesis in the thymus gland bud that correspond to a degree of differentiation of its cellular elements are taking place. In this regard, interesting, in our opinion, are results obtained from the study of patterns of glycogen production by epithelial and mesenchymal components of the thymus gland bud in the prenatal phase of human ontogenesis.

The early occurrence of glycogen in the thymus gland bud at the beginning of the genesis suggests of its importance as not only an energetic but also a plastic material. All stages of the thymus gland embryogenesis studied by us manifested a plastic role of glycogen in the processes of cellular elements and organ tissues differentiation, which coincides with the periods of the most intense morphological specialization of the human thymus gland parenchyma. The latter has been confirmed by the data we obtained from studying the cytological and histological characteristics of the organ, as well as the results of cytometric measurements of changes of glycogen quantitative parameters in the prenatal human ontogenesis (Table 2).

Table 2

Trends in quantitative changes of glycogen content in thymus gland buds of human embryos, pre-feti and feti

Age of study subjects (weeks)	Glycogen content (in conditional units)	P (reliability factor)
5-week buds	12.10±0.08	0.001
6-week buds	15.44±0.11	0.05
7-week pre-feti	13.70±0.05	0.01
8-week pre-feti	23.90±0.02	0.02
9-week pre-feti	15.85±0.04	0.01
10-12- week pre-feti	13.80±0.08	0.001
13-16- week feti	13.20±0.13	0.001
17-20- week feti	12.50±0.03	0.05
21-24-week feti	11.80±0.05	0.02
25-30- week feti	17.00±0.01	0.01
31-35- week feti	17.28±0.04	0.02
36-40- week feti	17.32±0.07	0.05

The content of glycogen in the epithelial bud of the thymus gland (buds up to 13.0 mm PCL) was constantly growing and reached 15.44 ± 0.11 conditional units at the time of the gland transformation into a reticuloepithelial organ. The pre-feti development was associated with reduction of this indicator up to 13.70 ± 0.05 conditional units (before feti reach 19.0–20.0 mm PCL) and by the time of the thymus gland transformation into a lymphatic epithelial organ (before feti reach 27.0–29.0 mm PCL) the indicator grew up again to 23.90 ± 0.02 conditional units.

During subsequent weeks of intrauterine development, the content of glycogen in the thymus gland buds was gradually decreasing. Accordingly, well at Month 6 of development, when the bud of the organ had almost gained a definitive form, the glycogen level in the bud arrived at 11.80 ± 0.05 conditional units. Starting from a 7-month fetus, the synthesis of glycogen by thymus gland bud began to increase, and its content reached 17.00 ± 0.01 conditional units. Further, until birth, this content remained almost unchanged at the level of 17.28 ± 0.04–17.32 ± 0.07 conditional units.

Thus, the accumulation of glycogen reflects the most intense periods of differentiation of the thymus gland bud in the prenatal phase of human ontogenesis.

The analysis of accumulation of polysaccharide complexes revealed that mucopolysaccharides in the connective tissue of thymus gland, which differentiated from the mesenchymal bud constituents, emerged quite early. For example, glycosaminoglycans such as hyaluronic acid and chondroitin – 4–6 sulfates could be found in a mesenchyme around the epithelial bud of the thymus gland (the future capsule of the gland) yet in a 2-month pre-feti. Since the process of glycosaminoglycans formation, as a rule, preceded the subsequent collagenization, their accumulation in the intermediate substance of the connective tissue contributed to its intensive formation and development phenomena, such as subsequent formation of the capsule of thymus gland and its partition walls. At the same time, the content of glycosaminoglycans decreased with the development of stromal component of thymus gland, and completely disappeared by the 8-th month of intrauterine development. Neutral mucopolysaccharides, on the contrary, had begun to occur from the 4-th month of intrauterine development, and their content kept growing until birth.

Consequently, the physicochemical state of a biopolymer complex of intermediate substance of the connective tissue, a possibility to evaluate its histophysiological state, and its important role in inter-tissue interaction are considered a precondition of targeted differentiation of all tissue components of the thymus gland bud in the phase of prenatal ontogenesis.

Conclusions

The results of the lectinohistochemical study of lectin receptor changes in early thymus gland morphogenesis will be helpful for clarification of the issue of repression and derepression of glycopolymers with different terminal unreduced monosaccharide residues on the surface and in the cytoplasm of parenchyma and stroma of organs, which is essential for understanding the processes of intercellular and inter-tissue interaction.

Regular redistribution of glycopolymers in epithelial bud and adjacent mesenchyme takes place during the first 12 weeks of human thymus gland embryogenesis. Ingress of epithelial cells in the ventral wall section of III and IV pharyngeal pockets in adjacent mesenchyme and their conversion into epithelial bands is associated with accumulation of N-acetyl-neuraminic acid and N-acetyl-D-glucosamine, which are receptors of Wheat germ (WGA) and Sambucus nigra (SNA) lectins. Differentiation of the epithelial bud of the thymus gland leads to intensive accumulation of Soybeans (SBA), Wheat germ (WGA), Sambucus nigra (SNA), and Peanut (PNA)

lectin receptors on cytomembrane and in the cytoplasm of cells. Somewhat less expressed these receptors are in cells adjacent to mesenchyme of the epithelial bud of the thymus gland. During the first 12 weeks, these GPM were present both on cytomembrane cells of epithelial bud of the thymus gland and the surrounding mesenchyme, and in their cytoplasm. Throughout the study period, we proved stable presence of GPM with terminal unreduced residues of Peanut agglutinin (PNA) ß-D-galactose on the surface and in the cytoplasm of the epithelial rudimentary cells and adjacent mesenchyme. The end of the Week 12 of the thymus gland embryogenesis was characterized by a decrease in the number of receptors to the said lectin in cytoplasm of mesenchymal cells adjacent to the epithelial buds and young collagen fibers. Intrauterine development of thymus gland at the end of Week 7 - 8 was characterized by a short-term emergence of receptors to Lens culinaris lectin (LCA) with terminal unreduced residues of α-D-mannose (in embryos with 23.0–45.0 mm PCL) and Laburnum anagyroides lectin (LABA) with terminal unreduced residues of α-L-fucose (in embryos of 23.0–27.0 mm PCL). In our opinion, this fact was associated with an ingress of extraorganic blood vessels in the thymus gland bud, their merging with intraorganic blood vessels and transformation of the thymus gland bud from the epithelial organ into a lymphopepithelial one, since the most intensive accumulation of lectin receptors in the tissues of epithelial bud and adjacent mesenchyme coincided in time (embryogenesis) with formation of vascular network of thymus gland and transition from the embryonic to pre-fetal development phase.

Accumulation of glycogen reflects the most intense periods of differentiation of the thymus gland bud in the prenatal period of human ontogenesis, and the physicochemical state of a biopolymer complex of intermediate substance of the connective tissue, a possibility to evaluate its histophysiological state, and its important role in inter-tissue interaction ensure targeted differentiation of all tissue components of the thymus gland bud in the prenatal ontogenesis phase.

References:

1. Сапин М. Р. Сегодня и завтра морфологической науки / М. Р. Сапин // Морфология. – 2000. – Т. 117. – № 3. – С. 6–8.

2. Жукова Н. Ф. Исследование пренатального онтогенеза узкоспециализированных групп млекопитающих / Н. Ф. Жукова, И. М. Ковалёва, О. В. Нечаева // Таврич. мед.-биол. вестник. – 2006. – Т. 9. – № 3. – Ч. III. – С. 63–66.

3. Kovalyova I. M. Peculiarities of prenatal development of Lungs in some plain-nosed (Vespertilionidae) and horseschoe (Rhinolophide) Bats / I. M. Kovalyova // Вестник зоологии. – 2002. – Т. 36. – № 1. – С. 85–90.

4. Zhukova N. F. Peculiarities of prenatal development of digestive system of bats / N. F. Zhukova, M. F. Kovtun // Bat international research conference. Abstracts for 13th Int. Bat Research Conf. (Poland, Mikolayki, 2014, 23–27 Aug. 2014). – Warszawa: Mus. and Inst. of Zool., 2014. – P. 36–37.

5. Леонтюк А. С. Тенденции современных исследований процессов эмбрионального морфогенеза тканевых и органных систем / А. С. Леонтюк // Морфология. – 2002. – Т. 121. – № 2–3. – С. 91.

6. Борисов Н. И. Филогенетичекие основы тканевой организации животных / М. И. Борисов, П. В. Дунаев, В. Н. Бажанов. – Новосибирск : Наука, 1996. – 126 с.

7. Внутриутробное введение антигена как модель для изучения симптомокомплекса висцеромегалии / [Н. А. Волошин, Е. А. Григорьева, М. С. Щербаков, М. Б. Вовченко, А. А. Светлицкий, С. В. Чугин] // Таврич. мед.-биол. вестник. – 2006. – Т. 9. – № 3. – Ч. 4. – С. 41–43.

8. Внутриутробное введение антигенов – модель для изучения морфогенеза лимфоидных органов / [Н. А. Волошин, М. В. Карзов, Е. А. Григоьева, О. Г. Кущ и др.] // Таврич. мед.-биол. вестник. – 2012. – Т. 5. – № 3. – С. 43–46.

9. Newborn organ's visceromegalia as fetuses reaction on intrauterine antigen stimulation / [M. Voloshyn, M. Ivanov, M. Shcherbacov, M. Vovchenco, O. Kushch, A. Medvedev, E. Gorodnicheva] // Italian J. Anatomy and Embryology. – 2009. – Vol. 104. – Suppl. № 1. – P. 749.

10. Скорук А. Г. Структура природжених вад на Вінниччині у 2002–2012 рр. (за даними Вінницького обласного патологоанатомічного бюро) / А. Г. Скорук // Український медичний альманах. – 2013. – Т. 16. – № 3 (додаток). – С. 129–131.

11. Игнатов В. В. Углеводузнающие белки – лектины / В. В. Игнатов // Соросов. образоват. журнал. – 1997. – № 2. – С. 14–20.

12. Ященко А. М. Лектини як гістохімічні маркери в нормі і патології: автореф. Дисс. докт. мед. наук: спец. 14.03.09 / А. М. Ященко; Нац. мед. ун-т ім. О. О. Богомольця. – К., 2004. – 35 с.

13. The mannose-binding lectin: a prototypic pattern recognition molecule / [K. Takahashi, W. K. Ip Eddie, I. C. Michelow, R. A. Ezecowitz] // Current Opinion in Smmunology. – 2006. – № 18. – P. 16–23.

14. Вивчення ролі лімфоїдної системи в процесах морфогенезу органів за допомогою лектинів / [М. А. Волошин, М. Б. Вовченко,

М. С. Щербаков, О. Г. Кущ, О. А. Григорєва] // Саміт нормальних анатомів України та Росії, присвячений року Росії в Україні (Тернопіль, 28–30 травня 2003 року). – Тернопіль: Укрмедкнига, 2003. – С. 19–22.

15. Шаповалова Е. Ю. Ранний гистогенез углеводных компонентов тканей и волокнистого каркаса органов производных экто- и энтодермы у человека / Е. Ю. Шаповалова // Таврич. мед.-биол. вестник. – 2001. – Т. 4. – № 1–2. – С. 171–176.

16. Шаповалова Е. Ю. Рецепторы лектинов в раннем гистогенезе эпителиальных и мезенхимных производных первичной ротовой полости у человека / Е. Ю. Шаповалова, Т. И. Забашта, А. Д. Луцик // Таврич. мед.-биол. вестник. – 1999. – № 1–2. – С. 45–48.

17. Иванов И. И. Нарушения женской репродуктивной системы в период полового созревания при диффузной эутиреоидной гиперплазии щитовидной железы / И. И. Иванов, В. Н. Косолапова // Пробл., достиж. и перспективы развития мед.-биол. наук и практического здравоохранения: тр. Крым. гос. мед. ун-та им. С. И. Георгиевского. – Симферополь: КГМУ, 2006. – Т. 142. – Ч. II. – С. 69–71.

18. Барсуков Н. П. Гистохимическая характеристика становления структурных компонентов и межтканевых отношений в стенке желудка человека в эмбриогенезе / Н. П. Барсуков, Г. А. Барсукова, Н. М. Романенко // Вісн. проблем біол. і мед. – Полтава-Харків, 2007. – Вип. 16. – С. 190–191.

19. Волошин Н. А. Особенности распределения структур, содержащих рецепторы к лектину арахиса, в тимусе крыс в раннем постнатальном периоде онтогенеза / Н. А. Волошин, М. Е. Иванов // Український медичний альманах. – 1998. – № 2. – С. 51–53.

20. Олийнык И. Ю. Лектиногистохимические характеристики эпителиальных клеток тимуса на этапах постнатального онтогенеза белой крысы / И. Ю. Олийнык // International Journal on Immunorehabilitation. – 2004. – Vol. 6. – № 1. – P. 36.

21. Castells M. Characterization of glycoconjugates in developing rat respiratory system by means of conventional and lectin histochemistry / M. Castells, J. Ballesta, M. Madrid // Histochemistry. – 1991. – V. 95. – P. 419–426.

22. Олійник І. Ю. Інтегративний підхід у вивченні лектиногістохімічних характеристик перетворень щитоподібної залози людини в пренатальному онтогенезі / І. Ю. Олійник // Клін. та експерим. патологія. – 2006. – Т. 5. – № 2. – С. 67–71.

23. Олійник І. Ю. Лектиногістохімічна характеристика ембріотопографічних перетворень щитоподібної залози людини / І. Ю. Олійник // Клін. анат. та операт. хірургія. – 2006. – Т. 5. – № 3. – С. 64–68.

24. Олійник І. Ю. Зміна вуглеводного складу тканин у процесі раннього ембріонального гістогенезу щитоподібної залози людини / І. Ю. Олійник // Укр. мед. альманах. – 2006. – Т. 9. – № 4. – С. 87–90.

25. Скорук А. Г. Лектин-вуглеводні взаємодії в ембріотопографічних перетвореннях загруднинної залози людини / А. Г. Скорук // Актуальні проблеми сучасної медицини: Вісник Української медичної стоматологічної академії. – 2014. – Т. 14. – Вип. 3 (47). – С. 247–251.

26. Скорук А. Г. Експресія лектинів зав'язі пшениці (WGA) та бузини чорної (SNA) у ранньому пренатальному онтогенезі загруднинної залози людини / А.Г. Скорук // Значення морфологічних наук на сучасному етапі розвитку медицини : матеріали наук.-практ. інтернет-конференція з міжнародною участю, приурочена 70-річчю з дня заснування Буковинського державного медичного університету (м. Чернівці, 26-27 листопада 2014 року). – Чернівці: Медуніверситет, 2014. – С. 87–89.

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STOKES POLARIMETRIC IMAGING OF OPTICAL ANISOTROPY OF HISTOLOGIC SECTIONS IN THE ORBITAL REGION STRUCTURES

Summary

We were the first to offer the method of Stokes polarimetric statistic analysis of microscopic sections of the orbital region structures in human fetuses of different periods (5-10 months) of their fetal development (FD) and to apply an objective statistical analysis of coordinate distributions of