Реферати

ФУЛЛЕРЕНЫ C_{60} УСИЛИВАЮТ ТОКСИЧЕСКИЙ ЭФФЕКТ ТОЛУОЛА НА СОСТОЯНИЕ ФЕРМЕНТАТИВНОЙ СИСТЕМЫ БИОТРАНСФОРМАЦИИ КСЕНОБИОТИКОВ

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Развитие нанотехнологий способствует появлению новых ультрависокодисперсних форм веществ - наноматериалов, влияние которых на здоровье человека может быть непредсказуемым. Целью данной работы было исследовать эффект комбинации фуллеренов C60 с известным химическим токсикантом толуолом на активность ферментов первой и второй фазы метаболизма ксенобиотиков в печени крыс. Животным интраперитонеально вводили суспензию фуллеренов (60 мг / кг), толуол (0,5 мл / кг) и толуол с растворенными в нем фуллеренами. В динамике (3-72 ч) в микросомах печени определяли активность УДФ - глюкуронилтрансферазы, етоксирезоруфин-О-деетилазы (ЕРОД), глутатионтрансферазы. Максимальные изменения всех показателей во все сроки исследования наблюдалось в IV группе животных, которым вводили фуллерены, растворенные в токсиканте толуоле. В этом случае активность ЕРОД и УДФ - глюкуронилтрансферазы достоверно возрастала, а активность глутатионтрансферазы достоверно снижалась по сравнению с животными, которым вводили только толуол. Сделано выводи, что карбоновые наночастицы фуллерены C60 способны усиливать токсическое воздействие химического токсиканта толуола на систему биотрансформации ксенобиотиков.

Ключевые слова: фуллерены, толуол, ферменты биотрансформации ксенобиотиков.

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FULLERENE C60 STRENGTHEN TOLUENE TOXIC EFFECT ON ENZYMES SYSTEM STATE OF XENOBIOTICS BIOTRANSFORMATION

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The development of nanotechnologies contributes to the emergence new ultra high dispersed substance forms called nanomaterials. Their influence on human health can be unpredictable. The aim of this research is to investigate the effect of fullerenes (C_{60}) combination with known chemical toxicant toluene on the activity of the first and second group enzymes of xenobiotics metabolism phase in rat's liver. Laboratory rats received intraperitoneal injections of fullerene suspension (60 mg/kg), toluene (0.5 ml/kg) or toluene with dissolved fullerenes. UDP-glucuronosyltransferase, ethoxyresorufin-*O*-deethylase (EROD), glutathione-S-transferase activity were identified in microsomes liver in as a time series starting in hour 3 of the experiment and up to hour 72. Maximum changes of all data in all research terms arerecordered in 4 animal group. Fullerens dissolved in toxicant toluene were injected to the 4 animal group. In this case EROD toxicant toluene and UDP-glucuronosyltransferase activity was increased accurately and glutathione-S-transferase activity was decreased accurately in comparison with the animals with only toluene injection. The conclusion is that carbon nanoparticles fullerene C_{60} are able to enforce the toxic influence of chemical toxicant toluene on the system of xenobiotics biotransformation.

Key words: fullerenes, toluene, enzymes of xenobiotics biotransformation.

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APPLICATION OF MATHEMATICAL APPROACHES IN MEDICINE ON THE EXAMPLE OF FOLLICULAR THYROCYTES SECRETORY ACTIVITY STUDY

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Application of the information technologies to the process of data analysis, obtained during medical research, helps find out and explain the activity patterns of certain organs or their systems, their interrelations and interaction, as well as study the main and transitional functioning stages of any biological subject. The very mathematical study itself, being the higher level of cognition, permits to clearly observe the dependency of certain phenomena on other ones, and this gives us the opportunity to formulate hypotheses concerning interdependence of various systems functioning in an integral living organism. The study results of the mathematical approaches application to the study of secretory function of the thyrocyte, the basic morphofunctional thyroid unit have been presented. Development and analysis of the profile correlation pictures concerning the follicular thyrocytes secretory potential and further data integration helped determine the patterns and the peculiarities of the thyrocyte secretory function in various states: normal, increased and decreased functional activity.

Key words: follicular thyrocyte, cytophysiologies, correlation analysis, correlation portrait, expert systems.

The paper is a fragment of the research project "Development of prognostic and diagnostic criteria, creation of experimental models, improvement of the metabolic processes disorders treatment at certain diseases of internal organs and skin", state registration number 01164004506.

The fundamental principles of the theory of information and cybernetics are being widely implemented into the theory and practice of many spheres, including medicine which is no longer the empirical science only. Usually, the tool for advanced research of biological objects is an expert system. The study results, obtained with its help, make possible the primary description and data classification; obtaining the comparable results; checking-up of the output concepts and functional dependencies between them; formation of certain medicine sphere patterns [9].

Any organism consists of a number of constituent elements, each of them having their own morphofunctional features [1]. It gives us the possibility to describe the properties of every element in a biological system (using certain parameters) and to determine whether there exist any dependencies between them [5]. Under the influence of various environmental factors, there are constant adequate and non-adequate changes in the biological system. During the living process all the physiological functions parameters are changing within a wide range: from normal, determining the state of dynamic balance of a given system to deep structural changes in organs, the latter being a symptom of a serious pathological process [1].

Normal and pathological processes have a number of interconnected qualitative and quantitative features that predetermine the most appropriate way of biological system functioning, taking into account its structure and potential capabilities. At the same time, most of qualitative biological phenomena are quantitative, too, therefore, they are eligible for quantification [2].

The problem of endocrine pathology, thyroid pathology in particular, is topical not only in Ukraine [4]. Since the thyroid gland participates in most of the living processes of our body, any violation of its activity leads to functional disorders and organic changes. The fact that in recent years there has been an increase in thyroid pathology prompts to search informative methods for studying changes in the thyroid gland under different conditions of the organism's existence [7, 8].

The purpose of the study was to apply the mathematical technologies to investigate the specificities of the thyrocyte status changes: the main thyroid morphofunctional cell under the conditions of its reduced and increased functional activity.

Materials and methods. The object of study was the secretory potential profile of the thyrocyte, with such constituent ultrastructres as: intra-follicular colloid, microvilli of the apical cytosolic membrane, lysosome bodies, and secretory granules (table 1) [10].

Table 1

The profile of follicular thyrocytes secretory potential

Ultrastructural element	The studied feature of the ultrastructural element	The quality of the studied ultrastructural element feature	Reference character of the studied ultrastructural element feature
Intra-follicular colloid	electron density	insignificant	**E_1**
		moderate	**E_2**
		significant	**E_3**
Microvilli of the apical cytosolic membrane	quantity	insignificant	**H_1**
		moderate	**H_2**
		significant	**H_3**
	density, length	insignificant	**H_4**
		moderate	**H_5**
		significant	**H_6**
Lysosome bodies	quantity	insignificant	**G_1**
		moderate	**G_2**
		significant	**G_3**
	size	small	**G_4**
		medium	**G_5**
		big	**G_6**
	electron density	insignificant	**G_7**
		moderate	**G_8**
		significant	**G_9**
Secretory granules	quantity	insignificant	**M_1**
		moderate	**M_2**
		significant	**M_3**
	electron density	insignificant	**M_4**
		moderate	**M_5**
		significant	**M_6**
	allocation	apical cellular pole	**M_7**
		along the whole cytosolic membrane	**M_8**
	topographic connection with lysosome bodies	present	**M_9**
		absent	**M_{10}**

The assessment of the profile ultrastructural elements status was performed in figures from 0 to 4 points. The feature absence was marked as 0 depending on the expression level, insignificant expression – 1 point, moderate – 2 points, significant – 3 points; the feature's normal expression was marked as 4 points. For the purposes of establishing the connections between the profile constituents, their strength and direction, the paired correlation quotients were applied which were calculated according to the well-known Pearson formula:

$$r_{xy} = \frac{\sum_{i=1}^{i=n} (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{i=n} (x_i - \bar{x})^2 \sum_{i=1}^{i=n} (y_i - \bar{y})^2}}$$

where: r_{xy} – paired correlation coefficient between *x* and *y* indicators,
x_i – meaning of the indicator *x* in *i* survey,
y_i – meaning of the indicator *y* in *i* survey,
n – number of surveys,
$\bar{x}$ – average value of indicator *x* for *n* of performed surveys,
$\bar{y}$ – average value of indicator *y* for *n* of performed surveys.

Subacute study was carried out on 40 non-linear white male rats, which formed 4 groups with 10 animals in each one. The rats of group 1 were kept on a complete, commonly-vivarium feed, the rats of group 2 – in model conditions of alimentary iodine deficiency, the rats of group 3 – in model conditions of hypothyroidism induced by taking the mercazolil (3 mg per kg body weight), the rats of group 4 – in model conditions of hyperthyroidism induced by taking the thyroidin (15 mg per 100 g body weight). Mercazolil (INN – Thiamazole) and thyroidin (generic name – Thyroid Tablets, USP) were consumed physiologically during feeding.

After the experiment, the rats were decapitated under ether anesthesia, their thyroid glands were thoroughly separated from the connective tissue, fixed in osmium tetroxide and dehydrated in ascending alcohols and acetone, followed by polymerization in epoxy resins. LKB 8800 (Sweden) ultramicrotome produced ultrathin glands sections with the thickness of 4-6 µm were further contrasted with the salts of uranyl acetate and lead citrate and studied under Selmi TEM-100-01 (Ukraine) electron microscope. At all stages of the study, international requirements to the humane treatment of vertebrate animals were observed in accordance with the "Guidelines for Accomodation and Care of Animals" (Strasbourg, 2006, Annex 4) and Helsinki Declaration on humane endpoints to experiment animals.

The research was carried out by methods for semi-quantitative analysis of electron diffraction patterns and determination of hormonopoietic cells special possibilities profiles [2]. The results were processed by means of the correlation analysis using the Microsoft Excel of Microsoft Office 2010 software.

The analysis of correlation connections was performed with consideration of their strength, number and connection sign. The positive paired correlation quotient meaning was a sign of the same direction as the studied indices change, while the negative meant that when one index is increased, another (connected to it) is decreased; the meaning $r_{xy} = 1.0$ pointed to the existence of direct proportional relation between the indices *x* and *y*, $r_{xy} = -1.0$ – inversely proportional. The structural organization of interrelations between the indicators considers strong and very strong connections (according to the Chaddock correlation scale, the ones within the following limits: $0.91 < r_{xy} < 1.0$ and $0.71 < r_{xy} < 0.9$) to be the most significant.

The notion of "intrasystemic correlation portrait" stands for the reflection of the structural organization of interrelations between all the elements of the studied profile on the basis of the calculated array of paired correlation meanings. The basis for development of the secretory potential profile correlation portraits was their "fundamental elements", i.e. those follicular thyrocyte ultrastructures which are the most significant for its secretory activity. Practical development of correlation portraits was carried out with "actual features" being taken into account, i.e. those profile ultrastructures between which significant connections can be established. A detailed analysis of correlation portraits was carried out on the basis of their "key points" – profile ultrastructure elements with the largest number of correlation connections. Interpretation of the established correlations was carried out based on the principles of cytophysiology, taking into account the functional significance of each ultrastructural cell element [1].

Results and their discussion. For the purpose of developing correlation portrait of the thyrocyte secretory potential profile, there have been selected a moderate number of microvilli on the thyrocyte cytosolic membrane (as "fundamental elements") (H_2), their moderate length and density (H_5), moderate quantity of lysosome bodies (G_2), moderate quantity of secretory granules (M_2), moderate level of electron density (M_5), the existence of topographic connection between lysosome bodies and secretory granules (M_{10}). To better understand the specificities of the correlation portraits structure in the studied profile, we have created a modelled version for intact animals (fig. 1). It was found out that the actual profile features were H_2, H_5, G_2, G_4, G_5, M_5, M_7, M_{10} and there were established the following correlation connections between them: very strong ($|r| \geq 0.9$) – 5 (1 of them being indirect); strong ($0.8 \leq |r| < 0.9$) – 2 (1 of them being indirect). The "key points" of the portrait were H_2, H_5, G_4, M_7, M_{10}.

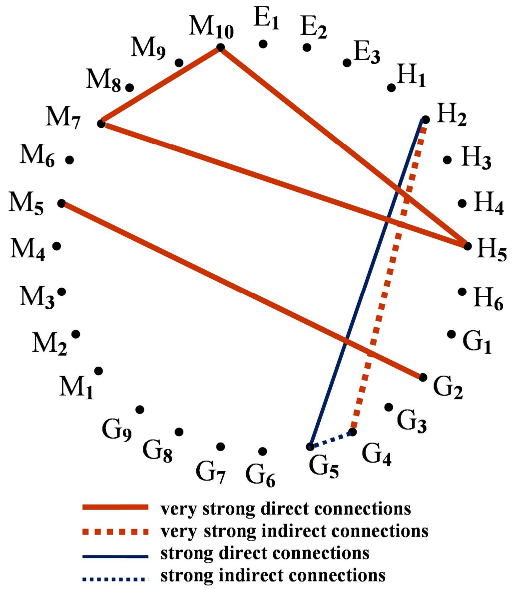

Fig. 1. Graphic representation of the correlation portrait structure of the follicular thyrocytes secretory potential profile in the intact white male rats (group 1).

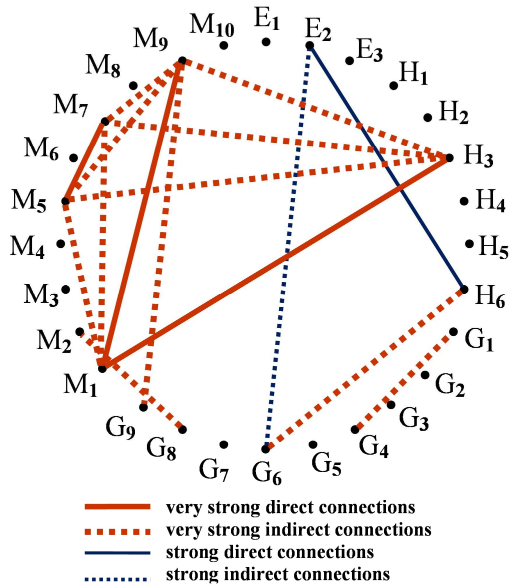

Fig. 2. Graphic representation of the correlation portrait structure of the follicular thyrocytes secretory potential profile in white male rats under the modelled conditions of alimentary iodine deficiency (group 2).

We determined that under the conditions of moderate density of microvilli on the apical cytosolic membrane (H_5) the secretory granules are being allocated on the thyrocyte apical pole (M_7), and between the secretory granules and lysosome bodies there is a topographic connection (M_{10}); $|r| \geq 0.9$. Such specificities of the correlation portrait point out to the optimal possibilities of the produced hormonal product secretion. It confirms the existence of a very strong indirect connection between the moderate number of microvilli on the apical cellular pole (H_2) and the small size of lysosome bodies (G_4), as well as a very strong connection between the moderate quantity of lysosome bodies (G_2) and the moderate electron density of secretory granules (M_5). Strong connections between the moderate number of microvilli on the apical cellular pole (H_2) and the middle size of lysosome bodies (G_5) testify to the well-balanced secretion process.

During the process of developing the correlation portrait of the studied profile under the modelled conditions of alimentary iodine deficiency (group 2) it was determined that "actual features" were E_2, H_2, H_3, H_5, H_6, G_1, G_2, G_4, G_6, G_8, M_1, M_2, M_5, M_7, M_9, M_{10} and there were established the following correlation connections between them: very strong ($|r| \geq 0.9$) – 14 (10 of them being indirect); strong ($0.8 \leq |r| < 0.9$) – 2 (1 of them being indirect). The "key points" of the portrait were H_3, M_1, M_5, M_7; the feature M_9 had the most numerous connections (fig. 2).

There has been established the existence of very strong connections between the increased quantity of microvilli on the apical cellular pole (H_3), insignificant number of secretory granules (M_1), their moderate electron density (M_5) and apical allocation (M_7). Such connections between the thyrocyte ultrastructural elements may serve as indicators of the moderate degree functional tension. The absence of topographic connection between secretory granules and lysosome bodies (M_9) is a sign of complicated secretion of the produced hormonal product. It can be confirmed by the close connection that has been established between M_9 and the significant electron density of lysosome bodies (G_9). Strong connections between moderate electron density of the intra-follicular colloid (E_2), and significant density, the length of microvilli on the apical cellular pole (H_6 – direct) and big size of lysosome bodies (G_6 – indirect) can also be a proof of a significant tension of the thyrocyte secretory activity.

The existence of a very strong indirect connection between insignificant number of lysosome bodies (G_1) and their small size (G_4) signifies about the disorder of lysosome functional activity. At the same time, strong indirect connection between moderate electron density of lysosome bodies (G_8) and moderate number of secretory granules (M_2) testifies to the level of thyrocyte secretory activity at which it is possible to maintain the secretion processes of thyroid hormones in the limits eligible for thyroid activity keeping. Therefore, all things considered, it has been established that under the studied experimental circumstances the leading role in the process of thyroid hormones secretion is played by lysosome bodies.

During the process of the correlation portrait development under the modelled conditions of drug-induced mercazolil hypothyroidism (group 3) it was established that its actual features were E_1, H_3, H_6, G_3, G_4, G_6, G_8, G_9, M_1, M_2, M_5, M_6, M_8, M_9 and the following correlation connections were established between them: very strong ($|r| \geq 0.9$) – 5 (2 of them being indirect); strong ($0.8 \leq |r| < 0.9$) – 14 (5 of them being indirect). The "key points" of the portrait were E_1, H_3, H_6, G_6, G_9, M_5, M_6 (fig. 3).

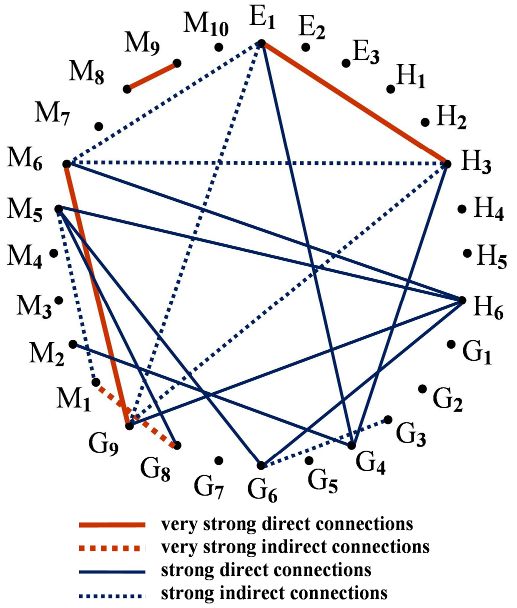

Fig. 3. Graphic representation of the correlation portrait structure of the secretory potential profile of follicular thyrocytes in white male rats under the modelled conditions of drug-induced mercazolil hypothyroidism (group 3).

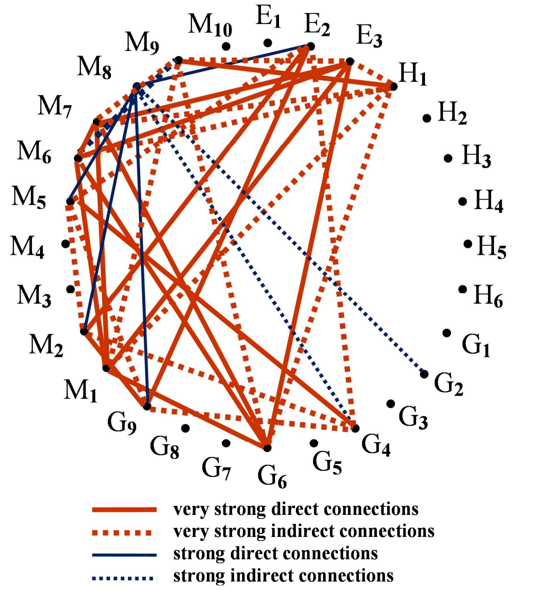

Fig. 4 Graphic representation of the correlation portrait structure of the secretory potential profile of follicular thyrocytes in white male rats in the modelled conditions of drug-induced thyroidin hyperthyroidism (group 4).

During the portrait analysis a very strong direct connection was noticed between the uniform allocation of secretory granules along the whole cytosolic membrane (M_8) and the existence of topographic connection between secretory granules and lysosome bodies (M_9), and this is the sign of substantial complexities with the realization of the thyrocyte secretory activity. Another thing proving it is the existence of a very strong indirect connection between the moderate electron density of lysosome bodies (G_8) and the insignificant number of secretory granules (M_1), and a strong connection between G_8 and the moderate electron density of secretory granules (M_5). The existence of strong connections between significant density of microvilli on the apical cytosolic membrane of the thyrocyte at their usual length (H_6), big size of lysosome bodies (G_6), their significant electron density (G_9), and moderate and significant electron density of secretory granules (M_5, and M_6) also indicates that under the conditions of functional thyroid insufficiency the thyrocyte secretory activity is substantially complicated.

A strong connection between the moderate number of secretory granules (M_2) and mostly small size of lysosome bodies (G_4) can be interpreted as the possibility of a normal course of thyroid hormones secretion. At the same time, the existence of a strong indirect connection between a significant number of lysosome bodies (G_3) and their big size (G_6) signifies that under the studied conditions, the process of thyroid hormones secretion is accompanied by the phenomena of functional tension.

Under the conditions of a moderate number of secretory granules (M_2) the lysosome bodies size (G_4) is rather small and it is proved by a strong connection between them. The established strong connections between the insignificant electron density of the intra-follicular colloid (E_1), the increased number of apical microvilli (H_3), small lysosome bodies size (G_4), their significant electron density (G_9) and the significant electron density of secretory granules (M_6) can be a sign of the secretion processes non-conformity. Generally, the most significant for secretory activity is the status of apical microvilli, secretory granules and lysosome bodies.

Under the modelled conditions of drug-induced thyroidin hyperthyroidism (group 4) the actual features of the studied profile correlation portrait were E_2, E_3, H_1, G_2, G_4, G_6, G_9, M_1, M_2, M_5, M_6, M_7, M_8, M_9 and the following correlation connections were established between them: very strong ($|r| \geq 0.9$) – 31 (16 of them being indirect); strong ($0.8 \leq |r| < 0.9$) – 6 (3 of them being indirect). The "key points" were E_2, E_3, H_1, G_4, G_6, G_9, M_1, M_5, M_6, M_7, M_8, M_9 (fig. 4).

During the portrait analysis very strong connections were noticed between the moderate intra-follicular colloid electron density (E_2), small size of lysosome bodies (G_4), their significant electron density (G_9), the moderate number of secretory granules (M_2), their moderate electron density (M_6), secretory granules allocation along the whole cytosolic membrane (M_8). We think that it indicates that there exists a significant dissociation between the thyroid hormones synthesis and their secretion.

We have discovered very strong connections between intra-follicular colloid electron density (E_3), decreased number of microvilli of the apical cytosolic membrane (H_1), big size of lysosome bodies (G_6), insignificant number of secretory granules (M_1), their significant electron density (M_5), apical allocation of secretory granules (M_7), and the absence of the topographic connection between secretory granules and lysosome bodies (M_9) which testify to serious disorders of the produced thyroid hormones secretion. It is also proved by the existence of indirect strong connection between the moderate number of lysosome bodies (G_2) and the uniform allocation of secretory granules along the whole cytosolic membrane (M_8). Generally such correlation portrait picture serves as a sign of substantial tension during the process of the produced hormonal product secretion. The leading ultrastructures of the thyrocyte under the studied model conditions were secretory granules and lysosome bodies.

Thus, detailed study and generalization of medical-biological data in scientific research are carried out using the possibilities of disponing contemporary mathematical technologies including the correlation analysis [11]. Our results are consistent with the data [4] to increase the informativeness of the results obtained in the study of various nosologies, as well as with the views [9] on significant expansion of the researchers' cognitive potential when implementing formalized results into the practice of biological objects studies. The above resonates with the opinions [3,6,8] regarding the expediency of using expert systems in biological studies, as well as [7], where information is provided on using the binary calculations in recognition techniques to establish the identity between sequences in order to thereby establish a connections between structures and functions.

Our suggested approach to analyzing the secretory function of follicular thyrocytes is considered a promising variant of a soft expert system that can use data obtained after quantitative transformation of qualitative and binary indicators in order to in-depth synthesis and interpretation of the study results [10]. Summing up the results obtained in the present work, we tend to believe that the analysis of the interrelationships between ultrastructures implementing the secretory direction of the follicular thyrocytes activity allows to receive a significant array of important information about a cell at its various functional states. Visualization of this information by correlation portraits, which is its graphic representation, helps to deepen the information both on the available morphological status and on the functional capacity of the cell under the study conditions. The very method of creating correlation portraits, we consider as a basis of correlation networks, which is an informative method of biological objects studies, as reported by [5].

Conclusions

1. Application of the correlation analysis for construction of intra-system correlation portraits of the follicular thyrocytes profile secretory function has permitted to determine that the most functionally responsible for the release of the produced hormonal product under the normal conditions are apical microvilli of moderate length and density of location, as well as secretory granules located at the cytosome apical poles, and lysosomal cells that are observed in moderate amounts.

2. Under the conditions of alimentary-induced hypothyroidism, the main load on elimination of the produced hormonal product falls on apical microvilli, the number of which is growing.

3. In the case of a potential hypothyroidism, secretion of the hormonal product is provided by an increased number of apical microvilli and lysosomal cells, the sizes and electron density of which are variable.

4. With hyperthyroidism, secretion is realized mainly due to variable-size lysosomal bodies and secretory granules; the number, localization and electron density of secretory granules vary widely enough.

We see prospects for further research in the adaptation of the suggested mathematical approaches to be applied in cytophysiology and cytomorphology.

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Реферати

ЗАСТОСУВАННЯ МАТЕМАТИЧНИХ ПІДХОДІВ У МЕДИЦИНІ НА ПРИКЛАДІ ВИВЧЕННЯ СЕКРЕТОРНОЇ ДІЯЛЬНОСТІ ФОЛІКУЛЯРНИХ ТИРОЦИТІВ

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Залучення інформаційних технологій до аналізу даних, отриманих під час медичних досліджень, дозволяє виявити та пояснити закономірності діяльності окремих органів або систем, їх взаємозв'язки та взаємодію, з'ясувати основні та проміжні етапи функціонування будь-якого біологічного об'єкта. Саме математичне дослідження, яке є якісно вищим етапом пізнання, дозволяє чітко простежити залежність одних явищ від інших, що в подальшому дає можливість формулювати гіпотези щодо взаємозумовленості функціонування різних систем цілісного живого організму. У роботі представлені результати використання математичних підходів до дослідження секреторної діяльності тироцита – основної морфофункціональної одиниці щитоподібної залози. Створення та аналіз кореляційних портретів профілю секреторних можливостей фолікулярних тироцитів дозволило, узагальнивши отримані дані, встановити закономірності й особливості секреторної діяльності тироцита в різних станах – норми, підвищеної та пониженої функціональної активності.

Ключові слова: фолікулярний тироцит, цитофізіологія, кореляційний аналіз, кореляційні портрети, експертні системи.

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ПРИМЕНЕНИЕ МАТЕМАТИЧЕСКИХ ПОДХОДОВ В МЕДИЦИНЕ НА ПРИМЕРЕ ИЗУЧЕНИЯ СЕКРЕТОРНОЙ ДЕЯТЕЛЬНОСТИ ФОЛЛИКУЛЯРНЫХ ТИРОЦИТОВ

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Привлечение информационных технологий к анализу данных, полученных во время медицинских исследований, позволяет выявить и объяснить закономерности деятельности отдельных органов или систем, их взаимосвязи и взаимодействие, выяснить основные и промежуточные этапы функционирования любого биологического объекта. Именно математическое исследование, которое является качественно высшим этапом познания, позволяет чётко проследить зависимость одних явлений от других, что в дальнейшем даёт возможность формулировать гипотезы относительно взаимообусловленности функционирования различных систем целостного живого организма. В работе представлены результаты использования математических подходов к исследованию секреторной деятельности тироцита – основной морфофункциональной единицы щитовидной железы. Создание и анализ корреляционных портретов профиля секреторных возможностей фолликулярных тироцитов позволили, обобщив полученные данные, установить закономерности и особенности секреторной деятельности тироцита в различных состояниях – нормы, повышенной и пониженной функциональной активности.

Ключевые слова: фолликулярный тироцит, цитофизиология, корреляционный анализ, корреляционные портреты, экспертные системы.

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PATHOGENETIC MECHANISMS OF EXPERIMENTAL GINGIVITIS PROGRESSION UNDER THE INFLUENCE OF LIPOPOLYSACCHARIDE

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The paper presents the results of patogenetic rationale for the use of gel with lipopolysaccharide for gingivitis modelling. It shows, that lipopolysaccharide applications lead to significant increase in activity of elastase by 26.8%, malonic dialdehyde by 32.8%, urease by 78.9%, degree of dysbiosis by 32.6%, decrease in activity of lysozyme by 57.6% and antioxidant-prooxidant index by 29.7%. Thus, lipopolysaccharide application leads to the progression of inflammation processes in gums of experimental animals, dysbiosis and oxidative stress, that is pathogenetic links of gingivitis progression in humans as well.

Key words: gingivitis, periodontal disease, experimental model, experimental animals, lipopolysaccharide

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Periodontal diseases continue to occupy a special place among all dental pathology. This is due to a number of reasons, among which the main are the diversity of nosological forms, etiological factors and pathogenetic mechanisms, the lack of highly effective means for their prevention and treatment. Those periodontal diseases that arise in the setting of the pathology of various organs and systems, particularly the digestive system, occupy a special place [4, 7, 9].

A significant role in the progression of dental pathology in general and periodontal diseases, in particular, belongs to the liver – a human internal organ, which functioning is associated with the performance of such vital functions as antitoxic, regulatory, metabolic [2, 10, 11].