INTRODUCTION
The paper has been written within the research carried out at the Department of Human Anatomy of the Higher State Educational Establishment of Ukraine “Ukrainian Medical Stomatological Academy”, entitled “Age-related aspects of the structural organization of the organs of the human immune system, glands of gastrointestinal and urogenital system in normal condition and pathology”; State registration number 0116U004192.

Comparison of organs' structure of the human and some animals in the relation to their functions contributes to understanding the adaptation of living organisms, as the integral systems, to the conditions of survival, as well as their origination and evolution. It is known that the digestive system (System digestorium) is a phylogenetically developed system of the organs that are diverse in structure and functions, the importance of which is in the perception, mechanical and chemical (enzymatic) digestion and absorption of nutrients needed to compensate the metabolic and material costs in the process of vital activity of the body. It is known, that the validity of the experimental simulation of the pathologic process in the laboratory environment is achieved by pre-establishing a sufficient homology degree between the corresponding functional systems of human and experimental animal. Consequently, the priority task is to choose the most appropriate laboratory animal species, and the key factor is the minimum costs of animals' keeping and conducted experimental studies [1, 2, 3].

THE AIM
The paper was aimed at the study of the general comparative anatomy of the digestive system of humans and white rats through the bibliographic analysis of the publications.

MATERIALS AND METHODS
Current scientific publications on the study of the human and the white rat gastrointestinal tract morphology were used as the material for the research by analyzing, synthesizing and generalizing the information obtained.

REVIEW AND DISCUSSION
Conditionally, in the digestive system two interrelated divisions, namely, the digestive tract and the complex of digestive glands associated with certain parts of the digestive tract is usually distinguished. The digestive tract of the rat, similar to the human one, starting from the mouth, involves the pharynx, esophagus, stomach, small intestine and large intestine. The digestive glands can appropriately be divided into the large and small ones. The large glands are located outside the digestive tract, being connected with it through the excretory ducts, some of which enter into the mouth cavity (large salivary glands), and the others enter into the duodenum (the pancreas and bile ducts). Both the human and rat have them in similar accordance [4, 5].
In this respect, the issue of small digestive glands, which are also known as intramural (intraparietal) glands due to their location in the thickness of the digestive tract membrane, is not an exception. They are usually classified according to the segment they belong to (with the exception of the mouth cavity, where they are called minor salivary glands). It should be noted that their physiological properties are directly related with the function of the corresponding segments of the digestive tract.

Apparently, the general anatomic organization of the digestive system of white rats is similar to human one. However, the dimensional characteristics are disproportionate, small size is a positive feature for the experimental studies in comparison to other bigger laboratory animals. But all this is not enough for complete validity of the experimental studies.

Among rodents, rats have a natural tendency to being omnivorous. Nevertheless, the solid cereal products predominate in their diet, requiring effective apparatus for their gnawing, grinding and chewing that in the course of evolution led to the formation of a special dentoalveolar system, which consists mainly of the combination of two teeth types with different structure and functional properties. The first type includes, so-called, short-crown or short (brachydontic) teeth, and the second type includes long-crown or high (hypselodontic) teeth. The first type is characterized by non-recoverable physiological attrition during the life, whereas for teeth of the second type, replenishment of hard tissues is inherent in proportion to their wear. Short-crown teeth are entirely inherent in predatory animals and humans, unlike herbivorous (ruminant) animals and rodents. The latter ones have species variations, which are expressed in two of their representatives - rabbits and white rats. While all rabbit teeth have no species differences, except for the dimensions [4, 11].

In all other aspects, the initial segments of the digestive systems of humans and rats (with the exception of dimensions and general configuration) are almost similar. In this way, in the oral cavity of both the human and rat two segments are distinctly indicated - the vestibule and the proper oral cavity, the ducts of the parotid glands enter in the first one, and the ducts of submandibular and sublingual ducts enter into the second one. The small salivary glands have the same differentiation in localization; the labial and buccal glands are in the mucous membrane of the vestibule, and the palatine and lingual glands are assigned into the proper oral cavity. Noteworthy, the salivary glands (especially the minor ones) are involved into the mechanism of the local immunity formation, due to the corporate interaction of their ducéal epithelium with the individual elements of the immune system, resulted in the synthesis of the Class A secretory immunoglobulins that is also specific to the epithelial associations of other digestive tract segments of both the human and rat one [1]. According to many authors the process of immunoglobulin transferring into the lumen of glandular ducts is closely connected with the migration through the epithelial wall of lymphocytes [9, 10]. The final formulation of immunoglobulin molecules occurs in the products of secretion of glands. Secretory immunoglobulin A, which has an increased resistance to the hydrolytic enzymes activity, provides reliable protection of the epithelial layer of the oral mucosa from the pathogenic microorganisms. In this regard, the widespread presence of the small cells in the wall of the salivary glands excretory ducts is notable, which are assigned to the interepithelial lymphocytes by the shape and location, which is also specific to the epithelium of other digestive tract segments of both humans and rats. In conclusion, it can be noted that the swallowed saliva, due to the contained secretory immunoglobulins, is able to increase the antimicrobial potential of the mucous membranes of the distal segments of the digestive tract.

The bolus, when swallowed, directs from the oral cavity into the esophagus passing through the pharynx which is an intermediate segment between them; the human pharynx is a funnel-shaped tube, tapered towards the bottom and flattened anteroposteriorly, in which three sections are distinguished in the terms of the level of openings: the choanae, the oropharynx and the aperture of larynx. In rats, it is much simpler because of the high location of the larynx, which is primitive in structure.

Formed in the oral cavity, the bolus passes to the stomach through the esophagus. The unipath of this process is normally provided by the wave-like contraction of the esophageal musculature (which has voluntary properties only at the beginning at swallowing) and the correlated change of the mucous membrane configuration. The publications report, that the esophagus of mammals has no species differences, except for the dimensions [4, 11].
The anatomy of other digestive tract segment, including the stomach, the small intestine and the colon is quite different, which in mammals have certain varieties, depending on the diet. It is mainly manifested by the form and structure of the stomach. For example, in humans the stomach is a unilocular formation consisting of the cardiac part (the point where the esophagus connects to the stomach) and the alternate pyloric part (the point where it connects to the duodenum). The rest interim part, which is the largest one, is the body and fundus (fornix of ventricle) of the stomach. Depending on its consistency, the food remains in the human stomach for fermentation processing from 20 minutes to 6 hours.

The publications report that the stomach of all rodents, unlike human one, has two cavities. In rats, regardless of the mixed diet, containing a large amount of cereals and solid food, such structure of the stomach is preserved. It consists of the esophagus, or forestomach, and the rest larger part, which is essentially comparable to the human stomach. These two parts are partially separated by a well-defined ridge. It is believed that the forestomach is used mainly for bacterial digestion while in the other part food fermentation occurs [4, 7, 11, 12]. It is quite obvious that the experimental studies, aimed at studying the morphofunctional disorders in the stomach with the possibility of extrapolating the results to humans, suggest that this feature of its structure in rats should be taken into account.

The next, the longest part of the digestive tract (small intestine) performs the main functions in the process of consuming nutrients, which are mainly the products of enzymatic hydrolysis of proteins, fats and polysaccharides. The final phase of this process is the absorption of these nutrients into the internal medium of the body. The conveyor nature of digestion in the small intestine is broadly expressed in its well-known anatomical segments as the duodenum, jejunum and ileum, with the lengths of approximately 30 cm, 2m and 3m, respectively, in humans. Apparently, the length of the small intestine in rats is certainly several times shorter than the length of the human one. However, the publication data should not always been considered as valid. It has been reported that the length of the rat duodenum is comparable to the human one, and the rest of its small intestine is approximately 1 meter long. Eventually, the whole small intestine of the rat is only 4-5 times shorter than the human one. Obviously, the digestive tube should be thin enough to fit the limited volume of rat’s abdominal cavity. Unfortunately no data on its thickness have been found in publications to date. It is known, that the transverse size of the human small intestine varies along its length in the range of 2 to 3 cm [4, 8].

According to the system analysis, the large intestine can be considered as the third part of the gastrointestinal tract, in which the process of concentrating the ballast substances contained in food and the formation of feces that temporarily accumulate in the ampular part of the rectum occur. In addition, this process is combined with bacterial digestion, which consists in the cellulose degradation in the process of vital activity of normal microflora. The main place where it occurs is the cecum, which is a shallow reservoir located below the confluence of the distal part of the ileum in the large intestine. This transition zone is notable for the presence of a one-way shutter called the ileocecal valve, which normally reliably prevents the content of the large intestine from getting back into the small one. Therefore, the cecum is quite reasonably considered as the initial section of the large intestine, the continuation of which is the longest section known as the large intestine, it emborders the loops of the small intestine in the form of a rim [13, 14, 15]. In humans, the colon is divided into four sections: ascending, transverse, descending and sigmoid, which converts into the rectum. According to the publications, in rats the difference is the absence of the sigmoid colon [8, 16]. But it is not the only difference between the large intestines of the rat and the human. The most noteworthy one is the initial section of the large intestine - the cecum, which in rats is not domed like a human one, but has an elongated funnel-shaped form with a large basal part (base of the cecum) and a pointed apex. Thus, in rats, the cecum, in proportion to the other parts of the gastrointestinal tract, is a more developed formation than in humans, which is apparently the result of the higher proportion of fiber-containing food in their diet. In addition, the rat cecum does not have a vermiform appendix, which in humans is an marked formation that varies according to its location, shape and size (its thickness is normally individually variable within the range of 0.5 to 0.8, and the length is from 7.0 to 10.0 cm). Its cavity is connected with the cavity of the cecum by means of the orifice [9, 17].

Despite the large differences in anatomical shape, the abovementioned sections (organs) of the digestive tract have a common universal principle of structure. Since these organs are cavitary (tubular), when speaking about their structure we mean the principle of their walls’ construction, which, from the esophagus to the rectum, consists of three coaxial membranes: the inner, middle and outer.

The outer layer of the digestive tract is heterogeneous in its origin, structure and function. In the esophagus it is represented by the loose fibrous connective tissue with a fat admixture and is called the adventitial (external) membrane. In the cavity of the abdomen, a similar membrane occurs in the organs located meso- and extraperitoneally according to the peritoneum. Commonly, the blood and lymph vessels, as well as the nerves, pass through these membranes. The outer membrane of other organs, located intraperitoneally, is a thin serous membrane.

The middle position in the wall of the digestive tract is occupied by the muscular coat, which, starting from the middle third of the esophagus, is represented by smooth (unstriated) muscular tissue, the bundles of which are arranged in one, two or three layers (depending on the digestive tract) longitudinally, circularly or diagonally. Due to their contractile activity various movements of the digestive tract are carried out. Importantly, that between the muscular and adjacent mucous coats there is a more or less apparent layer of loose fibrous connective tissue called...
the submucosal layer. It contributes to the mucosa sliding mobility and the ability to form various folds: longitudinal, transverse and twisted. In the places where the stomach converts into the duodenum and the ileum into the large intestine, they form a kind of one-way valves [9, 10].

CONCLUSIONS
In summary, taking into account the abovementioned features, it can be assumed that, generally, the anatomical organization of the digestive system of the white rat is similar to the human one. Though the dimensional characteristics are incomparable, small size is a positive feature for the experimental studies in comparison to other bigger laboratory animals.

Phylogenetically, the digestive systems of humans and rats are the homologous functional system that are much in common regarding the structure and functions of the organs, the significance of which is in the perception, mechanical and chemical (enzymatic) digestion and absorption of the nutrients into the body.

The presented data demonstrate similarities in comparative anatomical features of the structure of the digestive tract of a white rat and the human. The prospect for further research will encompass a more detailed comparative study of the histological structure of the digestive tract of the human and white rat through the bibliographic analysis.

REFERENCES

Authors’ contributions:
According to the order of the Authorship.

Conflict of interest:
The Authors declare no conflict of interest.

CORRESPONDING AUTHOR
Volodymyr Hryn
Department of Human Anatomy,
Ukrainian Medical Stomatological Academy
Shevchenko 23 str., 36011, Poltava, Ukraine
tel: +380(66)8126497
e-mail: vogrin034@gmail.com

Received: 03.08.2018
Accepted: 04.11.2018