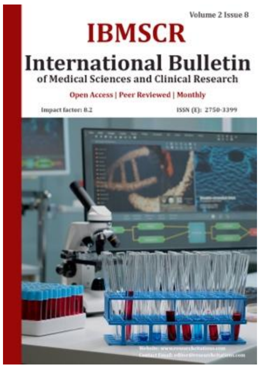

STRUCTURE, EMBRYONIC DEVELOPMENT AND FUNCTIONS OF THE STOMACH

B.B.Akbarova
okand University Andijon Branch
Lecturer of the Department of Histology, Cytology and Embryology
K.P.Inomjonova
Student of Kokand University Andijonv Branch
Email: inomjonovahabibam@gmail.com
tel: +998507170218
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Abstract: This article provides an in-depth analysis of the histological structure of the stomach, the differentiation of tissues during embryonic development, and the functional significance of the stomach wall. The stomach (ventriculus) represents the central organ of the digestive system, and its wall consists of four main layers: tunica mucosa, tunica submucosa, tunica muscularis, and tunica serosa. The article focuses particularly on the histological characteristics of the mucosal layer, the types of glands, and their cellular composition. The mucosal layer of the stomach is lined with a single-layered columnar epithelium, which contains numerous tubular glands composed of mucous cells, parietal (oxyntic) cells, chief (zymogenic) cells, and endocrine cells.

Keys words: Stomach, Embryonal, Endocrine, Stress, Mucous membrane, Gastritis, Epithelium, Specification.

Introduction. The stomach is an organ with an evolutionarily diverse structure that performs a number of important functions, including digestion, immune protection, and the hormonal regulation of metabolic balance. Vertebrate animals have adapted to various changes in the structure and histological organization of the stomach according to their specific nutritional needs and feeding habits. In humans, the gastric mucosa is completely glandular and consists of a single-layered columnar epithelium, and it is divided into two main parts. Each part contains specific cell types that function in a complementary manner. The fundic glands located in the proximal (upper) part of the stomach include acid-secreting parietal cells, enzyme-producing chief (principal) cells, as well as cells that produce protective mucus. The distal (lower) part of the stomach, namely the antral region, mainly consists of mucous cells and endocrine cells, among which are G cells that secrete the hormone gastrin. At the same time, for example in mice, the anterior part of the stomach contains a large "forestomach," which is lined with stratified squamous epithelium similar to that of the esophagus [1].

The **stomach** (Latin: *gaster*; Ancient Greek: γαστήρ) is an expanded part of the digestive system. In the stomach, food is stored, mechanically processed, and partially digested. As a specialized anterior part of the intestine, the stomach first appeared in some coelenterates, flatworms, and annelids. In vertebrates, the stomach is considered the anterior expanded portion of the intestine. In some fish, the stomach is not specialized, and in most fish it is not clearly separated from the esophagus and intestine. In amphibians and terrestrial animals, the stomach is clearly differentiated from other parts of the digestive system. The stomach of birds consists of separate glandular and muscular sections. The stomach of mammals has a complex structure and consists of an inlet and outlet region, as well as the fundus and body of the stomach. In most ruminant mammals, the stomach has four compartments: the rumen, reticulum, omasum, and abomasum. In some whales, the stomach is divided into five or six compartments.

According to the structure of the glandular layer, glandular or intestinal-type stomachs (humans, cats, dogs), esophageal type (echidna, platypus), and mixed, that is, esophageal–intestinal type stomachs (horses, pigs) are distinguished. In most mammals, the gastric glands are specialized.

In humans, the stomach is located in the abdominal cavity and resembles a bean in shape. Most of it lies in the left subcostal region, while a smaller part is located in the middle of the upper abdominal cavity. The upper part of the body of the stomach (fundus) is expanded and faces the diaphragm. The outlet of the stomach (pylorus) passes to the right behind the midline of the abdomen. The inlet of the stomach begins from the esophagus, and the outlet opens into the duodenum. When moderately filled with food, the stomach contacts the inferior surface of the liver and the diaphragm superiorly, and the transverse colon and its mesentery inferiorly. The concave border of the stomach (lesser curvature) is directed to the right and upward, while the convex border (greater curvature) is directed to the left and downward. To the left of the stomach is the spleen, and inferiorly and posteriorly is the pancreas. The stomach is surrounded on all sides by the peritoneum.

The capacity of the stomach varies among individuals: in a newborn it is 20–30 ml, while in middle-aged adults it is 1–3 liters; the stomach in men is larger than in women.

The wall of the stomach consists of the mucosal, submucosal, muscular, and serosal layers. Externally, the stomach is covered by a serous membrane. Beneath it, the muscular layer is composed of longitudinal (outer), circular, and obliquely oriented fibers. The submucosal layer connects the muscular layer of the stomach to the mucosa and is rich in blood vessels and nerves. The inner surface of the stomach is lined with a mucous membrane, beneath the folds of which numerous glands are located. Mucus is secreted by the glands of the cardiac region and the fundus, while enzymes are produced by the pyloric glands.

At the junction of the stomach and the duodenum, there is the pyloric sphincter, which is composed of several layers of circular muscle fibers and ensures the periodic emptying of the stomach. As a result of contractions of the smooth muscles of the stomach, tonic and peristaltic movements occur. Depending on the amount of food entering the stomach, tonic contraction may continue continuously for a long time. Peristaltic, wave-like movements proceed from the cardiac region toward the pyloric region; these movements mix the food and transport it into the intestine.

An empty stomach remains in a contracted state; water drunk on an empty stomach does not remain in the stomach but passes directly into the intestine. Food entering through the cardiac region expands the walls of the stomach and, due to peristalsis, is gradually moved downward. The stomach mixes food, prepares it for digestion, chemically modifies it, and transfers it into the intestine (evacuation). Under the influence of hydrochloric acid in the gastric juice, food swells and a favorable environment is created for the action of hydrolytic enzymes. The tubular glands located in the fundus and body of the stomach secrete hydrochloric acid, while other glands secrete pepsin and mucus; their secretion depends on the quality and quantity of food and is regulated by the nervous system and humoral factors.

In the first (conditioned reflex) phase, stimulation occurs as a result of seeing food, smelling it, eating, and the irritation of receptors in the mouth and pharynx. In the second

IBMSCR | Volume 6, Issue 01, January

(neurohumoral) phase, the direct effect of food on the gastric mucosa stimulates gastric juice secretion. In the third (intestinal) phase, reflex influences arising from stimulation of duodenal receptors and the effect of nutrients absorbed from the intestine into the blood lead to gastric juice secretion. Food may remain in the stomach from 3 hours to 8–10 hours. During this time, the food is thoroughly soaked with gastric juice and gradually passes in small portions into the duodenum. Gastric diseases include gastritis, peptic ulcer disease, and tumors [4].

FORMATION OF GASTRIC (STOMACH) TISSUES.

During embryogenesis, the stomach develops from the posterior foregut and forms among a number of adjacent tissues—the esophagus, intestine, liver, gallbladder, and pancreas. As in all endodermal organs, complex interactions between epithelial and mesenchymal tissues play an important role in stomach formation. Studies conducted in rodents (for example, mice) and chick embryos have shown that the mesoderm destined for the stomach (presumptive gastric mesoderm) determines stomach-specific characteristics in the adjacent endoderm (that is, it directs differentiation toward the gastric lineage) [3]. In addition, this mesoderm can reprogram endoderm taken from non-gastric intestinal regions toward a gastric fate [2]. However, the ability (competence) of the endoderm to respond to this signal is maintained only for a short period during early development. This indicates that the process of stomach formation is highly dynamic in both time and space (temporally and spatially). As a result of the work of several research groups, signaling pathways and transcription factor networks that control the early stages of stomach development have been identified. They act in a coordinated manner between epithelial and mesenchymal tissues and regulate gastric differentiation.

The early foregut epithelium consists of simple cuboidal cells and does not yet possess a complex structure. After the stages of stomach specification (i.e., acquisition of a stomach-specific developmental fate) and patterning, the epithelium transitions from a pseudostratified state to the tall columnar morphology characteristic of the adult organ. This process proceeds in a manner similar to the stages observed during intestinal development. Concurrent with these changes in cell shape, epithelial folding and the formation of glandular structures (glandular morphogenesis) occur. These processes continue during the postnatal period, ultimately resulting in the formation of a complex, highly organized gastric mucosa. The precise mechanisms coordinating these morphogenetic processes are not yet fully understood. However, several signaling molecules active during embryonic development (such as the WNT, FGF, BMP, and SHH pathways) have been identified as playing an important role in this process.

Gastric pathologies represent a set of morphofunctional changes arising from disturbances in the structure and function of the stomach wall. They are often accompanied by digestive disorders, pain syndromes, bleeding, or tumor processes. The etiology of gastric pathologies is multifactorial, with infectious, autoimmune, genetic, toxic, and stress-related factors being the main causes.

Gastritis. This is the most common pathology characterized by inflammation of the gastric mucosa. Types: Acute gastritis – develops due to chemical substances, alcohol, drugs (NSAIDs), or bacterial toxins. Chronic gastritis – a long-lasting inflammatory process that occurs due to *Helicobacter pylori* infection or autoimmune processes. Histological features: Infiltration of lymphocytes and plasma cells in the mucosa. Degenerative changes in glandular epithelium. In some cases, atrophy of glands (atrophic gastritis). Complications: Development of metaplasia and dysplasia – these conditions can lead to gastric cancer.

Gastric ulcer (Ulcus ventriculi). This is characterized by a necrotic defect extending into the mucosa and submucosa of the stomach wall. Pathogenesis: Excessive production of gastric acid. *Helicobacter pylori* infection. Influence of stress, NSAIDs, or corticosteroids. Histological structure: Fibronecrotic layer in the center of the ulcer. Surrounding granulation tissue and inflammatory infiltrate. Changes in blood vessels (microcirculatory disorders). Complications: Bleeding, perforation, sclerosis, and malignant transformation (cancer).

Polyps and hyperplastic changes. Hyperplastic polyps – formed due to the growth of mucosal glands. They are usually benign, but in some cases dysplasia develops, increasing the risk of malignancy.

Autoimmune gastritis. Develops as a result of antibodies against parietal cells. Consequently, intrinsic factor deficiency occurs, leading to B12 hypovitaminosis and pernicious anemia. Histological features: Loss of parietal cells (atrophy). Lymphocytic infiltration. Replacement of glands with fibrous tissue.

In recent years, it has been discovered that somatic stem cells are present in the gastric mucosa, and they continuously ensure epithelial renewal. This discovery has significant importance for understanding the regenerative potential of the stomach and the role of stem cells in cancer development.

Conclusion.

The stomach is a complex organ that plays a vital role in digestion, protection, and hormonal regulation in the body. Its development begins during the embryonic period and is regulated by the interaction between the epithelium and mesenchyme, as well as by signals such as WNT, BMP, and FGF. In gastric epithelial morphogenesis, cell growth, differentiation, and the formation of glandular structures occur in a coordinated manner. As a result, specialized structures such as parietal, chief, and endocrine cells are formed.

Modern scientific research allows for a deeper study of the molecular mechanisms involved in stomach development, providing insights into the causes of gastric diseases, enabling their early detection, and facilitating the development of effective treatment methods. This lays the foundation for future advancements in gastroenterology and regenerative medicine.

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IBMSCR | Volume 6, Issue 01, January