

Histological investigation of the cells in colon one humped camel (*Camelus dromedarius*)

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Summary

The aim of this investigation is to determine the most of the cells in colon, and the main salient differences of the layers and a tunic which was addressed here not all. The colon was characterized by a delicate lining that is moisturized by mucus and also by a gel that is a byproduct of bacterial fermentation. This study was performed in three health camels which contain a different segments of the colon (proximal anza, centripetal, centrifugal, and distal anza), rectum and anus were histologically examined. The epithelium facing the lumen of the colon is covered with openings of tubular intestinal glands that penetrate deep into the thick mucosa. The glands consist of absorptive cells that absorb water and goblet cells that secrete mucus. In addition, the scattered Paneth cells were observed which given a role in regulation of normal bacterial flora of the small intestine.

Introduction

The primitive gut (colon embryology) is divided into foregut, midgut and hindgut. Midgut gives rise to the cecum, ascending colon and right 75% of transverse colon (also in addition to the distal duodenum to ileum). Hindgut develops into remainder of transverse colon to ano-rectal line. Thus, the colon begins where the small intestine ends and extends down to the anus. The colon is actually may be considered as the main component of the large intestine. The shorter of the two intestinal groups, the large intestine, consists of different parts (segments) with various functions. The segments of these parts are: the transverse colon, ascending colon, appendix (when present), descending colon, rectum and anus (3).

One of the function of the colon is to absorption of vitamins B and K, some electrolytes (Na^+ and Cl^-), and most of the remaining water, to form stools, and to eliminate it (5). The colon is structured as one long continuous hollow tube, and it is a muscular tube composed of lymphatic tissue, blood vessels, connective tissue, and specialized muscles for carrying out the tasks of

water absorption and waste removal (7). The lumen (interior) of the colon has a delicate lining epithelium. The colon epithelium has large number of goblet cells which secrete mucus thus aid in lubricating the passage of waste through the entire length of the colon. This moist lining also protects underlying tissues and the nerve endings that extend down into the colon wall (2). The GALT (gut associated lymphatic tissue), comprising Peyer's patches, lamina propria lymphocytes and intra-epithelial lymphocytes of the intestine, is populated by lymphocytes that migrate there from the vasculature (9).

Due to the scarcity of information on the one humped camel, this study was undertaken to describe the histology of the colon and try to relate the findings to the organ function whenever possible.

Materials and methods

Specimens were collected from three one humped camel (*Camelus dromedarius*). One centimeter of different segments of the colon (proximal anza, centripetal, centrifugal, and distal anza), rectum and anus were fixed in 10% formaldehyde in phosphate-buffered saline (PBS) at pH 7.4 for 48 hours at room temperature. After fixation for 48 hours, the tissues were processed following standard histological procedure [dehydration with an ascending grade of alcohol, clearing in xylene and impregnation (embedding) in liquid paraffin wax] was performed. Immediately after embedding, the specimens were processed for histology using standard histological techniques (10). The tissues were sectioned at 5 μ m thick and collected on glass slides. The samples were stained with hematoxylin and eosin (H&E) for routine histological procedure, as well as for demonstration of the glandular tissue. The slides were then dipped in xylene and mounted with cover slip using DPX mounting medium. The slides were examined under light microscope to study the general morphology and histology of colon.

Results

Anatomically different segments of the camel colon are unique in their convolutions (anza) and to a certain degree similar to the colon of the porcine (3, 4, 6). The lining epithelium of the entire colon is simple columnar with large number of goblet cells (Fig. 1). The glands are simple straight tubular with large number of goblet cells scattered mainly in the upper portion of the glands (Fig. 2). Blood capillaries and few arterioles extend close to the surface epithelium in the

lamina propria of loose connective tissue (Fig. 3). Lymphocytes and plasma cells are predominant cell types within the lamina propria of the colon.

At the base of the colon glands the goblet cells decreased in number. Nuclei of these glands are located at the base of the secretory tubules due to the large amount of mucus within the cells. Scattered Paneth cells were observed in relatively large number (Fig. 4). These cells contain eosinophilic granules which secrete antibacterial lysozymes stored within a small vesicle and have basophilic basal cytoplasm.

Relatively thin muscularis mucosa is always present below the glands separating the lamina propria from the tunica submucosa (Fig. 5). In few regions of the tunica submucosa, a small aggregation of lymphoid tissues (Gut Associated Lymphoid Tissue-GALT) was observed. However, lymphocytes of different sizes as well as plasma cells were always present within the lamina propria and within the GALT are detected (Fig. 6).

The tunica submucosa is regular connective tissue with blood vessels, and lymphatics scattered within it. Submucosal nerve plexus and ganglia were present inside the tunica submucosa (Fig. 7). The tunica muscularis appeared to consist of relatively thick inner circular layer and much smaller outer longitudinal cell layers (Fig. 5). Inner circular layer appeared to be consisted of two layers of almost equal sizes separated by thin intermuscular connective tissue. Myenteric nerve plexus and ganglia were always present between the outer and the inner muscular layers. Blood vessels, lymphatics and nerve fibers are predominant tissue within the relatively thin tunica serosa. Simple squamous epithelium (mesothelial) cells cover the outer surface of the tunica serosa.

The terminal portion of the colon is connected to the rectum which is histologically similar to the colon with the exception of the presence of large amount of GALT and sometimes diffuse lymphatic tissue within the tunica propria submucosa.

The last segment at the rectum anus junction showed an abrupt change from simple columnar to keratinized stratified squamous epithelium (Fig. 8).

GALT/ lymphoid follicle are present close to the external opening (Fig. 8). The basal layer of the epithelium appeared to have large number of melanin granules which indicate the presence of melanocytes in this region (Fig. 9). At the external surface of the anal region, hair follicle and arteriovenous anastomosis were scattered below the surface epithelium (Fig. 10).

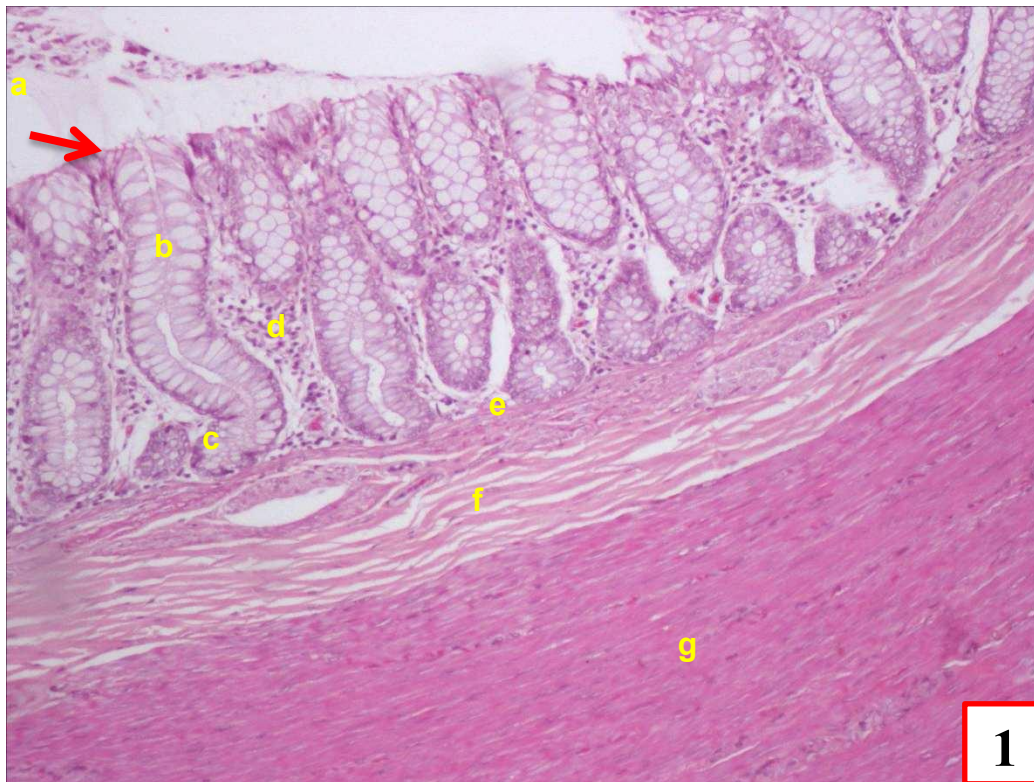


Figure 1. One humped camel colon stained with H & E stain. Mag. x150.
a. Surface epithelium, b. Simple straight tubular gland, c. Base of the gland, d. Lamina propria, e. Lamina muscularis mucosa, f. Tunica submucosa, g. Tunica muscularis

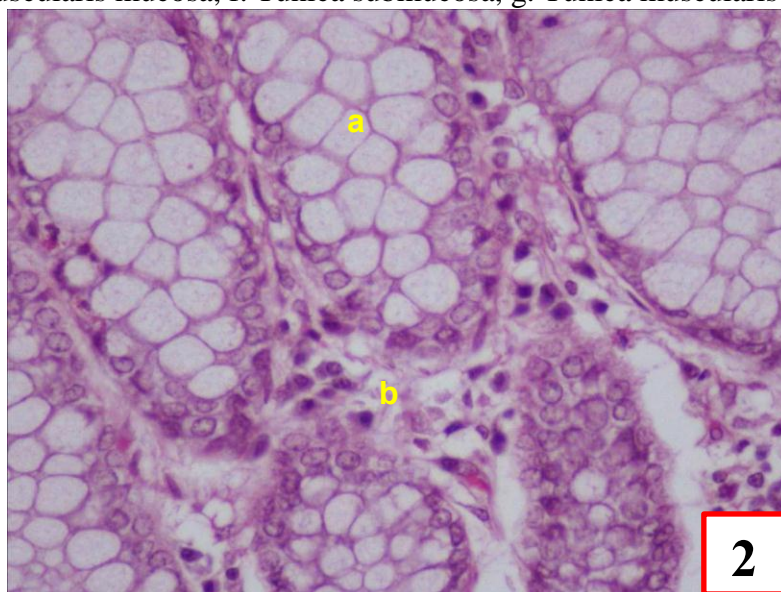


Figure 2. Colonic gland with large number of goblet cells (a) and loose connective tissue between the glands, lamina propria (b) stained with H & E stain, Mag. x 250.

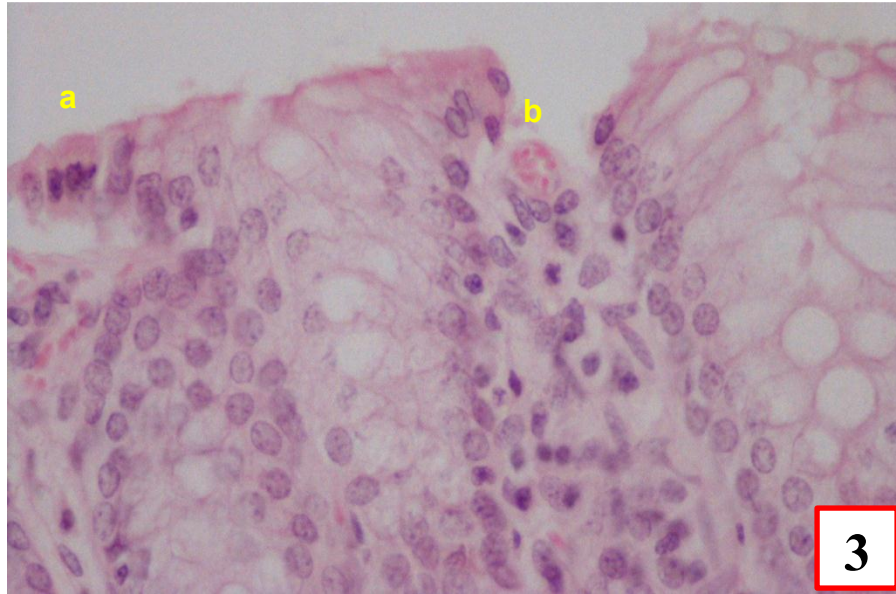


Figure 3. Simple columnar epithelium at the surface of the colon one humped camel (a) and small blood capillary reaching close to the surface epithelium (b) stained with H & E stain, Mag. x 250.

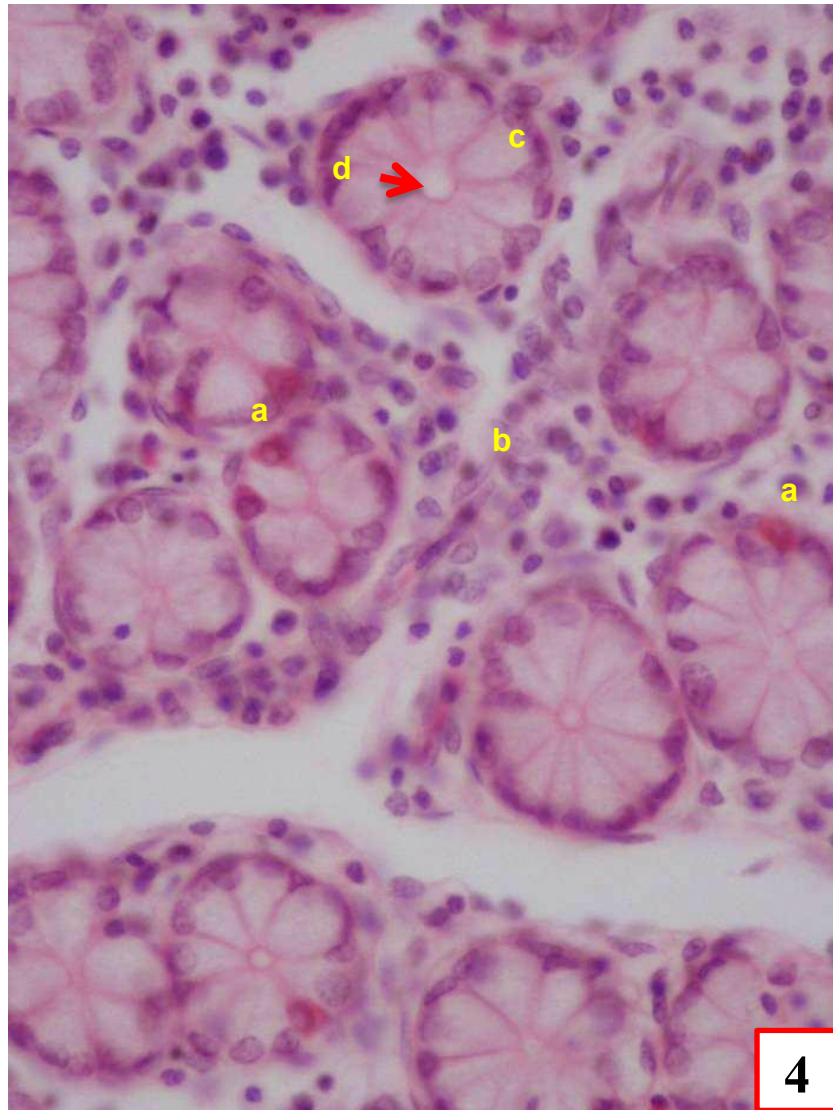


Figure 4. Cross section at the base of the colonic glands stained with H & E stain. Mag. x 200. a. Paneth cells, b. Lamina propria, c. Basal nuclei of the colonic gland, d. Lumen of the gland

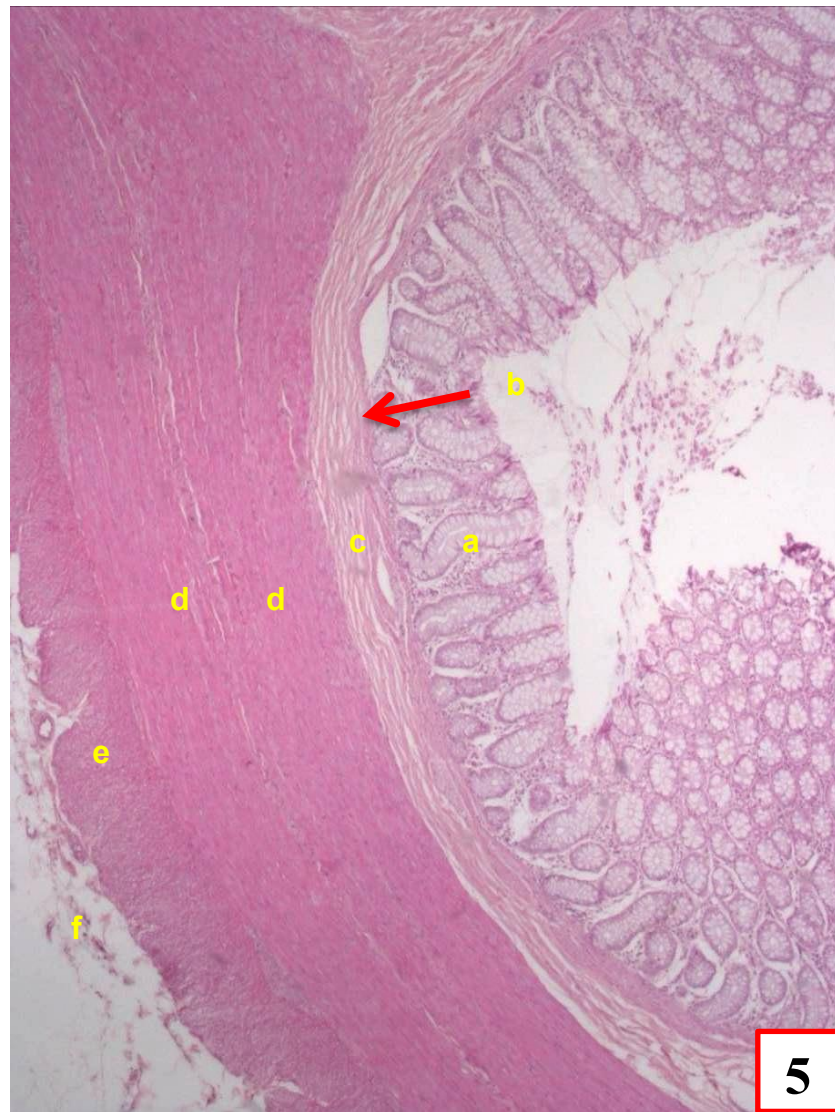


Figure 5. Cross section of the entire wall of the colon showing all tunics, stained with H & E stain, Mag. x 140, a. Tunica mucosa filled with glands, b. muscularis mucosa, c. Tunica submucosa, d. Inner layer of the tunica muscularis, e. Outer layer of the tunica muscularis, f. Tunica serosa

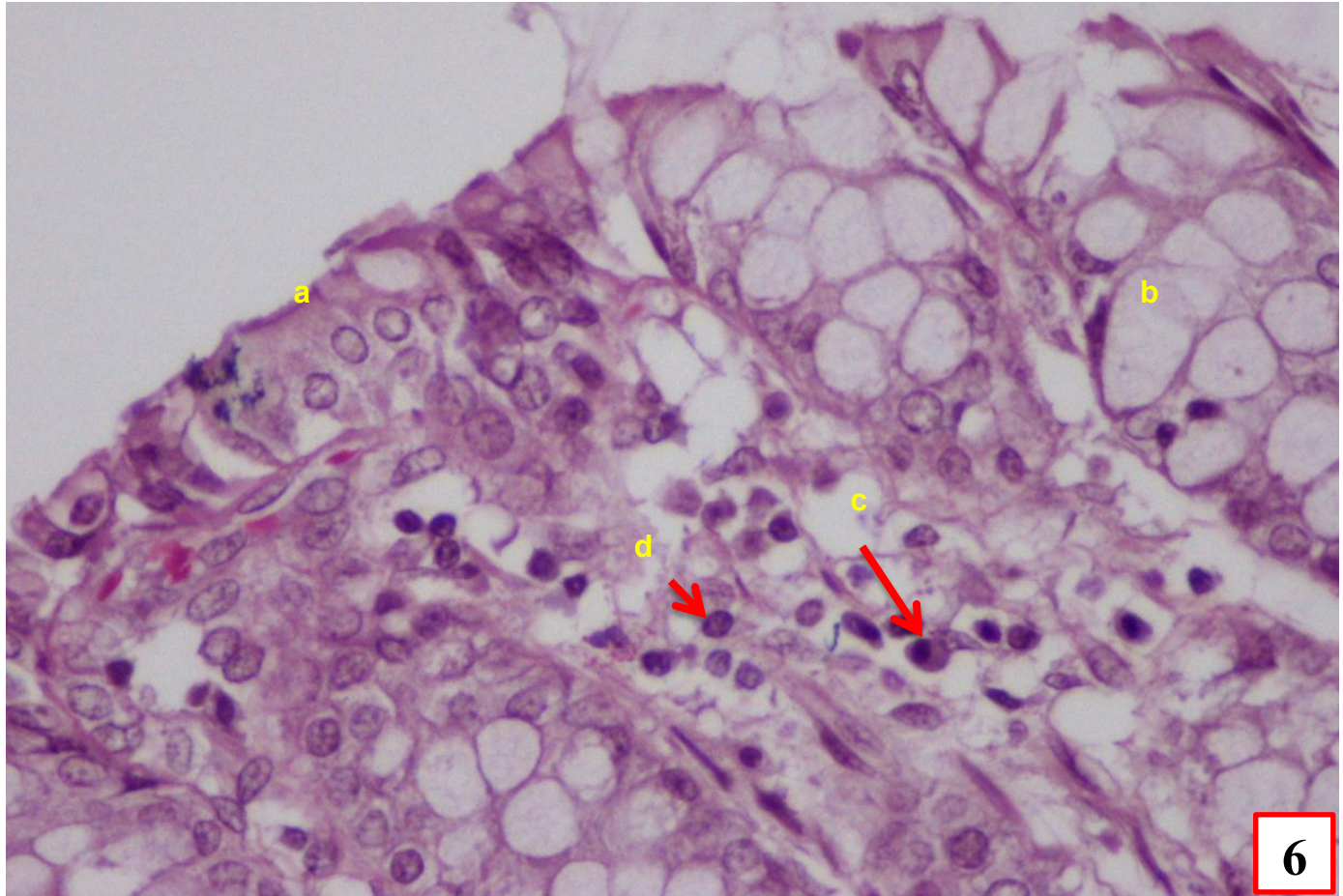


Figure 6. Surface region of the camel colon. Stained with H & E stain, Mag. x 280.
a. Simple columnar epithelium, b. Goblet cell, c. Plasma cell, d. Lymphocyte

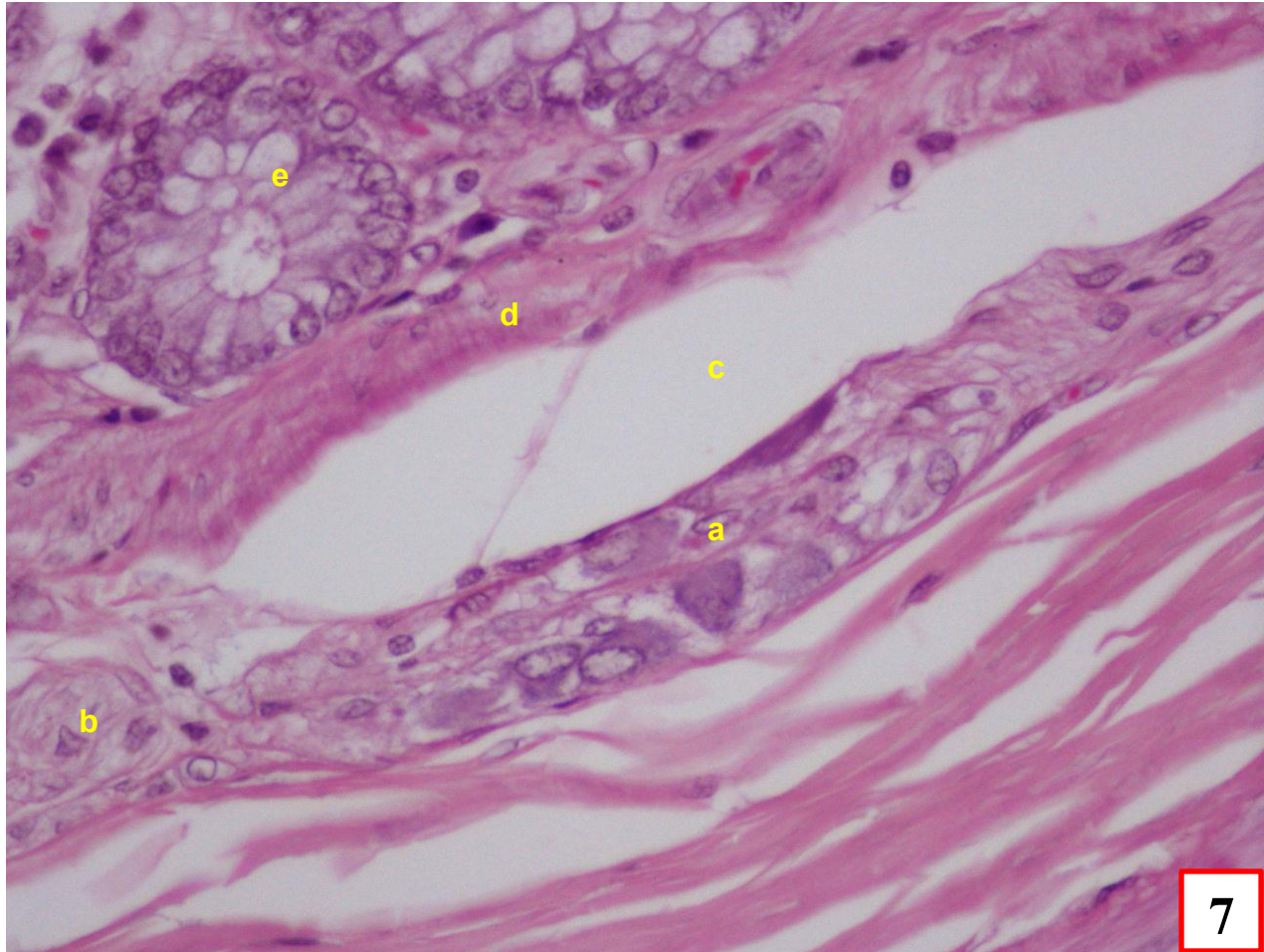


Figure 7. Histological section at the tunica mucosa/submucosa junction showing submucosal ganglia (a), submucosal nerve plexus (b), blood vessel (c), muscularis mucosa (d) and base of a gland in the tunica mucosa (e). H & E Stain, Mag. x 200.

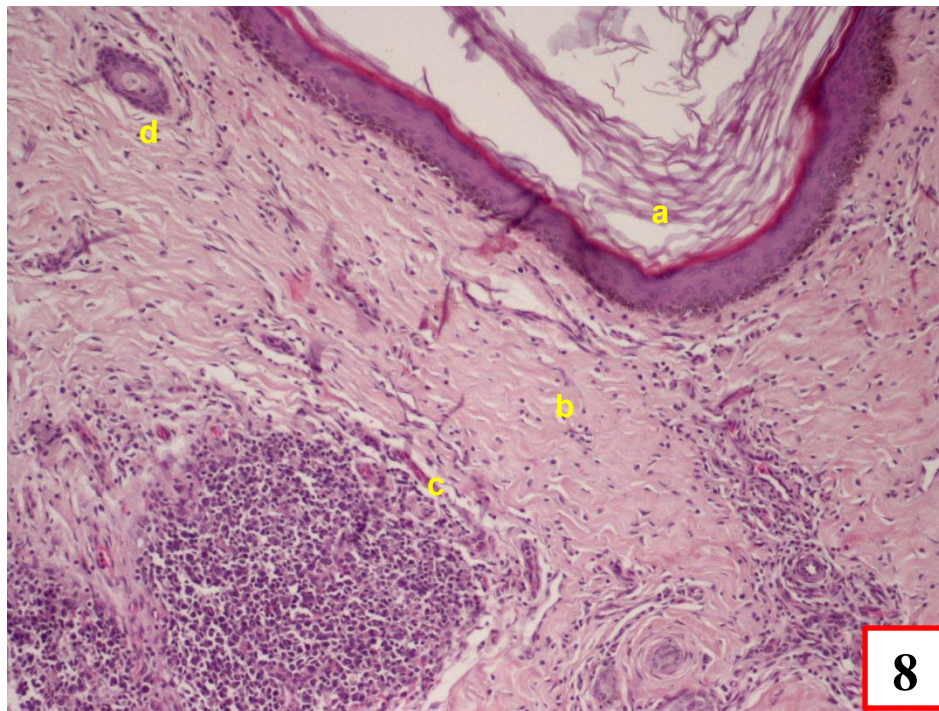


Figure 8. Histological section at the anal region showing keratinized stratified squamous epithelium (a), connective tissue (b), lymphoid follicle (c), and hair follicle (d). H & E Stain, Mag. x 150.

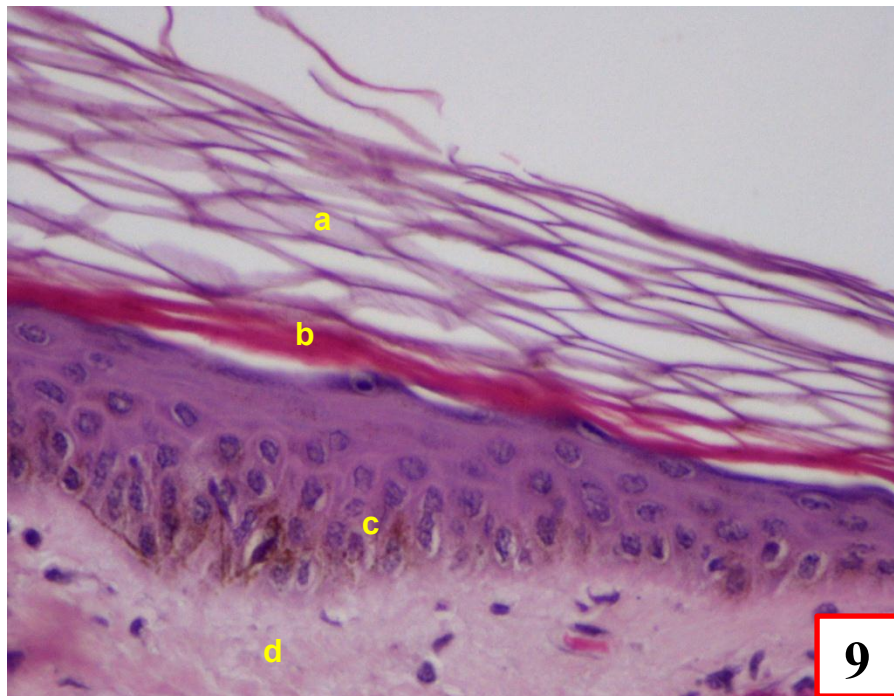


Figure 9. Higher magnification of outer surface of the anal region of one humped camel showing keratinized stratified squamous epithelium (a), artifact due to sectioning (b), melanin pigment at

the basal cell layer of the epidermis (c), and connective tissue in the dermis (d). H & E Stain, Mag. x 200.

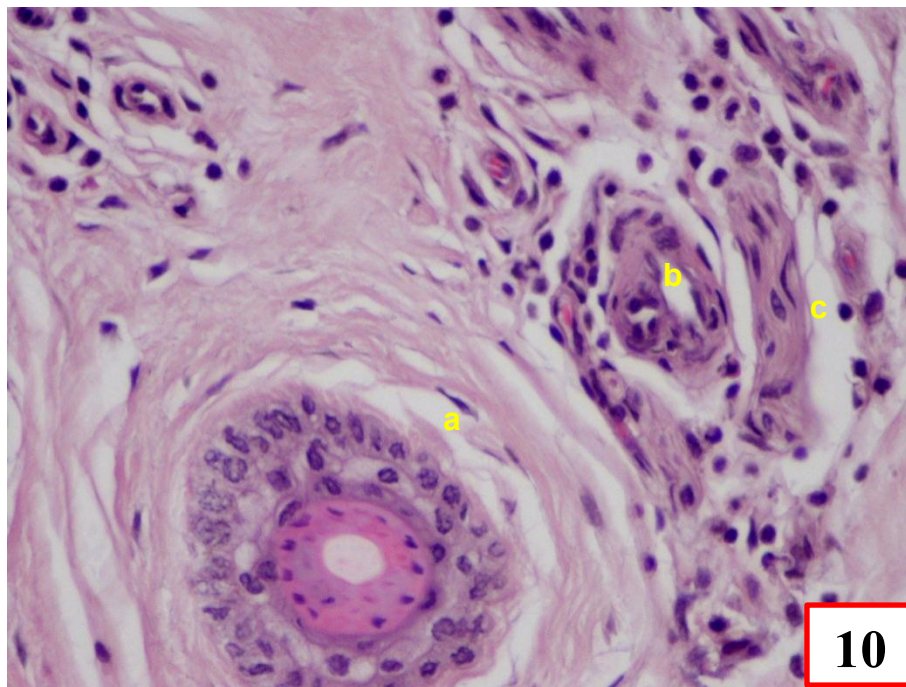


Figure 10. Higher magnification showing hair follicle (a), Arteriovenous anastomosis (b) and nerve fiber (c) at the skin region of the anal area of one humped camel. H & E stains, Mag. x 250.

Discussion

Histologically, the overall structure of colon in one humped camel is similar to other mammalian species especially to the colon of the porcine, although few variations are distinguishable. Only the main salient differences was addressed here and not all layers and tunics. The paneth cells are reported to be scattered in the small intestine and in much smaller numbers within the large intestine in human being and only occasionally in the colon (7). These cells are found to be in large number in the colon of the one humped camel under normal physiologic condition. They are present at the base of the colonic glands. Paneth cells have given a role in regulation of normal bacterial flora of the small intestine (7). They are occasionally present in the colon; however, in this study they are present in large number in the base of the colonic glands. This indicates the need for the paneth cells and their secretory vesicles to control (decrease) the number of the microflora inside the colon. However, paneth cells, one of four major epithelial cell lineages in the small intestine, reside at the base of the crypts and have apically oriented secretory granules. These granules contain lysozyme which has the ability to digest the cell walls

of certain groups of bacteria. Paneth cells are also reported to have phagocytic ability. In addition, these granules contain high levels of antimicrobial peptides that belong to the alpha-defensin family. Paneth cells secrete these microbicidal granules that contain alpha-defensins when exposed ex vivo to bacteria or their antigens, and recent evidence reveals that antimicrobial peptides, particularly alpha-defensins, which are present in paneth cells, contribute to intestinal innate host defense (1). Therefore, one could easily state that these paneth cells in one humped camel could easily protect the animal from gastrointestinal infection or make it less vulnerable due to their large number in the colon of this animal species.

In addition, the collagen layer in the sub mucosa was observed which assists the absorbed water to enter capillaries via passive diffusion. While, there is no lymph vessels in this part of human the intestine which was considered as an indicator of the slow rate of metastasis in colon cancer (8). These lymphatic vessels were not studied in this research. Further study is very much needed to elucidate this issue in one humped camel.

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