The Comparison of the Histology and Ultrastructure Between Healthy and Abnormal Tissues

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The Comparison Of The Histology And Ultrastructure Between Healthy And Abnormal Tissues

Ashley Secunda

Senior Honors Thesis

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INTRODUCTION

During my spring 2008 semester, I took Biology 496, Scientific Imaging. In this course, the students were exposed to the proper use of a camera, developing photos, fixing tissues for microscopy, increasing our skills in scanning and transmission electron microscopy (SEM and TEM), and learning about histology. Because I learned a great deal during my class, I became interested in learning more about the process of fixing tissues and the usage of the microscopes. I decided to do a Senior Honors Thesis, to gain more knowledge about the histology and ultrastructure of various tissues and organ systems in an organism.

My goals for this project were to thoroughly research various tissue systems such as the ovaries, the uterus, the skin, the stomach, and the small and large intestines, and compare structure and function of healthy and diseased tissues. I also wished to increase my proficiency in fixing tissues, as well as being able to use the scanning electron microscope, and the transmission electron microscope. After studying and observing different tissues samples, my thesis become fixed on how structure affects function, and how the function of an organ system will fail if the microstructure fails. Although I collected many healthy tissue samples, I was not able to acquire diseased tissue specimens. Thus, it was decided that I would compare my healthy tissue samples to unhealthy tissue found in the various literature.

To test my thesis, I fixed tissue specimens, which I then studied under scanning and transmission electron microscopy. I gathered the tissues from a veterinary clinic once they had been removed from an animal. I finally compared my prepared tissues to my research of healthy and diseased tissues, and found the similarities and differences of the structures.

Fixation/Preparation Process

At first the fixation process for the scanning electron microscope (SEM) and the transmission electron microscope (TEM) were the same. The process begins with collecting a fresh sample from whichever organ system that was chosen and have it placed in fixative. The specimens were fixed in Karnovesky's Fixative for one to two hours in the refrigerator. Then, two razor blades were used to cut the tissue into the appropriate sized pieces and in proper orientation. The SEM tissue was cut into pieces that had no penetration distance greater than a 1mm square. The TEM tissues were cut to be no longer than 1mm in length and width. The cut samples were then rinsed in buffer solution and transferred to fresh buffer. The samples for SEM and TEM were then stored in the refrigerator over night.

The next day the tissue samples were fixed in osmium tetroxide for about two to four hours under the venting hood. Then, by an increasing sequence, the specimens were dehydrated using 50%, then 70%, then 95%, and then 100% ethanol. Each step in the sequence was dried for about ten minutes. At this point, the tissue samples for SEM and TEM were then separated into fresh tubes of 100% ethanol. Changes of both types of samples (SEM and TEM) in 100% ethanol continued for the next two days. After the changes of ethanol, the SEM samples were stored in 100% ethanol until the next step of critical point drying.

The fixation process for TEM continued on with additional steps as compared to SEM. On day four, the TEM tissue samples were changed from the 100% ethanol to a mixture (1:1) of LR White and 100% ethanol for about two hours. For those two hours, they were placed on the shaker table in the refrigerator. After the two hours, the sample was changed to undiluted LR White and left on the shaker table in the refrigerator for two to four more hours. Once the time ended, the samples were changed to undiluted LR White and left on the shaker table over night

in the refrigerator. On the fifth day, the TEM samples were changed to undiluted LR White and placed in TEM embedding capsules and put in the oven for twenty-four hours. On the last day, the TEM tissues were removed from the oven and saved for sectioning.

For SEM, after dehydration, the samples were then critical point dried, gold plated and observed under the scanning electron microscope. For TEM, after the capsules were taken from the oven, they were allowed to cool, and then the specimens taken out of the capsules. A trapezoid was cut into the dried capsule by using glass knives and the microtome. Once the sample was prepared and cut, the specimen was then ready for the ultramicrotome where really thin slices were taken of the sample. Those thin trapezoid shaped pieces were then collected on copper disks and air dried. Once dried, the samples were ready to be viewed under the transmission electron microscope.

Scanning Electron Microscopy

The scanning electron microscope (SEM) is a useful tool in the studying of tissues. As the name suggests, the SEM is an electron microscope. It uses high-energy electron beams to scan the tissue sample in a raster pattern (a parallel scanning pattern) in order to attain a topography picture of the sample. The SEM is greatly used because the experimental sample has a large depth of field, and the sample can be viewed by high magnifications.

Transmission Electron Microscopy

Transmission electron microscopy (TEM) is also a technique that utilizes electron beams to study tissue samples. With this method, however, samples must be cut ultra thin so that the electrons can interact with the sample to produce a picture. Electromagnetic lenses focus the electrons into a precise, thin beam that can pass through the specimen.

THE OVARIES

The ovaries are paired organs located within the pelvis and are connected to the body by a broad ligament. The job of the ovaries is to provide a means of female reproduction by making ova. Attached to the broad ligament is the mesovarium (connective tissue), which supplies the ovary with blood. They consist of different layers beginning with the germinal epithelium. This layer is surface epithelium covering the ovaries and consists of a modified peritoneum. The tunica albuginea is the layer underneath the germinal epithelium. This layer is described as being dense and poorly vascularized connective tissue.

The ovary is then divided into two different sections; the cortex and the medulla. The cortex is composed mainly of a connective tissue framework called the stroma, which is an extension of the broad connecting ligament and mesovarium. Very few elastic fibers and smooth muscle are found within the cortex, unlike within the central medulla. This framework structure supports ovarian follicles during their development as well as stromal cells. Many ova at different stages of development can thus be found in the cortex.

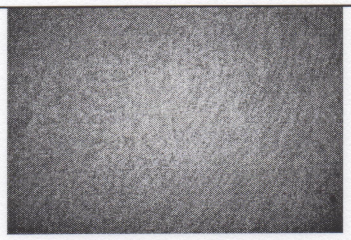
The central region of the ovary, the medulla, is a separate portion from the cortex. It is comprised of a collagen framework and is highly vascularized. Within this network are fibroblasts, elastic fibers, and smooth muscle cells. Large blood vessels, lymph vessels, and nerve fibers are also found within the medulla. Arteries have an especially tortuous course with thick muscular walls within the medulla. Different types of epithelioid cells can be found within the medulla. The first type is called the interstitial cells. Depending on the species and how many offspring are birthed at one time, depends on how many interstitial cells there are. Within premenstrual female humans, there are few interstitial cells found within the ovary that secrete estrogen. Species that produce large litters have many groupings of interstitial cells. Another

type of epithelioid cell is called the hilus cell. These cells secrete androgens. The medulla is indistinguishable from the cortex under histological techniques.

THE UTERUS

Located within the midline of the pelvis is the uterus; another portion of the female reproductive system. It is here that offspring of a female grow and develop. This organ, like the ovary, consists of different areas. The areas of the uterus are the fundus, the body, and the cervix. The fundus is the portion above the body of the uterus, whereas the body is described as the broad portion of the uterus where the oviducts connect. The cervix is the lower portion of the uterus. It is narrow, circular, and opens into the vagina. It consists mostly of collagenous connective tissue, and some elastic fibers and smooth muscle. The cervical mucosa of the cervix contains many branched cervical glands. Depending on the time of ovulation, usually around the midpoint of a female's cycle, the cervical glands will secrete a serous fluid that aids spermatozoa to enter the uterus. During times of pregnancy, the same cervical glands will secrete thick mucus, plugging up the cervical opening. This prevents sperm, and bacteria from entering the uterus where the fetus is developing. Like the fundus and the body of the uterus, the cervix changes during the menstrual cycle. It, however, does not slough off its cells during the time of menstruation.

Smooth muscle cell. (TEM)



Collagen fibril bundles of connective tissue. (TEM)

The fundus and the body are composed of varying tissue layers called the endometrium (or the mucous membrane), the myometrium (or the muscular coat), and a serosa layer (or a perimetrium). The endometrium, or the thick mucosa layer, consists of long tubular glands that extend to the stroma. Two layers make up the endometrium where the upper two-thirds are

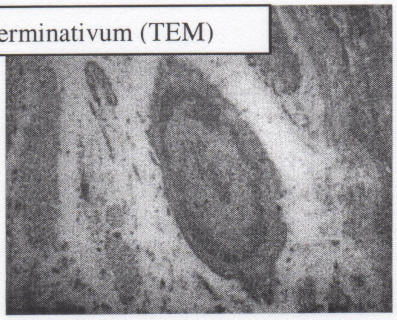
called the stratum functionalis. As the stratum functionalis grows, develops, dies, and then sloughs off, it produces the menstrual cycle. This cycle is connected to the activities of the ovaries. The lower one-third portion of the endometrium is called the stratum basalis. This layer regenerates the upper stratum functionalis. The second layer, the myometrium, consists of smooth muscle, as well as collogen, and elastic fibers. The smooth muscle layers are broken down into three different layers. These include the inner longitudinal, the middle circular, and the outer longitudinal layer. These layers help with the hypertrophy (the increase in size of an organ) and hyperplasia (the increase of cell population – in this case smooth muscle cells) during pregnancy. The final layer, the serosa coat is attached to a think layer of connective tissue and is equivalent to the peritoneum.

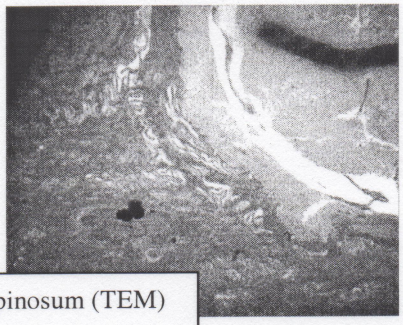
THE SKIN

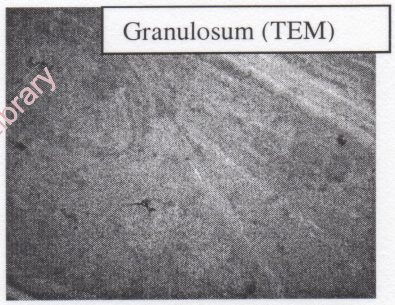
The skin is the largest organ of the body. It serves many functions for the organism including protection (immune, physical, etc.), regulation of body temperature (including insulation), water regulation (desiccation and absorption), sensory ability, and excretions (oil, gas, etc.). Histologically, the skin is termed as either thin or thick on an organism. Thick skin can be found on the palms of hands in humans, and on soles of feet. These areas of thickness are such due to increased friction of the skin. With the increased friction, the skin builds up more dead skin over time, and becomes calloused. These areas usually do not contain hair follicles. Thin skin on the other hand, such as those found on the eyelid, usually will have hairs. Different areas of skin, whether thick or thin, will have different levels of oil secretions from glands within the skin.

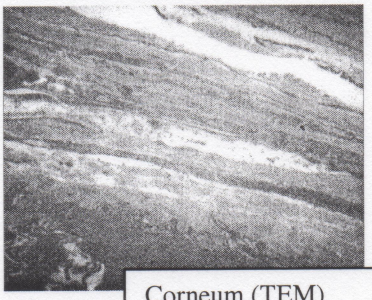
Increasing magnification of hair shaft found within skin (SEM)

The skin is divided into two main layers, which are the epidermis and the dermis. The epidermis, the outer layer of the skin, is composed of stratified squamous keratinized cells. There are four classifications of cells present in this stratified squamous layer. These include keratinocytes, langerhans cells, melanocytes, and merkel cells. The epidermis itself, is also composed of five varying layers. The first is the stratum basal or germinativum. This is the deepest layer of the epidermis. This single layer of cuboidal to low columnar cells connects to the deeper dermis layer of the skin, and rests upon a basement membrane (basal lamina). The cells within this layer are mitotically active, and thus renew themselves by moving upward into the next superior tissue layer. The next layer superior to the stratum germinativum is called the stratum spinosum. This layer is the thickest of all five layers of the epidermis. This layer is composed of polyhedral cells and flattened cells, and is about five cells thick. The cells have a prickly or spiny appearance. The third layer is named the stratum granulosum. This layer is three to five cells thick and is composed of flattened keratinized cells. This is the outermost layer that of cells that still have nuclei. This layer also provides a waterproof protection due to the granules producing lipid-rich sheets within the extracellular space. The fourth layer is called the stratum lucidum, and is only present in thick skin. This cell layer also lacks organelles and nuclei. Instead, the stratum lucidum layer contains keratin filaments which are densely packed, and eleidin, a "transformation product of

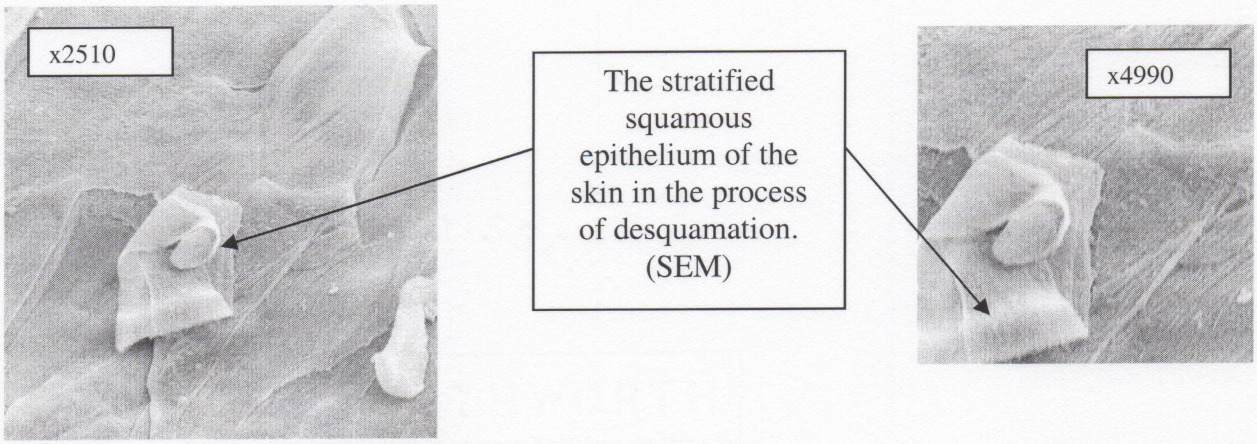

Germinativum (TEM)


Spinosum (TEM)

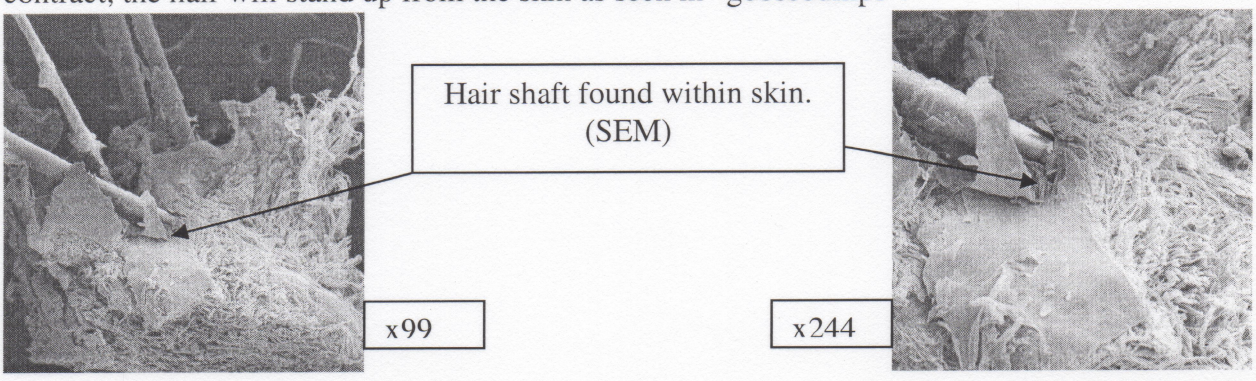

Granulosum (TEM)


Corneum (TEM)

keratohyalin" (Gartner and Hiatt, 331). The last layer is called the stratum corneum. This layer is composed of several layers of flattened, keratinized cells. The most topical cells are the ones that are sloughed off (desquamated). Cells that are not shed are those that are situated in an amorphous matrix.



The second layer of skin is the dermis. This layer is mostly dense connective tissue and does not have a defined, straight border between the epidermis and the dermis. The dermis layer is also composed of varying cellular layers as is the epidermis. The dermis, however, is only comprised of two layers instead of five. These include the papillary layer, and the reticular layer. The papillary layer is the most superficial layer near the epidermis, but is still separated by the basement membrane. This layer also contains many capillary loops that travel between the interface dermis and epidermis layers. Continuous with the papillary layer is the reticular layer. Within this tissue layer, one can find sweat glands, sebaceous glands, and hair follicles. In this connective tissue layer, smooth muscle is also found. This smooth muscle will wrinkle the skin, such as in the penis and the scrotum, and within the hair follicles. When the smooth muscle contract, the hair will stand up from the skin as seen in "goosebumps".



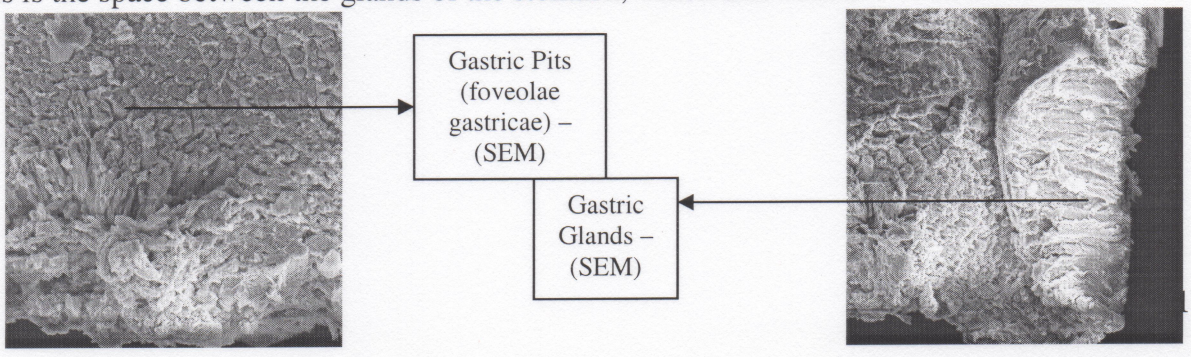
THE STOMACH

The stomach is the first major organ encountered once food has entered the mouth and has passed through the esophagus. The food will enter the upper portion of the stomach via the cardiac sphincter. Upon reaching the stomach, the food encounters a highly acidic environment. The acidity ranges from a one to a four on the acid-base (pH) scale. The acidity of the stomach will range, however, based upon species of the organism, time of day, intake of food, and various other factors. The acidity of the stomach along with the digestive enzymes residing there causes the breakdown of particles of food from larger pieces to smaller pieces. After the food has been digested by the stomach it will become liquid in consistency and will be called chyme. It is because of this process of food break down that water and nutrients will be more easily absorbed by the body (more surface area of broken up food particles). Such nutrients that will be absorbed by the stomach include water, ions, alcohol, caffeine, and some lipid soluble drugs, such as aspirin. In addition to its digestive capabilities the stomach can also act as a storage system. The upper portion of the stomach has decreased intensity of peristalsis muscle contractions, thus allowing the food to remain in the upper stomach for a longer period of time. The lower, more intense peristalsis waves will cause the food in the lower part of the stomach to be pushed out through the pyloric valve into the beginnings of the small intestine (duodenum).

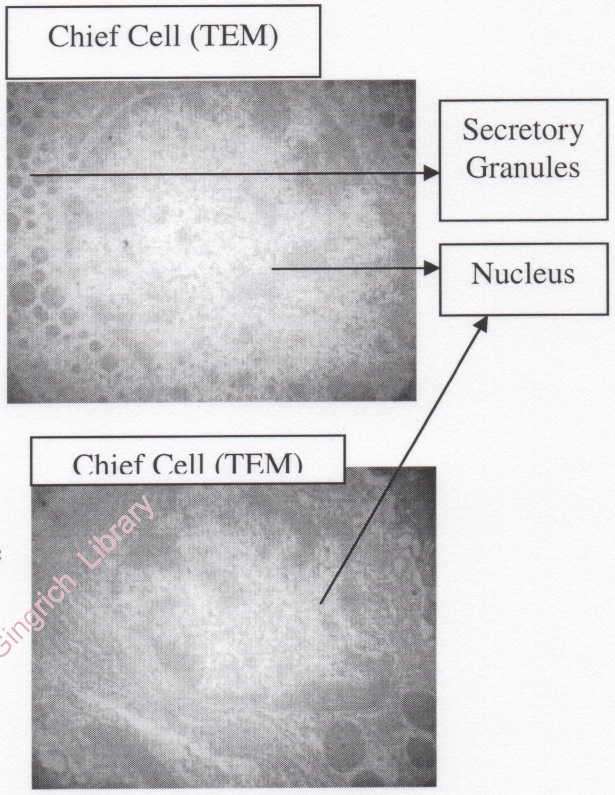
The stomach is divided into very distinct areas. The first portion of the stomach is the cardiac sphincter. This is where the food passes through the esophagus into the stomach. The food then enters into the upper portions of the stomach called the cardia and the fundus. The food is then pushed into the largest part of the stomach called the corpus; or the body. From there it will pass the lesser curvature, which is the smaller concave area of the stomach found on the right, and the greater curvature, which is the convex area of the stomach found on the left.

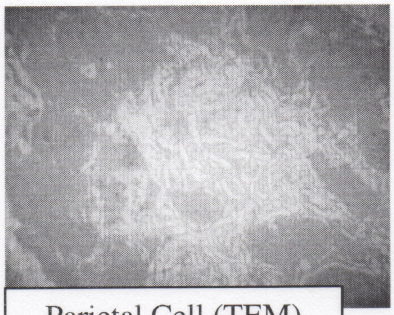
The food will then travel to the bottom portion of the stomach called the pyloris and then into the pyloric valve where the stomach connects to the small intestine.

In addition to the divisions of the stomach, the stomach, when dissected is clearly comprised of different muscle, and connective tissue layers. The first layer is called the mucosa. It is here that one finds the rugae of the stomach. The rugae are folds and ridges of the inner stomach tissue. The rugae help the stomach to expand when it is filled with food. Thus, the rugae are more apparent when the stomach is empty as compared to when the stomach is full. Gastric pits and glands are also scattered amongst the lining of the stomach. These structures are accountable for the enzymes and acid that seep into the stomach area. The mucosa is also coated with mucous. Mucous decreases abrasions from food and also protects the tissue from the acidic fluid. The last component found on the mucosa of the stomach is the microvilli. Microvilli increase the surface area of the stomach for absorption. The layer below the mucosa is called the submucosa tissue layer. This layer contains the larger blood vessels and nerves, as well as collagen and elastic fibers. The musclaris externa is a deeper layer consisting of three kinds of smooth muscle. These types of muscle include an inner oblique, a middle circular, and an outer longitudinal layer. The smooth muscles layers do not run evenly throughout the whole stomach. For instance, in the fundus, the muscle layers run in different directions. Another example is of the pyloric sphincter. It is strengthened by the thickening of the inner and middle muscle layers. The outer layer of the stomach is the serosa. This layer consists of connective tissue and is covered by mesothelium. Lastly, a layer of the stomach worth mentioning is the lamina propia. This is the space between the glands of the stomach, which also contains connective tissue.



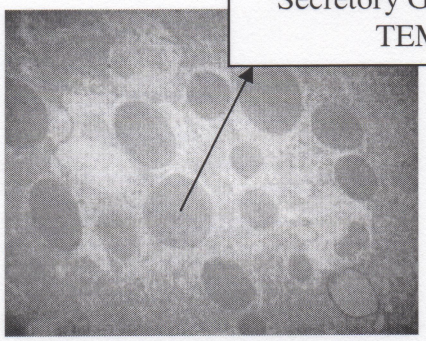
Many different kinds of glands are present within the stomach in order for it to perform the necessary functions of digestion. There are three types of glands. They include the cardiac glands, oxyntic (gastric/fundic) glands, and pyloric glands. The gastric glands are mainly found in the upper portions of the stomach near the connection of the esophagus. These glands are tortuous or branched. Some of the cells in this category will secrete mucous to coat the stomach. Other cells will secrete gastrin, which is a polypeptide hormone. This hormone activates other glands in the body of the stomach. Oxyntic glands are mostly found in the fundus and corpus of the stomach. In these areas there are about 15 million glands. These cells will contribute the most to the volume of gastric juices in the stomach. Within the oxyntic gland category, there are five different kinds of cells. In no specific order, the first type is called the mucous neck cells. As the name suggests, these columnar cells produce mucous. They are found in the neck regions of the gastric glands. The second kinds of cells are stem cells. These cells renew the gastric mucosa over a period of time. Chief cells are the third category of cells. They secrete pepsinogen, which is the precursor to the enzyme pepsin.




Parietal Cell (TEM)

These cells are the most abundant cells in the stomach. The fourth division of cells is the oxyntic or parietal cells. These cells are responsible for producing the hydrochloric acid found in the gastric juices of the stomach. The last section

of cells are called the enterendocrine cells. The last major category of glands are called the pyloric glands, which are mainly located in the lower regions of the stomach. It is here that the gastric pits are deeper. They are also more tortuous and branched than the oxyntic glands. Lastly, secretory cells reside in the lower area of the stomach.



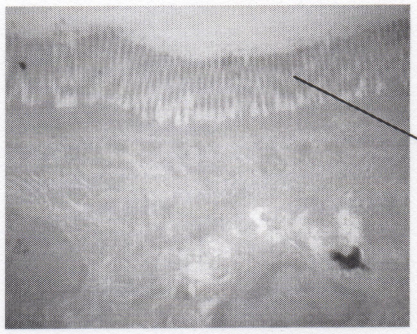
THE SMALL INTESTINE

The small intestine is the adjacent organ connected to the stomach. Peristalsis waves will push the liquid chyme from the stomach, through the pyloric sphincter, and into the first part of the small intestine called the duodenum. In the small intestine, the most digestion of the food occurs through the utilization of enzymes. When the food moves throughout the various portions of the small intestine, nutrients such as saccharides, lipids, vitamins, and water are absorbed. This occurs through such structure as the villi, which are finger like projections. By the way of peristalsis muscle contractions, the food will slowly move through the 13 to 23 foot organ of the small intestine until it reaches the large intestine.

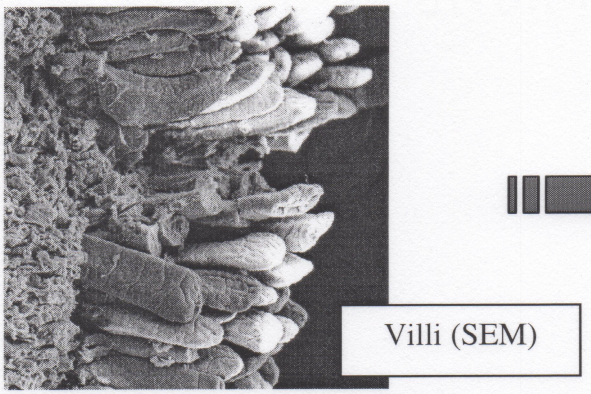
The small intestine, like the stomach, is divided into different regions. The first region is the smallest and is called he duodenum. This portion of the intestine is about ten inches in length and connects to the gallbladder and pancreas. The gallbladder will create bile, which will emulsify fat, while the pancreas adds digestive enzymes for food break down. The next portion of the small intestine is called the jejunum and it measures eight feet in length. Finally, food will go through the longest portion of the small intestine called the ileum. The ileum is about 12 feet

in length. All portions of the small intestine are then attached to the body cavity wall by a thin layer of mesentery.

The small intestine shares similar characteristics in tissue layers like that of the stomach. The mucosa (Mu) is the first layer. This layer contains plicae circilaris (valves of Kerkring), villi, and crypts of Lieberkuhn. All these structures function in increasing surface area for absorption of nutrients from the chyme. The plicae circilaris are described as crescentic folds and are most numerous within the end of the duodenum, and the beginning of the jejunum. The number of these structures decrease as one goes down the intestine. The villi are found to be finger like projections that cover the inner wall of the small intestine. The duodenum and the proximal jejunum contain the highest number of villi. The last component of the mucosa is the crypts of Lieberkuhn, which are "invaginations of the mucosa between the base of the villi." The



Villi (TEM)

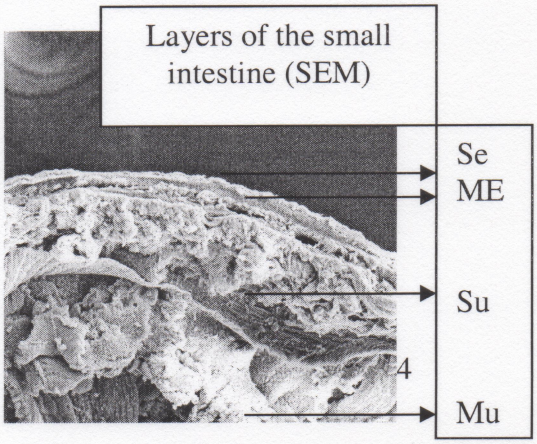


Villi (SEM)

Ville - larger magnification (SEM)

muscularis mucosa is the next layer found within the small intestine. This layer aids in the height and ridges of the mucosa layer and is comprised of a thin layer of smooth muscle. The next layer is the submucosa (Su), which is also found in the stomach. This layer possesses

Layers of the small intestine (SEM)



the connective tissue and elastic fibers. The muscularis externa (ME) has outer longitudinal and inner circular smooth muscle. The smooth muscle is thickened around the ileocecal sphincter, which is at the end of the small intestine. This sphincter connects the small and large intestine together. The muscle around the ileocecal sphincter is also always partially contracted in order to delay the liquid chyme from entering the large intestine. This delay causes further absorption of nutrients by the small intestine. The last layer is the serosa (Se). This layer makes up the outer layer of the intestinal wall, and consists of sheets of squamous cells.

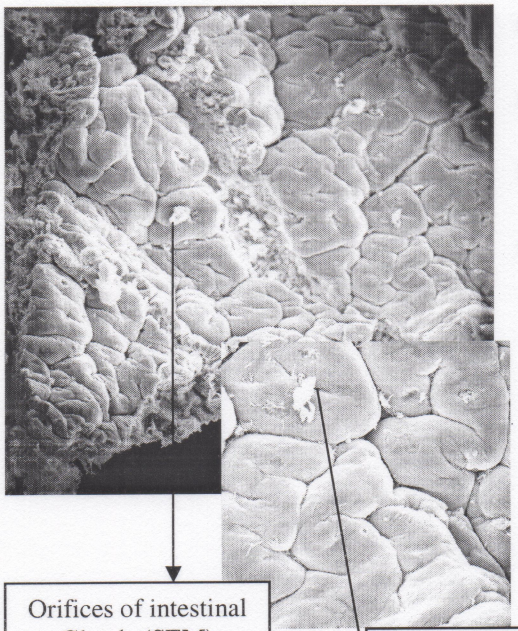
Within the layers previously described are various types of cells that aid in the function of digestion. In the mucosa layer, three cells types exist. The first are a group called absorptive cells. These cells are columnar in shape and have microvilli for the function of absorption. The second grouping is called goblet cells and they secrete mucous between the absorptive cells. The last type of cell is the enterendocrine cell. There is one type of special gland within the submucosa layer of the small intestine, called Brunner's Glands. These glands are mostly found in the beginning of the duodenum. Their function is to produce an alkaline fluid with a pH of about 8.2 to 9.3. The alkalinity of the fluid made by the Brunner's Glands neutralizes the highly acidic gastric juices that may leak from the stomach.

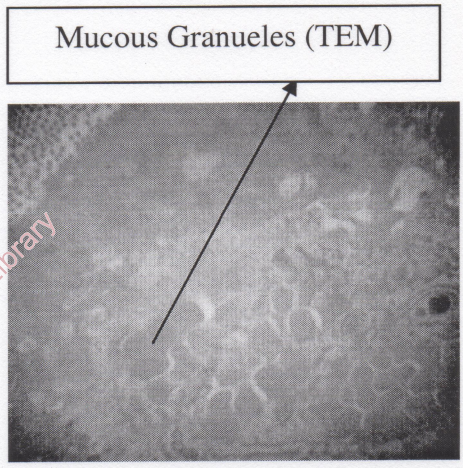
THE LARGE INTESTINE

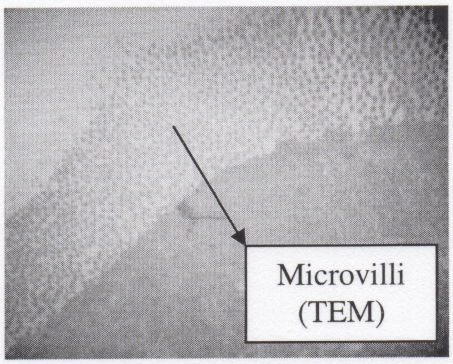
The last portion of the gastrointestinal tract is the large intestine. In the large intestine, there is no enzymatic digestion of food. It is here that further absorption of nutrients occurs once it leaves the small intestine through the ileocecal valve. The large intestine will function to continually absorb electrolytes, salts, vitamins, and water (to maintain the fluid balance in the body). After about twelve to twenty five hours to finish the digestive process, the food then exits through the rectum by means of peristalsis contractions.

The large intestine is divided into several main parts. The cecum is the first portion of the large intestine. This area is distinguished by the bottom "pouch" area which leads to nowhere. The main function of the cecum is to absorb water and salts into the thick mucous membranes. The mucous along with the strong muscle contractions of peristalsis, aid in the movement of the food. The cecum continues on into the ascending colon which is smaller in diameter. Next comes the transverse colon which is the longest portion of the large intestine and displays a slight concavity in placement. The descending colon follows the transverse. This part of the colon like the other parts is covered with peritoneum. The last section of the large intestine is called the sigmoid colon. The sigmoid colon is where fecal matter collects for future disposal. The fecal matter will be moved by peristalsis into the rectum and then out through the anus. Overall, the large intestine measure about five feet in length and the diameter of the large intestine decreases in size from the ascending colon to the sigmoid colon (from 3 inches to about 1.5 inches).

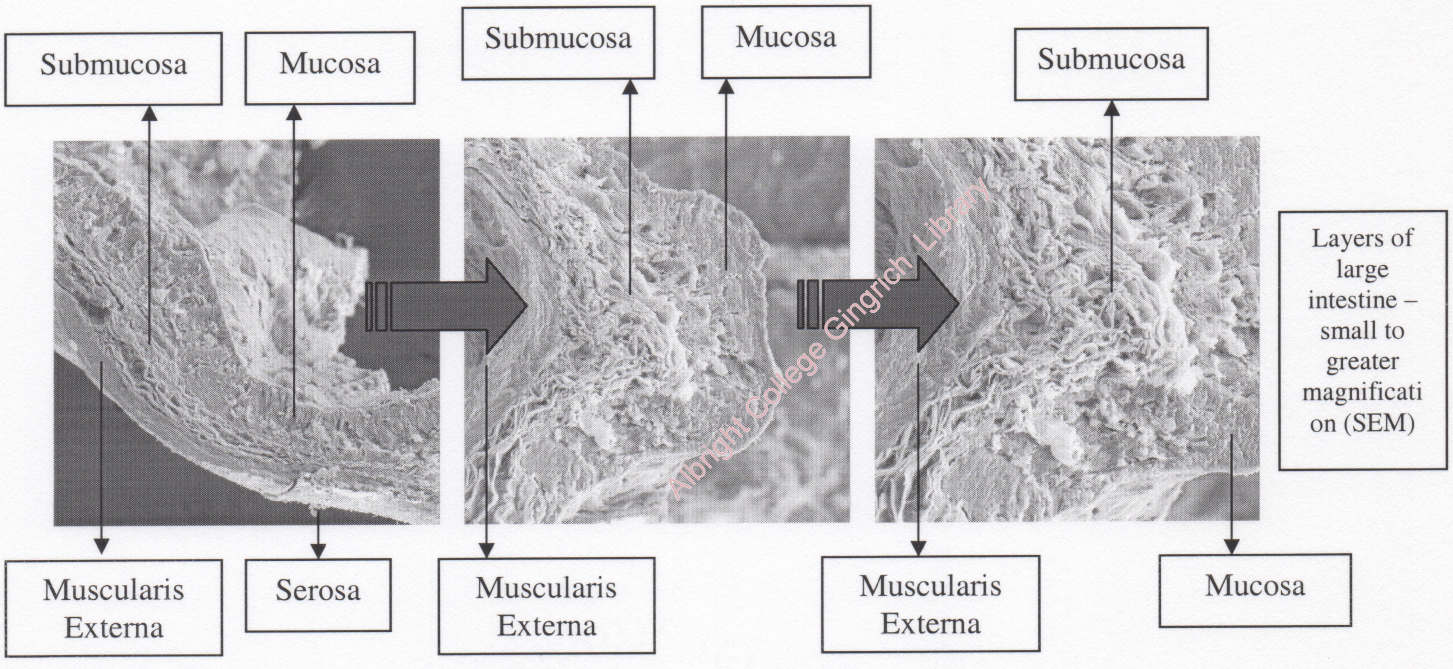
Varying layers of tissue continues on into the large intestine, as was seen with the stomach and small intestine. Like the other organs, the mucosa is the inner most layer of the large intestine. Unlike in the small intestine, however, the mucosa layer of the large intestine does not have villi. Since the large intestine lacks these structures, the inside of







the colon appears smooth. Instead of villi, the glands such as the crypts of Leiberkuhn jut out into the intestinal space along with microvilli. Other structures present are columnar cells, lymph nodes, and goblet cells. Like in the small intestine, the goblet cells in the large intestine secrete mucous to aid in the movement of the fecal matter, and for better absorption of nutrients. The submucosa again consists of connective tissue. It also contains large blood vessels and nerves. The muscularis externa of the large intestine has two layers of smooth muscle tissue. These include the outer longitudinal and the inner circular. The longitudinal layer is said to be incomplete due to fact that it is thin in places when it runs along the large intestine. Three bands of longitudinal muscle do run the length of the intestine though. These bands have come to be specified as lineae coli or taenia coli. The inner circular layer, however, is described as complete due to its prominent thickness throughout the colon. The final layer, as previously mentioned, is the serosa, which is the connective tissue layer of the colon.



FIBROMYOMATOUS IN THE UTERUS

Many abnormalities could occur within the uterus. One such disease that plagues women is called fibromyomatous. It is the most common type of tumor, and in 5-10% of women it causes infertility. Fibromyomatous causes infertility or problems with pregnancy by either blocking the pathway of spermatozoa, or by elongating or changing the shape of the endometrial cavity, thus preventing implantation of the early embryo. Tumors furthermore may cause inflammation, cause endometrial erosion, or reduce the amount of blood supply to the endometrial cavity. Even with removal of the tumors through a process called myomectomy, the tumors may grow back and usually do, especially when numerous tumors are removed from one area. About 15-59% of women have recurrent tumors. Such recurrence causes more obstacles for women who are trying to become pregnant.

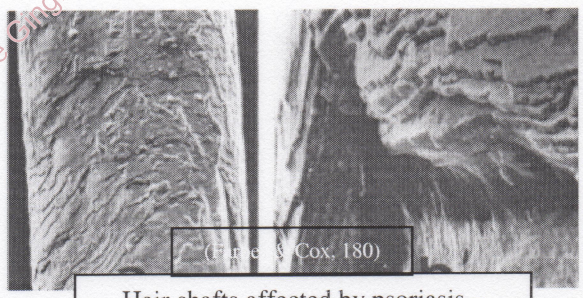
The tumors of fibromyomatous occur within the myometrium of the uterus. Thus, normal myometrium was studied in comparison to fibromyomata, and non-neoplastic, or host myometrium of fibromyomatous uteri. Within the myocytes, no irregularities were found in perinuclear cell organelles (cells near the nucleus). The intracellular cells were also normal in both the normal myometrium uteri tissue and the host myometrium, except for the mitochondria, intermediate filaments to myofilaments, myelin figures, and the endoplasmic reticulum. The mitochondria within the host myometrium were found to be enlarged and more numerous than found in normal myometrium. The mitochondria also had abnormal folding of the cristae. Intermediate filaments were increased as compared to myofilaments in the host myometrium. In addition, myelin figures were degenerated due to ischemia. Lastly, the endoplasmic reticulum in the host myometrium was found to be dilated. Sarcolemma dense bands of the myometrium

were studied and found an increase in length of these bands in the host myometrium. Caveolae (invaginations of the plasma membrane) were found to be reduced.

The increase and abnormality of certain structures within the host myometrium indicate problems occurring within the tissue. The increase in number of mitochondria, and the abnormal appearances in addition to the myelin bodies may indicate degeneration and cell injury due to ischemia. Large numbers of the intermediate filaments within the host myometrium points to a problem of cytoskeleton production. Like the intermediate filaments, increased length of the sarcolemma bands may also show that there is a problem in the cytoskeletal production process. In relation to the sarcolemma, caveolae were found to be reduced (less in myometrium and even less in fibromyomata), thus reducing the amount of calcium extrusion pumps that are related to the caveolae. With less calcium extrusion pumps, the more calcium stays within the cell and cannot be actively pumped out. An increase in calcium ions in the cells are thought to cause such painful symptoms such as dysmenorrhoea (extreme uterine pain normally found during mentruation) (Richards et al., 1998).

PSORIASIS OF THE SKIN

Psoriasis is an autoimmune disease affecting the skin, nails, and sometimes the hair. The disease presents itself on the skin as red, scaly patches. These reddened areas form white or silvery areas on the skin where dead skin has deposited. This disease can appear on any part of the body, and is not contagious to other beings.

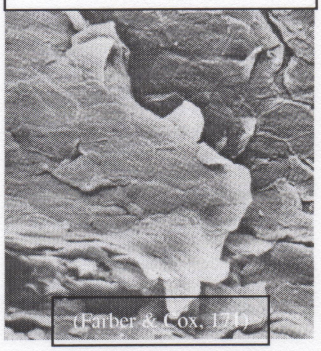


Hair shafts affected by psoriasis – damage has occurred to cuticle. (SEM)

Under the utilization of scanning electron microscopy (SEM), psoriatic epidermis was studied. Unlike the normal, smooth arrangement of overlapping

cells within normal, healthy tissue, psoriatic skin was disconnected. Each cell could be seen as having distinct, sharp borders, and irregular shapes. The horny cells sloughing off were polygonal in shape, as well as having increased abnormal folding.

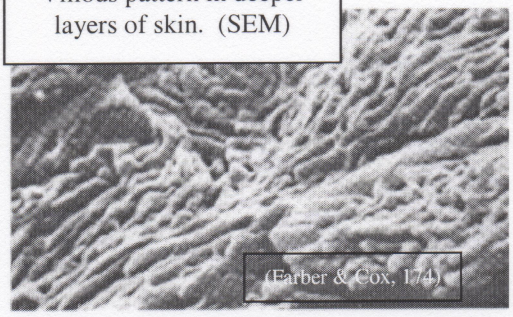
Psoriatic skin that shows abnormal, irregular patterns. (SEM)



(Farber & Cox, 177)

Within the stratum corneum, various differences were also observed. These included widened intracellular spaces, abnormal desquamation of skin cells, and abnormal intracellular connections. Under higher magnifications, such as a magnification of times 4,000, a villous pattern (having/being covered with many fine, soft hairs) was observed on the epidermis scales. With normal tissue, however, the surface should be smooth, and not wrinkled in appearance.

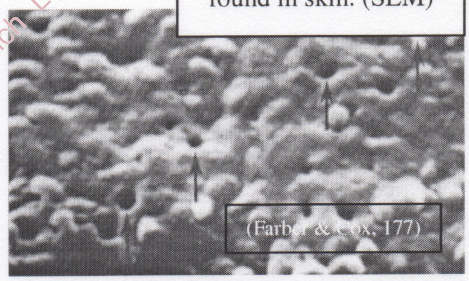
Villous pattern in deeper layers of skin. (SEM)



(Farber & Cox, 174)

After stripping (in order to see the deeper levels of the skin), it was found that the middle and basal layers of the epidermis had less folding. In addition, the surfaces became rougher. Although deeper layers did not display a villous appearance, they did show that the intracellular spaces were closed, and that the cellular borders were indistinguishable. Furthermore, "desmosome-like bridges" were seen between adjacent cells. In some rare instances, after viewing psoriatic skin under SEM, pore-like structures could be seen associated with the villous pattern. It is unknown whether these pores were openings or depressions of the cells (Farber and Cox, 1971).

Pore-like structures found in skin. (SEM)



(Farber & Cox, 177)

IRRITABLE BOWEL DISEASE - ULCERATIVE COLITIS/CROHN'S DISEASE

There are many diseases that affect the intestines. These include, but are not limited to ulcerative colitis and Crohn's disease. Ulcerative colitis (UC) is in general referred to as a type of irritable bowel disease, where the colon or rectum becomes inflamed. Ulcers form in the lining of the intestinal lining, causing bleeding and pus within the colon itself, or causing a person to have diarrhea. This disease occurs in individuals between 15 and 30, affecting both men and women equally. There is a higher risk of ulcerative colitis if a person is Caucasian or of Jewish decent. An individual who has a biological family member with UC or Crohn's disease has an even greater risk of acquiring UC.

Crohn's disease is also an inflammation of the bowel and is generally referred to as an irritable bowel disease. Unlike ulcerative colitis, however, Crohn's disease may cause harm to the whole digestive tract which is composed of the mouth, the esophagus, the stomach, the small intestine, the large intestine, and the rectum. Many patients with Crohn's disease, however, will have the illness affecting the lower portion of their small intestine. The swelling of any portion of the gastrointestinal tract will cause an individual pain, and frequent diarrhea. Most people find that they have Crohn's disease between the ages of 20 and 30, and like ulcerative colitis, there is an increased risk if one is of Jewish decent, or if an person has a blood related relative with either Crohn's or UC. There is no proven cause of UC or Crohn's disease, but the medical community believes it is a problem of the immune system. They think that the immune system attacks the bacteria or food particles within the intestines/GI tract, and causes the inflammation of the bowel.

In those individuals with ulcerative colitis, there were many abnormalities seen in the lining of the intestinal wall. Goblet cells were not regularly dispersed throughout the mucosa

when being viewed through scanning electron microscopy (SEM). This would affect the amount of mucus secreted throughout the intestinal tract. The mucosa, however, appeared normal when being viewed through low magnification on the SEM. In most instances, there were limited numbers of goblet cells. In addition, crypt openings were also affected. The openings were inflamed, distorted, and/or reduced just as seen with the goblet cells. Villi and microvilli (seen under transition electron microscopy), which aid in absorption of food, were shortened, swollen, or absent. With the villi and crypt cells being infected, absorption within the digestive tract would be disrupted. The lining of the intestine was seen to be degenerated and comprised of lesions.

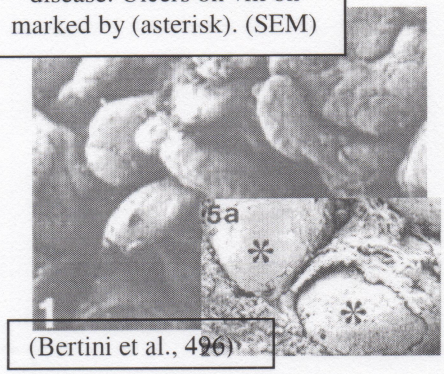
Normal crypt cell openings as shown by arrows. (SEM)

Deterioration of crypt cell openings as shown by arrows. (SEM)

The mucosal layer is broken down. Mucus and cell debris is scattered. (SEM)

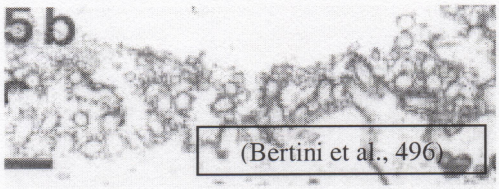
Increased mucus (asterisk) and goblet cells (arrows) are present. (SEM)

Abnormal vili due to Crohn's disease. Ulcers on vili on marked by (asterisk). (SEM)

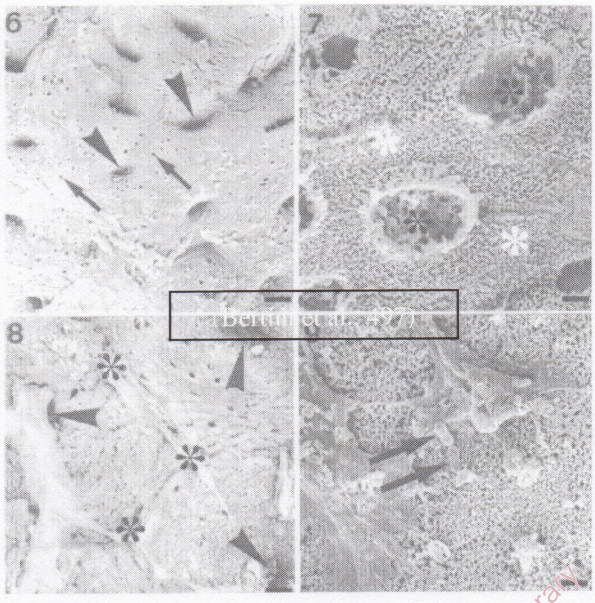


When studying Crohn's disease under scanning electron microscopy, there are changes seen within the intestinal tissue. Firstly, the villi appeared to be abnormal. These structures were shortened, irregularly shaped, and swollen. Some areas of the

tissue did not even have villi present. Other areas showed that the villi had ulcers or sores on the tips. By using transition electron microscopy (TEM), it was found that microvilli were also affected by having abnormalities. In addition to damage to the villi and mircovilli, lesions were also present on the lining of the tissue. Witin these areas, numerous amounts of bacteria were observed (Bertini et al., 1997).



Irregular microvilla. (TEM)



Normal histological area with crypt openings (arrow heads) and mucus (arrows). (SEM)

Normal histological area with absorptive cells (white asterisk) and mucus cells (black asterisk). (SEM)

Areas with lesions show regular pattern of crypt openings (arrow heads) and large extrusive zones (asterisk). (SEM)

Area with lesions present and bacteria (arrows). (SEM)

CONCLUSION

After finishing my studies, I found that I had reached my objective in improving my skills significantly in the fixation process of my tissue specimens, and in using the scanning electron microscope (SEM), and transmission electron microscope (TEM). Although not all my data (SEM and TEM pictures) could be used (due to insufficient fixing and wrong orientations), I was still able to learn from my research and through the literature already available. With the satisfactory pictures of healthy, normal tissue that were taken, I was able to understand and show

how various microstructures could be affected by disease. Furthermore, by observing these abnormal structures and by acknowledging that function was also being compromised, I was able to understand how gross symptoms of an individual could occur.

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