# STUDIES ON GROSS ANATOMICAL AND HISTOMORPHOLOGICAL ORGANISATION OF THE COMPONENTS OF FEMALE GENITALIA OF GREY GIANT RABBIT

*(Oryctolagus cuniculus)*

**A Thesis**

**: *Submitted to the* :**

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We, the undersigned, having been satisfied with the performance of Sri Sanjay Ray, in the viva-voce Examination, conducted today, the 8th March 2002 recommended that the thesis be accepted for the award of the Degree.

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**DEDICATED TO MY BELOVED PARENTS**

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## CERTIFICATE

*This is to certify that the work recorded in the thesis* entitled "**STUDIES ON GROSS ANATOMICAL AND HISTOMORPHOLOGICAL ORGANISATION OF THE COMPONENTS OF FEMALE GENITALIA OF GREY GIANT RABBIT(*Oryctolagus cuniculus*)**" *submitted by Sri Sanjay Ray in partial fulfillment of the requirements for the Doctor of Philosophy in Veterinary Anatomy, Histology & Embryology, West Bengal University of Animal & Fishery Sciences, is the faithful and bonafide research work carried out under my personal supervision and guidance. The research findings presented in the thesis have not so far been submitted for any other Degree / Diploma. The assistance and help received during the course of investigation have been duly acknowledged.*

**(Prof. R.K.Ghosh)**
**Chairman**
**Advisory Committee**

**Dated, Belgachia**
**The** 18/10/01

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SANJAY RAY

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# CHAPTER - 1

# INTRODUCTION

At the new millennium 2000, Veterinary Council of India has included the species of rabbit in this professional course curriculum on the basis of increasing demand of the food products which are procured from this species. Rabbit husbandry has become a lucrative farming in the developing countries after second world war. The wild rabbit *Oryctolagus cuniculus* of South Europe and North Africa have been discovered by Phoenicians when they reached the shores of Spain about 1000 BC. The Romans apparently spread the rabbit throughout the Roman empire as a game animal. Rabbit had still not been domesticated, but Varron (116 to 27 BC) suggested that rabbits be kept in leporaria, stone - walled pen or parks, with hares and other wild species for hunting. These leporaria were the origin of the warrens or game park that subsequently developed in the middle ages. It is known that monks were in the habit of eating laurics during Lent as they were considered "an aquatic dish" (Sic). In France, it became the sole right of the lord of the manner to keep warrens. Rabbits were hunted little, and were captured with snares, nooses or nets. In the sixteenth century Olivier de Sarres classified three types of rabbits - wild rabbit, semi wild rabbit and domesticated rabbit. But in last 30 years the rabbit has gained the better position of a full fledged self sufficient industry equipped with manifold commercial as well as domestic importance. Vietmeyer (1985) stated "livestock for use in developing countries should like computers, be getting smaller and becoming more 'Personal'. Mainframes, such as cattle, cannot solve the widespread shortage of meat because they require to much space and expense for the landless and the poor. Miniframes, such as sheep and goats, could play an increasing role. But tiny 'User friendly' species for home use show the most promise - and they are being overlooked..

In fact, after second world war the countries faced population explosion and showed the disparity of demand and supply of nutrient in general and Animal protein in particular. That's why about 60% of the total population of our country are suffering from protein deficiency. The per-capita of meat available in India is about 6.4 gm per day as against optimum of 85 gm. per day as recommended by India Council of Medical Research (ICMR) and most of the world's human population is fed by the output of small farms (Gallardo, 1984). Rabbit meat production is therefore an attractive

proposition especially when the aim is to produce quality animal protein. Regarding the advantage of rabbit rearing Banerjee, G.C. (1998) suggested that :

(a) Investment on housing and management is less.

(b) Rabbits breed fast (31 days is the average gestation period) and achieve rapid weight gains .

(c) They are commonly fed on leafy plant and vegetables with relatively little concentrate feed.

(d) The rabbit meat is purely white, containing low fat and low cholesterol .

(e) The protein of rabbit meat is of higher biological value.

(f) Sodium level is low in rabbit meat. So it can be suggested to the cardiac patient for consumption.

(g) Rabbit meat do not reflex any religious bar and is accepted to all.

Holmees *et al* (1984) stated that rabbit meat contained low fat level excellent quality of high protein with good nutritive value, and with high digestability and palatability.

The existing literature Lepri (1996) showed that the nutritive value of rabbit meat in terms of protein content, iron content, potassium level is excellent and the production of the same can be achieved in no intensive rural condition with limited feed requirement.

The rabbits are not only used for meat purpose but it also provide fur, skin, manure, toys and novelties. The average wool production is 700 - 800 gm ( German angora) per animal per year in Indian condition (Pull and Pull , 1994). The adult female produces average 1 kg fur per year compared to 700 -800 gm by males.

Cheeke (1986) and Owen (1976) stated that rabbit farming gained superior position other than different livestock due to

- Labour costs are minimum and management can be done easily by any family members such as children, handicapped person, aged person and women.
- Initial investments is low and therefore lower income group people can easily start the farm.
- Rabbits can easily accept the family diet and food preservation techniques are also available on small rural and peri urban farms.
- Due to short gestation period, (average 31 days) and high prolificacy rate, it gives quick return.

- Rabbit can take easily green leafy plants and vegetables with little concentrate feed.

In 1985, Vietmayer suggested to establish the microlivestock industry because now a days rabbitry business is actually profitable in growing countries.

Recently, the Department of Animal Resources and Development, Government of West Bengal, has taken interest to develop and establish the rabbit farm in different area, and also encourage the poor farmers to start rabbit farming with its supervision and help.

To find out a suitable breed and for its improvement, a detail knowledge is essential on the structural and functional organisation of different organ system in general and genital system in particular.

Since such type of informations so far available on this species of animals are limited, an attempt has been made to explore gross anatomical disposition and histomorphological organisation on various components of female genetalia of rabbit along with those of foetal membrane and placenta.

It is believed that the results of this investigation will certainly be a useful tool to the animal physiologists and breeders for better understanding the functional aspect of all these organs in the animals under normal as well as in altered physiological conditions and thereby would be helpful for the development of rabbit husbandry.

# CHAPTER - 2

# REVIEW OF LITERATURE

# REVIEW OF LITERATURE

To improve the breeding characteristics as well as potentiality of reproduction of a species a pre size knowledge on the various components of the reproductive organs i.e. their morphological details both in gross and microscopic level is essential.

As the rabbit farming in gaining its importance due to popularity and on the basis of its economical stand point, investigation on various aspect of this species is going on through out the globe. Studies on female genitalia therefore is a major field of work that has been undertaken in this investigation.

Some works on this aspect has been reported by various investigators time to time which seen to be neither complete nor methodical from the point of there practical usefulness in the improvement of rabbit farming.

However the available literatures on the structure of female genital organs have been reviewed chronologically in this chapter.

- Gross structure of various components of female genitalia.
- Histomorphology of the organs of female reproductive system.
- Mammary glands
- Placenta.

## A. Gross structure of various components of female genitalia

Literatures available on gross structure of female genitalia of rabbit as recorded by various workers / authors are reviewed here.

Silvernale, N. Max (1965) recorded that the ovaries were small , pinkish gland situated against the lumbar walls into the abdominal cavity a short distance below the kidney. The fallopian tubes were small, funnel shaped. The fallopian tube enlarged posteriorly formed uterus. The two uteri fused posteriorly to each other formed vagina. The vagina passed straight and formed vestibule. This vestibule which was opened to the exterior by a slit like vulva.

Parker, T. J and Marshall, A.J. (1967) presented that the ovaries were small avoid bodies attached to the dorsal wall of the abdomen behind the kidney. The eggs were entered the wide funnel shaped opening with fimbriated of the paired oviduct or fallopian tube. Posteriorly each tube passed into a thick wall uterus. The two uteri

opened separately into a median tube, vagina. The vestibule was a median passage in between the vagina and opening of bladder. On its ventral wall , there was a small, hard, rod like body with a pointed apex that was clitoris and composed by two very short corpora cavernosa and a soft grooved corpus spongiosum. The vulva was external opening of vestibule, bounded laterally by two prominent folds labia majora.

Mukherjee, D. (1972) observed that the ovaries were paired ovoid bodies attached with the dorsal wall by mesovarium. The ovary was compact body formed the stroma and egg cells. The oviduct was convoluted . The mouth of the fallopian tube opened very close to the ovary. The muscular uterus was formed by dilatation of fallopian tube. The two uteri opened into a median tube, vagina which was leaded into the passage that was vestibule. The vestibule contained a small pointed process, clitoris. The external opening of the vestibule was bounded on the side by folds and its opening was vulva. At that time of development the foetus remain attached to the uterine wall of the uterus till birth by the placenta.

Vidyarthi, R. D. (1978) stated that the two ovaries were small solid, about 20 mm. in length attached by folds of peritonium to the dorsal wall of the abdomen behind the kidneys. Each ovary was well supplied with blood vessels and hold in place by ligament to the body wall. The funnel of each side was fringed with finger like, cilia lined processes, fimbrae. Each funnel leaded into a narrow thin walled slightly convoluted , fallopian tube . Posteriorly of each fallopian tube was continued into a thick walled, muscular, richly vascular and highly distensible , uterus. The uteri opened separately into a single median tube, vagina. The lower end of vagina almost met the urethra from the uranary bladder, there was a single wide but short urogenital canal, vestibule which was situated dorsal to the pubic symphysis. In the region of vestibule there was a small clitoris. The vestibule opened to the exterior at the vulva. Two small cowper's gland and a perineal gland presented on the dorsal wall of vestibule. The rectal gland was situated dorsal to the rectum.

Vishwanath. (1984) demonstrated that the ovaries were paired small bodies attached to the dorsal abdominal wall behind the kidney. There were two oviducts, each opened into the abdominal cavity by a small aperture bounded by a wide, thin and fimbriated funnel , the fallopian tube , applied to the corresponding ovary. The funnel was continued behind into the fallopian tube which was indeed the narrow, twisted proximal part of the oviduct. Each oviduct passed backwards and dilated posteriorly to form the uterus. The two uteri united to form the median vagina. The vagina passed

backwards on the dorsal side of the neck of the bladder which it united to form the urogenital canal, vestibule. The vestibule opened to the exterior at the slit like vulva which was bounded laterally by two prominent folds, labia majora. On the ventral wall of the hinder ends of the vestibule was situated a small, hard, rod like body, clitoris.

Mclaughlin, A. Charles and Chiasson, B. Robert. (1985) explained that the ovaries were small in size. The ovaries were situated some distance caudal to the kidney and suspended independently by mesovarium. The mature ovaries showed a translucent sphere, graafian follicle and darker lumps or depressions, corpora lutea. In rabbit only one egg matured at a time. The female reproductive tract was enlarged into a funnel shaped structure, osteum. The osteum beard finger like projections, fimbrae. The mesentery supported the osteum. The oviduct or fallopian tube was a very short constricted portion of the female reproductive tube which was opened into the enlarged uterus. In uterus, the left and right uteri separated for their entire length and distinguished from the rest of oviduct by their thick muscular walls. The mesometrium supported the uterus. The two uteri united caudally and formed vagina. The urethra and vagina joined and formed the urogenital sinus. The vulva was the external margin of urogenital sinus. The clitoris was situated at ventral surface of urogenital sinus and body of clitoris was formed by two corpora cavernosa.

Grove, A. J. and Newell, G.E. (1990) reported that ovaries were small ovoid bodies. The oviduct were funnel like, closely applied to the surface of ovaries. Each oviduct the upper part of which was fallopian tube, passed backward and inward towards the median line where it joined it fellow of the opposite side to formed a median channel, the vagina. Each fallopian tube dilated to formed a uterus. The vagina was joined by the urethra and was continued as a common urinogenital chamber, the vestibule which was opened out to the exterior by the slit like vulva. At the entrance to the vestibule was a small rod like body, the clitoris. The clitoris was irectile and homologue of the penis.

Prasad, S.N. and Kashyap, V. (1991) described that the ovaries were paired of ovoid bodies of pale yellowish colour and situated on the dorsal side of abdomen and which was attached to the dorsal wall by a fold, mesovarium. The anterior end of fallopian tubes were funnel shaped and fimbriated. The fallopian tube enlarged posteriorly and formed a thick wall tube, uterus. The two uteri posteriorly fused each other and formed a common median tube, vagina. It was wider tube that passed straight back and met neck of uranary bladder in pelvic cavity, formed common urogenital canal,

vestibule which opened into the exterior by the slit like vulva. The walls of the vestibule were very vascular. At the entrance of the vestibule there was a small rod like body projected into it, clitoris.

Jorden, E.L. and Verma, P.S. (1993) noted that female reproductive system formed by a pair of ovaries , a pair of oviduct, uterus, vagina , vestibule and vulva.. The ovaries were paired , small, whitish, oval bodies attached to the dorsal wall of the abdomen behind the kidney. The ovaries were attached with the dorsal body by mesovarium. Each ovary showed on its surface many projections. There was a fimbriated funnel closed to each ovary, oviduct. The oviducts behind the funnel was differentiated into two parts. First part coiled with narrow diameter, the fallopian tube was ciliated , glandular and muscular and the second part was thick muscular, vascular and glandular with wider diameter, uterus . The uteri of the both side joined together and formed vagina. The vagina passed backwards and joined to the neck of uranary bladder formed a common passage , urinogenital canal or vestibule . The vestibule was opened to the outside by a self aperture, vulva. At the ventral surface of vestibule there was a small rod like clitoris which was homologous to the penis.

Lebas *et al* (1997) recorded that ovaries were oval shaped and not exceeded 1 to 1.5 cm. The oviduct was made up by ampulla and isthmus . The uterine horns were joined at the back into a single organ, there were actually two independent uteri of about 7 cm, opening separately through two cervical ducts into the 6 to 10 cm vagina. The urethra opened midway along the vagina at the vaginal vestibule. The whole structure was supported by broad ligament .

Ghosh, R.K. (1998) stated that ovary was elongated structure with a pinkish colour. Each ovary was 1 cm long and 4 mm thick. The fallopian tube was slender flexuous tube and was 5 cm. length. The horns were curved , narrow, slightly flexuous and thick walled cylindrical tubes. The average length was about 9 cm in non - pregnant condition. The lumen of the horn presented 3 - 4 longitudinal folds and the folds were nodular elevations along its length. The caudal parts of the horns were remained in close in apposition without any union between them and opened separately at the cranial end of vagina. The body of uterus was absent and external os were two in number .

Banerjee, G. C. (1998) mentioned that ovaries were oval shaped and not exceeded 1 - 1.5 cm. Beneath the ovary there was oviduct which were made by ampulla and isthmus. Though outwardly the uterine horns were joined at back into a single organ , there were actually to independent uteri about 7 cm, opening separately through

two cervical ducts into the 6 - 10 cm vaginal. The urethra opened midway along the vagina at the vaginal vestibule.

Chakraborty *et al* (1999) described that two small solid ovaries about 20 mm. in length, attached by the folds of peritonium to the dorsal wall of the abdomen behind the kidney. Each ovary was well supplied with blood vessels. Closely associated with each ovary but not in contact presented funnel shaped end of oviduct, fringed with finger like cilia lined process fimbrae. Each funnel leaded into a narrow thin walled slightly convoluted fallopian tube which was lined internally with ciliated epithelium. Posteriorly each fallopian tube continued into a thick walled, muscular, richly vascular uterus. The uterus opened separately into a single median tube, vagina. The lower end of the vagina met the urethra from the uranary bladder that there was a single wide but short urogenital canal or vestibule. In the region of vestibule there was a small clitoris. The vestibule opened into the exterior at the vulva.

## B. Histomorphology of the organs of female reproductive system

Copenhaver, W.M. (1964) stated that the ovary was devided into two zones - outer cortex and inner medula, The medula was composed by a stroma of a loose connective tissue, rich in elastic fibers and contained numerous large blood vessels, lymphatics and nerves. Bundles of smooth muscles fibers were found near hilum. The cortex was broad peripheral layer interrupted at the hilum where the medula became continuous with the tissues of masovarium. It contained more compact, richly cellular stroma which were scattered the peculiar granular structure of the ovary, the ovarian follicles. The connective tissue cells were fusiform or spinddle shaped with elongated vascular nuclei and smooth muscle fibers. Underneath the germinal epithelium the tunica albuginea was composed by few cells and more closely packed fibers. In myometrium of the uterus the muscles were arranged in three different layer. Inner layer contained longitudinal fibers, the middle layer contained circular or spiral fibers and outer layer composed of both circular and longitudinal fibers. The perimetrium was composed by structure of serous membrane. The wall of the vagina consisted of three layers. The mucosa was composed of stratified squamous epithelium, lamina propria composed of loose connective tissue, muscularies were composed of smooth muscle fibers and a thin layer of inner circular fibers. In vagina mucosa there was presence of transverse fold instead of longitudinal folds.

Carleton, H.M. and Short, R.H.D. (1965) described that the fallopian tube or oviduct of rabbit was lined by a very vascular mucous membrane which was partly covered with ciliated epithelium and presented numerous longitudinal fold. The folds were complex in the upper part of the oviduct. The ciliated cells were interspersed with non ciliated columnar cells. The cilia beated towards the uterus and were most numerous at the top and a least numerous at the bottom of the tube. Externally the tube was covered by serous coat which was a thin longitudinal stratum of plain muscular fibers overlying circular fibers of the same tissue. These layer was not distinctly marked. The fallopian tube commenced near the ovary with an opened end, the margins of which were spread out into a number of process, fimbrae. One or two of these fimbrae were directly attached to the surface of ovary. The ciliated epithelium covered the fimbrae and continued into much smaller non ciliated cells of the ovarian surface and observed also numerous large vessels of the fimbrae of fallopian tube in guineapig .

Sisson.S., (1975) stated that in mare the cranial extremity of each of uterus horn formed a blunt point which received uterine tube. In cow the junction between the tip of the horn and the uterine was not abrupt as in the mare. The mucous membrane of the horn and body presented on a characteristic feature the uterine caruncles. These were oval prominence about a hundred in number, scattered over the surface or arranged in rows of about a dozen.

Vidyarthi, R.D. (1978) stated in the structure of ovary that outer epithelial layer was the germinal epithelium within which was connective tissue stroma or consisted mainly of collagen fibers among which was a little unstriated muscle. The blood vessels, the lymphatics vessels and nerve fibers were presented in the stroma. Oogonia appeared in the germinal epithelium and gradually forced down into the ovary in the form of small ovigerous tubes. The oogonia surrounded by cells formed the germinal epithelium, became separated from the later as eggnest or young graafian follicles. A young graafian follicle contained a tiny practically yolkless egg surrounded by a single layer of protective follicular cells. As it matured it sank deeper and deeper into the connective tissue of the ovary and showed changes the follicular cells were multiplied and soon fluid filled space appeared which eventually united to form a single follicular cavity, filled with liquor folliculi , which was a nutrient fluid and was used for the nourishment of the egg. The follicular cavity separated the outer layer, membrana granulosa, from cumulus or discus proligerous. The cells immediately surrounded the egg and became arranged in the form of layer of cylindrical cells, corona radiata. A thick

proliferated membrane zona pellucida invested the ovum and within this laid the non articular vitalline membrane. Such a follicle was graafian follicle and arounded each there was a richly vasculary basement membrane. When the follicle was near the outer surface of the ovary, it brusted by increasing turgidity and aided by the contraction of the unstriated muscle fibers around it.

Dellmann, H.D. and Brown E ; M. (1987) described that the uterine wall was composed by endometrium or mucosa, myometrium or muscularies and perimetrium or serosa. The endometrium was lined by simple columnar epithelium but no cilia . The superficial layer of propria submucosa was rich vascular loose connective tissue with many fibroblast. Many macrophages, mast cells were present. Heterophil, eosinophil, lymphocytes, plasma cells entered from blood. Many malanocytes were present in sheep uterus. The deep layer of propria submucosa consisted of loose connective tissue. In primates the endometrium was divided into functional zone (composed of compact and spongy layer) and basal zone. The compact and spongy layers of primates were analogous to the superficial and deep layers of the propria submucosa in the bitch.A small basal zone contained the endometrial gland. In ruminants , caruncles were present. They were rich in fibroblast. Fifteen caruncles were present in each row of uterine horn and the number of rows were four. They were dome shaped in cow and cup shaped in ewe. The myometrium consisted of thick inner circular and outer longitudinal layer of smooth muscle cells with arteries , vein and lymph vessels. The perimetrium consisted of loose connective tissue covered by the peritoneal mesothelium. Smooth muscle cells occurred in perimetrium . Numerous lymph and blood vessels and nerve fibers were present . The vaginal mucosa was lined mostly by stratified squamous epithelium. The cranial part presented the goblet cell. The propria submucosa consisted of loose or dense irregular connective tissue contained lymphatic nodules in the caudal part. The tunica muscularies consisted two or three layers. A thick inner circular smooth muscle layer was separated into bundles by connective tissue and was surrounded by a thin outer longitudinal smooth muscle layer. The tunica adventatia or the serosa consisted of loose connective tissue and contained large vessels, nerves and ganglia. The vulva was covered by skin that was richly supplied with apocrine and sebaceous glands , striated muscle fibers of the constrictor vulvae were found under the dermis. The labia was specially well supplied with small blood and lymph vessels.

Prasad, S.N. and Kashyap, V.K. (1991) noted that the ovary of the mammals was a compact body, the bulk of which was made up of a mass of fibrous connective

tissue and spindle shaped cells, the two together formed the stroma. Each egg cell was surrounded by a nourishing epithelial layer , follicle. The follicle was made up of a row of single cells but with growth the rows of cell layers increase. The germinal epithelium formed the outer coat of the ovary. This layer was formed independent primary follicle. One group of cells enlarged and formed the developing oocyte and the others formed a single layered follicle around it. The follicle enlarged and sank deeper into the stroma it required a fluid filled space, antrum , This fluid was liquor folliculi . This crescentic space gradually became larger and separated the oocyte from the rest of the follicle cells except one point, which was inner most layer surrounding the ovum, corona radiata. The cumulus oophorus was continued with in the membrana granulosa which constituted the inner cellular living of the graafian follicle . The membrana granulosa of the graafian follicle was surrounded by a vascular connective tissue layer and contained blood vessels, nerves and it was enclosed within another connective tissue layer. The graafian follicle ruptured and released the oocyte. The follicle cells proliferated , filled up empty space of discharge follicle and formed yellow body or corpus luteum which appeared as larger yellowish white patch on the surface of ovary.

Hafez, E.S. E. (1993) Stated that the oviductal mucosa was made of primary, secondary folds. The mucosa in the ampulla was thrown into high, branched folds that decrease in height toward the isthmus and became low ridges in the utero-tubal junction. The complex arrangement of these mucosal folds in the ampulla almost completely filled the lumen, so that there was only potential space. The cumulus mass was the intimate contact with the ciliated mucosa. The mucosa consisted of one layer of columnar epithelial cells. The underlying submucosa of smooth muscle fibers and connective tissue was permeated by fine blood and lymph vessels. The epithelium contained ciliated and non ciliated cells. The ciliated cells of the oviductal mucosa had slender motile cilia ( Kinocilia) that extended into the lumen.

Jorden, E.L. and Verma , P.S. (1993) Stated that histologically each ovary was made up of fibrous and vascular connective tissue, stroma . The ova were situated in the stroma in their various stages of maturation. Groups of germinal epithelial cells were found in the stroma , follicles. One follicular cell developed to become an ovum and other cells formed a mass of cells around the ovum discuss proligerous. A fluid filled cavity appeared in the follicle which separated an outer layer of cells, the membrana granulosa formed the cells of discuss proligerous. The follicular cells secreated a striated membranous layer around the ovum, zona pellucida. Mature follicle that was graafian

follicle. The graafian follicle migrated towards the surface of the ovary and ruptured to release the ovum. Gradually these follicle cells proliferated and blood clot transformed into a yellow coloured corpus luteum.

## C. Mammary Gland

Dellmann, D. H. and Brown, E.M. (1976) described that in mammary gland the alveolus was lined by a layer of simple cuboidal epithelium. The lumen was partially collapsed and irregular on outline. Stellate and spindle shaped myoepithelial cells were found between the epithelial cells and the basal lamina of the alveolus. The duct system began within the lobule as an interlobular duct. The epithelium was simple cuboidal but did not have the secretory activity of the alveolus and alveolar duct and contained spindle shaped myoepithelial cells. Ducts entered the interlobular connective tissue septa, it became the interlobular duct and consisted of two layers of flattened cuboidal cells. Longitudinal smooth muscle fibers became associated with these duct and formed the large lactiferous duct. The two layer cuboidal epithelium continued these duct and smooth muscle became more prominent. In ruminants several lactiferous ducts employed into a single sinus was at the base of the teat. The sinus was lined with two layer cuboidal epithelium and contained a layer of smooth muscle. In bitch each lactiferous duct enlarged at the base of the teat and formed several lactiferous sinus.

Elias, *et al* (1987) Stated that each lobe of the mammary gland has a individual duct lined with an epithelium which varied from stratified squamous near the exit to simple cuboidal towards the alveoli.

Ghosh, R.K. (1998) reported that the lactiferous sinus was not prominent in mammary gland.

## D. Placenta

Mukherjee, D. (1972) Observed that the placenta was discoidal (deciduate) or haemochorial type in rabbit.

Datta, A.K. (1995) Stated that placenta of the rabbit was haemoendothelial according to the tissue forming placental barrier.

Prasad , S.N. and Kashyap. V. (1991) demonstrated that the placenta was haemoendothelial type in the rabbit.

# CHAPTER - 3

# MATERIALS AND METHODS

# MATERIALS AND METHODS

Total fifteen adult female apparently healthy rabbits were utilised in this investigation. Out of all these experimental animals three were gravid. The rabbits were procured from the Department of Animal Sciences, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia and Government of West Bengal , Directorate of Animal Resources , Goat, Sheep and Rabbit breeding farm, Buddha Park , Kalyani, Nadia , for raring in the animal house of the Department.

These rabbits were maintained in the animal house with rational food and water ad-libitum. The age and body weight of the animals were not considered. The rabbits were randomly assorted into three groups :

i. Group one was utilised for gross morphological studies of the female genital organs.

ii. Second group was utilised for histological observation.

iii. Third group was utilised for the study of placenta on microscopic level..

For gross anatomical study, the animal was embalmed as per standard procedure. This was done by bleeding the animal through carotid canulation and subsequently by transfusion of the embalming fluid (formalin 10%, water 85% , glycerin 2% , phenol 1% and Arsenic tetraoxide 2%) with the help of a human drip set. The whole procedure was done under general anaesthesia ( Zylazine with Ketamine). Zylazine was given 1.1 mg per kg body weight intravenously. The Ketamine was given 2.2 mg / kg. body weight intravenously) and under strict surgical asepsis. The embalmed animal was kept for 48 hours at room temperature.

A mid line incision from the caudal end of the linea alba was given to expose the viscera of the abdomen. The components of the female genital organs i.e. body, horn of uterus and fallopian tubes were detected and displayed keeping its normal anatomical position undisturbed.

The disposition of the various components was observed carefully and recorded by taking snaps. The relative positions were also taken into consideration.

The pelvic cavity was also exposed after removing one of the hind legs and by removing a part of the hip bone and some skeletal muscles to get a clear view of the caudal part of the genital tract (vagina and vulva).

After making necessary photographic record the organs were separated from the body to make measurements of its various parts regarding their shape and size.

For histological slide preparation a set of six fresh animals were utilised. Tissues were collected in 10% formalin immediately after sacrificing of the animals. The same organs were also used for taking measurements of their various dimensions.

The organs which were collected for this purpose are :

1. Ovary.
2. Proximal end of fallopian tube.
3. Middle part of fallopian tube.
4. Uterine end of fallopian tube.
5. Proximal end of horn.
6. Middle part of horn.
7. Distal part of horn.
8. Middle part of vagina.
9. Middle part of vagina with urethra.
10. Vestibule.
11. Mammary gland.

For the study of placental organisation in histological level a set of three gravid animals were utilised. Under surgical procedure and general anaesthesia par histerectomy were performed and the uteri were taken out for the study of foetal membranes and their attachments with the uterine (horn) walls.

The gravid horns were opened, placental attachments were exposed and photographed. The said area (foetal membrane and its junction with the endometrium) were collected carefully and preserved in 10% formalin for histological preparations.

For making comparative histological study some other tissues were also collected in 10% formation as follows :

1. Non attached part of the gravid horn.
2. Wall of non gravid horn of the gravid uterus.
3. Ovaries of concerned side of the gravid as well as non gravid horn.
4. Placenta

All the tissues collected in 10% formalin were processed as per standard procedure and 4 μ (micron) sections were cut by wes wax rotary microtome. The sections were deparaffinised in Zylene and stained with haematoxilin and eosin as per routine method. Harris haematoxilin (Harris, 1900) was used in the staining procedure. Photomicrographs were made under light microscope in various magnifications. For the record on the semigross appearance of the luminal surface of horn, stereoscopic microscope was used.

The different parts of the genitalia were measured, data were recorded and analysed by standard statistical method (Snedecor and Cochran , 1967).

# CHAPTER - 4

# RESULTS

# RESULTS

Gross morphological structure of all the components of the female genitalia of rabbit along with the histomorphological organisations of various tissues have been studied in this investigation. The structure of the mammary gland and the attachment of foetal membranes with the endometrium were also considered in details.

The results have been presented in this chapter under the following headings:

## A. GROSS ANATOMICAL STRUCTURE

1. Morphology of the female genitalia as a whole.
2. Disposition of various parts of the genitalia in the body.
3. Structure of individual organs:
   a) Ovary
   b) Fallopian tube
   c) Horns of the uterus
   d) Vagina
   e) Vestibule and Vulva
4. Attachment of foetal membranes with the endometrium.

## B. HISTOMORPHOLOGICAL ORGANISATION

The organs which have been studied for histological details are as follows:

a) Ovary
b) Fallopian Tube (Proximal Part, middle Part and distal part of the tube).
c) Horn of the uterus (Proximal Part, Middle Part, and Distal Part of horn).
d) Vagina
e) Vestibule & Vulva
f) Mammary gland
g) Placenta.

# GROSS ANATOMY

## Female genitalia of rabbit : (General consideration)

This system comprised of ovary, fallopian tubes, horns of uterus, Vagina and Vestibule & Valva. There were two ovaries and each of them was found to be an elongated pale yellow coloured organ situated almost at the floor of the corresponding aspect of the abdominal cavity close to the ventral aspect of the first part of the cecum.

Both the fallopian tubes were found to be narrow and extended from the tip of the horn in a tortuous manner to the level of the situation of the ovary. Each tube was tortuous, long and remained within the layer of peritoneum. (fig. 1)

Practically the body of the uterus was not detected due to complete division of the organ into two long horns of almost equal shape and size.

Each horn was found to be thick walled muscular tube which extended in front at first in a curved and then in a tortuous manner. They were attached with the corresponding aspect of the broad ligament. Caudally both the horns were seen to be little dilated and placed in close opposition.

The vagina was an elongated comparatively thin wall tube placed in the pelvic cavity in between the rectum and bladder. A considerable part of the urethra was attached to the ventral wall of the organ. The vestibule was very short and vulva was the terminal part of the genitalia and was placed below the anus. (fig. 2).

## Ovary:

Both the ovaries were elongated Structure with pinkish colour. The ovary was found to be intimately attached to a fold of Peritonium. It was placed in a cranio Caudal direction within a fold of the Fallopian tube. The length of the left ovary was $1.42 \pm 0.19$ cm. The length of the right ovary was $1.4\,2 \pm 0.19$ cm. The width of the left ovary was $0.56 \pm 0.14$ cm and that of the right ovary was $0.54 \pm 0.05$ cm. (fig. 3)

Therefore the organ was nearly three times elongated than its width. Both the ends were rounded. The dorsal surface was free and the ventral surface was attached to the broad ligament (fig.11). The hilus was extended along this ventral attachment

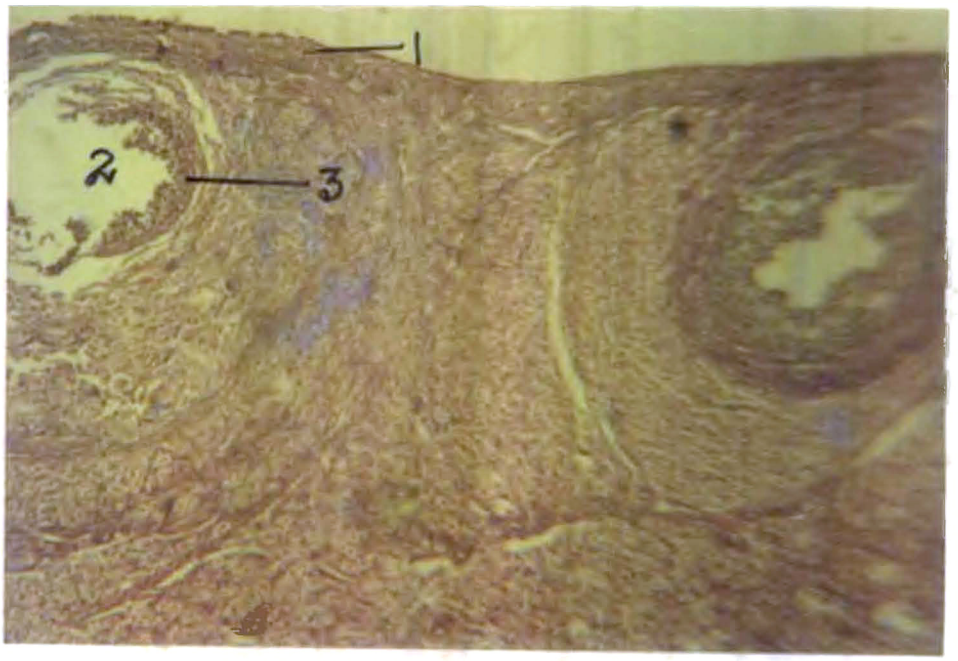


Fig.H -1: Photomicrograph of the cortex of ovary of rabbit. (50X)H &E Stain :
1. Germinal epithelium 2. Mature follicle without ovum 3. Follicular cells

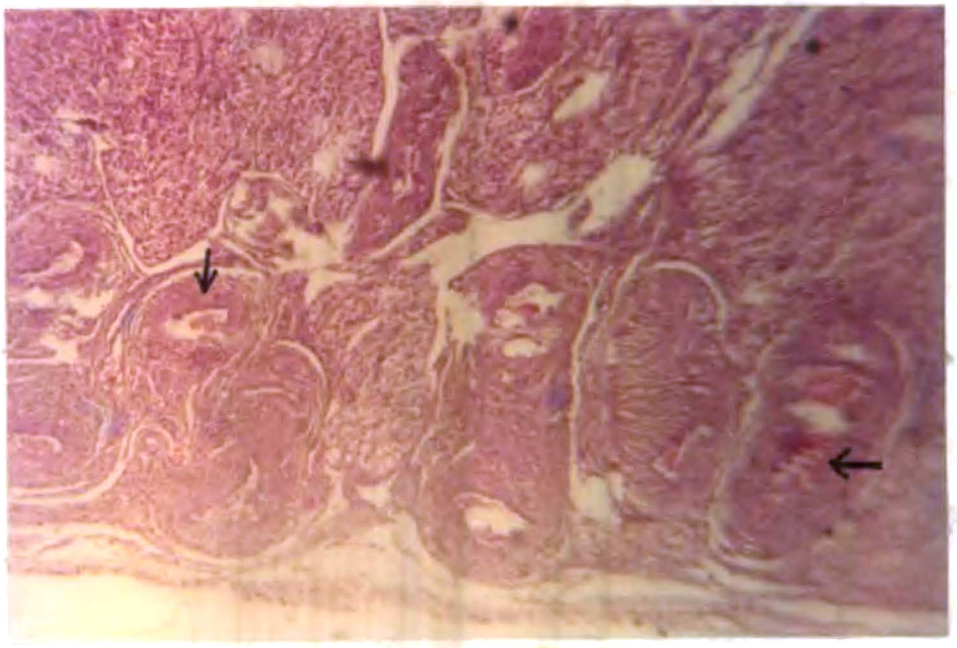

Fig.H -2: Photomicrograph of the hilus of the ovary showing a number of thick walled transverse sections of ovarian artery (arrow) containing blood cells (arrow) (50X) H & E Stain :

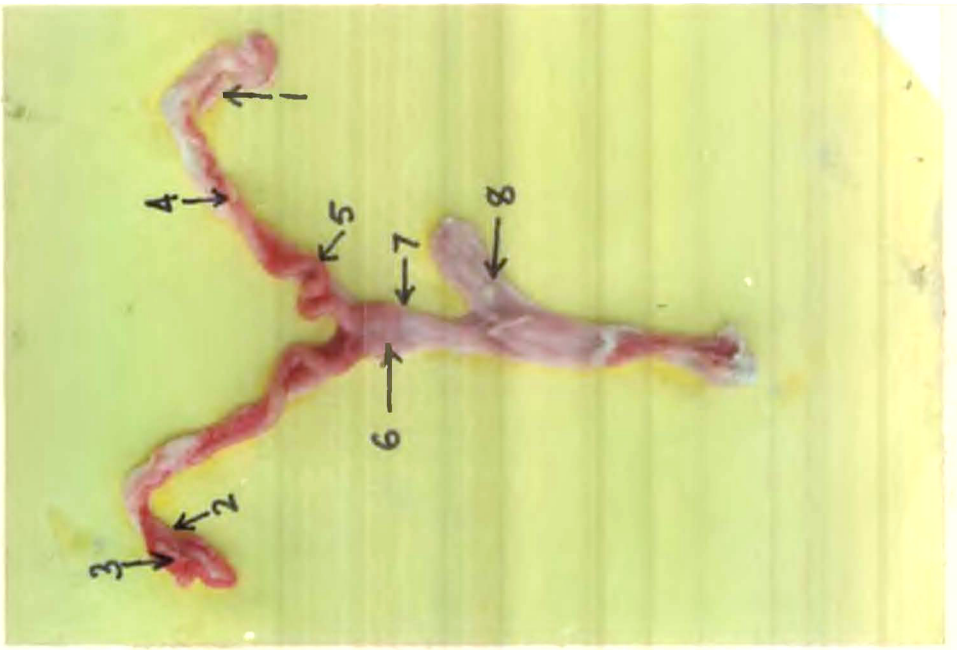


Fig.1 Female genitalia of rabbit showing its various components :
1. Ovary 2. Infundibulum 3. Ampulla 4. Isthmus 5. Horn 6. Neck of uterus. 7. Vagina cranial part 8. Bladder


Fig.2 External genitalia of female rabbit :
1. Opening of rectum 2. Labia minor 3. Labia major 4. Opening of the vestibule

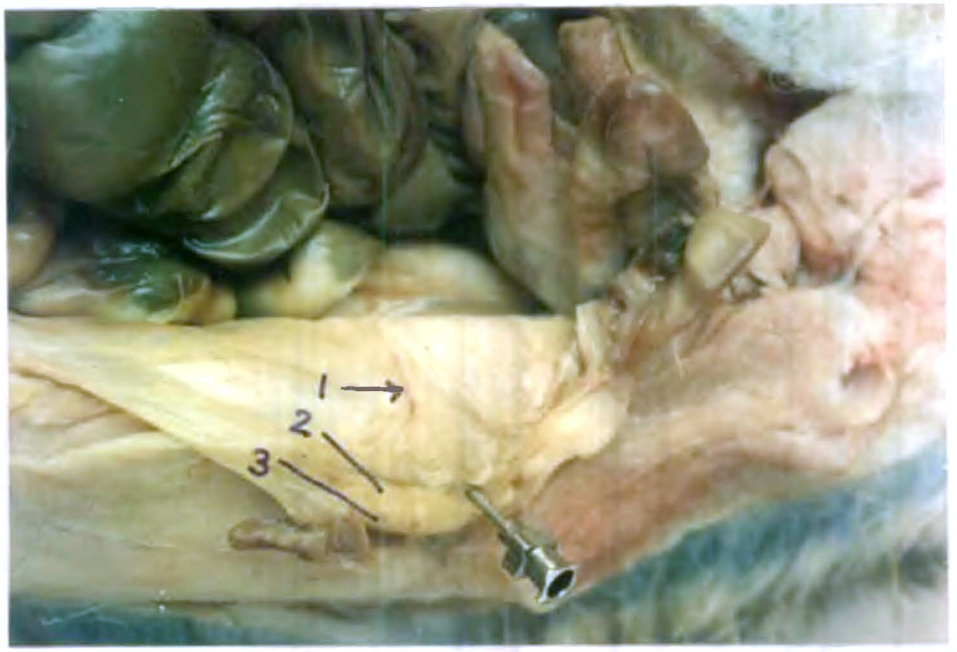


Fig.3 Nacked eye appearance of the ovary, mesovarium and vessels of the ovary : 1. Ovarian vessels 2. Dorsolateral surface of ovary 3. Mature ovarian follicle

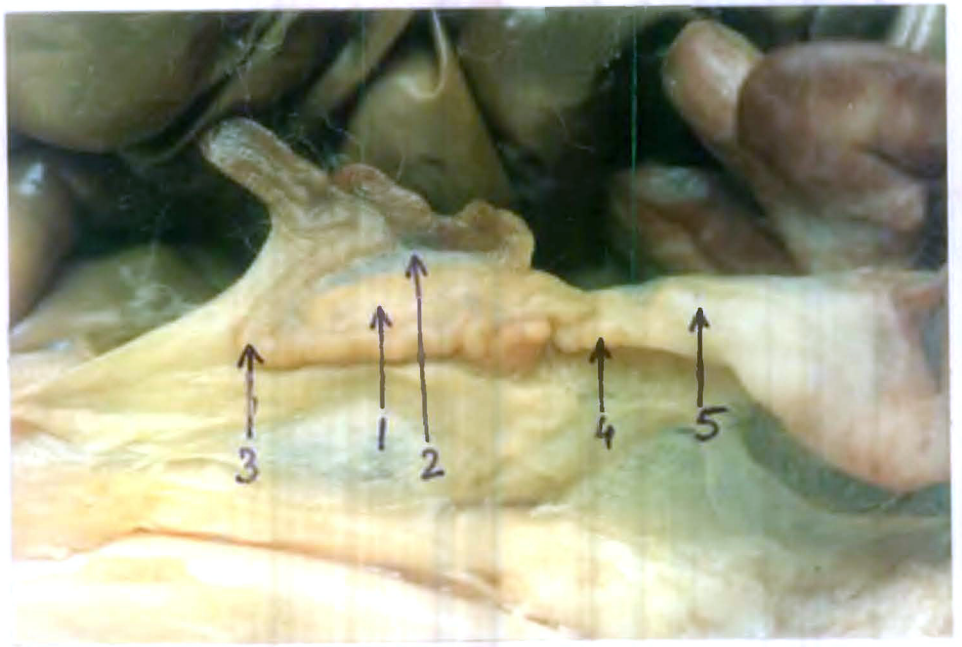


Fig.4 Gross morphology of the cranial portion of the female genitalia of rabbit : 1. Ovary covered by mesovarium 2. Mesovarium 3. Loop of the oviduct winding round the cranial end of the ovary 4. Isthmus 5. Tip of the horn 6. Beginning of the horn

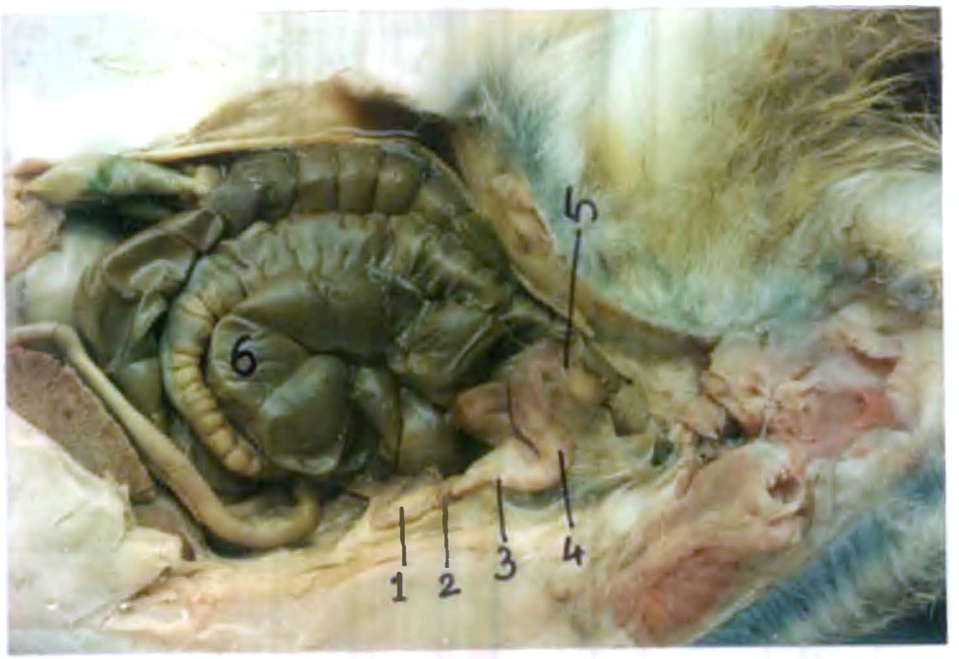


Fig.5 Gross appearance of the female genitalia of rabbit in situ (Left side of the abdomen exposed) :
1. Ovary 2. Oviduct 3. Termination of the horn 4. Middle part of the horn 5. Beginning part of the horn. 6. Caecum

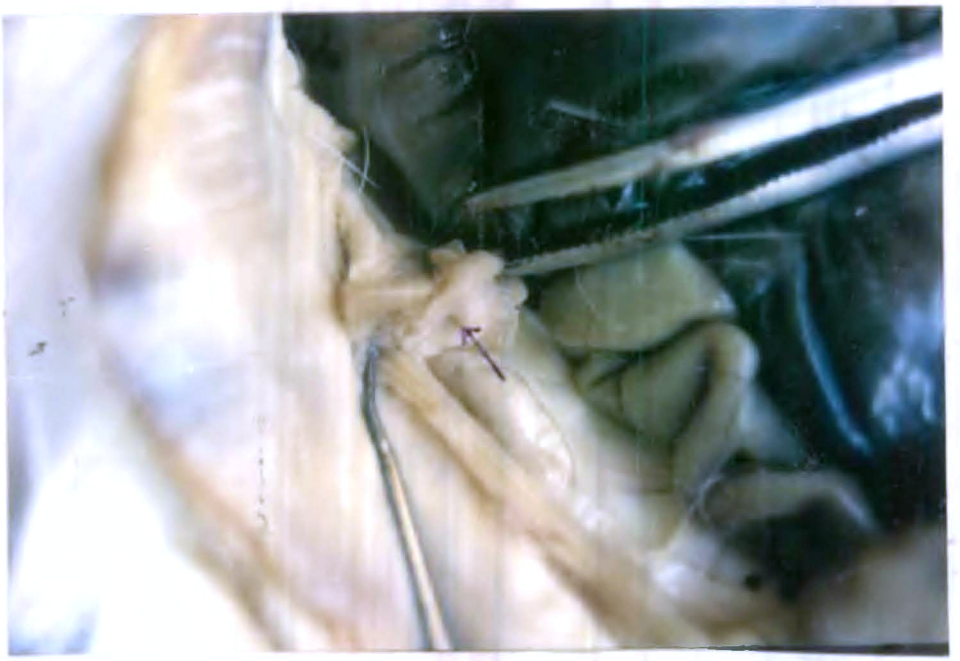

Fig.6 Gross photography of the infundibulum showing fimbrae and infundibular opening (arrow) :

The surface of the ovary was moderately smooth with some prominences for the presence of maturing follicles. These prominences appeared to be translucent. (fig 4) Scar marks for regressed corpus Lutium were also seen in some specimens.

A part of the fimbriated margin of the infundibulum of the fallopian tube was found to be attached to the cranial end of the organ in most of the specimens.

The average weight of the ovaries was 339 ± 014.0 and ranged from 250 to 360 mg. The ovary was a compact organ of situated at the floor of the corresponding aspect of the abdominal cavity closed to the ventral aspect of the first part of cecum. Both the ovaries were suspended by the masovarium. Well developed ovarian artery was found to be passing along the cranial aspect of broad ligament.

**Fallopian tube :**

The fallopian tube was a slender flexuous tubular organ and formed the cranial part of the female genitalia of rabbit. This duct tube extended from the tip of the corresponding horn of uterus in the from of a narrow thick walled tube. The beginning of the tube was very narrow. It started from the tip of the blunt termination of the horn of uterus and therefore possessed an intramural part. The first part was found to be highly tortuous than the 2$^{nd}$ part of the tube. The second part was comparatively dilated and thin walled. The first part represented the Isthmus and the second part represented Ampulla of the organ. The Ampulla was less flexuous and made a turning around the lateral, cranial and a part of the medial aspect of the ovary in a little flexuous manner and continued with the infundibulum (fig. 4 , 5 and 1).

The terminal part of the oviduct was highly dilated and represented funnel shaped infundibulum. However the fimbrae of the infundibulum were although recognised, the characteristic finger like projections were not well detected. The margin of the funnel was found to be thin and appeared to be irregular. The length of the fallopian tube ranged from 4.9 to 6.1 cm with a average value of 5.34 ± 0.432 cm. The abdominal opening of the tube was clearly visible at the center of the infundibulum (fig. 6). The mesosalpinx or the peritoneal fold derived from the broad ligament enclosed the whole length of the tube.

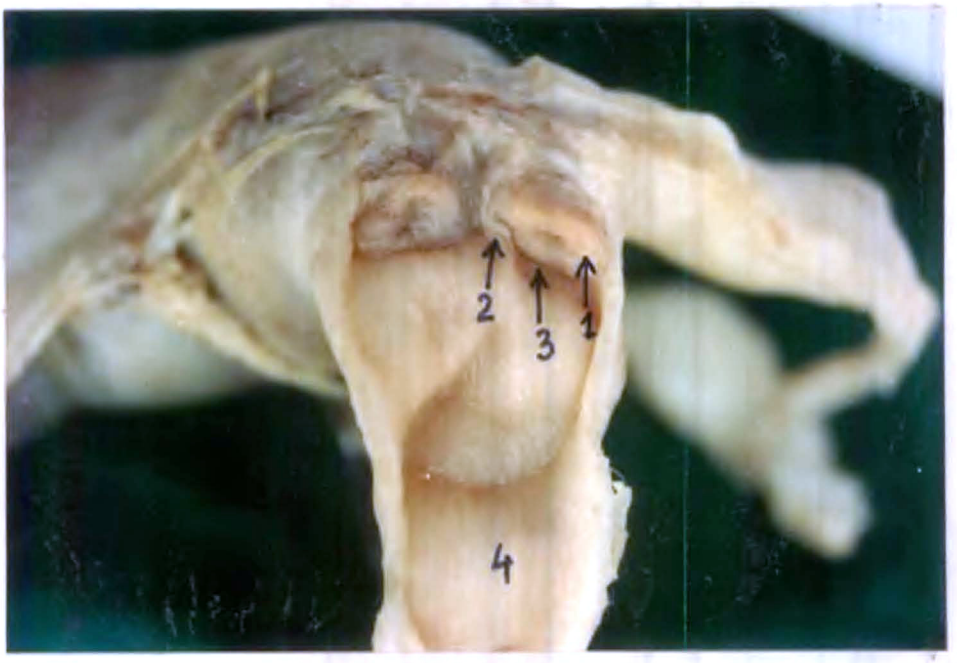


Fig.7 Gross photography of the exposed cranial part of vagina. Two external os placed bilaterally by either side of the mucosal fold :
1. External os 2. Mucosal fold 3. Fornix vagina 4. Floor of vagina

Fig.8 Gross photography of the exposed lumen of horn of uterus showing mucosal fold (arrow) :

**Uterus :**

The horns of the uterus were the largest components of the genitalia. The uterus was found to be completely bicornuate because each horn had a separate opening at the cranial end of the vagina. (fig. 7). The horns were curved , slightly flexuous narrow thick wall cylindrical tubes. Each horn started in the form of a broad thick-walled muscular tube from the cranial end of the vagina . It extended at the beginning in forward and upward direction. Subsequently it went downward for a small length, made a flexure at the prepubic area and then proceeded forward along the floor of the corresponding aspect of the abdomen and continued as the fallopian tube (fig. 5,1)

The terminal part of the horn ended in the form of a blunt tube from where the narrow isthmus of the fallopian tube started. (fig. 12).

At the beginning both the horns were considerably thick and were placed side by side and were covered by a common fibro muscular coating. However identity of individual horn at this part were also visible under the said cover. The lengths of the horns of left and right sides were 10.02 ± 1.15 and 10.36 ± 0.62 cm respectively and the average diameter of the region was 6 mm. in non pregnant condition.

The tubular horns experienced a small parallel course of about 2 -.3 cm and then started diverging on either side. The width diminished gradually with their forward course. The greater curvature was facing at the dorsolateral aspect and was free. The lesser curvature, which faced ventromedially and was attached with the broad ligament.

The broad ligament was moderately thick and contained vessels, smooth muscle fibers, nerves and connective tissues. The whole outer surface of the horns presented faint grooves along their lengths.

Since the wall of the horn is very thick in non pregnant condition, the lumen is very narrow and irregular in appearance. On opening of the lumen it was observed that a good number of longitudinal folds are protruding into the lumen (fig. 8). These long infoldings of the endometrium were found to be intersepted by presence of frequent transverse grooves and there by in some places where these transverse grooves are more closely situated, took a nodular pattern.

In some specimens it was observed that both the horns were connected by a fibromuscular band in a oblique manner (fig.9).

Fig.9 Gross photography of the caudal part of the horn of uterus showing a connection (fibro muscular ) between them (arrow) :

Fig.10 Gross photography of the external genitalia of female rabbit showing the labia minor (arrow) :

Fig.11 Gross photograph of female genitalia of rabbit showing attachment of broad ligament to the lesser curvature of the horn of uterus. (arrow) :

The caudal terminal part of each horn which protruded into the cranial lumen of the vagina represented os of the uterus. Since both the horns terminated separately, two well visible cervices were detected.

Each cervix was thick wall closed tube with a covering of multi lamilated mucous membrane. The external opening was very much prominent. A thick mucous fold was detected in between the cervices (fig.7). The fornix vaginae are therefore double (one for each cervix) and are not much capacious.

**Vagina :**

This was a comparatively thin walled tube which extend caudally from the uterus to the vestibule and was placed along the mid floor of the pelvic cavity. The organ was related dorsally to the rectum and ventrally to the bladder and the floor of the pelvic cavity. The neck of the bladder and the urethra was found to be comparatively long and was situated at the mid - ventral aspect of the vaginal tube. A considerable part of the urethra was seen to be embedded at the floor of the vagina.

The lumen of vaginal tube exhibited numerous faint longitudinal mucosal folds which were prominent at the cranial portion. The external urethral orifice was found to be a slit like passage without having a diverticulum close to it.

The length, width and the diameter of the organ was found to be $8.92 \pm 1.67$ cm, $1.18 \pm 0.14$ cm and 1.0 cm respectively.

**Vestibule and Vulva :**

Vestibule was found to be very small and extended from the level of external urethral orifice to the ischial arch. The mucosal folds were found in this part of the tube.

The Vulva was the external margin of the urogenital sinus which hanged down-ward just below the anus. It was covered by skin and fine hairs. Fine hairs were distributed over the external surface of vulva. The vulva was laterally bounded by two prominent swellings represented fold labia minora (fig.10). The length and width of the vulva was $1.56 \pm 0.43$ and $1.1 \pm 0.20$ cm respectively.

The dorsal commissure was not very much recognisable but the ventral commissure was found to be formed by the junction of ventral ends of the labia. The labia minora was found to be surrounded by an irregular fold of skin which represented labia majora. This external fold did not present any regular shape but was

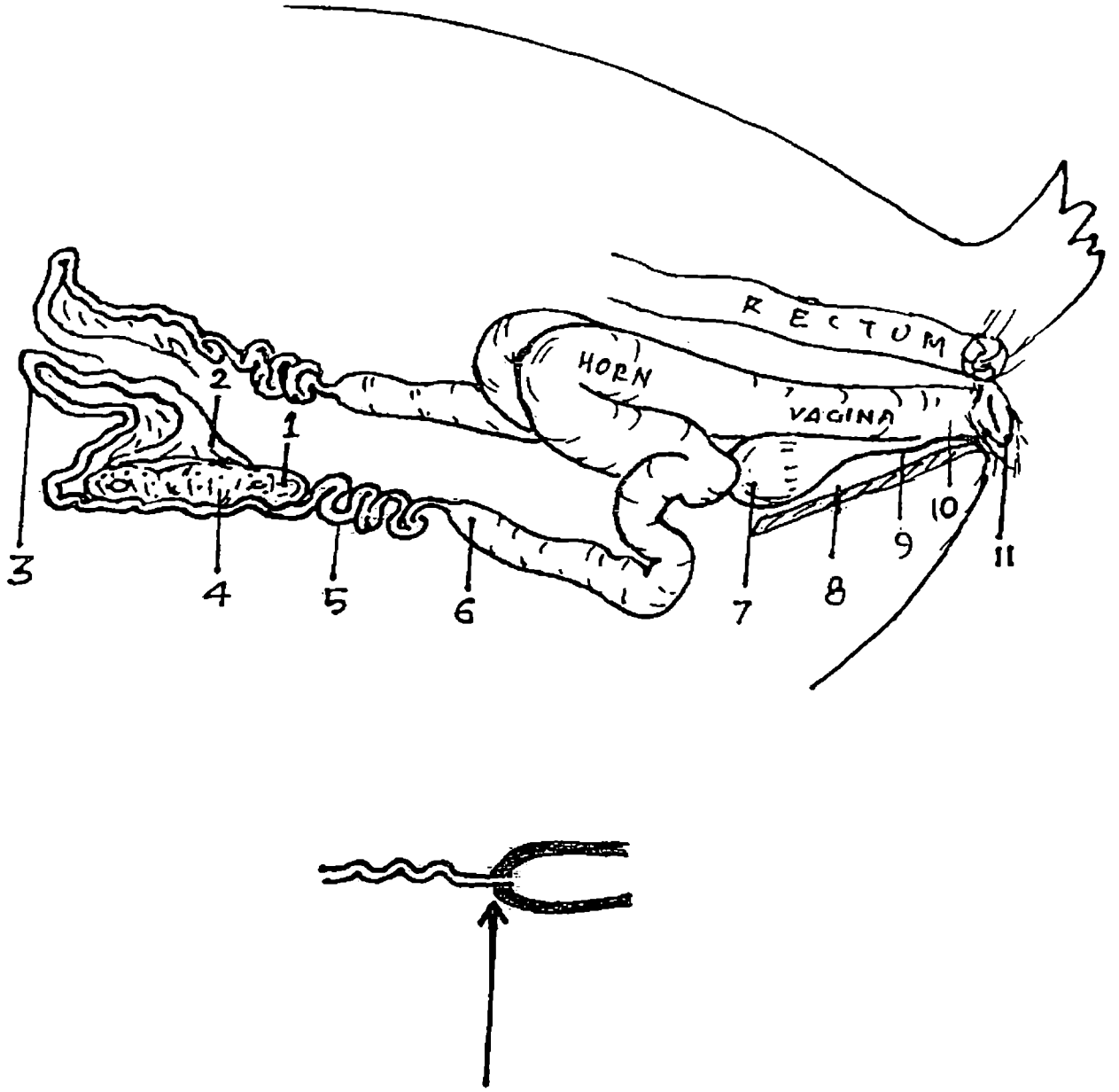


Fig.12 Schematic diagram of the genitalia of female rabbit (in situ) :
1. Caudal end of ovary 2. Infundibulum 3. Ampulla 4. Middle part of ovary 5. Isthmus 6. Tip of horn 7. Bladder 8. Floor of pelvic cavity 9. Urethra 10. Vestibule 11. Labium
Arrow - Junction between oviduct and tip of horn.

wrinkle in appearance. The outer margin of this so called labia majora was stooded with plenty of fine hairs. (Fig.10)

In normal stage the external orifice was found to be a slit like aperture and directed almost vertically. An irregular elevation was noticed on the mucous membrane close to the Ventral commissure represented clitoris. (Fig.10)

**Biometry of various organs of female genitalia of Grey giant rabbits :**

**Table- 1 : OVARY**

| Name of Organs | Max. Range | Min. Range | Mean | Standard Error | Standard Deviation |
|---|---|---|---|---|---|
| 1. Left Ovary Length (cm). | 1.6 | 1.1 | 1.42 | 0.192354 | 0.17 |
| 2. Left Ovary Width (cm). | 0.7 | 0.4 | 0.56 | 0.114018 | 0.102 |
| 3. Right Ovary Length (cm). | 1.6 | 1.1 | 1.42 | 0.192 | 0.172 |
| 4. Right Ovary Width (cm). | 0.6 | 0.5 | 0.54 | 0.054772 | 0.049 |
| 5. Ovary Weight (mg). | 360 | 325 | 339.8 | 14.0961 | 12.61 |

**Table- 2 : FALLOPIAN TUBE**

| Name of Organs | Max. Range | Min. Range | Mean | Standard Error | Standard Deviation |
|---|---|---|---|---|---|
| 1. Fallopian tube (left) Length (cm). | 6.1 | 4.9 | 5.34 | 0.483 | 0.432 |
| 2. Fallopian tube (right) Length (cm). | 6.0 | 5.0 | 5.49 | 0.491 | 0.453 |

**Table- 3 : HORN OF UTERUS**

| Name of Organs | Max. Range | Min. Range | Mean | Standard Error | Standard Deviation |
|---|---|---|---|---|---|
| 1. Right horn of uterus Length (cm). | 11.0 | 9.6 | 10.36 | 0.622 | 0.557 |
| 2. Left horn of uterus Length (cm). | 11.2 | 8.2 | 10.02 | 1.158 | 1.036 |

**Table- 4 : VAGINA AND VESTIBULE**

| Name of Organs | Max. Range | Min. Range | Mean | Standard Error | Standard Deviation |
|---|---|---|---|---|---|
| 1. Vagina Length (cm). | 11.7 | 7.8 | 8.92 | 1.67541 | 1.50 |
| 2. Vagina Width (cm). | 1.4 | 1 | 1.18 | 0.148324 | 0.133 |
| 3. Vulva Length (cm). | 2 | 1 | 1.56 | 0.43359 | 0.388 |
| 4. Vulva Width (cm). | 1.4 | 0.9 | 1.14 | 0.207364 | 0.185 |

## HISTOLOGICAL OBSERVATION

### Ovary :

Like those of other mammals the ovaries of rabbit exhibited cortical and medullary areas, although no demarcation between these zones was detected. The surface was formed by a layer of flattened cells and connective tissue elements, represented the so - called germinal epithelium. However the ovarian follicles in their various stages of development were found in the cortical zone. Few large follicles with or without ovum could be seen close to the surface in the histological slides. The matured follicles presented most of the usual characteristics to those of other higher mammals. The oogonia follicular cells, antrum and the theca could be clearly identified (fig. H- 1) A good number of thick wall sections of the arteries were found to a

arranged in compact manner which were actually the sections of the same blood vessels remained in a coiled disposition at the hilus of the organ. Some sections of the contained with red corpuscles. (fig. H-2). The Stroma of the organ was found to be less compact and was more vascular. It contained vessels, nerves, and lymphatics and connective tissue elements. This area represented the medula of the organ. The follicles either mature or immature were not found in medularly zone. In some specimens multiple matured follicles were detected at the Periphery of the organ.

## Fallopian tube :

Considerable variation was observed in the wall of the organ at different portins of fallopian tube.

**(A) Infundibulum :**

This was a thin wall Tube. The lumen was dilated but mostly engorged with various folds of the mucous membrane. (fig. H -3). The mucousal fold were found to be branched and extended upto the centre of lumen, leaving a small irregular free space at the center. The muscularies mucosae did not extend inside the mucosal folds. Therefore the infolding appeared to be very soft and Pliable. The muscular and serous layers were found to be very thin. The various layers of smooth muscle of this part of fallopian tube was not well recognised.

**(B) Ampulla :**

Wall of the middle part of this tube was found to be comparatively thicker. The outer serous layer was found to be thick. The muscular layer was thick and comprised of both inner circular and outer longitudinal muscles. A good number of blood vessels were observed in the serous layer. Muscularies mucosa was also detected. Numerous mucosal fold of short height protruded into the lumen of the tube. Each infolding was short, thick and sometimes branched. The tip of each mucosal fold was blunt and therefore gave a denticulated appearance under low power light microscope. A very thin layer of muscularies mucosa was seen to be extended into the infoldings. Since the mucosal fold could not reached upto the centre of the lumen, the luminal space was comparatively greater in this part of this tube. (fig. H- 4)

**(B) Isthmus :**

This part of the tube was comparatively narrow and thick walled. The serous covering was comparatively thick and enclosed good number of vessels. The


Fig.H - 3: Photomicrograph of the proximal end of fallopian tube (infundibulum) (25X) H & E Stain :

1. Wall 2. Lumen 3. Mucosal folds

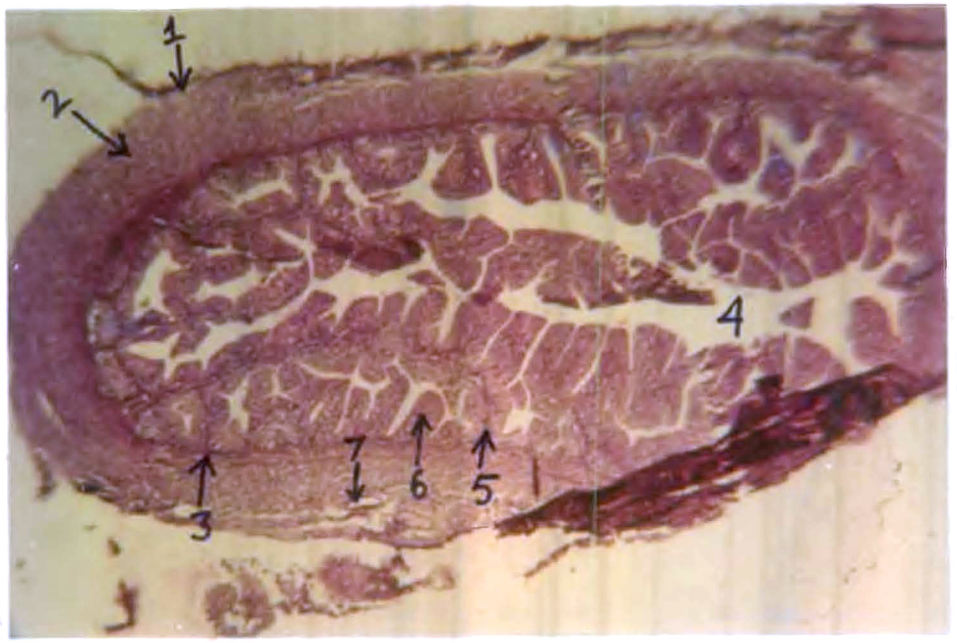


Fig.H - 4: Photomicrograph of the middle part of fallopian tube (50X) H & E Stain :

1. Serous layer 2. Layer of longitudinal museles 3. Layer of circular muscles 4. Lumen 5. Muscularis mucosa 6. Mucous fold 7. Blood vessel

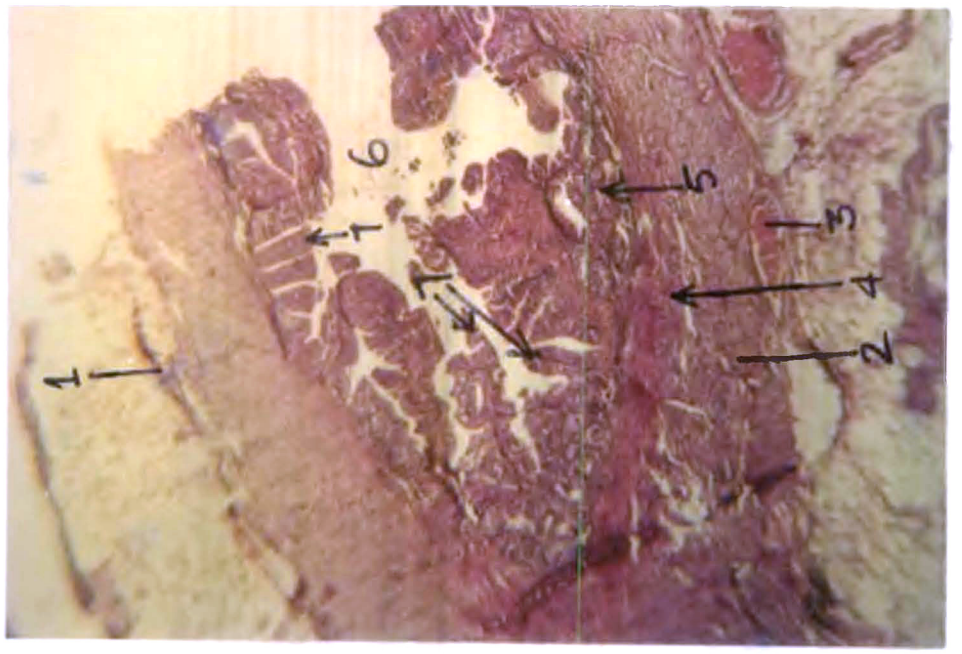


Fig.H - 5: Photomicrograph of the distal (uterine) end of the fallopian tube (50X) H & E Stain :

1. Serous layer 2. Longitudinal muscle 3. Blood vessel 4. Circular muscle 5. Submucosal gland 6. Lumen 7. Mucosal folds

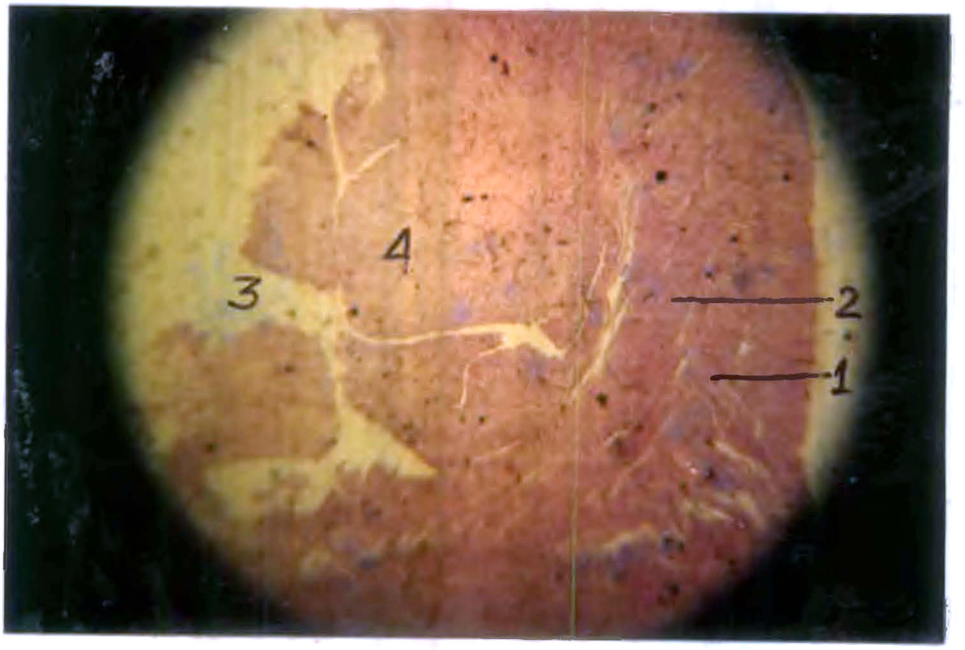


Fig.H -6: Photomicrograph of the proximal of the horn of uterus (25X) H & E Stain:

1. Longitudinal muscle 2. Circular muscle 3. Lumen 4. Mucous folds


Fig.H -7: Photomicrograph of the middle part of the horn of the uterus (25X) H & E Stain :

1. Mucosal fold 2. Lumen 3. Space between folds

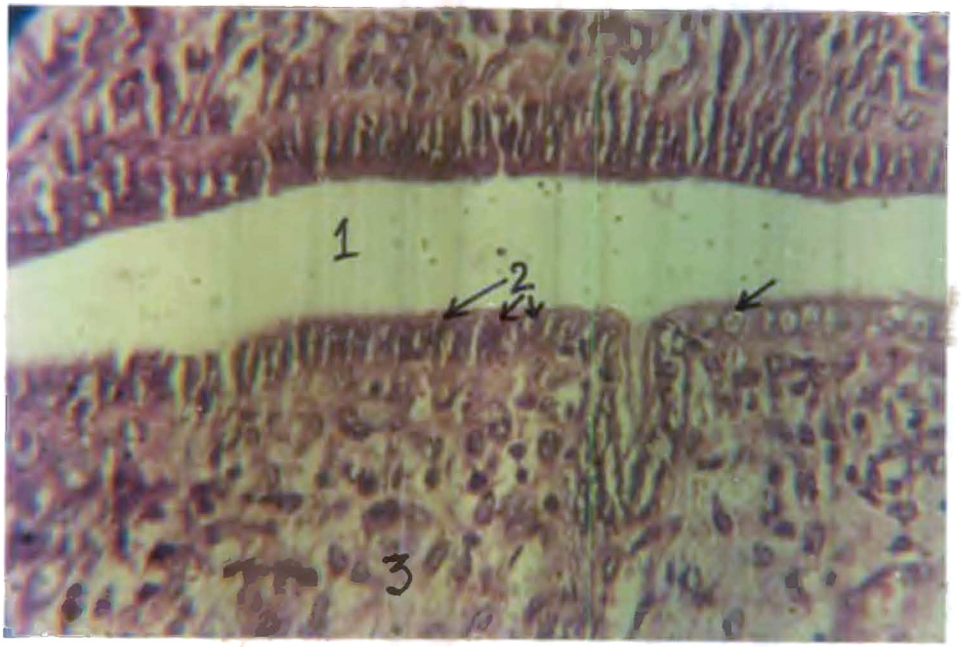


Fig.H -8: High power photomicrograph of the endometrium at the proximal part of the horn of uterus (450X) H & E Stain :

1. Space between endometrial folds 2. Columnar epithelial cells 3. Spongiosum

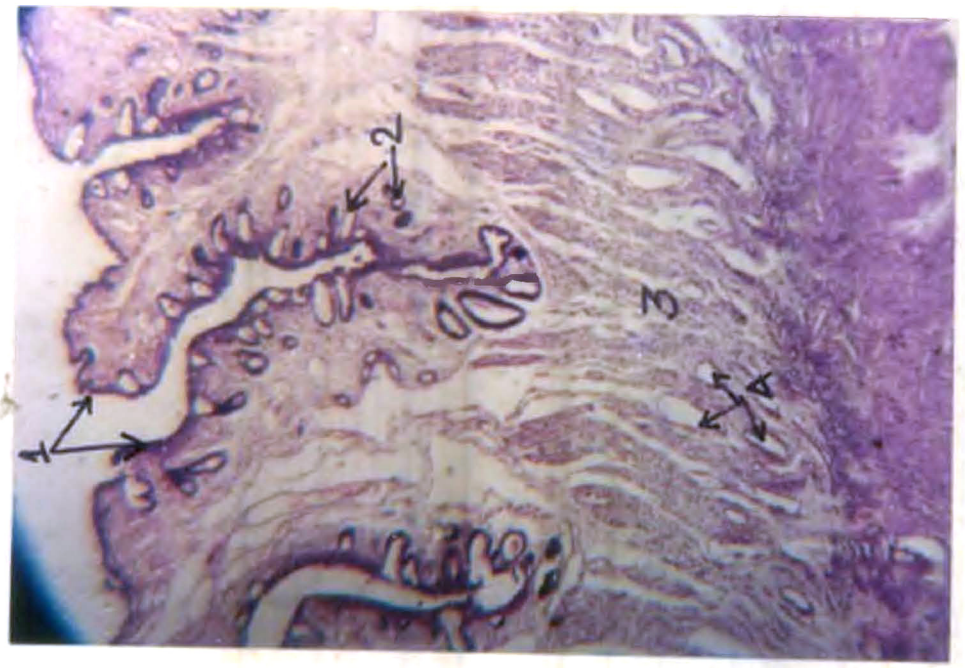


Fig.H -9: Photomicrograph of the endometrium of a non- gravid horn of gravid uterus of rabbit. (50X) H & E Stain :

1. Mucosal folds 2. Endometrial glands 3. Spongiosum 4. Blood vessels

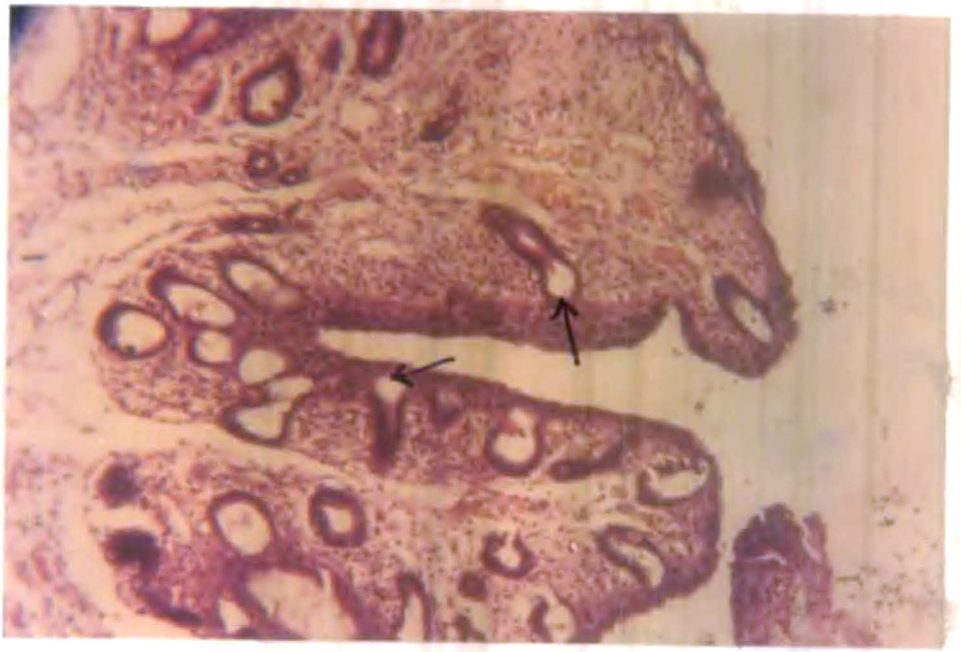

Fig.H -10: High power photomicrograph of the endometrial folds of the non gravid horn of gravid rabbit showing plenty of glands close to the surface area (arrow) (100X) H & E Stain :

muscular layer was very thick. The outer longitudinal and inner circular layer was well recognised. The muscularies mucosa was also detected. In a few places submucosal glands were found. The mucosal folds were few in number but each of them was large in Size. Each fold had a broad base and a blunt apex. The apex of these fold did not reached upto the lumen. Therefore luminal space is greatest in this part of this tube (fig. H-5). Some folds of this area were small and gave a denticulated appearance like that of middle (ampulla) part of the tube. The continuation of serous layer with that of broad ligament was visible in some histological preparations.

## Uterus :

The uterus in this species comprised of two separate horns without having a body. Each horn of the uterus was composed by three layers - inner endometrium middle myometrium and outer perimatrium.

**(A) Endometrium :**

In normal (non-pregnant) condition the endometrium was found to be highly infolded and these infoldings were large and occupied most of the space of the lumen (fig H-6, H-7 and H-20) . These infoldings of the endometrium extended throughout the whole length of this tubular organ in a linear manner. Each of the endometrial fold appeared as a broad tongue shaped structure with a blunt apex and a broad base as appeared in transverse histological sections. The space between the folds were found to be narrow and extended up to the bases.

The surface epithelium of these folds comprised of a layer of tall columnar cells without any cilia on them (fig. H-8). Some cells presented a large round or oval nucleus (arrow). Covered by the epithelium and enclosed in the infoldings there was a good number of cells and connective tissue, elements, vessels and nerves and represented the spongiosia of the endometrium. Endometrial glands and their ducts were also found in histological sections.

In pregnant animals the endometrium was found to be in proliferative stage. Numerous endometrial glands with their ducts were found within the endometrium (fig. H- 9 and 10) of the non gravid horn of the pregnant rabbit. In higher magnification (fig.- H - 11) it was observed that the cells of the surface epithelium were low columnar with large oval nucleus in this stage. The duct of the glands were thick and the spongiosum was composed of loose connective tissue with good amount

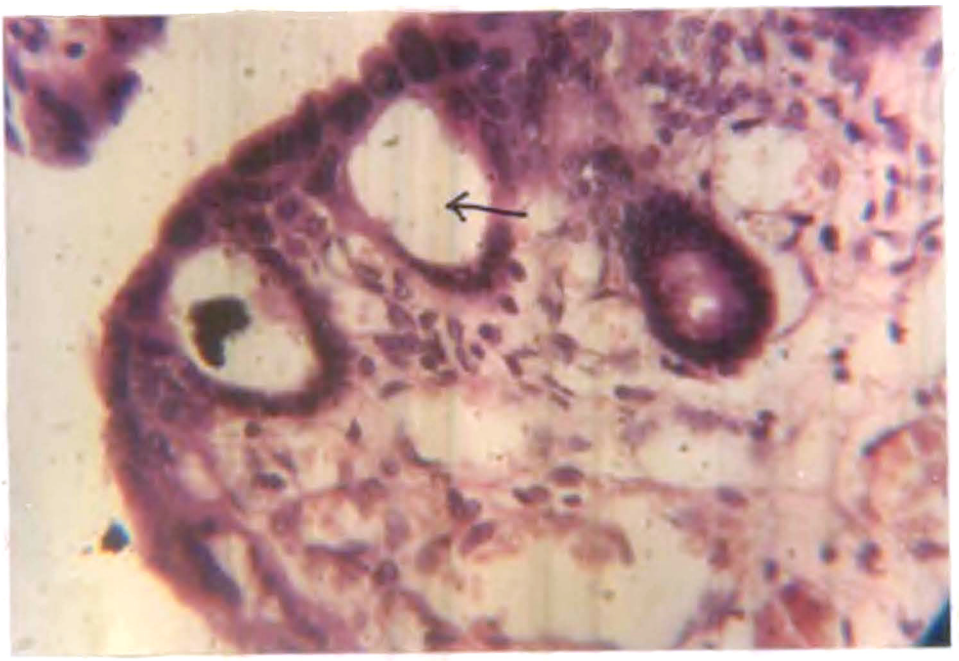

Fig.H -11: High Power photomicrograph of a mucosal fold of the non gravid horn of pregnant rabbit showing cuboidal type large nucleated surface epithelium. Large opening of the uterine glands are also dipicted. (arrow) (50X) H & E Stain :

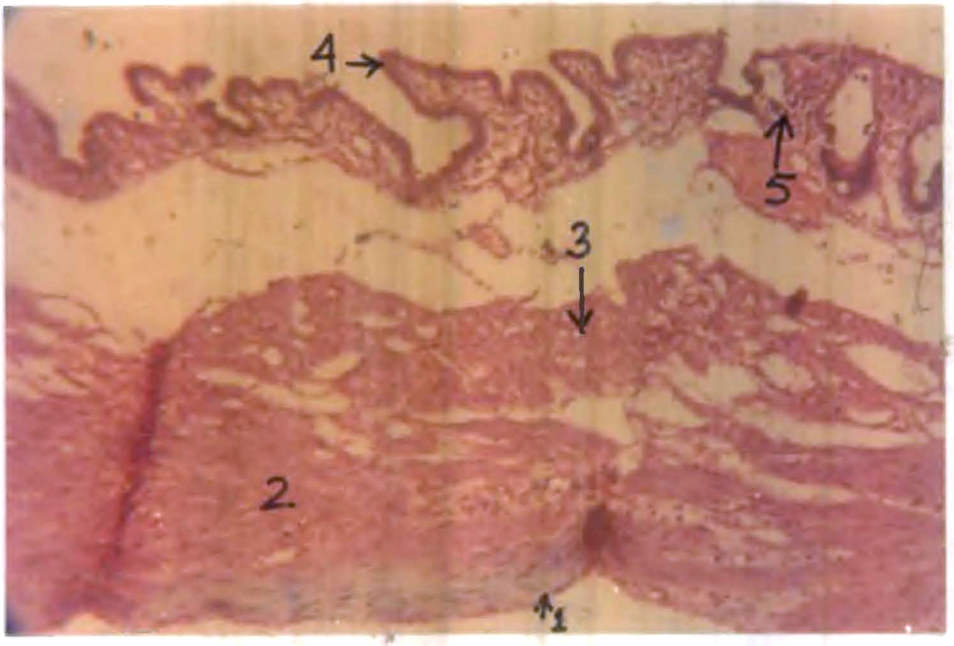


Fig.H -12: Photomicrograph of uterine wall of the pregnant rabbit (non attached Part) (100X) H & E Stain :

1. Serous layer 2. Muscular layer 3. Spongiosum 4. Mucosal fold 5. Endometrial gland

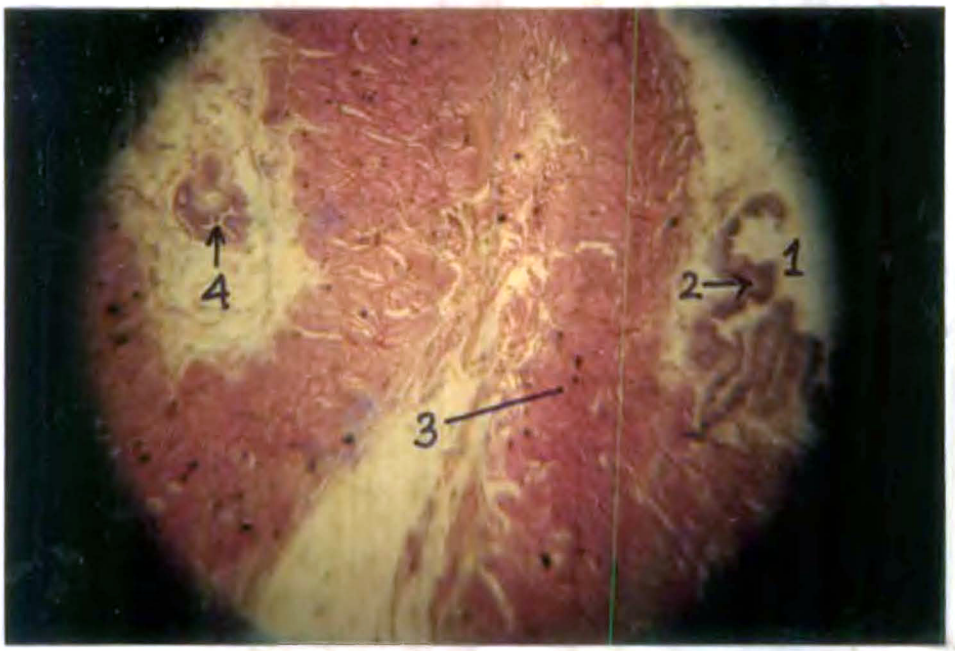


Fig.H- 13: Low power photomicrograph of the vagina along with urethra (25X) H & E Stain :

1. Lumen of the vagina 2. Mucosal folds of the vagina 3. Wall of the vagina 4. Lumen of urethra

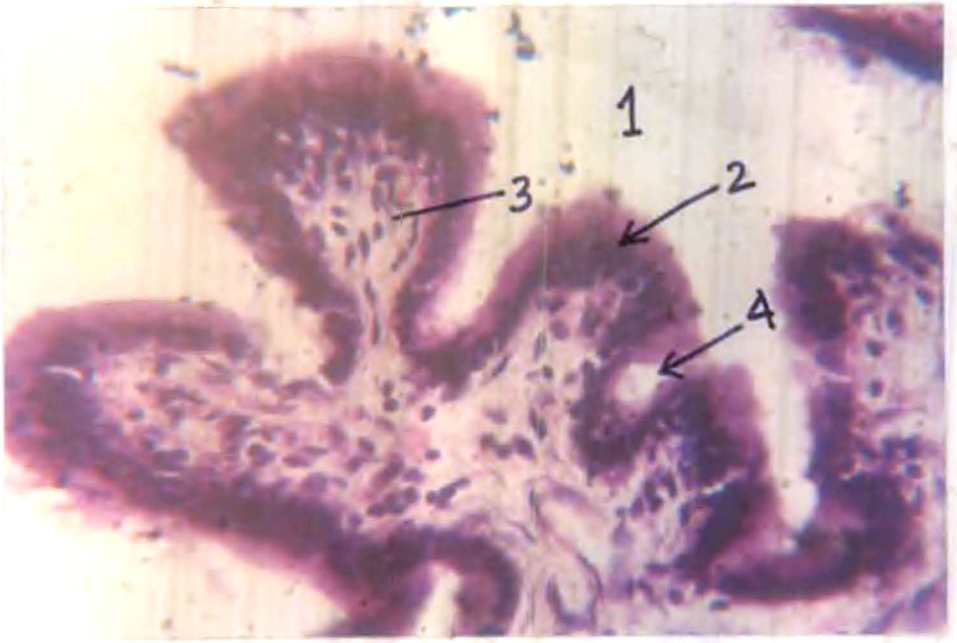


Fig.H -14: Photomicrograph of the wall of vagina of gravid rabbit (450X)H & E Stain:

1. Lumen of the Vagina 2. Vaginal epithelium covered by cornified material 3. Lamina propria 4. Vaginal glands

of space in between them. Most of the glands were found to be placed in close apposition with the surface of the endometrium . All the glands were mostly simple and without much coil. They were large, hollow tubular structures and were lined by nonciliated columnar or cuboidal cells. Endometrial edema ( presence of excessive tissue fluid in the endometrium ). was also visible in this active phase of the organ.

The submueosa consisted of loose connective tissue and contained less amount of cells and had good amount of tissue spaces.

In the free portion of the endometrium of gravid horn , where attachment of foetal membrane is not present, the characteristic of the endometrial infoldings were found to be changed to a great extent. These infoldings were found to be small but numerous. They were sometimes branched and the endometrial spongiosum was found to be less in amount (fig. H-12). Good number of endometrial glands were also detected in histological sections.

**(B) Myometrium :**

This layer was found to be very thick and contained bundles of smooth fibers. This bundles were hold together by connective tissue. Two distinct muscular layers were visible in histological slides. Inner circular layer of muscle was found to be little less in thickness than that of outer longitudinal muscular layer. A faint interstitial layer was also detected in between the two layers of smooth muscle. The interstitial layer contained blood vessels, collagen fibers and a small amount of connective tissue. A thin layer of elastic fibers was also found at the outermost zone of the longitudinal muscle fibers, which represented sub - serous connective tissue.

**(C) Perimetrium :**

The perimetrium was the peritonial layer of the broad ligament. It was firmly attached to the myometrium i.e. the longitudinal muscle fibers of the uterus. This attachment between the perimetrium and myometrium was made by a thin layer of elastic fibers. Some smooth muscle cells, lymph and blood vessels were also detected in the perimetrium. Continuation of this layer with that of broad ligament was detected in most of the slides.

**Vagina :**

This fibromuscular tube presented a comparatively thin wall which was composed of three layers of tissues at the cranial part and the rest of the part was composed of only muscular and mucous coat. Faint longitudinal mucosal fold extended throughout the length of the organ. The lumen of the vagina was found to be partly

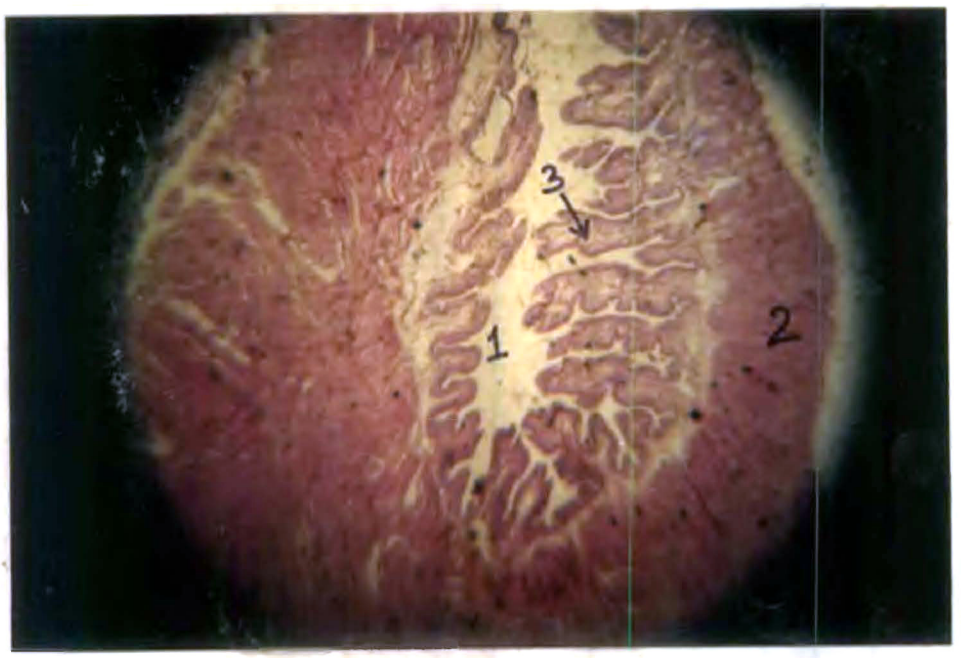


**Fig.H -15: Low power photomicrograph of wall of the vulva of gravid uterus (25X) H & E Stain :**

**1. Lumen of the Vulva 2. Wall 3. Mucosal folds**

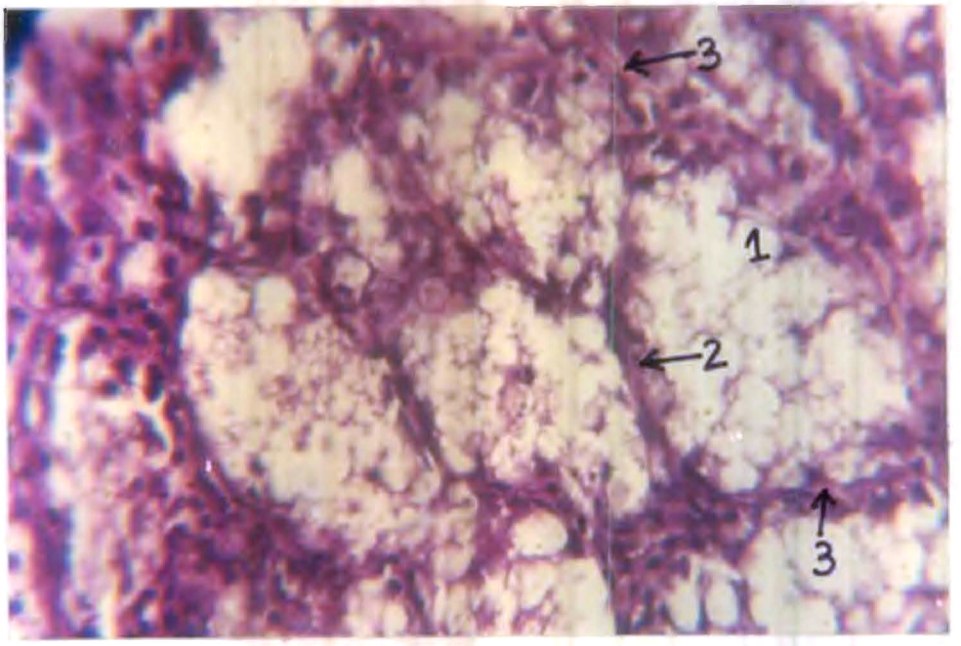


**Fig.H -16: Photomicrograph of the mammary gland of gravid rabbit (450X) H & E Stain :**

**1. Alveolus 2. Connective tissue septa 3. Myoepithelial cells**

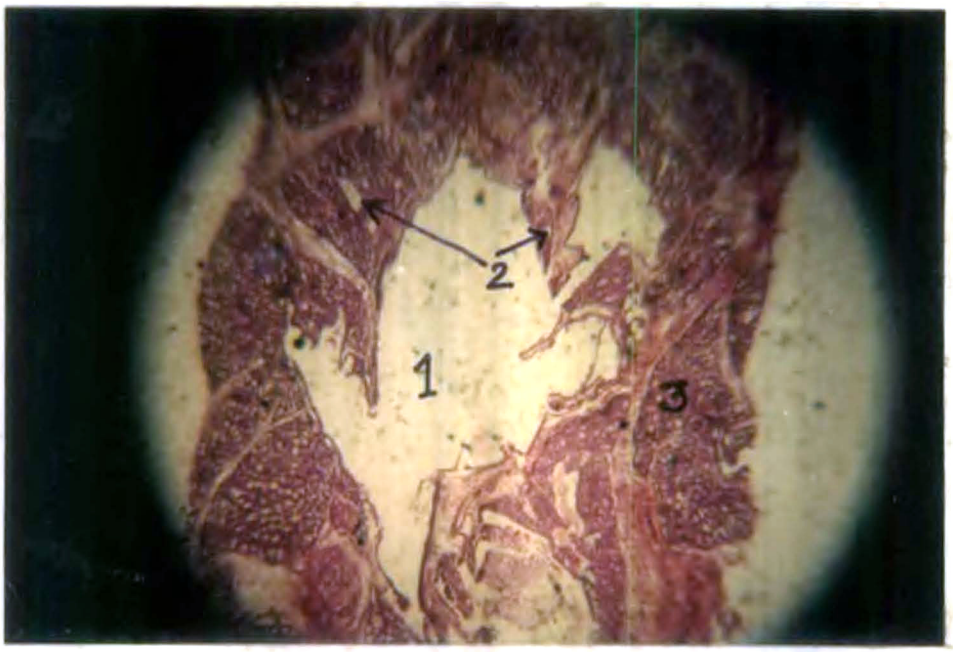


Fig.H -17: Low power photomicrograph of the mammary gland (closed to the apex of the gland) (25X) H & E Stain :

1. Lactiferous sinus 2. Lobular duct 3. Lobule

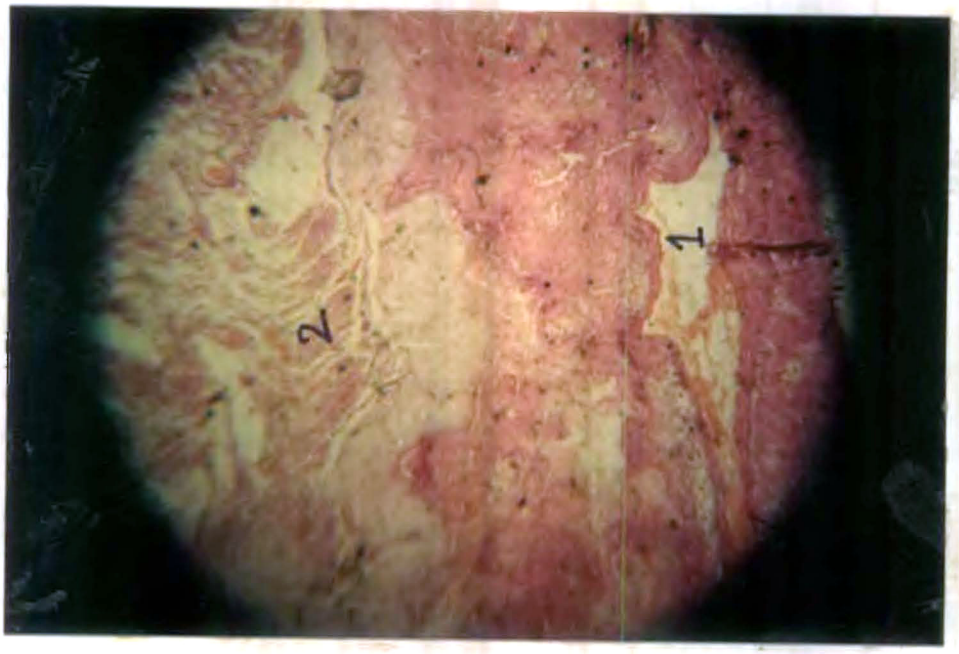


Fig.H- 18: Low power photomicrograph at the junction between endometrium and foetal membrane (25X) H & E Stain :

1. Large blood vessel in the myometrium 2. Foetal membrane invading endometrial tissue

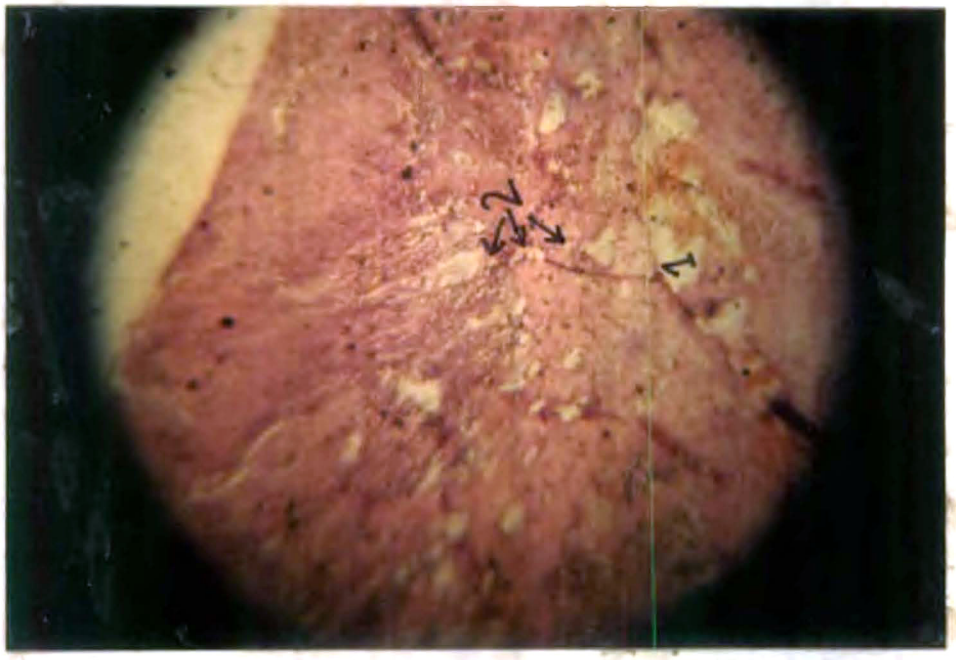


Fig.H- 19: Low power photomicrograph at the junction between endometrium and foetal membrane. (25X) H & E Stain :

1. Large blood vessels in the myometrium 2. Foetal membrane invaded endometrium and reached closed to the maternal vessel (arrow)

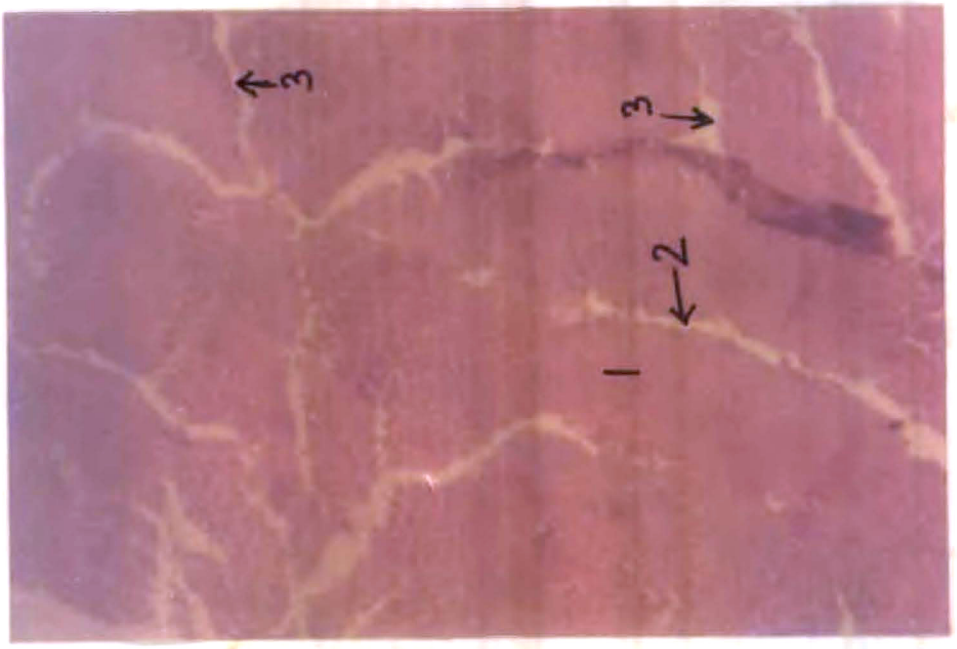


Fig.H - 20: Stereoscopic photomicrograph of the luminal surface (endometrium) of the horn of uterus :

1. Mucosal fold (longitudinally arranged) 2. Space between two mucosal folds
3. Transverse interruption of the mucosal fold

obliterated due to the mucosal infolding at its cranial end (fig. H-13). The mucosa consisted of stratified squamous epithelium and lamina propria (fig.H- 14). In some specimens the epithelial cells were cuboidal in shape which were covered by a layer of cornified material. The lamina propria consisted of loose irregular connective tissue which also contained lymphoid tissue in diffuse manner. Few glands were also found (fig.H- 14) in this layer which presented intraepithelial glands. The submucosa was composed of loose connective tissue which contained blood vessels.

Two distinct muscular layers (inner circular and outer longitudinal) were visible. The thickness both the layer was found to be equal . This muscular layers were separated by thin layer of connective tissue which contained numerous elastic fibers.

The outermost layer (tunica serosa/advantatia) which was present only at the cranial part was composed of loose connective tissue which contained blood vessels and nerve fibers.

The mucosal fold between the vagina and vestibule (so called hymen) could not be recognised in any of the specimens under the study.

**Vestibules and Vulva :**

The wall of the vestibule presented similar type of cellular disposition to that of caudal part of vagina. However the mucosal fold were found to be well developed and presented secondary and sometimes tertiary branching (fig. H-15) in the cranial portion. This mucosal infolding were found to be long and extended towards the lumen of the tube. The mucosal folds gradually diminished in size and were absent at its termination. The epithelium was composed of stratified squamous epithelium which was continuous caudally with the external covering of labia vulvae and skin. The submucosa was composed of loose connective tissue which contained blood and lymph vessels. The musculature of the tube was found to be neither longitudinal nor circular in disposition. However, the muscular layer was very thick and was found to be arranged in oblique directions. The musculature of the vulva appeared to be spongy due to presence of spaces between them and gave the character of irrectile tissue.

**Mammary gland :**

This Compound tubulo alveolar gland was composed of numerous lobules separated by connective tissue septa. (fig. H- 16) . The alveoli were large and irregular

in shape. The size of the alveoli were found to be variable. Each of the alveoli were lined by simple cuboidal epithelium which rested on a delicate basement membrane. Few myoepithelial cells were also detected in histological slides, within the interlobular connective tissue septa. Few interlobular ducts could also be detected. Each mammary gland contained a lactiferous sinus of moderate size. A number of lobular duct opened into the lactiferous sinus (fig. H- 17). The septa close to the lactiferous sinus was found to be well developed. The sinus appeared to be multi - chambered due to invagination of the glandular parenchyma at the upper part of the sinus. The mucous membrane of the sinus was lined by cuboidal epithelium which had more than one layer of cells.

**Placenta :**

According to the tissues forming the placental barrier, the placenta of rabbit falls under the category of haemo - endothelial placenta.

In this type of placenta the endomatrial epithelium, the endomatrial stroma, Syncytotropoblast and the endothelial of maternal vessel gradually degenerates and only the cytotropoblast, a small amount of primary mesoderm and endothelium of foetal vessels remain as the placental barrier. The tropoblast cells of chorion degenerates to such an extent that only endothelium of foetal vessels intervenes between maternal and foetal blood. In a low power magnification of a histological slide, it was observe that a large maternal blood vessel was appeared with in the myometrium (fig. H- 18). The foetal membrane in the form of finger like projections invaded the endometrial epithelium and established connections with the maternal tissue. The foetal membrane was also found to be invaded the endometrial spongiosum . The placental labrynth was also clearly visible.

In more advance stage it was observed that the tropoblastic cells of the chorion invaded into the depth at the uterine wall and reached close to the uterine blood sinuses ( intervillous space) intending to make more intimate association between them and therefore the characteristics haemo-endothelial placentation was established, since the foetal vessels came into direct contact with the maternal blood.

second part (Ampulla) was a comparatively dilated and thin walled and less flexuous. The cranial portion of this part made a turning over the cranial aspect of the corresponding ovary. The terminal funnel shaped infundibulum presented indistinct finger like fimbrae. The infundibulum presented a well developed opening at the center.

In most of the specimens the infundibular attachment with the corresponding ovary was detected.

Many of the earlier workers, Silvernale (1965), Mukherjee (1972), Vidyarthi (1978), Vishwanath (1984), Jorden and Verma (1993) have recorded the convoluted appearance of the fallopian tube in this species. They also stated about the dilated funnel shaped termination of the tube with fimbriated margin. Subdivisions of the oviduct (Isthmus, Ampulla and Infundibulum) has been presented by Lebas (1997) and Banerjee (1998) while describing the organ in their texts.

None of the above mentioned workers mentioned about the disposition of the ampulla of the oviduct around the cranial part of the corresponding ovary.

The average length of a oviduct was found to be $5.34 \pm 0.432$ cm. Ghosh (1998) has stated also that the said length was 5 cm in this species. The junction between the horn of uterus and the tube was abrupt and resembles that of mare as described by Sisson.S. (1975).

**Uterus :**

Actually this species is having a bicornuate uterus because it was observed that both the horns (cornua) although come in very close apposition at their caudal end but do not open together in a common cavity like other mammals but open separately into the Vaginal tube.

Each horn was a curved slightly flexuous, narrow thick walled cylindrical tube. It was directed forward , upward , downward and again forward along the floor of the corresponding aspect of the abdomen. The cranial part became gradually narrow but terminated abruptly in a blunt point where the narrow (Isthumus) fallopian tube is attached. This suggests the presence of an intramural part of the tube.

The average length of the horn ranged from 9.6 to 11.0 cm. and the diameter was 0.6 cm in non pregnant condition.

A good number of workers, Parker and Marshall (1997) Vidyarthi (1978), Mclaughlin *et al* (1985), Jorden and Verma (1993) have reported the presence of two uteri in this species of animals considering their bicornuate appearance. Lebas (1997) and Banerjee (1998) have recorded the length of each horn to be as long as 7 cm whereas Ghosh (1998) reported that the length of each horn was 9 cm.

The greater curvature of the horn faced dorsolaterally and the lesser curvature was extend ventromedially. The broad ligament which was composed or double fold of peritonium, smooth muscles, vessels, nerves and connective tissues, was attached to the lesser curvature of the organ. The outer surface of the body of the horn presented faint longitudinal grooves. These were probably due to the grooves which developed between the bundles of longitudinal muscles, covered by serosa.

References, regarding gross anatomical disposition with ligamentus attachments could not be found in the existing literature.

The lumen of the thick walled horn was mostly occupied by endometrial infoldings along its length which presented nodular appearance. The horns of both the sides never united together at their caudal part like other mammals and therefore the body of the uterus was found to be absent in this species. However these horns opened separately at the cranial lumen of the vagina forming two well developed cervices around each of them. A muscular band which connected the two horns at the base in some specimens may have been provided to put an additional support to keep the horns in close apposition at that level.

Each of the cervices was found to be thick walled multilamilated muscular structure and found to be separated with each other by a fold of mucous membrane.

Most of the earlier workers have stated the presence of double cervices as each of the tube opened separately in the cranial end of the vagina. The presence of longitudinal mucosal folds in the lumen of the horn has been mentioned by Ghosh (1998).

**Vagina :**

The vaginal tube was thin walled and extended caudally from the uterus to vestibule along the floor of the pelvic cavity. Like other mammals it was dorsally related to the rectum and ventrally to the bladder and urethra. Faint but numerous longitudinal mucosal folds were found in the lumen of the organ. A considerable length of the urethra was found to be embedded along the floor of this tubular organ. The urethral opening was a slit like aperture on the floor and no suburethral diverticulum was detected.

This findings are in agreement with those of Vidyarthi (1978), Jorden and Verma (1993) and Chakraborty (1999), who have mentioned that the vagina was a straight medium tube which extended along the floor of the pelvic cavity.

The length of the vagina was about 9 cm and the width was about 2 cm. Lebas *et al* (1997) and Banerjee (1998) have also mentioned that the length of rabbit ranged from 6 to 10 cm. No published reference regarding the thickness of the vaginal wall and the mucosal folds at the lumen of the organ was available.

**Vestibule and Vulva :**

The terminal part of the female genitalia which extended from the external urethral orifice, forms the vestibule. The vulva hanged downward from the ischial arch and placed just below the anus. The labia minora was prominent but the labia majora was irregular. Plenty of fine hairs which were continuous to those of skin were distributed along the margin of the labia majora. The dorsal commissure was irregular but the ventral commissure was organised. A raised tissue close to the ventral commissure represented clitoris which however was not very prominent.

As mentioned in various literatures and texts , Parker and Marshall (1967), Mukherjee (1972), Vishwanath (1984), the species had well developed labia and ill developed clitoris. This conforms the present findings. The slit like external opening of the vulva which have been recorded by Silvernale (1965), Grove and Newell (1990) and Prasad *et al* (1991), also supports the present findings.

# HISTOLOGICAL OBSERVATION

## Ovary :

The organ was covered by so-called germinal epithelium which was composed of a flattened cells and connective tissue. A number of round or oval bodies of different sizes were found in the cortical area. They represented ovarian follicles at their various stages of development. At the hilum of the organ sections of the tortuous ovarian artery was found. The stroma of the medullary zone was less compact and more vascular. Beside blood vessels the medulla contained nerve fibers, lymphatics and connective tissue elements.

This findings is in accordance with the statement of Copenhaver (1964), Vidyarthi (1978), Dellmann and Brown (1987), Prasad and Kashyap (1991) and Jorden and Verma (1993) who have mentioned that the ovary had a outer layer of germinal epithelium, cortex and medulla. The cortical portion contained more number of ovarian follicles of various shapes and sizes. The medulla comprised of loose connective tissue, nerve fibers lymphatics and good amount of blood vessels.

In the ovarian follicles of the rabbit exhibited usual characteristic features. Follicular cells, oogonium, and the antrum was found in maturing follicles. This is in agreement with the description of Vidyarthi (1978), Prasad and Kashyap (1991) and Jorden and Verma (1993) who have mentioned the presence of all these components in the graafian follicle.

## Fallopian tube :

The whole of the oviduct was composed of outer serous coat, middle muscular coat and the inner mucous coat. The muscular coat was composed of inner circular and outer longitudinal muscles. However the thickness of this coat was found to be highly variable in different parts of this tube. The mucosal folds were also variable in disposition. The mucosa had a single layer of columnar epithelial cells. These were either ciliated or nonciliated and their proportions was also variable.

The wall of infundibulum of the tube was seen to be very thin. The mucosal folds were highly developed and made up of $1^{st}$ , $2^{nd}$ order and $3^{rd}$ order branches. Most part of the lumen was occupied by all these primary and secondary folds of the mucous membrane leaving a small irregular passage towards the centre.

The ampulla had a comparatively thicker wall. All the three layers were well recognisable under light microscope. The serous membrane was developed and accommodated numerous blood vessels. The muscular layer was thick and the mucous membrane presented folds of short height. Few of the folds were branched.

The Isthmus had the thickest wall. The muscular coat was highly developed. Circular and longitudinal layers of muscles were well recognised. The luminal space was more and the mucosal folds were short and blunt.

All the above mentioned findings were found to be similar to those of Carleton and Short (1965) in rabbit and guineapig, Dellmann and Brown (1987) in cow and mare, and Hafez (1993) in various farm mammals, who have stated that the fallopian tube presented variable thickness in its wall and in the characteristics of mucosal foldings in its different parts. The wall of the infundibulum was thin and the mucosa was made up of primary, secondary and tertiary folds. Presence of ciliated and noncialiated columnar epithelium in the mucosa of the fallopian tube has also been described by all these authors. They also mentioned about the presence of circulars and longitudinal muscle fibers in the wall of the tube. Presence of blood vessels along the length of the tube has been mentioned in their description. However the tertiary branches of the mucosal folds in the infundibulum as stated by Hafez (1993) could not be detected in the present investigation.

Therefore the fallopian tube exhibited a general pattern of histomorphological organisation like those of other mammals.

## Uterus :

Since there is no existence of the body of uterus due to complete separation of both the horns from the tip to the cervix, only a horn is considered for investigation in this section. This tubular organ was composed of three layers of tissues- inner endometrium, middle myometrium and outer perimetrium.

**(A) Endometrium :**

This was the inner most layer and composed of linear longitudinal folds which extended along the length of the horn. It was observed in transverse section that these infoldings were broad at their bases, blunt at their tips and occupied most part of the lumen in non - pregnant condition. The surface epithelium was columnar without any cilia on them. The spongiosa was well developed and contained connective tissue, vessels

and nerves. Large hollow tubular glands, lined by nonciliated columnar or cuboidal epithelium were found in plenty. These glands were developed in proliferative stage and reduced in non proliferative stage. Tissue spaces were found to be numerous with in the submucous layer.

The presence of linear longitudinal mucosal fold has not been recorded by earlier workers excepting Ghosh (1998) who while describing the gross structure of rabbit uterus stated that the lumen of horn presented 3 -4 longitudinal folds. These folds presented nodular elevations along its length. Dellmann and Brown (1987) has given detail description on the histomorphological disposition of the tissues of uterus in various farm animals. He stated that the wall of uterus was composed of endometrium or mucosa, myometrium or muscularies and perimetrium or serosa. The endometrium was lined by simple columnar epithelium. The superficial layer of lamina propria contained many blood vessels, loose connective tissue, fibroblast, macrophages, mast cell, heterophil, eosinophil, lymphocyte and plasma cell. In sheep uterus it also contained malanocytes. The deep layer contained loose connective tissue. He also described about the endometrium of primates. According to him the endometrium of primates divided into a functional zone (spongy) and a basal zone.

The presence of caruncles in the endometrium in ruminants as have been described by Dellmnn and Brown (1987) , Sisson : (1975) and many other authors , were not found in this species.

**(B) Myometrium :**

Each horn had a very thick myometrial layer which was composed of inner circular and outer longitudinal muscle. A thin layer of interstitial zone was found in between the muscular layer which contained blood vessels, collagen fibers and connective tissue. A thin subserous layer was also detected. This is in agreement with the a record of Dellmann and Brown (1987) who mentioned about the presence of inner circular and outer longitudinal layer of smooth muscle in the wall of the uterus. The muscular layer contained various branches of blood vessels. However, Copenhaver (1964) has described that in the body of the human uterus the muscles were arranged in three different layers. A thin inner layer contained longitudinal fibers, the middle layer contained circular or spiral fibers and outer layer was composed of both circular and longitudinal fibers. This arrangement was probably due to excessive development of the body of the uterus in this species.

**(C) Perimetrium :**

This peritoneal component of the broad ligament had usual structure of serous membrane. It was firmly attached with the myometrium with the help of thin layer of elastic and smooth muscle fibers. Dellmann and Brown (1987) stated that perimetrium consisted loose connective tissue covered by peritoneal mesothelium . He also stated that the smooth muscle cells , lymph and blood vessels and nerve fibers were also present in this serous membrane. Copenhaver (1964) also stated that perimetrium was firmly attached to the underline musculature of uterus and composed of usual structure of serous membrane.

## Vagina :

The vagina was a fibro muscular tube which extended from cervix to vestibule and composed of tunica mucosa and tunica muscularis. A small cranial part had a outer serous covering. Throughout the length there were faint longitudinal folds which were directed towards the lumen. These folds were more extensive at the cranial end. The mucosa was composed of stratified squamous epithelium. Cuboidal epithelium in the cranial part in some specimen was also detected. Few intraepithelial glands were found in some specimens. Submucosa was composed of loose connective tissue which contained blood vessels and lymphoid tissue. The muscular layer was composed of inner circular and outer longitudinal muscles . The tunica serosa was composed of loose connective tissue which accommodated blood vessels and nerve fibers. The muscle fibers were not detected . Copenhever (1964) recorded presence of all the three layers in the wall of the cranial part of vagina in human. He stated that the mucosa was composed of stratified squamous epithelium, lamina propria composed of loose connective tissue, muscularis was composed of many longitudinal disposed smooth muscle fibers and a thin layer of inner circular fibers. However, he has stated that the vaginal mucosa of human had transverse folds instead of longitudinal folds as has been observed in this investigation.

The present findings it also agreement with the description of Dellmann and Brown (1987) in domestic mammals. He has recorded the presence of all the three layers in the vaginal wall of domestic mammals. Longitudinal mucosal folds which extended throughout the length of vagina in cow has been mentioned by the author. However, the presence of some prominent circular mucosal fold in the vagina of cow as

has been mentioned by Dellmann and Brown (1987) and Sisson. (1975) could not be detected in this species.

It may therefore be stated that there is no major difference in histological organisation of the vaginal wall between other domestic mammals and rabbit was detected in this study.

**Vestibule and Vulva :**

No variation was observed in the histological organisation in this part of the genitalia with that of vagina only difference was the thickness of the muscular layer and the disposition of the muscular bundles at the terminal part of the tubular organ. However, the mucosal folds were characteristics in this tube which were elongated and presented primary , secondary and even tertiary branches.

**Mammary gland :**

The histological organisation of the parenchyma of the mammary gland was mostly identical to that of other mammals. It contained numerous lobules of varying sizes separated by connective tissue septa. The alveoli were lined by cuboidal epithelium . Myoepithelial cells were also found attached with the basement membrane. Compound lactiferous sinus was also detected above the base of the teat. The mucous membrane of the sinus was composed of cuboidal cells.

These findings are in accordance to those of Dellmann and Brown (1987) in cow who have been mentioned that the mammary gland is composed of lobes and lobules. These were separated by connective tissue septa. Each lobule was composed of numerous alveoli which were lined by a single layer of simple cuboidal epithelium. They have also mentioned about the presence of myoepithelial cells at the basal lamina of alveolus. Presence of lactiferous ducts and a single large lactiferous sinus was also recorded by them. They have mentioned about the presence of double layer of cuboidal cells at the lining membrane of lactiferous sinus.

Elias *et al* (1978) also stated that each lobe of the mammary gland had an individual duct lined with an epithelium which varied from stratified squamous near the exit to simple cuboidal towards the alveoli. However , the findings regarding the structure of the lactiferous sinus is not in agreement with that of Ghosh (1998) who has reported that the lactiferous sinus was not prominent in the mammary gland of rabbit.

**Placenta :**

Histologically, the characteristic features of haemo-endothelial type of placentation was observed. Gradual invasion of foetal membrane into the endometrium and subsequently into the uterine blood sinuses situated within the myometrium were detected in the slides of early and advanced stages of placentation in rabbit. This findings confirms the records, made by Prasad and Kashyap (1991) and Datta (1995) who have stated that placenta of rabbit was haemo-endothelial according to the tissues forming placental barrier.

However , Mukherjee (1972) has stated that the placenta of rabbit belongs to haemochorial type which is not at per with the present findings.

# CHAPTER - 6

# SUMMARY AND CONCLUSION

# SUMMARY AND CONCLUSION

Gross anatomical disposition and histomorphological organisation of various components of female genitalia of rabbit (*Oryctolagus cuniculus*) was studied in this investigation. The ovary was found to be elongated structure in this species. Both the ovary and the cranial part of the genitalia (fallopian tube and cranial part of the horn of uterus) was placed on either side of the floor of the caudal part of the abdomen. The horns of the uterus were found to be completely separated and no existence of the body of uterus was detected and thereby bicornuate characteristics of the uterus in this species. Each horn presented a separate external os. The lumen of the horns presented numerous longitudinal folds along the whole length of the tubular structure. The vagina, vestibule and the vulva exhibited usual characteristics to those of other mammals. Broad ligament was attached to the lesser curvature of the horns and also covered the caudal portions of both the horns which were placed in close apposition between the rectum above and the bladder below. The vulva possessed both the minor labium and major labium. Clitoris was ill developed. Histologically all the components i.e. ovary, fallopian tube, horn of the uterus, vagina, vestibule exhibited usual characteristic to these of other mammals. The lactiferous sinus of the mammary gland was found to be multichambered at its upper part. Characteristic feature of haemo-endothelial type of placentation was observed in histological observation.

All the above mentioned findings may be utilised by the Physiologist, Embryo -transfer Technologist, Breeders and other related workers for the development of the rabbit husbandry

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