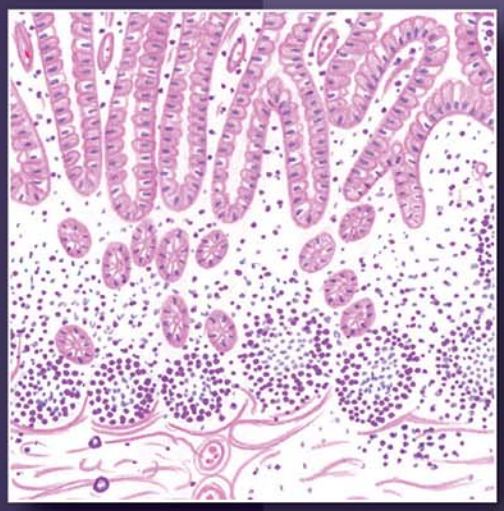
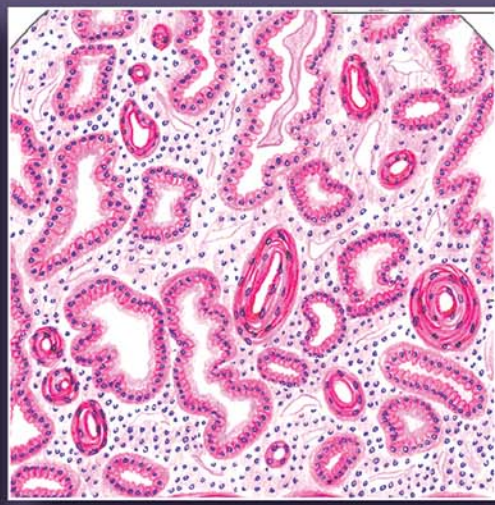
it our website www.ejaypee.com, for detailed information on anatomy books, visit our website www.ejaypee.com, for detailed information on anatomy books, visit our website www.ejaypee.com,

diginerve®
A Jaypee Initiative
• Video Lectures • Dr. Wise AI Chatbot
• Question Bank • Notes
Download App





Practical Manual of HISTOLOGY

As per the Revised Competency-based Medical Education Curriculum (NMC)

Seema Prakash
Parveen Ojha

JAYPEE

Contents

Practical 1: Microscope 1
- Definition 1
- Types 1
- Different Parts of a Microscope 2
- Guidelines for Drawing Histology Diagrams 2

Practical 2: Epithelium 3
- Epithelial Tissue 3
- Origin of Epithelium 8

Practical 3: Connective Tissue 17
- General Features 17
- Types of Connective Tissue 20

Practical 4: Cartilage 28
- Unique Properties of Cartilage 28
- Components of Cartilage 28

Practical 5: Bone 34
- Functions of Bone 34
- Composition of Bone Tissue 34
- Types of Bone 36

Practical 6: Muscle 41
- Types of Muscles 41

Practical 7: Glands 47
- Classification of Glands 47
- General Features in Microscopic Anatomy of Salivary Glands 48
- Special Features in Major Salivary Glands 49

Practical 8: Blood Vessels 54
- General Structure of a Blood Vessel 54
- Types of Blood Vessels 54

Practical 9: Lymphatic Tissue 62
- Lymphoid Tissue 62
- Flow of Lymph 64

Practical 10: Integumentary System 71
- Skin 71

Practical 11: Respiratory System 76
- Conducting Part 76
- Respiratory Part 76

Practical 12: Digestive System 83
- Alimentary Canal 83
- Esophagus 84
- Stomach 84
- Small Intestine 86
- Large Intestine 87
- Rectum 88
- Vermiform Appendix 88
- Tongue 88
- Liver 89
- Gallbladder 90
- Pancreas 90

Practical 13: Urinary System 105
- Kidney 105
- Nephron 106
- Ureter 107
- Urinary Bladder 108

Practical 14: Male Reproductive System 113
- Testis 113
- Epididymis 114
- Vas Deferens or Ductus Deferens 114
- Prostate 114

Practical 15: Female Reproductive System 120
- Ovary 120
- Uterus 121
- Uterine or Fallopian Tubes 122

- Placenta 122
- Umbilical Cord 123
- Mammary Gland 123

Practical 16: Endocrine Glands 135
- Thyroid Gland 135
- Suprarenal Gland/Adrenal Gland 135
- Hypophysis Cerebri (Pituitary Gland) 136
- Pineal Gland 138

Practical 17: Nervous System 143
- Structure of a Neuron 143
- Neuroglial Cells 143
- Nerve 144
- Spinal Cord 144
- Cerebral Cortex 145
- Cerebellum 145

Practical 18: Special Senses 153
- Eye 153
- Cornea 153
- Ear 155
- Olfactory Epithelium 155

15 Practical

Female Reproductive System

AN52.2	Describe and identify microanatomical features of the female reproductive system; ovary, uterus, uterine tubes, cervix, placenta, umbilical cord.
AN52.3	Describe and identify microanatomical features of corpus luteum.
AN9.2	Draw and describe microanatomy of mammary gland.

It consists of ovaries, oviducts, uterus, vagina and external genitalia. Organs involved in female reproductive system are:

OVARY (FIG. 15.1)

(RUHS 2007)

Ovaries are almond-shaped organs about 3 cm long, 1.5 cm wide and 1 cm thick. The surface of the ovary is covered by simple squamous or cuboidal epithelium called the germinal epithelium. Under the germinal epithelium, a dense connective tissue tunica albuginea lies. Beneath the tunica albuginea is the cortex of ovary. Deep to cortex lies medulla, which is a rich vascular bed with loose connective tissue.

Cortex: Cortex contains ovarian follicles in various stages of development in the highly cellular connective tissue called stroma. Following are various stages in the development of ovarian follicles.

1. **Primordial follicle:** The most numerous follicles located just inferior to tunica albuginea are primordial follicles. These follicles are the smallest and simplest in structure. Here primary oocyte is surrounded by a single layer of squamous follicular cells.
2. **Primary follicle:** As the primordial follicle grows, its follicular cells divide by mitosis and forms layers of cuboidal cells known as granulosa cells. A single layer of granulosa cells that immediately surround the oocyte is corona radiata. Between the corona radiata and oocyte, a noncellular glycoprotein layer called as zona pellucida is present. Stromal cells that surround the follicle differentiate into an inner vascular theca interna and outer fibrous theca externa.
3. **Secondary follicle:** As primary follicle increases in size, a fluid called liquor folliculi begin to accumulate between the follicular cells. Fluid areas coalesce to form a fluid-filled cavity follicular antrum. Follicle with an antral cavity is called the secondary follicle. This follicle is large and situated deep in the cortex.
4. **Mature follicles/graffian follicles:** As follicle increases in size, antrum also enlarges. Primary oocyte completes its first meiotic division and becomes secondary oocyte. Granulosa cells reorganize and some of the cells of this layer concentrate at one point on the follicular wall. This group of cells is called cumulus oophorus. Follicle at this stage is so large that it forms a bulge on the surface of the ovary. Now the follicle bursts and releases secondary oocyte. This process is called ovulation.
5. **Corpus luteum:** After ovulation granulosa cells and theca interna cells form a temporary endocrine gland named as corpus luteum. In the corpus luteum, due to release of follicular fluid during ovulation, there is a collapse and folding of follicular wall. Blood vessels of the stromal cells invade the granulosa cells. Now granulosa cells and theca interna cells enlarge and accumulate lipid to become pale staining luteal cells. If fertilization takes place, corpus luteum will survive for the next few months, but if fertilization does not occur, corpus luteum will last only for a few days.

JAYPEE BROTHERS

- **Corpus albicans:** When corpus luteum degenerates, luteal cells are swollen and become thin and pyknotic, and a scar of connective tissue will replace these dead luteal cells. This white scar is called corpus albicans.
- **Atretic follicle:** In each menstrual cycle, only one follicle reaches maturity and ovulates. The other maturing follicles start to degenerate. This process of degeneration and disappearance of follicles is called follicular atresia.
- **Medulla of ovary:** Deep to the cortex, lies medulla with loose fibroelastic connective tissues, lymphocytes, blood vessels and nerves. The demarcation between the cortex and medulla is not very clear.

UTERUS (FIGS. 15.2A AND B)

Uterine wall is relatively thick and composed of three layers:

1. Perimetrium—outer most serous coat
2. Myometrium—middle muscular coat
3. Endometrium—innermost mucous coat

- **Perimetrium:** It consists of two layers (i) an outer connective tissue layer rich in blood vessels and elastic tissue fibers and (ii) an inner mesothelial lining.
- **Myometrium:** It is the thickest middle layer of uterus having bundles of smooth muscle fibers separated by connective tissue. Smooth muscle fibers are arranged in three layers, the outer and inner longitudinal layer and a middle thick layer of circular muscles. Middle layer also contains large blood vessels. During pregnancy, myometrium undergoes hyperplasia as well as hypertrophy, i.e., increase in the number of smooth muscle fibers and an increase in the size of cells respectively.
- **Endometrium:** It consists of an inner epithelial lining and outer lamina propria. The epithelium is a mixture of ciliated and secretory simple columnar cells. Lamina propria has simple tubular glands that sometimes branch in their deeper portions. Epithelium of glands is also simple columnar epithelium, but ciliated cells are rare here. The connective tissue of lamina propria is rich in fibroblasts and ground substance. Endometrium can be divided into two zones: (l) Deeper stratum basalis and (2) Superficial stratum functionalis.
  1. **Stratum basalis:** It is the deeper zone just adjacent to the myometrium and has lamina propria with closed tips of uterine glands.
  2. **Stratum functionalis:** It is made of surface epithelium, uterine glands and lamina propria. **Stratum functionalis undergoes changes during the menstrual cycle, but stratum basalis remains unchanged.** Blood vessels in the endometrium are of special importance in periodical sloughing of most of this layer.

Arcuate arteries are the circumferentially oriented arteries present in the middle layer of the myometrium. From these arteries, two sets of arteries arise to supply blood to the endometrium (1) Straight arteries which supply stratum basalis (2) Spiral arteries which supply stratum functionalis.

Cyclical changes in endometrium: Endometrium undergoes monthly cyclical changes in thickness and histological appearance due to ovarian hormones. These changes are divided in to three phases:

Proliferative Phase

- This phase begins on the 5th day of the menstrual cycle.
- Proliferative phase occurs due to increased levels of estrogen secreted by developing ovarian follicles.
- Thickness of endometrium at the end of this cycle is 2–3 mm. Stratum functionalis increases in thickness in this phase.
- Uterine glands are straight and have a narrow lumen.
- Spiral arteries are seen in the deeper region in the endometrium.
- Lamina propria in the upper region is cellular and resemble a mesenchymal tissue, but in basal region, connective tissue is more compact.

Secretory Phase

- This phase is seen after ovulation.
- Secretory phase is due to progesterone secreted by corpus luteum.

JAYPEE BROTHERS

- Endometrium becomes very thick, measuring about 6–7 mm.
- Glands have now become highly coiled with a dilated lumen and secretory material is seen in their lumen.
- Spiral arteries extend up to the upper portion of the endometrium, i.e., stratum functionalis and the arteries are highly coiled and thick walled.

Menstrual Phase

This phase results in necrosis of endometrium secondary to the constriction of coiled arteries and **change are due to the decline in the ovarian secretions of estrogen and progesterone.** The endometrium of functionalis layer degenerates and is shed off. The endometrium is now reduced to a thin layer of lamina propria with blind ends of uterine glands. Coiled arteries are necrotic and only deeper part of vessels are seen.

UTERINE OR FALLOPIAN TUBES (FIG. 15.3)

Uterine tubes are two muscular tubes measuring about 15 cm in length. Each tube has four parts—intramural part, isthmus, ampulla and infundibulum opening in the peritoneal cavity.

Histologically, there are three layers in uterine tubes:

1. **Mucosa:** Mucosa shows extensive mucosal folds resulting in an irregular lumen of the uterine tube. It consists of (i) epithelium and (ii) lamina propria.
   a. Epithelium contains two types of cells ciliated columnar cells and non-ciliated secretory cells called peg cells.
   b. Lamina propria is a thin fibrous layer with fibroblasts. In each menstrual cycle, under the influence of estrogen, epithelium of uterine tubes will also show cyclical changes, and proportion of ciliated and non-ciliated cells varies with the stage of the menstrual cycle.
2. **Muscular coat:** Two layers of smooth muscles are present an inner circular and outer longitudinal layer. Interstitial connective tissue is abundant between the two muscle layers. So, the two layers are not very distinct.
3. **Serosa:** Serosa is the outermost layer of visceral peritoneum.

PLACENTA (FIG. 15.4)

Placenta is involved in providing nutrition, hormones, oxygen and removing metabolic wastes of the fetus.

Placenta is formed by both fetal and maternal tissue. Fetal part of the placenta is formed by chorionic plate (trophoblast and extraembryonic mesoderm) and maternal part by decidua basalis (a part of uterine endometrium). From the chorionic plate, many chorionic villi arise and attach to decidua basalis.

Decidual tissue sends incomplete septa towards the chorionic plate and divides placenta into lobules or cotyledons. These septa project into intervillous spaces. Each cotyledon contains 2–3 chorionic villi. A slide of placenta will show a cross-section of many such chorionic villi separated by intervillous space containing the maternal blood in a spiral arteries.

In earlier stages of pregnancy (Fig. 15.5A): Chorionic villi is surrounded by two layers of the trophoblastic epithelium. An outer dark staining syncytiotrophoblast layer and an inner light staining cytotrophoblast layer. Syncytiotrophoblast layer has multiple nuclei and no intercellular boundaries. Cytotrophoblast cells are cuboidal in shape and rest on a basement membrane.

Core of each villus shows embryonic connective tissue and fusiform mesenchymal cells and dark staining macrophages (Hofbauer cell). Branches of umbilical arteries and veins (fetal blood vessels) containing fetal nucleated erythroblasts can be seen. Intervillous space has maternal blood with nonnucleated erythrocytes.

At term pregnancy (Fig. 15.5B): Chorionic villi show disappearance of the cytotrophoblast layer. Core of a villus has fetal blood vessels with mature blood cells.

Placental barrier: Chorionic villi are separated from intervillous space by trophoblastic epithelium which form a placental barrier.

In early pregnancy, this barrier will be formed by (From outer to inner side)

- Syncytiotrophoblast cells
- Cytotrophoblast cells

JAYPEE BROTHERS

- Basal lamina of cytotrophoblast cells
- Fetal connective tissue
- Basal lamina of fetal capillaries
- Nonfenestrated endothelium of fetal capillaries

At term pregnancy: As cytotrophoblast layer disappears so placental barrier is now formed by:
- Thin layer of syncytiotrophoblast
- Basal lamina of fetal capillaries
- Endothelium of fetal capillaries

UMBILICAL CORD (FIG. 15.6)

Umbilical cord extends between placenta and fetus. It carries oxygenated blood from the placenta to fetus through a single umbilical vein and deoxygenated blood from the fetus to placenta through two umbilical arteries.

A cross-section of the umbilical cord will show the following features:
Amniotic membrane covers the umbilical cord, so the cord is lined by flattened amniotic epithelial cells. Deep to the epithelial lining, mucous connective tissues called Wharton's jelly is present. This jelly contains highly branched fibroblasts, collagen fibers and ground substance. Fibroblasts are widely separated from each other. In the connective tissue, two umbilical arteries and one umbilical vein are also present. Umbilical arteries are thick-walled and show wavy internal elastic lamina and narrow lumen. Umbilical vein is thin-walled and has a wide lumen.

MAMMARY GLAND

- Mammary glands are modified sweat glands. These start developing in females at puberty. A remarkable change in size and functional activity occurs during pregnancy and lactation. Atrophic changes start appearing at the age of 40.
- Each mammary glands has 15–20 radially arranged lobes. A single large lactiferous duct drains each lobe. Each lobe is surrounded by a dense fibrous connective tissue capsule. Each lobe has several small compartments called lobules. In each lobule, grape-like clusters of milk-secreting glands called alveoli are present.

Histology of Inactive Mammary Gland (Fig. 15.7A)

In an inactive gland, the connective tissue is abundant and glandular element is minimum. Glandular part consists of small tubules or intralobular ducts lined by cuboidal or low columnar epithelium. At the base of epithelium are contractile myoepithelial cells. These ducts are surrounded by intralobular connective tissue in which fibroblast, lymphocyte, plasma cell and eosinophil are present. Surrounding connective tissue is interlobular connective tissue made up of dense collagen fibre and adipose tissue.

Histology of Mammary Gland in Early Pregnancy

Mammary gland undergoes intense growth during pregnancy as a result of the synergistic action of several hormones estrogen, progesterone, prolactin and human placental lactogen. During the first half of pregnancy, intralobular duct undergoes rapid proliferation and form terminal buds that differentiates into alveoli. Alveoli are a spherical collection of epithelial cells which become active milk-secreting glands during lactation. Intralobular ducts and alveoli are lined by two-layered epithelium—an inner luminal epithelium and outer layer of flattened myoepithelial cells.

A loose intralobular connective tissue surrounds the alveoli and ducts. Interlobular connective tissue is dense with adipose cells. Interlobular excretory ducts are present in the interlobular connective tissue. These excretory ducts join to form large lactiferous duct lined by pseudostratified columnar epithelium.

JAYPEE BROTHERS

Histology of Mammary Gland in Late Pregnancy

Alveolar cells become secretory, and a few alveoli contain a secretory product also but the secretion of milk begins only after parturition. Intralobular excretory duct also contains a secretory material. Intralobular connective tissue decreases but interlobular connective tissue will increase due to enlargement of glandular tissue.

Histology of Mammary Gland during Lactation (Fig. 15.7B)

Lactating mammary gland contains a large number of distended alveoli filled with secretions and vacuoles. Milk is produced by the epithelial cell of alveoli and accumulates in their lumen and duct also. Secretory cells of alveoli are small and low cuboidal, and their cytoplasm contains a spherical droplet of various sizes at their apex. These cells appear vacuolated as the fat is dissolved during histological preparation. Due to the increased size of the glandular epithelium (alveoli) and increased presence of adipose cells, the interlobular connective tissue is reduced as compared to the morphology of inactive gland.

JAYPEE BROTHERS



Fig. 15.1: Ovary: Different stages of follicular development.

JAYPEE BROTHERS

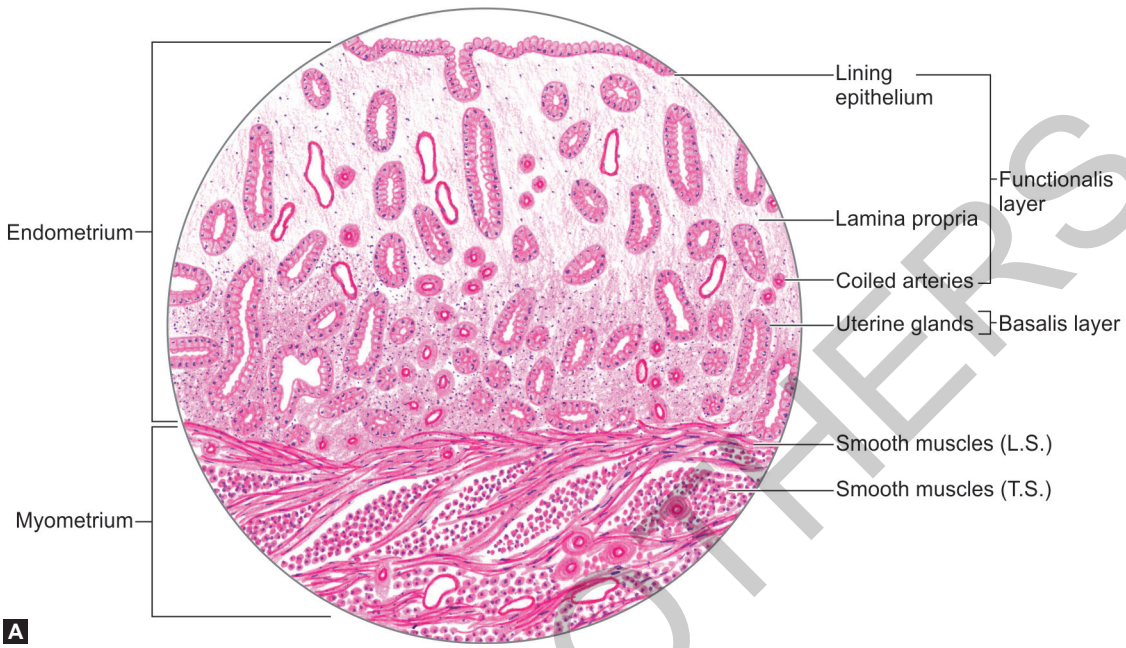
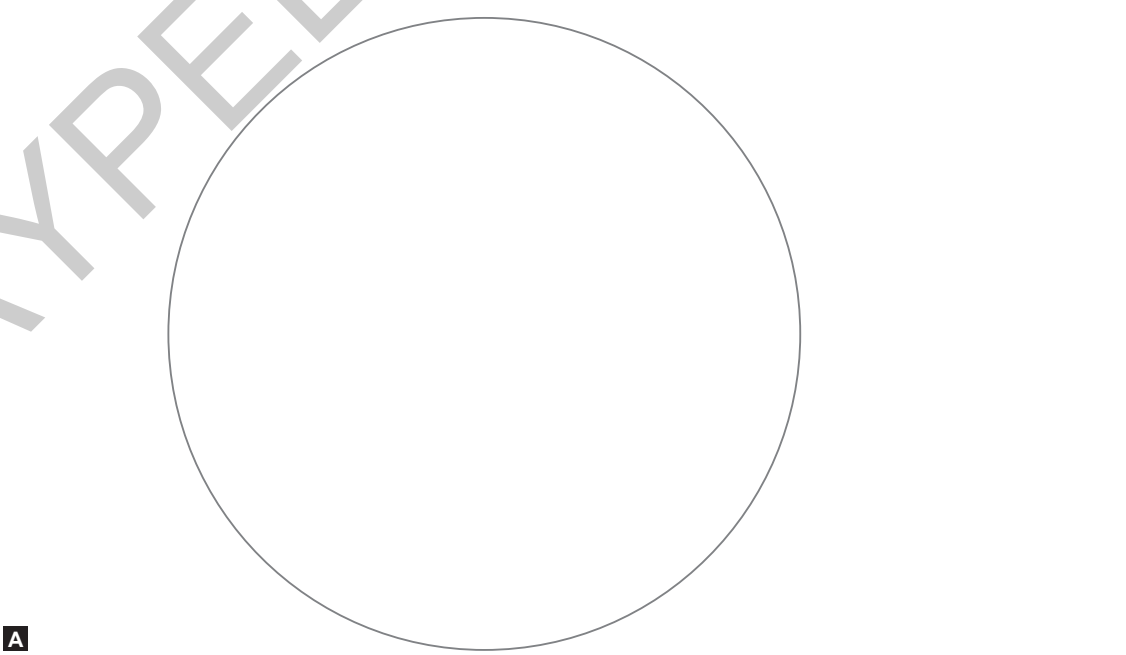


Fig. 15.2A: Uterus: Proliferative phase.

Uterus has three layers	• Perimetrium is outermost connective tissue covering • Myometrium is middle thick layer with three layers of smooth muscles • Endometrium is inner most lining of simple columnar epithelium with simple tubular uterine glands and spiral arteries
In proliferative phase	• Endometrial thickness in 2–3 mm uterine glands are straight with narrow lumen • Spiral arteries are in deeper part of endometrium
In secretory phase	• Endometrial thickness in 6–7 mm • Uterine glands are highly coiled, dilated and tortous with saw toothed appearance. Spiral arteries are highly coiled and thick walled and extend into upper part of endometrium.



JAYPEE BROTHERS

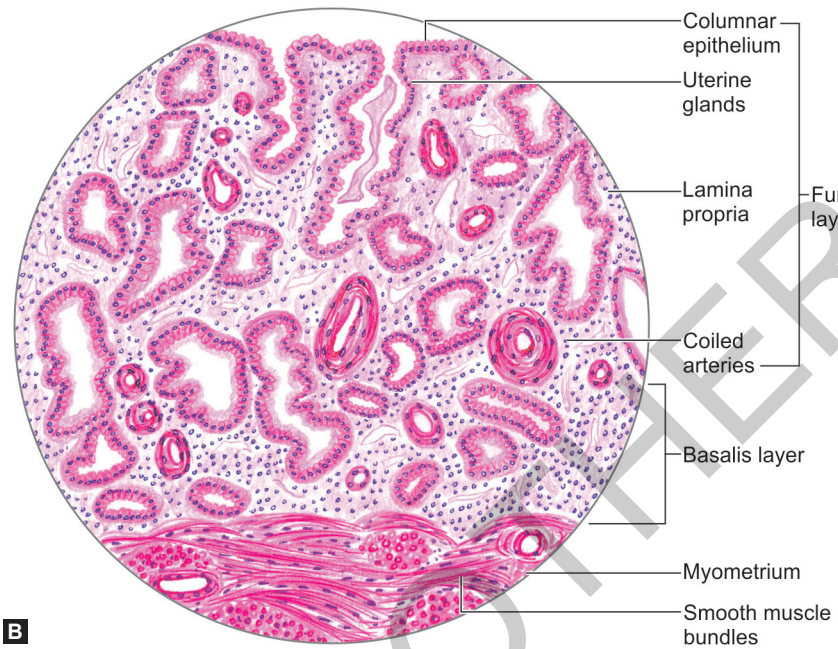
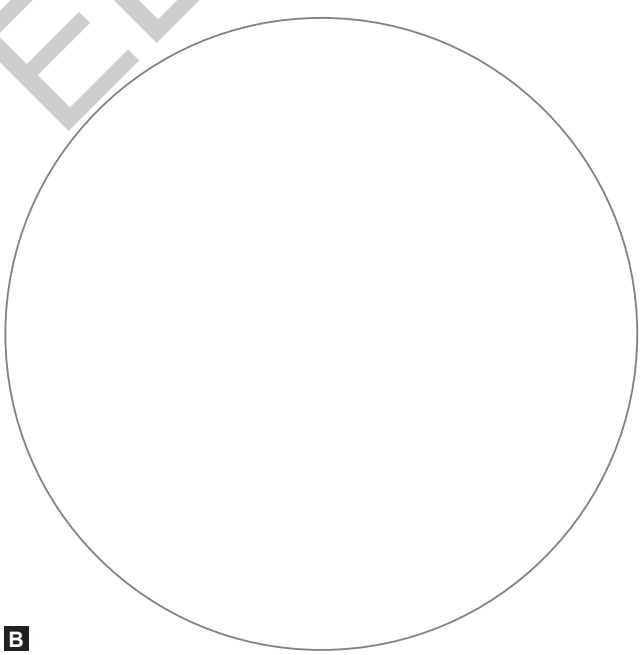


Fig. 15.2B: Uterus (Menstrual phase).

Identification features:

1. Stratum functionalis layer degenerates and is sloughed off. Uterine glands filled with blood can be seen.
2. Intact stratum basalis layer with bases of uterine gland can be identified.



JAYPEE BROTHERS

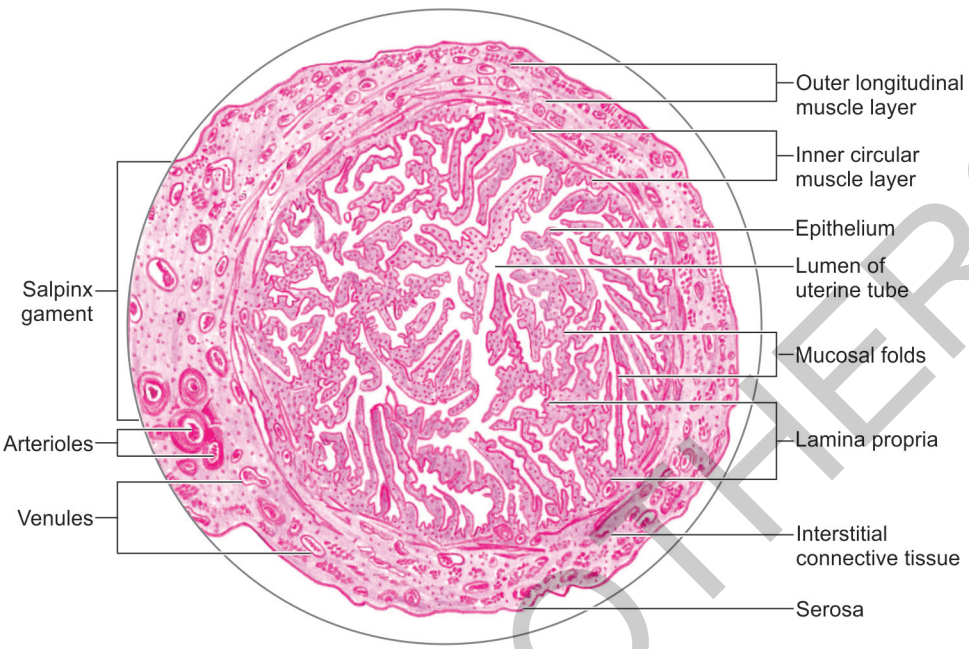


Fig. 15.3: Uterine tube.

Identification features:

Ampulla with mesosalpinx ligament:

1. Mucosa is extensively folded and has simple columnar epithelium with two types of cells-ciliated columnar cells and nonciliated secretory peg cells.
2. Muscle layer has inner circular and outer longitudinal layer of smooth muscles.

JAYPEE BROTHERS

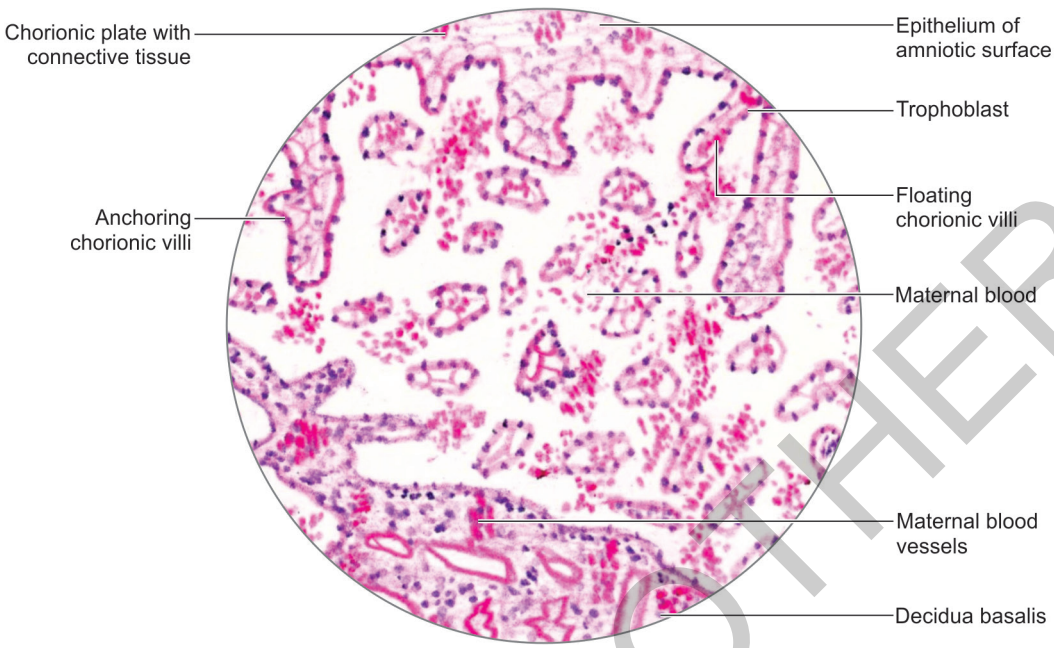
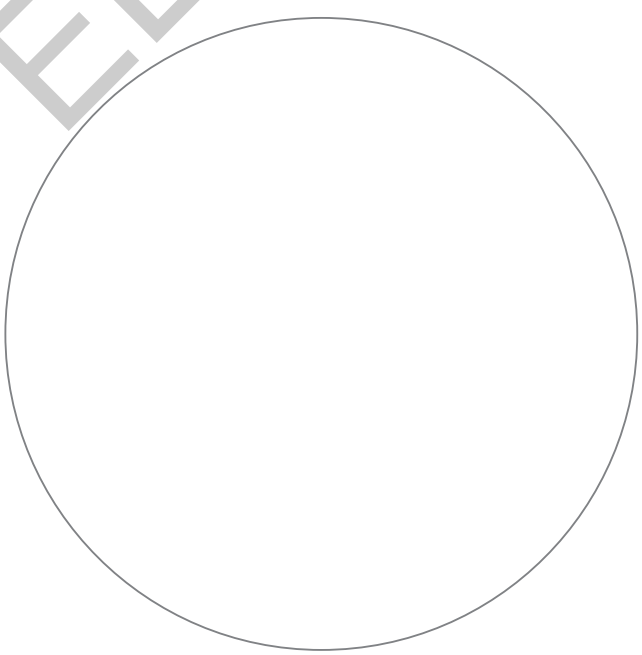


Fig. 15.4: Human placenta.

Identification features:

1. Sections of chorionic villi in different shapes and sizes are seen.
2. Each chorionic villi have two layers of trophoblast cells—outer layer of syncytiotrophoblast and inner of cytotrophoblast cells.
3. Central core of villi has embryonic connective tissue with fetal capillaries.
4. Intervillous space contains maternal blood cells.



JAYPEE BROTHERS

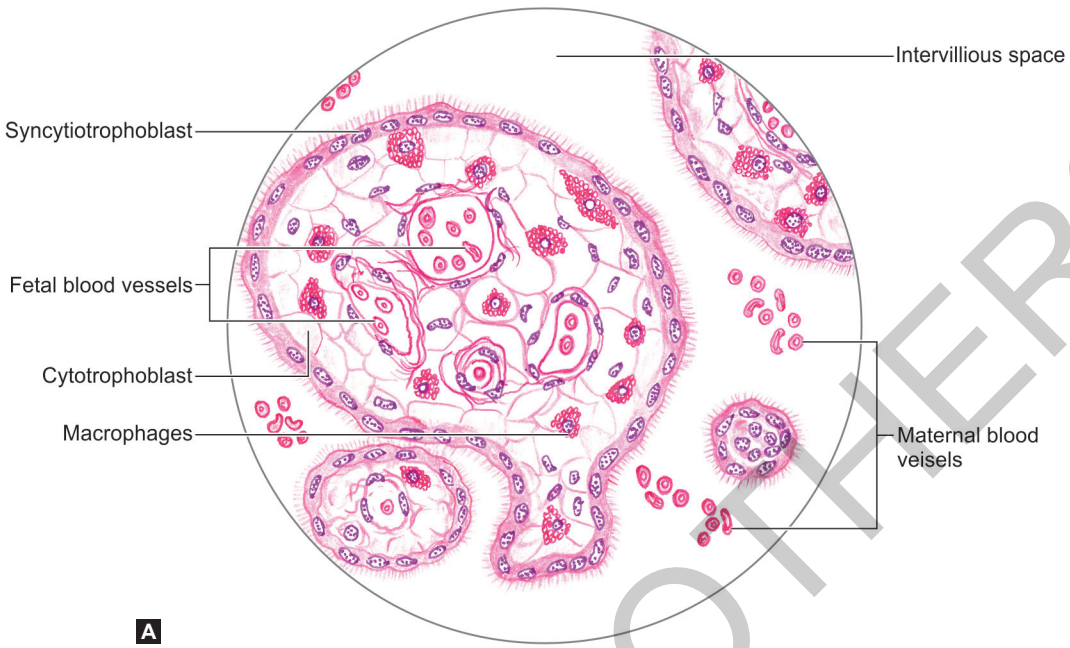
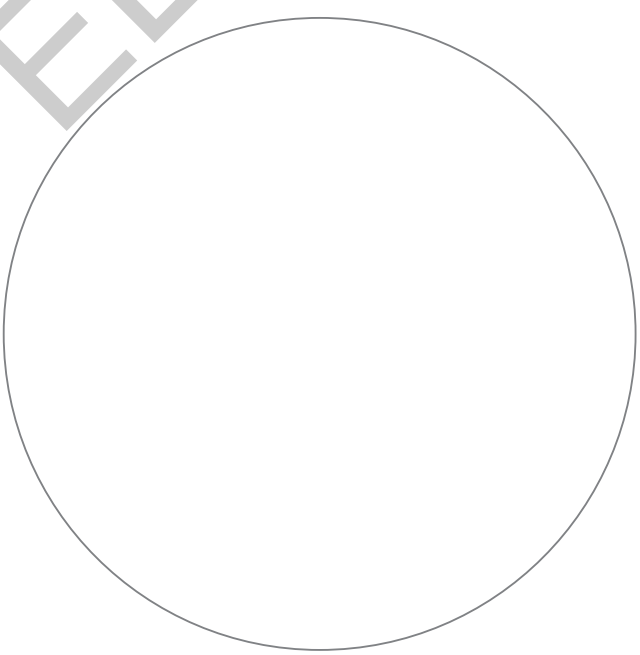


Fig. 15.5A: Chorionic villi.

Identification features:

Placenta during early pregnancy:

1. It is surrounded by trophoblast epithelium that consist of: (i) Outer—syncytiotrophoblast (Dark staining); (ii) Inner—cytotrophoblast (Light staining).
2. Core of chorionic villus contain. Mesenchyme have two type of cells that is fusiform and macrophage (Hofbauer cells), fetal blood vessels.
3. Intervillous space surrounded by maternal blood cells.



JAYPEE BROTHERS

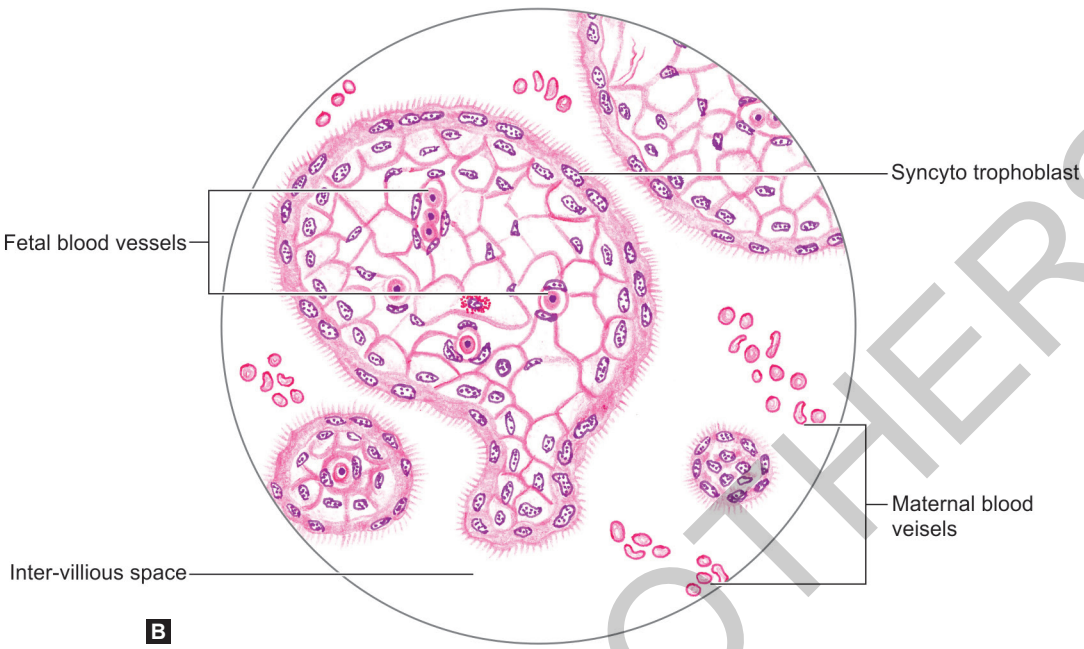
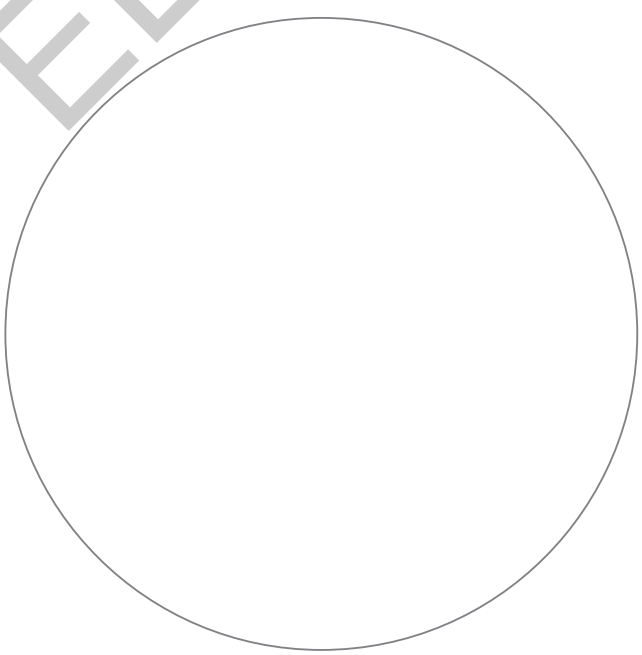


Fig. 15.5B: Chorionic villi.

Identification features:

Placenta at term:

1. It is surrounded by only thin layer of syncytiotrophoblast.
2. Core of chorionic villus contain—connective tissue differentiated with more fibers and fibroblast, large round macrophages (Hofbauer cells), mature blood cells in fetal blood vessels.



JAYPEE BROTHERS

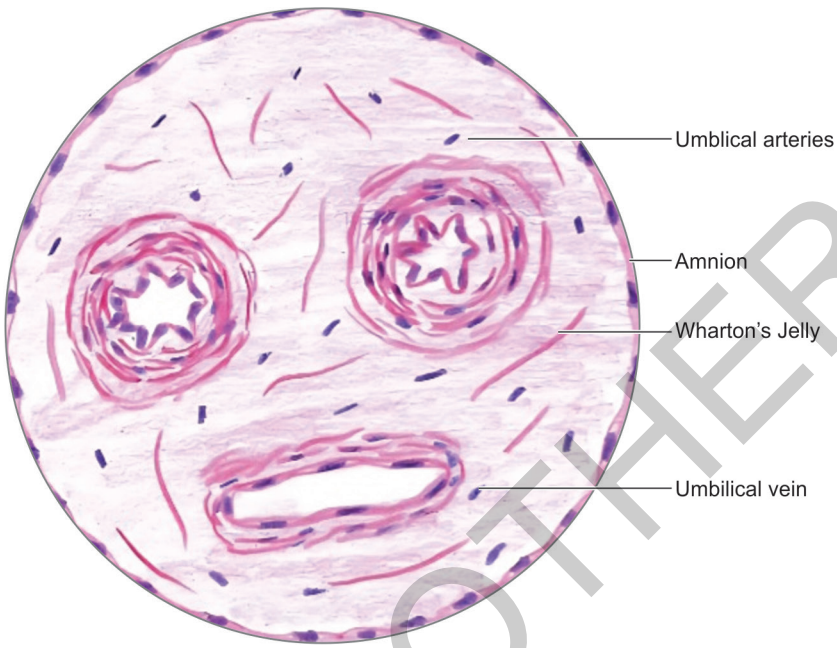
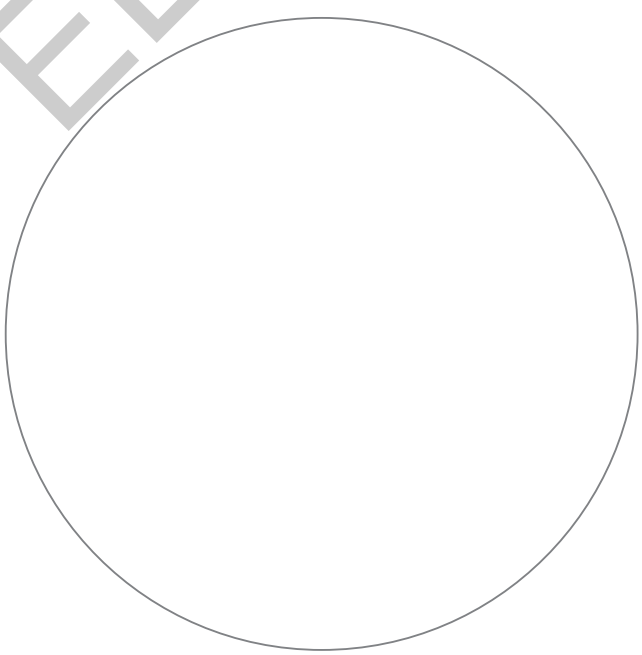


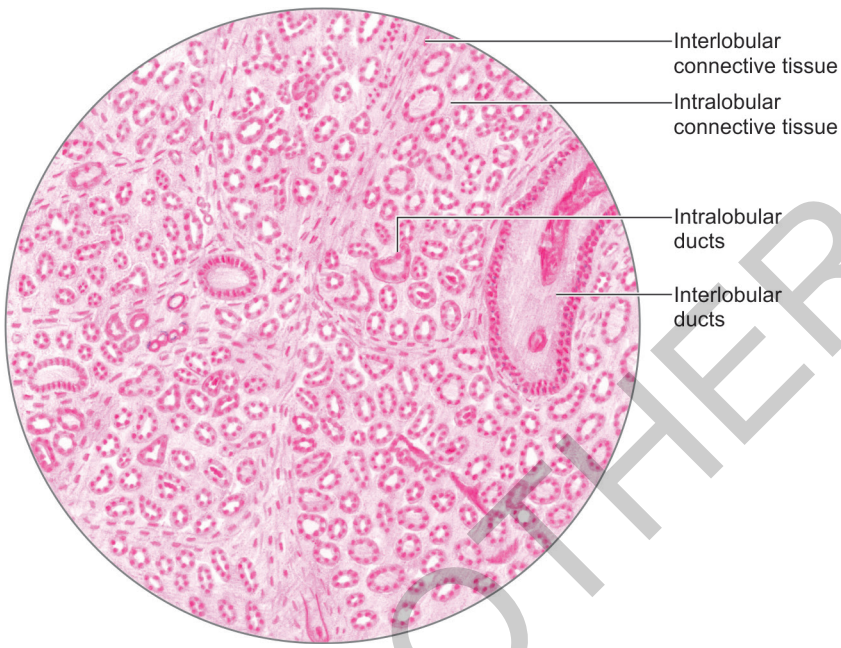
Fig. 15.6: Umbilical cord.

Identification features:

1. Amniotic membrane made of flattened cells covers cord.
2. Mucoid embryonic connective tissue known as Wharton's jelly is present in core.
3. Two thick walled umbilical arteries with wavy internal elastic lamina and narrow lumen are present.
4. One thick-walled umbilical vein with wide lumen is present.



JAYPEE BROTHERS



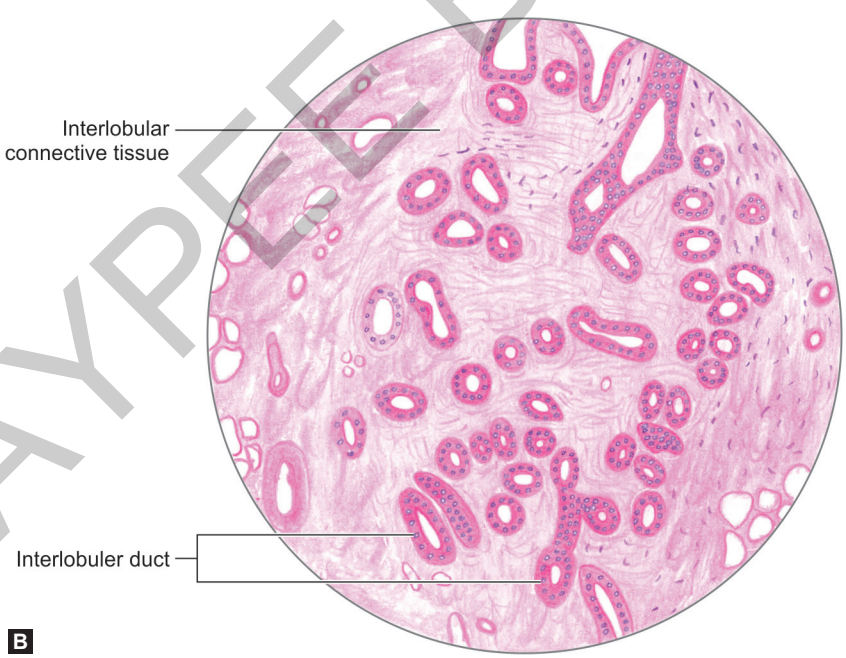
A

Fig. 15.7A: Inactive mammary gland: Abundant connective tissue with fat cells and minimal glandular tissue.

Identification features:

In early pregnancy:

1. Well developed lobes, lobules and duct system is present.
2. Alveoli are empty and lined by simple cuboidal epithelium and associated myoepithelial cells.



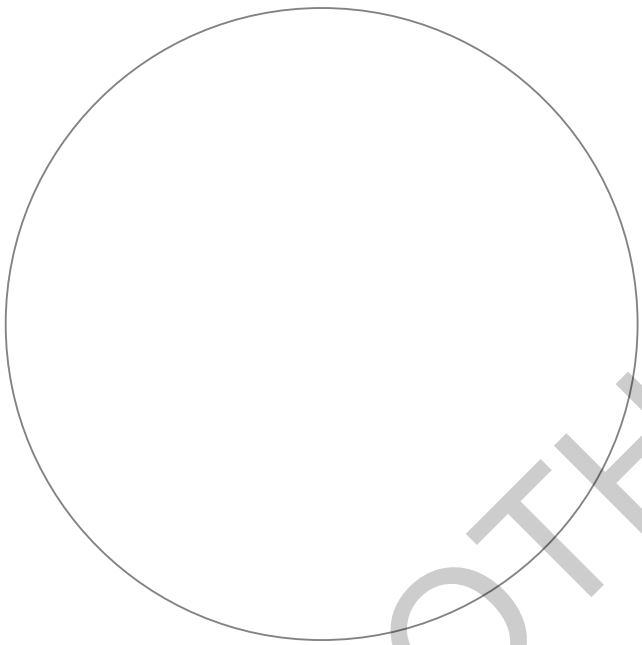
B

Fig. 15.7B: Lactating mammary gland.

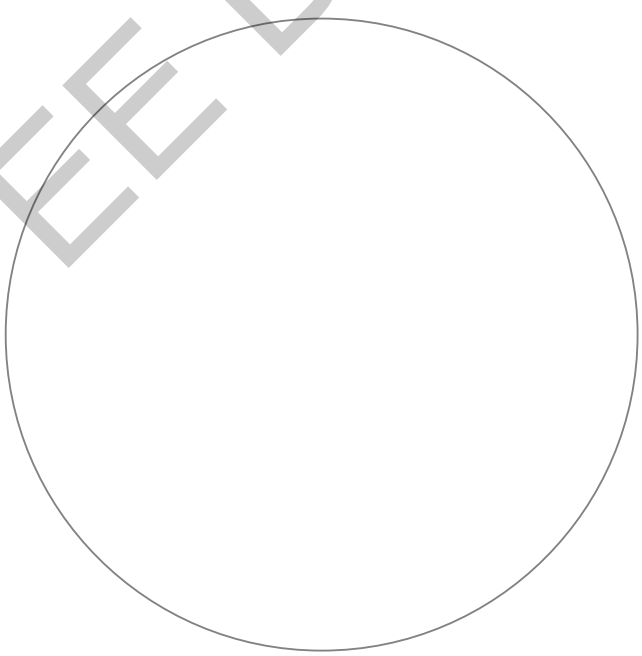
Identification features:

1. More prominent glandular element than connective tissue.
2. Alveoli are distended and filled with secretions and vacuoles.

JAYPEE BROTHERS



A



B

JAYPEE BROTHERS

for detailed information on anatomy books, visit our website www.ejaypee.com, for detailed information on anatomy books, visit our website www.ejaypee.com, for detailed information on anato

Practical Manual of HISTOLOGY

Salient Features

- Written in a simple language to help in better understanding and memorizing
- Prepared by a team of senior and experienced teachers of the subject
- All diagrams are colored and hand-drawn, hence can be easily redrawn
- Manual prepared according to the required NMC competency
- Questions of earlier university examinations are marked at appropriate places for guidance

Seema Prakash MBBS MS (Anatomy) is currently serving as Senior Professor and Head, Department of Anatomy, Rajasthan University of Health Sciences, College of Medical Sciences, Jaipur, Rajasthan, India. She has previously also served as Head, Department of Anatomy, RNT Medical College, Udaipur, Rajasthan. She has guided several PG students and authored multiple research papers.

Parveen Ojha MBBS MS (Anatomy) is currently serving as Professor and Head, Department of Anatomy, RNT Medical College, Udaipur, Rajasthan, India. She has also authored several research papers in Anatomy, which were published in International and National Journals.

Buy from ejaypee

JAYPEE BROTHERS

Shelving Recommendation
ANATOMY

ISBN 978-93-6616-798-5

9 789366 167985