Exercise 12
Urinary and Reproductive System

Objectives

After completing the exercise you should be able to:

- **Identify** – the different parts of the kidney based on their microscopic appearance.
- **Identify** – the renal corpuscles; including the glomeruli and Bowman’s spaces
- **Identify** – ureter, urinary bladder and urethra in microscopic sections
- **Identify** – the different stages of mammalian follicular development and degeneration in microscopic sections.
- **Identify** – the regions of the mammalian ovary.
- **Identify** – the different portions of the uterine tube based on their histologic appearance.
- **Identify** – the different regions of the female reproductive tract.
- **Identify** – the mammary glands in microscopic sections
- **Identify** – the testis, epididymis and vas deferens in light microscopic sections.
- **Identify** – Sertoli cells, primary spermatocytes, and spermatids in light microscopic sections, and explain the relationship between the developing spermatozoon and the Sertoli cell.
- **Identify** – the prostate gland in light microscopic sections.
- **Identify** – the seminal vesicle in microscopic sections

The Urinary System:

Introduction

The urinary system consists of the **kidneys**, **ureters**, and **urinary bladder**. Kidneys are large, bean shaped organs located retro-peritoneally in the posterior body wall. Superior to each kidney sits an adrenal gland that is embedded in the renal connective tissue. The ureters, the bladder and the urethra form the excretory passages, the structures that collect urine and drain it out of the body.

The kidney

If you split a kidney along its longitudinal axis you can differentiate between the outer darker cortex and a lighter inner medulla. The first parts of the urine-producing **nephrons** and parts of some tubules are located in the cortex. The medulla is composed entirely of tubules.

Around the periphery of the kidney is the **capsule**, a dense collagenous connective tissue envelope. Unlike the capsule of many other organs, this one doesn't send septa down into the parenchyma. There is almost no CT scaffolding in the kidneys internal volume.

At low magnification you'll be able to make out cortical and medullary areas. The cortex has large numbers of **renal corpuscles**, discernible as round structures containing small blood vessels. The renal corpuscles are the actual site of blood filtration and the initial stage of urine production. The medulla is deep to the cortex.

In sections of the kidney, identify the following structures:

- **Cortex:**
  - Renal corpuscles
  - Glomeruli
  - Bowman’s spaces

- **Medulla**
- **Renal papilla**
- **Calyx**
- **Ureter**
Among the sections on the list of slides, there is an injected preparation (U-7). In this slide liquid latex has been pushed through the renal artery under pressure, and it flows through the blood vessels to set them off against a green counter-stain. You will be able to see the vessels that constitute the renal blood supply. Slides U-11 and U-12, at low power will allow you to see most of the features of a kidney.

List of slides – Kidney

| U-1  | Mammal, median section |
| U-2  | Human                  |
| U-3  | Mammal, median section |
| U-4  | Rat                    |
| U-5  | Cat                    |
| U-6  | Mammal, PAS stain      |
| U-7  | Mammal, injected       |
| U-8  | Mammal, t.s.           |
| U-9  | Human                  |
| U-10 | Cat, young             |
| U-11 | Human, fetal           |
| U-12 | Human, infant          |
| U-13 | Human, t.s.            |
| U-14 | Monkey, t.s.           |

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List of optional slides – Kidney

| U-15 | Frog                |
| U-16 | Salvelinus          |
| U-17 | Turtle              |
| U-18 | Shark               |
| U-19 | Chick               |

Excretory Passages:

**Ureter**

An un-distended ureter exhibits a convoluted lumen, formed by the longitudinal folds. The wall of the ureter consists of **mucosa**, **muscularis** and **adventitia**.

- **The mucosa** consists of traditional epithelium and a wide lamina propria.
  - The lamina propria contains fibro-elastic connective tissue.
- **The muscularis**, in the upper ureter, consist of an inner longitudinal smooth muscle layer and an outer circular smooth muscle layer.
- **The adventitia** blends with the surrounding fibro-elastic connective tissue and adipose tissue which contains numerous arteries, venules and small nerves

List of slides – Ureter

| U-20 | Horse   |
| U-21 | Human   |
| U-22 | Mammal  |
| U-23 | Mammal  |
| U-24 | Monkey, t.s. |
| U-36 | Monkey, t.s. |
| U-37 | Human, t.s. |

REVIEW BOX SLIDE 40
**Urinary bladder**

The bladder is a temporary storage organ for urine, whose capacity (in humans) can be measured in terms of milliliters, or in miles between rest stops on the interstate highways.

The wall of the bladder is similar to that of the ureter, but there are said to be three layers of smooth muscle: inner and outer layers are longitudinal, and the middle more or less circular. The orientation of these is less than perfect, and given the shape of the bladder, this is perhaps to be expected. There is also a fair amount of elastic connective tissue in the wall to provide for elasticity and distensibility. The lining is urinary epithelium, extensively folded and puckered in the relaxed state. The scalloped free border should be easily visible, as are the inclusion bodies that are characteristic of the urinary epithelial.

**List of slides – Urinary bladder**

- U-25 Mammal
- U-26 Mammal, collapsed
- U-27 Mammal, expanded and collapsed
- U-28 Mammal
- U-29 Monkey, t.s.
- U-30 Human, t.s.
- U-31 Transitional epithelium
- U-32 Smooth muscle
- U-33 Bat
- U-34 Amphiuma
- U-35 Amphiuma, t.s.

**REVIEW BOX SLIDE 61**

**Urethra**

The urethra is a fibro-muscular tube and, in the male is associated with the prostate gland and penis, and therefore surrounded by glandular tissue, muscle sphincters and erectile tissue. Initially lined by transitional epithelium, the mucous membrane gradually changes into stratified columnar and finally stratified squamous cells in the distal part. The female urethra shows similar changes. Throughout its length, the urethra is surrounded by an outer coat of skeletal and smooth muscle fibers.

**List of slides – Urethra**

- U-38 Mammal, female

**REVIEW BOX SLIDE 62**

**Reproductive System: Introduction**

In this part of the exercise we will consider the histology and microscopic anatomy of the reproductive system tracts in mammals, both male and female.

The female reproductive tract includes an egg-producing unit, the **ovary**, and a long tube through which the discharged ova must travel (and in which fertilization takes place), the **uterine tube** or **oviduct**. This latter organ can be subdivided into different regions, all of which are physically continuous. The uterine tube leads to the uterus, the organ peculiar to placental mammals. It's in the **uterus** that gestation of the fetus occurs. Following the normal period of development the tern fetus is expelled through the **cervix**, which may be considered as a separate component of the system, and eventually through the vagina the last component of the tract.

The male reproductive system consists of the testes and their associated ducts to conduct sperm to the outside, also of various **male accessory glands** which produce non-sperm components of the ejaculate, and
that portion of the urethra which is used for the transport of semen. It also includes the intromittent organ, the **penis**.

**Gamete Producing Organs**

**The ovary**

The ovary has two anatomical portions: the **cortex** and the **medulla**. The cortex is the outer portion, in which you'll find the developing follicles. The latter is the CT core, which carries blood vessels into the organ. Arteries and veins are seen in the medulla.

The outer limit of the ovary is demarcated by a tough, dense connective tissue, the **tunica albuginea**, or "white coat." The name comes from the tunic's appearance in fresh gross specimens; it's a glistening whitish color. The tunica albuginea is made of collagen fibers, with a fair amount of smooth muscle worked into the weave.

The ovarian cortex is shot through with collagen fibers, continuous with those in the tunica. These fibers constitute the **ovarian stroma**, the framework which supports the ovarian parenchyma. The parenchyma is the "functional tissue," *i.e.*, the follicles and the various interstitial cell types. The individual follicles, each of which contains an egg which can potentially be ovulated, may be seen scattered through the cortex in various stages. These stages follow a distinct progression from the very earliest stage to the final, ovulated one.

Close up under the outer surface of the organ (*i.e.*, right up near the tunica albuginea) you will see primordial follicles, usually occurring in clusters. This is the very earliest stage of development, and most follicles in any given ovary never get beyond this stage. Within each primordial follicle is a **primary oocyte**, arrested in the course of its meiotic division. The wall of the primordial follicle is a thin layer of squamous **follicular epithelium**. Maturation proceeds gradually, and the follicle increases in size until it's a mature follicle (formerly called the Graafian follicle for Reijnier de Graaf, 1641-1673, a Dutch anatomist and physician).

When ovulation occurs, the emptied follicle fills with blood. Eventually the follicle fills up with cells from the surrounding tissue; this structure is called the **corpus luteum**, which produces progesterone.

After the secretion of progesterone is no longer needed the remains of the follicle becomes nothing but a scar, the **corpus albicans**.

**List of slides – Ovary**

- F-1  Mammal
- F-2  Mammal, t.s.
- F-3  Monkey, t.s.
- F-4  Mammal, graafian follicles
- F-5  Monkey, graafian follicles, t.s.
- F-6  Mammal, immature
- F-7  Guinea pig
- F-8  Corpus luteum
- F-9  Corpus luteum, pregnancy
- F-10  Corpus luteum, human
- F-11  Corpus luteum, human, pregnant
- F-12  Corpus luteum, verum
- F-13  Corpus albicans, human
- F-14  Senile, t.s.

**REVIEW BOX SLIDES 63, 64, 65.**

**The testis**

The outer border of the testis is demarcated by a thick band of dense collagenous connective tissue, the **tunica albuginea**. The tunica albuginea has a good many blood vessels running through it, including some
rather large arteries. This is to be expected, since the inner portions of the testis require good circulation, and the blood supply has to come through the outer tunic. From the tunica albuginea, small septa subdivide the cavity of the testis into smaller compartments.

The bulk of the testicular tissue the seminiferous tubules. The lining cells of the tubules comprise the seminiferous epithelium. Each seminiferous tubule is lined by thick, multilayered germinal epithelium which contains proliferating spermatogenic cells and the supportive Sertoli cells. The Sertoli cell or sustentacular cell (Enrico Sertoli, 1842-1910, an Italian histologist) is easily identifiable in H&E preparations by its nucleus. This cell type is (as the name implies) not part of the sperm cell line, but a sort of "nurse" cell that sustains the proper environment for spermatozoa to develop.

The Sertoli cells sits on the outermost portion of the tubule, right up against the boundary. Its nucleus will be slightly separated from the tube border. The nucleus is pale-staining, with an oval to pyramidal shape and one or two prominent nucleoli. Although these cells have a very extensive and branching cytoplasmic structure, little of the Sertoli cell's true extent can be seen in the light microscope. The extensive branching nature of the cell's cytoplasm and its role in isolating the haploid components of the system from the rest of the body were not understood before the advent of the EM.

The immature spermatogenic cells, the spermatogonia, are located in the basal region of the tubule. The more mature, primary spermatocytes and spermatids in different stages of maturation are visible closer to the lumen. The tails of the more mature spermatids protrude into the lumen of the seminiferous tubules.

List of slides - Testis

M-1  Mammal
M-2  Mammal
M-3  Human
M-4  Human, t.s
M-5  Monkey, trichrome stain
M-6  Monkey, t.s.
M-7  Monkey, t.s.
M-8  Human, tubuli recti
M-9  Human, interstitial tissue
M-10 Human, senile
M-11 Human, atrophic
M-12 Human, Leydig cell hyperplasia

REVIEW BOX SLIDE 76

Female:

Fallopian tubes (oviduct)

The fallopian tube is divided anatomically into four parts.

The infundibulum – is the funnel shaped upper end, it leads into the ampulla
The ampulla – where fertilization occurs
The isthmus – is the section of the oviduct connecting to the uterus

The oviducts are muscular tubes in which the mucosa is branched and folded, exhibiting a columnar epithelium with ciliated and secretory cells. At the isthmus the smooth muscle layers predominate and the lumen is narrow with a few short longitudinal folds of mucosa.

List of slides – Oviducts/Fallopian tubes

F-15  Mammal
F-16  Guinea pig
F-17  Monkey
Uterus

The wall of the uterus, the myometrium, contains several indistinct layers of smooth muscle together with collagen and elastic fibers. An inner thick mucosa, the endometrium, consists of tubular glands extending down from the surface into connective tissue called the stroma.

With the help of your textbook and atlas, study the slides that illustrate the cyclic changes in the histology of the endometrium as the concentration of ovarian steroids changes during the menstrual cycle.

List of slides - Uterus

- F-25 Human
- F-26 Dog
- F-27 Cat
- F-28 Guinea pig
- F-29 Rabbit
- F-30 Monkey, t.s.

REVIEW BOX SLIDES 67, 68, 69, 70.

List of slides – Uterine cycle/human

- F-31 Proliferative, day 4-14
- F-32 Early secretory, day 14-18
- F-33 Secretory, day 18-23
- F-34 Secretory, day 23-25
- F-35 Late secretory, day 25-28
- F-36 Menstrual, day 1-4

List of slides - Uterus/human/thin sections

- F-37 Endometrium
- F-38 Myometrium
- F-39 Proliferative stage
- F-40 Secretory stage
- F-41 Menstrual stage
- F-42 Pregnant
- F-43 Contraceptive
- F-44 Mammal, pregnant and non-pregnant

The Cervix

The entrance to the uterine lumen is through the cervix, a conical projection from the end of the vaginal cavity. The wall of the cervix consists of connective tissue and muscle. There are cervical crypts or glands present, the epithelial covering is simple cuboidal, and the surface appears to be moderately folded.
The adult mammary gland is a compound tubuloalveolar gland that consists of approximately 20 lobules. All lobes are connected to lactiferous ducts that open at the nipple. The lobes are separated by connective tissue partitions and adipose tissue. The resting of inactive mammary glands are small, consisting primarily of ducts and do not exhibit any developed or secretory alveoli.

Male:

The Epididymis

The ductus epididymis is a long, highly convoluted tube. You will be able to see sperm in some of the sections. The tubules are lined by pseudostratified epithelium with stereocilia. A thin layer of smooth
muscle surrounds each tubule. Adjacent to the smooth muscle layer are cells and fibers of connective tissue.

**List of slides – Epididymis**

- M-13 Mammal
- M-14 Mammal
- M-15 Mammal
- M-16 Mammal
- M-17 Human, t.s.
- M-18 Monkey, t.s.
- M-19 Mammal
- M-20 Rat
- M-21 Monkey, t.s. (vas deferens)
- M-22 Monkey, t.s.
- M-23 Human, t.s.
- M-24 Guinea pig

**REVIEW BOX SLIDE 77**

**The prostate**

The parenchyma of the prostate consists of numerous, individual prostatic glands that vary in size and shape. The glandular epithelium also varies from simple cuboidal or columnar to pseudostratified epithelium. In older individuals, the secretory material precipitates to form the characteristic dense staining prostatic concretions of various sizes. The prostate is also characterized by the presence of a fibromuscular stroma composed of smooth muscle and connective tissue fibers.

**List of slides – Prostate**

- M-30 Human
- M-31 Human
- M-32 Human, young adult
- M-33 Human, middle age, t.s.
- M-34 Monkey, t.s.
- M-35 Prostate and Bladder
- M-36

**REVIEW BOX SLIDE 80**

**Ductus deferens and seminal vesicle**

The ductus (vas) deferens, which conducts spermatozoa from the epididymis to the urethra, is a thick-walled muscular tube consisting of inner and outer longitudinal layers and a thick intermediate circular layer. The ductus deferens is lined by pseudostratified, columnar epithelium similar to that of the epididymis; the epithelial lining and its supporting lamina propria are thrown into longitudinal folds permitting expansion during ejaculation.

Each seminal vesicle is a complex glandular diverticulum of the associated vas deferens. The lumen of each seminal vesicle is highly irregular and recessed, giving a honeycombed appearance at low magnification.

The epithelial lining is of a pseudostratified, tall columnar type and consists of secretory cells with lipid droplets in the cytoplasm giving it a foamy appearance. The epithelial cells often contain brown granules and characteristically have variable nuclear shape and size. The prominent muscular wall is arranged into inner circular and outer longitudinal layers.
Penis

The ductus deferens carries sperm to the urethra, and the sperm are discharged through that portion of the urethra which passes through the penis. Immediately surrounding the urethra are the blood sinuses of the corpus spongiosum, which could be filled with blood in some slides. Dorsally you can see the much larger blood sinuses of the corpus cavernosum. The latter are involved in the mechanism of erection. A very dense CT wall demarcates the corpus cavernosum, and septa divide it into chambers enclosing the erectile tissue. Careful examination of the blood sinuses in these areas will reveal that they are lined with simple squamous epithelium, as is the rest of the cardiovascular system.

Lists of slides – Penis

M-37  Mammal
M-38  Rat
M-39  Human, fetus
M-40  Human, infant
M-41  Human

List of optional slides – Sperm

M-43  Sperm, smear
M-44  Sperm, smear
M-45  Sperm, rat, smear
M-54  Sperm, turtle
M-55  Sperm, Ambystoma

List of comparative slides – Testis

M-46  Testis, rat
M-47  Testis, guinea pig
M-48  Testis, mouse
M-49  Testis, bird
M-50  Testis, Dictyophorus
M-51  Testis, toad
M-52  Testis, Anolis
M-53  Testis, amphiuma, t.s.