Benha University
Faculty of Veterinary Medicine
Histology and Cytology Department

HISTOLOGY Exam for **1st year 2nd semester**

15 January 2013 **برنامج جودة و مراقبة الأغذية** **Time:- 3** hours

(I) What do you know about:

1. Smooth muscle.

Long spindle like cell (30 – 200 u)
Centrally located nucleus & elongated.
At side pole of elongated nucleus there numerous mitochondria, R.E.R & large Golgi body
The cytoplasm appear unstructured under E.M, it consists of arrays & myofilaments. Acidophilic, homogenous cytoplasm.
The fine structure of the smooth muscle consists of actin, myosin and desmin filaments. It also contains caveolae, (pockets) in its cell membrane but no T tubules.
It has autonomic innervation.
Mesenchymal in origin.
Site of smooth muscle
Dispersed in C.T of some organs (prostate and seminal vesicle)
Small muscle bundle → erector pill muscle of skin
Constitute large bulk in the myometrium of the uterus
present in capsule of some gland
in the tunica media of the blood vessels
* The smooth muscle has involuntary action except in the muscle of urinary bladder and ciliary muscle of eye.
Smooth muscle contraction:-
Contractions are initiated by an influx of calcium which binds to calmodulin.
The calcium-calmodulin complex binds to and activates myosin light-chain kinase.
Myosin light-chain kinase phosphorylates myosin light-chains, causing them to interact with actin filaments. This causes contraction.
Smooth muscle cells relaxed and contracted. Cytoplasmic filaments insert on dense bodies located in the cell membrane and deep in the cytoplasm. Contraction of these filaments decreases the size of the cell and promotes the contraction of the whole muscle. During the contraction the cell nucleus is deformed.
The calcium ions leave the troponin molecule in order to maintain the calcium ion concentration in the sacoplasm. As the calcium ions are being actively pumped by the calcium pumps present in the membrane of the sarcoplasmic reticulum creating a deficiency in the fluid around the myofibrils.This causes the removal of calcium ions from the troponin. Thus the tropomyosin-troponin complex again covers the binding sites on the actin filaments and contraction ceases.

* Contractile activity → this depends up on excitation- contraction coupling which also depend on calcium influx and structure-organization of actin and myosin filaments.

2. Testis of bull.

The testes have, like the ovaries, two functions: they produce the male gametes or spermatozoa, and they

produce male sexual hormone, testosterone, which stimulates the accessory male sexual organs and causes the development of the masculine extragenital sex characteristics.

Each testis is suspended in an out pouching of the peritoneal cavity. This cavity, like the rest of the peritoneum, is lined by a serosa consisting of mesothelial cells supported by a fibrous connective tissue.

The testes were enveloped by visceral layer of the tunica vaginalis (peritoneal covering the testes and epididymis.

Both of these tunics consist of fibrous connective tissue with a thin surface of mesothelium.

The thickened posterior portion of the tunica albuginea, called the mediastinum, receives the blood vessels, lymphatics, nerves, and ducts which serve the testis.

Fibrous septa extend from the mediastinum into the body of the testis, these septa has the same structure as that of the tunica albuginea.

The testis consists of numerous lobules, each one contain numerous seminiferous tubules.

(I) Stroma:-

It is the background of the testis; it consists of connective tissue capsule or tunica albuginea (thin layer of dense irregular C.T) with occasional smooth muscle cells are present in the capsule *(Stallion)*.

The testicular artery and vein give arise numerous branches which forming tunica vasculosa, *present superficially in dog and ram.*

The T. albuginea gives (septulae testis) the connective tissue septa which extend toward the centrally mediastinum testis and dividing the testis into a varying number of lobules (lobuli testis).

Mediastinum testis is strand of C.T. which passes within the testis parallel to its longitudinal axis, and consists of dense C.T supporting the tubules of the rete testis.

In Horse a compact mediastinum and rete testis are restricted to the cranial pole.

(II) Parenchyma:-

It is the cellular element of the testis.

Seminiferous Tubules

The bulk of each testis consists of seminiferous tubules embedded in relatively sparse interstitial tissue. And consider as the structural units of the testis. Each begins blindly under the T. albuginea and goes convoluted then become straighted toward mediastinum testis and opening into tubules of the rete testis.

Sperm cells are produced by the tubules, while hormones are produced by endocrine cells (***Leydig cells)*** within the interstitium.

A few hundred tubules comprise one testis. Thin connective tissue septa, arising in the mediastinum, separate tubules into lobules.

The tubules are lined by a complex stratified epithelium which is most easily understood as consisting of two very different cell populations:-

1-Sertoli cells (supporting cells:-

1-they are large and supportive cells. Simple columnar, triangular or rectangular shape epithelium cells.

2-Each Sertoli cell rests on the basement membrane and extends to the lumen.

3-The Sertoli cells create the environment in which germ cells carry out the fundamental reproductive function of gamete production.

4-The simple columnar nature of the Sertoli epithelium is most evident prior to puberty, before the germ cells begin producing sperm.

5-In an adult testis, Sertoli cell nuclei are often inconspicuous among the much more numerous nuclei of germ cells

6-The nuclei of Sertoli cell can be readily recognized as those typical of columnar epithelium, oval, euchromatic, nuclei, usually with prominent nucleoli.

7-The cytoplasm of Sertoli cells assumes an elaborate shape, enveloping germ cells at various stages in meiosis.

Functions

nutritional support,

phagocytosis of residual bodies (shed cytoplasm)
formation of spermatides,
Androgen binding hormones production.
2- Germ (Spermatogenic) cells:-
Sperm Cell Formation
Male germ cells comprise a unique cell population which continually produces new male gametes, or spermatozoa, in the process called
spermatogenesis. Germ cells at all stages of meiosis are found embedded within the epithelium of the seminiferous tubules.
Spermatogonia
* They are the stem cells of the germ cell population.
* They divide mitotically to produce primary spermatocytes as well as more spermatogonia.
* They are found at the base of the tubular epithelium.
* They have relatively large round nuclei and lie adjacent to the basement membrane of the tubular epithelium.
* Spermatogonia are the first cells of *(A- spermatogenesis, it is the phase which the spermatogonia change into primary spermatocytes).* They originate in the 4th week of foetal development in the endodermal walls of the yolk sac and migrate to the primordium of the testis, where they differentiate into spermatogonia. Spermatogonia remain dormant until puberty. They are always in contact with the basal lamina of the tubule. The spermatogonia have diploid number of chromosomes.
* Two types of spermatogonia can be distinguished in the human seminiferous epithelium:
Type A spermatogonia have a rounded nucleus with very fine chromatin grains and one or two nucleoli. They are stem cells which divide to form new generations of both type A and type B spermatogonia.
Type B spermatogonia have rounded nuclei with chromatin granules of variable size, which often attach to the nuclear membrane, and one nucleolus. Although type B spermatogonia may divide repeatedly, they do not function as stem cells and their final mitosis always results in the formation of
Primary spermatocytes
* They are cells in the first stage in meiosis, during which DNA replicates twice.
* It results from the mitotic division of type B spermatogonia.
These cells are the largest cells in the seminiferous tubules; they are situated towards the center.
Their nuclei are large, spherical and deeply stained.
* Divide to produce secondary spermatocytes.
* They are found at mid-levels within the tubular epithelium.
B) Meiosis: (reduction division)
It is the maturation division of the primary spermatocytes (which contain the diploid number of chromosomes) into the spermatides (which contain the haploid number).
This requires two maturation divisions.
1- During the first maturation division (meiosis), the DNA content of each primary spermatocyte is duplicated during the interphase, thus each cell contains a tetraploid set of genes. a 2- 2- During the stages of meiosis, crossing over of genes of the chromosomes occur.
• Meiotic division of the primary spermatocytes consequently, gives rise to secondary spermatocyte.
Secondary spermatocytes
They are smaller cells with less abundant cytoplasm.
Divide one more time, without further DNA replication, to produce spermatides.
*the nucleus is small, centrally situated and dark and it has haploid number of the chromosomes..
* Are found at mid-levels within the tubular epithelium (like primary spermatocytes).
Spermatides
* They are the product of the final meiotic division.
* They are found near the lumen of the tubule.

* They are small spherical cells with small round nuclei centrally and smaller than 2nd spermatocytes..
* Undergo an elaborate process of maturation (called spermiogenesis) to become spermatozoa.

C) Spermiogenesis:

It is the process by which the spermatids differentiate into spermatozoa.
This process can be divided into 4 phases:

1. Golgi phase :

- Proacrosomal granules appear in the vesicles of the Golgi apparatus.
- They fuse to form single acrosomal granule.

2. Cap phase :

- The acrosomal vesicle and granule move toward the anterior pole of the nucleus.
- Then the acrosomal granule flattens to form the acrosome.
- The acrosome grows and covers the anterior two thirds of the nucleus forming the head cap.

3.Acrosomal phase :

- The acrosome remains localized at the anterior pole of the nucleus, and is referred to as the acrosomal cap.
- The centrioles move toward the caudal pole of the cell where the distal centriole gives rise to the caudal growth, flagellum.

4. Maturation phase :

- The nucleus becomes a compact mass.
- Elongation of the spermatid takes place.
- Two, rings, one small and dense and the other large and less dense arise around the distal centriole.
- The distal centriole becomes a funnel shaped basal body while the large ring disappears during further maturation.
- The small ring moves distally and makes the distal end of the middle piece of the mature spermatozoon. The mitochondria form a helix in the periphery of the middle piece.
- The connecting piece forms nine longitudinally arranged columns around the centrioles, connected distally to nine longitudinal fibers peripheral to the nine double fibrils of the flagellum.
- Finally semicircular ribs form the fibrous sheath around the tail fibers in the principal piece of the spermatozoon.

Spermatozoa

* They are highly specialized, motile cells, each with a single large flagellum.
* They form by maturation (i.e., without further cell division) from spermatides.
* They have very small, highly condensed, oval to conical nuclei. (The shape of entire sperm cells, with long flagella, is not evident in tissue sections.)
* They are found near the lumen of the tubule.
* The mature spermatozoon is about 60 µm long and actively motile. It is divided into head, neck and tail.

The head (flattened, about 5 µm long and 3 µm wide) chiefly consists of the nucleus (greatly condensed chromatin!).
The anterior 2/3 of the nucleus is covered by the acrosome, which contains enzymes important in the process of fertilization.
The posterior parts of the nuclear membrane form the so-called basal plate.
The neck is short (about 1 µm) and attached to the basal plate. A transversely oriented centriole is located immediately behind the basal plate.
The neck also contains nine segmented columns of fibrous material, which continue as the outer dense fibres into the tail.
The tail is further divided into a middle piece, a principal piece and an end piece. The axonema (the generic name for the arrangement of microtubules in all cilia) begins in the middle piece.
It is surrounded by nine outer dense fibres, which are not found in other cilia.
In *the middle piece* (about 5 µm long), the axonema and dense fibres are surrounded by a sheath of mitochondria.

The middle piece is terminated by a dense ring, the annulus.
The *principal piece* is about 45 µm long. It contains a fibrous sheath, which consists of dorsal and ventral longitudinal columns interconnected by regularly spaced circumferential hoops.
The fibrous sheath and the dense fibres do not extend to the tip of the tail. Along the last part (5 µm) of the tail, called the end piece, the axonema is only surrounded by a small amount of cytoplasm and the plasma membrane.
Interstitial Tissue
Seminiferous tubules are separated from one another by a delicate connective tissue stroma, or interstitial tissue. This interstitial tissue between the tubules contains clusters of endocrine ***Leydig cells*** which secrete testosterone.
Leydig Cells
*Testosterone-secreting Leydig cells occur in clusters within the interstitial tissue (stroma) of the testis.
*Leydig cells may be recognized not only by their location within the testicular interstitium but also by their round nuclei and extensive acidophilic cytoplasm.
*Leydig cells have an appearance typical of steroid-secreting cells.
*With electron microscopy they can be seen to contain abundant smooth endoplasmic reticulum and mitochondria with tubular cristae.
*Leydig cells may contain small eosinophilic cytoplasmic inclusions called Reinke's crystalloids. With age, Leydig cells may accumulate lipofuscin (brown "wear-and-tear" pigment).
* Leydig cells are numerous in the testis of the camel more than any other animals.
Lipid inclusions are found in all species and varying amount of glycogen are present in case of *stallion, bull and cat.*
Myoid Cells
Each seminiferous tubule is surrounded by a thin layer of contractile myoid cells, which produce waves of contraction to move immature (and not yet motile) spermatozoa out of the testis.
Rete Testis and Efferent Ductules
All of the seminiferous tubules converge onto a network of interconnecting channels, the rete testis, which are lined by a variable (often very low) cuboidal epithelium.
The rete testis in turn leads through numerous small efferent ductules from the mediastinum into the epididymis.

3. Isthmus.

Each oviduct is about 10 cm long. One end opens into the uterine cavity, the other into the peritoneal cavity adjacent to the ovary. The uterine tube is divided into four regions.
Each tube begins with the fimbriated, funnel-like opening, the **infundibulum**.
The next segment is the dilated **ampulla** with its alternating, branching folds.
The **isthmus** and then to a larger extent in
The **intrauterine** segment, the tube becomes reduced in diameter and its luminal mucosa far less folded. It is present in some animals as ***mare.***
The wall of the oviduct consists of a *mucosa, muscularis, and external serosa.*
(1) The mucosa: - has deep thin folds in the infundibular region. (a) The epithelium is simple columnar. The height of the epithelium is highest in the ampulla and is influenced by hormones, being somewhat higher just before ovulation.
There are two types of columnar epithelial cells found in the oviduct, ciliated and nonciliated) cells. The latter are recognized because their nuclei are near the lumen and their cytoplasm (and sometimes nuclei) bulge into the oviduct lumen. Peg cells are probably secretory cells.
Ciliated cells predominate, particularly in the infundibulum and ampulla, being slightly less in number as the ampulla grades into the isthmus. These are probably not separate cell types but rather different states of the same cell type. Thus, hormonal changes can influence the relative ratios of the two cell types. A few basal cells with pale cytoplasm and dark nuclei can sometimes be seen located near the basement membrane. They

are undifferentiated cells, which give rise to other cell types.
(b) The lamina propria consists of loose connective tissue and is rich in blood vessels. The lamina propria lacks glands.
(2) The smooth muscle in the muscularis:- is loosely arranged into inner circular and outer longitudinal layers, which are separated by a connective tissue layer. The outer longitudinal layer is best defined in the isthmus becoming less distinct as you approach the fimbriae. It may be unrecognizable in the infundibulum.
(3) The serosa or outermost layer: - of loose connective tissue contains blood vessels, lymphatics, and nerves and lined by simple squamous layer of mesothelial cells.

II- What are the histological structure of:

1. Urinary bladder.

It is an expanded ureter, because most of the layers present in the ureter are present in the bladder. The major differences are:-
(1) The relative increases in the thickness of individual layers of the bladder tunica muscularis.
(2) The presence of a scanty lamina muscularis in bladders of some animals.
Structure of urinary bladder:
I. Tunica mucosa:-
1- *Lamina epithelialis:* - lined by transitional epithelium varies in thickness, depending on the species and degree of distention. There are lymphocytic migration from lamina propria to epithelial cell, they numerous in ruminants.
2-*Lamina propria* composed of loose connective tissue with a substantial amount of elastic fibers. The fibers become more abundant at the bladder neck, where they are arranged circularly. Lymphatic nodules in the lamina propria are a common finding in all domestic animals.
3- Lamina muscularis mucosa:
The presence and amount of a lamina muscularis mucosa vary with the species:-
In horse it is well developed.
In ruminant, dog and pig*:* it is extremely thin and sometimes only isolated cells are seen.
In cat, it is absent.
II. Tunica submucosa is somewhat looser and contains more elastic fibers than that of the lamina propria; large blood vessels and small ganglia are present at the bladder neck.
III. Tunica muscularis:
The bladder muscularis is composed of three rather ill-defined layers: an inner and outer longitudinal layer and a middle circular layer.
IV. Tunica serosa or adventitia:
It consists of a loose connective tissue only or with and the mesothelium

2. Esophagus of birds.

Epithelium→ st.sq.epith. it may be ciliated columnar or cuboidal in some spp.
L.Propria→ loose CT
T. Submucosa→ fibroelastic CT
T.Muscularis→ *outer circular and inner longitudinal and oblique skeletal muscles* then this muscle orientation change caudally and become *smooth muscles*
T. Serosa→ loose CT lined by mesothelial cells.

3. Thyroid gland.

The thyroid gland consists of two lobes united by a broad band of similar tissue called isthmus.
The most part of the two lobes is located in the cervical region, in front and around the sides of the trachea just below the larynx.
The isthmus lies over the 2nd and 3rd cartilaginous rings of trachea. The gland is covered by the cervical fascia.
It is derived from the endoderm. It synthesizes thyroxin hormone which control the metabolic rate in body cells.

In certain species they also partly secreted calcitonin which controls the calcium level in blood.

Structure of Thyroid Gland

The thyroid gland is surrounded by a thin fibrous C.T. capsule.

Thin trabeculae extend from the capsule into the parenchyma. They divide the gland into irregular lobules; each lobule is packed with thyroid follicles which are supported by a network of reticular fibers with extensive capillary bed. The thyroid follicle is the structural and functional unit of the gland, they are rounded, tubular or irregularly in shape.

They vary greatly in size depending on the level at which the follicles are cut and their functional activity.

Each thyroid follicle is surrounded by a basement membrane and consists of a single layer of cuboidal cells surrounding a lumen filled with a structureless acidophilic material, the colloid.

An active follicle tends to have walls of cuboidal to high cuboidal epithelium, while inactive follicles have flattened epithelium.

The thyroid follicle contains also in addition Para follicular cells (C, clear, or light cells).

These cells lie adjacent to the follicular cells but do not reach to the follicular cavity, they are larger than follicular cells and their nuclei are eccentrically.

These cells produce calcitonin which controls the blood calcium level.

With EM; the follicular cells presents the characteristics of a cell which synthesizes, secretes, reabsorbs, and digests proteins. The basal part of these cells is rich in granular ER. The nucleus is generally spherical and centrally situated. The apical pole contains Golgi apparatus and secretory granules. Abundant lysosomes are present. Mitochondria, distended cisternae of rER, and ribosomes are dispersed throughout the cytoplasm, the apical cell membrane have microvilli.

III- Discus the function structure relationship of the following:

1. Crop.

The crop has a resident bacterial population, mostly Lactobacillus species, which ferment some carbohydrates in the food for their own purposes. Lactic acid is the by-product of this fermentation so the pH of the feed drops as the food is retained in the crop. Geese and ducks do not have a true crop but have an enlarged part of the lower esophagus. This gives waterfowl a similar ability to store food but bacterial fermentation is less compared to other poultry

2. Testis of poultry.

The testicular capsule was, relative to mammals, thin, being 81.5 +/- 13.7 microm in the quail, 91.7 +/- 6.2 microm in the domestic fowl, 104.5 +/- 29.8 microm in the turkey and 91.8 +/- 18.9 microm in the duck. The orchido-epididymal border (hilus) of the capsule was much thicker than elsewhere in all birds (from 233.7 +/- 50.7 microm in the duck to 550.0 +/- 147.3 microm thick in the turkey). The testicular capsule, other than the tunica serosa and tunica vasculosa, comprised, in the main, smooth muscle-like or myoid cells running mainly in one direction, and disposed in one main mass. Peritubular tissue was similarly composed of smooth muscle-like cells disposed in several layers. Actin and desmin intermediate filaments were immunolocalized in the inner cellular layers of the capsule in the quail, domestic fowl and duck, but uniformly in the turkey. Vimentin intermediate filament immunoreaction in the capsule was moderately and uniformly positive in the testicular capsule of only the quail. Actin and desmin, but not vimentin (except very faintly in the turkey) or cytokeratin, were immunolocalized in the peritubular tissue of all birds. The results therefore establish, or complement, some previous observations that these birds have contractile cells in their testicular capsule and peritubular tissue, whose function probably includes the transport of testicular fluid into the excurrent duct system, the epithelium of the rete testis was composed of a mixture of numerous non-ciliated and fewer ciliated cells. Both cell types contained many inclusions in the cytoplasm all of which indicated that the cells could modify the luminal contents

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