Investigation of several physiological parameters associated with sexual maturation in Different ages male goats of the local breed

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Abstract:
The current study was conducted at the Higher Studies Laboratory of the Department of Animal Production, Faculty of Agriculture, University of Muthanna, from 1/12/2022 to 1/6/2023. The aim was to identify specific indicators of sexual puberty in local goat. The study comprised a total of 40 goats, which were divided equally into four age groups, with eight animals in each group. The time intervals are as follows: I spans from 4 to 6 months, II from 6 to 8 months, III from 8 to 10 months, and IV from 10 to 12 months. The goat testes were obtained from the government-sanctioned culling in Samawah, soon following the slaughter of the animals. The testicles were inserted into the thrummus container beside the ice cubes. The specimens were transported to the laboratory within a span of one hour. The findings of the textile formula indicated the absence of sexual puberty indications in the initial age group (6 months), whereas preliminary indications of sexual puberty were observed in the second age group (6 months), and clear indications of complete sexual puberty were evident in the third age group (8-10 months), including an enlargement in sperm diameter and the presence of sperm at different stages of development. These indications were even more pronounced in the fourth age group (10-12 months .(

Introduction

Archaeological findings suggest that goats have been domesticated by humans for the past 10,000 years, mostly for their meat, milk, skin, and hair.It is widely thought that a significant number of domesticated cattle or wild goats are the direct progenitors of the modern domesticated goat species [1]. Goats are commonly chosen by impoverished farmers as livestock due to their ability to thrive and produce in challenging environments, such as mountainous areas. Unlike cattle and sheep, which struggle to survive in these regions, goats are smaller in size and have minimal dietary requirements, allowing them to adapt and reproduce even in harsh conditions [2.]

lacteous animals, such as goats, are vital assets in the livestock industry and local economy. They play a significant part in the national economy by meeting people's demands for meat, milk, by-products, and leather [3]. Animal taxonomy literature indicates that there are about 300 distinct varieties of goats distributed worldwide, and they hold significant significance in the lives of individuals and their food security [4]. Researchers are increasingly focused on improving the productivity of small ruminant animals, such as sheep and goats, due to the growing global demand for livestock, particularly meat and dairy products. This demand is particularly high in Arab nations. In the 1980s, the global goat population reached 460 million, and by the 1990s, it had increased to 609.5 million. Out of this, 49% were in Asia, 14% in Africa, and 15% in South America. In 1991, there were 363 million goats in tropical and subtropical regions, which accounted for 80% of the total in Asia and Africa. Research has indicated that the goat population in Arab nations, based on 1992 data, amounts to approximately 70

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million. The majority, approximately 67%, of these goats are found in Sudan, Somalia, Mauritania, and Yemen. This serves as proof of the goats' capacity to survive, procreate, and yield offspring amid the distinct ecological circumstances of the area[5], [6 .[

The male reproductive system comprises the scrotum, a pair of testicles, reproductive ducts, the male organ, and accessory glands. In male goats, the testicles are situated in the inguinal area, outside the body, and are positioned perpendicular to the body. They function as a secretory gland responsible for producing the male hormone testosterone. Externally, sperm are generated to fertilize the female egg and form the fertilized egg [7], [8]. The researchers aimed to enhance the reproductive efficiency of male animals, boost production, and improve livestock as a crucial component of economic productivity by enhancing animal productivity and reproductive efficiency[9] .In Iraq numerous studies were carried out to enhance the productive and reproductive efficiency of goats through the implementation of reproductive technologies in the area of sperm preservation for indigenous male goats in both cooling and freezing settings[10]. Artificial maturation of goat oocytes in a laboratory setting for the aim of in vitro fertilization and subsequent embryo transfer [11.[

Arab agricultural development initiatives have historically overlooked goats due to many situations and factors, such as the focus on increasing livestock production and the lack of scientific research on the development of native goat testicles. Thus, this study aimed to further our understanding of the physiological parameters associated with sexual maturity in male goats and to optimize their breeding and reproductive capabilities. Examine the testicle's histology using various histological techniques and at different stages of development.

Materials and methods

Study animals

The investigation was carried out in the graduate laboratory of the College of Agriculture/Al-Muthanna University using 40 samples of testicles from local male goats obtained from the Samawah slaughterhouse. The samples were categorized into multiple groups based on age (pre-puberty, sexual maturity, sexual maturity), and the study duration spanned from December 1, 2022, to June 1, 2023. Prior to slaughter, all animals underwent thorough examination to verify their freedom from diseases.

Histological study :

Five small tissue samples were obtained from different regions of the testicle. These samples were rinsed with a 0.9% Normal Saline solution, followed by fixation in a 10% neutral formalin solution for 24 hours at room temperature. After fixation, the samples were washed with tap water to remove the formalin. Subsequently, the samples were treated with increasing concentrations of ethyl alcohol (50%, 70%, 80%, 90%, 100%) for two hours at each stage to remove any remaining water. Finally, the samples underwent percolation using xylene until they turned yellow, a process that took 30 minutes and was repeated twice. The objective of this procedure is to eliminate the presence of alcohol. Subsequently, we employ molten paraffin wax for this purpose. The oven is set to a temperature of 60 degrees to saturate the sample with wax. Subsequently, the sample is left in the paraffin for a duration of two hours outside the oven, allowing it to solidify into a mold that encapsulates the sample. This mold is then used for cutting purposes.The sample is sectioned using a micrometer, which has a

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thickness of 5 microns, to obtain both cross sections and longitudinal sections for each sample. The specimens are positioned on glass slides and we employ Myer Albumin to secure the specimen onto the glass slide. Next, the histological slides are stained with Harris hematoxylin and eosin stain in order to analyze the histological composition of the testicle. The dyeing process commences by employing xylene, followed by the gradual addition of water using decreasing concentrations of ethyl alcohol for a duration of two hours every stage (100%, 90%, 80%, 70%, 50%). Subsequently, the dye is applied onto the slide, and the slide is securely covered with Canada balsam. Finally, the samples are examined. Examined with a microscope (Eclipse E200-LED; Nikon Corporation, Tokyo, Japan.(

Statistical analysis

The trial data was analyzed using the global trials analysis approach, specifically the completely randomized design (CRD), with the assistance of the statistical tool SAS (2018). If the procedure was employed to assess statistical disparities and ascertain the impact of age on anatomical and histological measurements of testicle diameters, the means were compared using a test.

The polynomial proposed by [12], as described by the subsequent mathematical model :

Yij=M+Ti+ +eij

Results and discussion

Histopathological observations of goat testes between the ages of 4 and 6 months

At this stage, the testicle is enveloped by a layer of loose connective tissue that is abundant in blood vessels. The tunica albuginea, which envelops each testicle, has septa that partition the testicle's parenchyma. The lobules. Each lobe consists of many testicular cords, which are tubular structures. The solid part of the testicle consists of spermatogenic cells positioned near the basement membrane. This is followed by a layer of vascular connective tissue called the tunica vasculosa, which is in contact with the stroma of the testicle. The interstitial connective tissue, which is abundant in blood vessels and also contains Leydig cells, is spread between the tunica vasculosa (Figure 1). This aligns with the findings of [13], who conducted a study on the histological composition of goat testicles

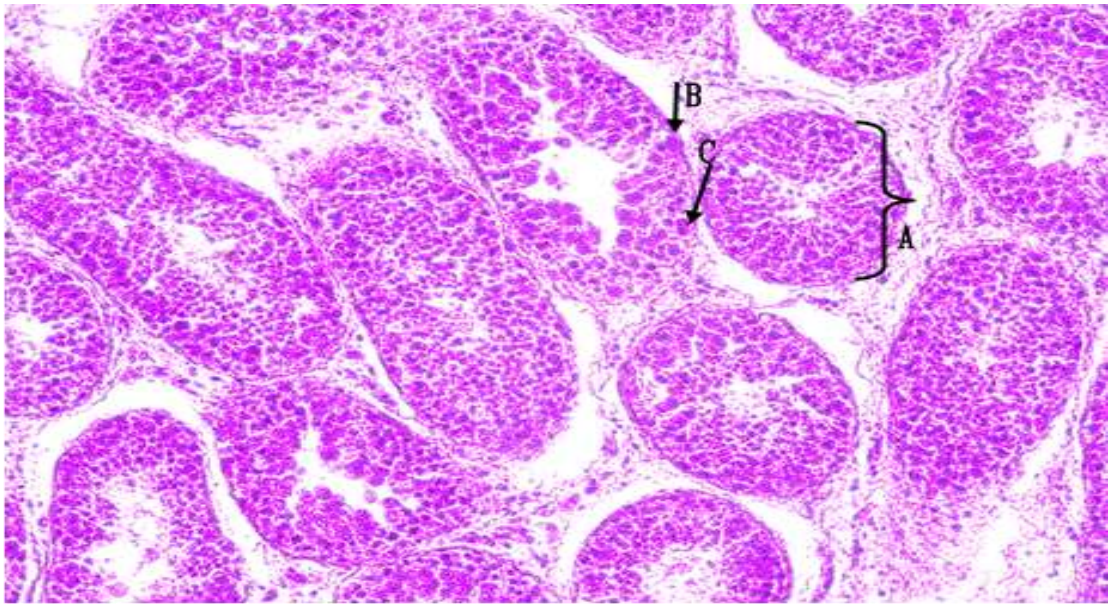

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Figure 1: A cross-sectional view of the testicle of a 5-month-old male goat. Observations: The presence of testicular cords or solid cords without sperm (A), a basement membrane (B), and gonocytes (C) were seen using H&E staining at 200x magnification

Histopathological observations of goat testes at 6-8 months of age

The result indicates significant differences in the average thickness of the capsule and the diameter of the seminiferous tubules at this age compared to previous ages. It also shows that the thickness of the capsule increases with age, along with an increase in dense collagen fibers. Additionally, the reticular and elastic fibers become coarser with age. We also observe the development of testicular cords into seminal tubules. However, the minimum diameter of advanced ages is not shown in)Figure 2-4(. This finding aligns with the outcomes reported by [14], who provided a detailed description of the testicles in goats.

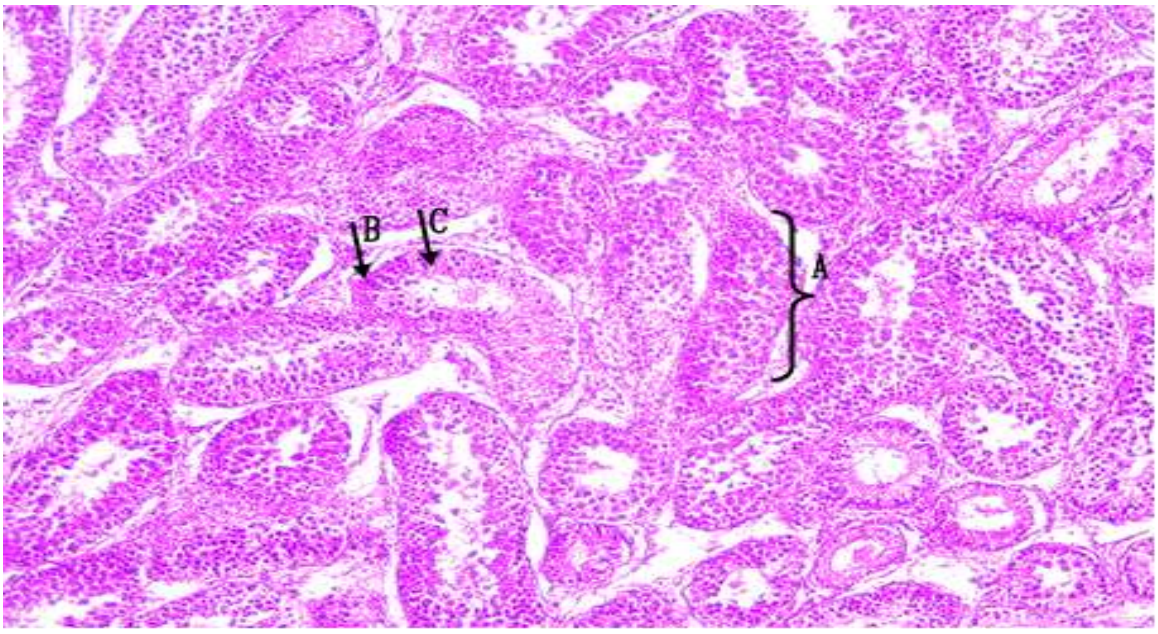

Figure (2): A transverse view of the testis in a juvenile male goat at the age of 6 months. Upon observation, it is evident that the testicular cords had a very narrow lumen and lack mature sperm, basement membrane, and mother cells. This observation was made using H&E staining at a magnification of 100x.

Histopathological observations of goat testes between the ages of 8 and 10 months

From the histological sections, namely)Figure 8), of the longitudinal slice of an 8-month-old male goat's testicle, it is observed that there are signs of sexual puberty. This is evident by the development of seminiferous tubules and the appearance of the basal membrane. Sertoli cells, also known as supportive cells, are present within the seminiferous tubule and serve the purpose of providing support and nourishment during the development process. Spermatogenesis takes place throughout sexual puberty. Similarly, a cluster of spermatogenic cells can be detected within the

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inner lining of the seminiferous tubule. The presence of sperm cells can be observed at several developmental stages, including primary, secondary, precursors of spermatids, sperm, and adult sperm. A cluster of Leydig cells is present in the interstitial tissue of the testicle. These indicators signify or demonstrate. The animal attains sexual maturity at the age of eight months (awake .(

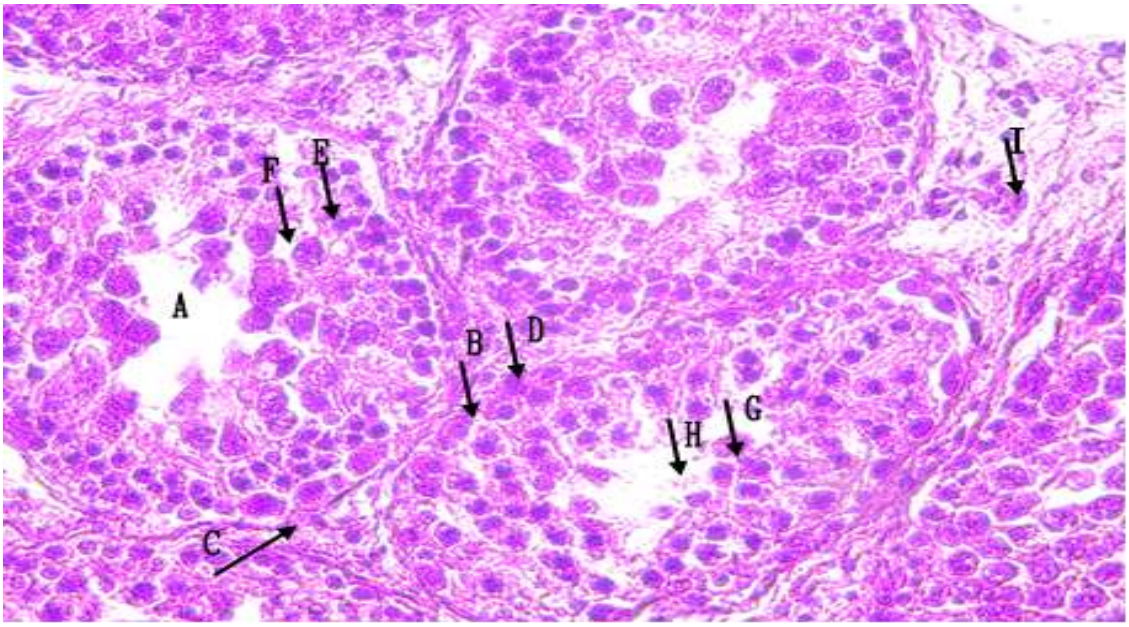

Figure (3): A cross-sectional view of the testicle of an 8-month-old male goat. Observations include the growth of seminiferous tubules (A), basement membrane (B), supporting cells (C), spermatogenic cells (D), and primary spermatocytes (E). Additionally, secondary sperm cells (F), spermatids (G), mature sperm (H), and Leydeck cells (I) were identified. The observations were made using H&E staining at a magnification of 400x.

Upon examination of the histological sections, it is evident that the seminiferous tubules have undergone significant development and their diameter has increased. These sections contain primary sperm cells, secondary sperm cells, spermatids, and mature sperm, as depicted in Figure 4

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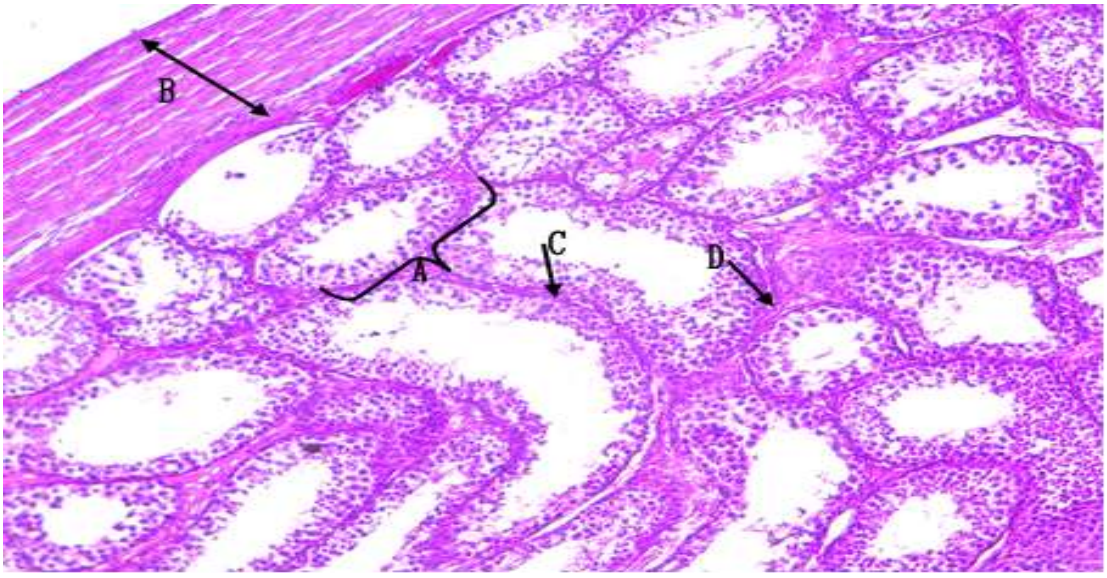

Figure (4): A transverse view of the testis in a 9-month-old male caprine. Observations include: the initiation of the tubules and colobule (A), the presence of sperm cells (B), the development of primary sperm cells (C), the presence of foundi (D), the existence of chondrium cells (E), and the presence of interstitial connective tissue. Female, Hematoxylin and Eosin stained tissue slide, magnification 200x

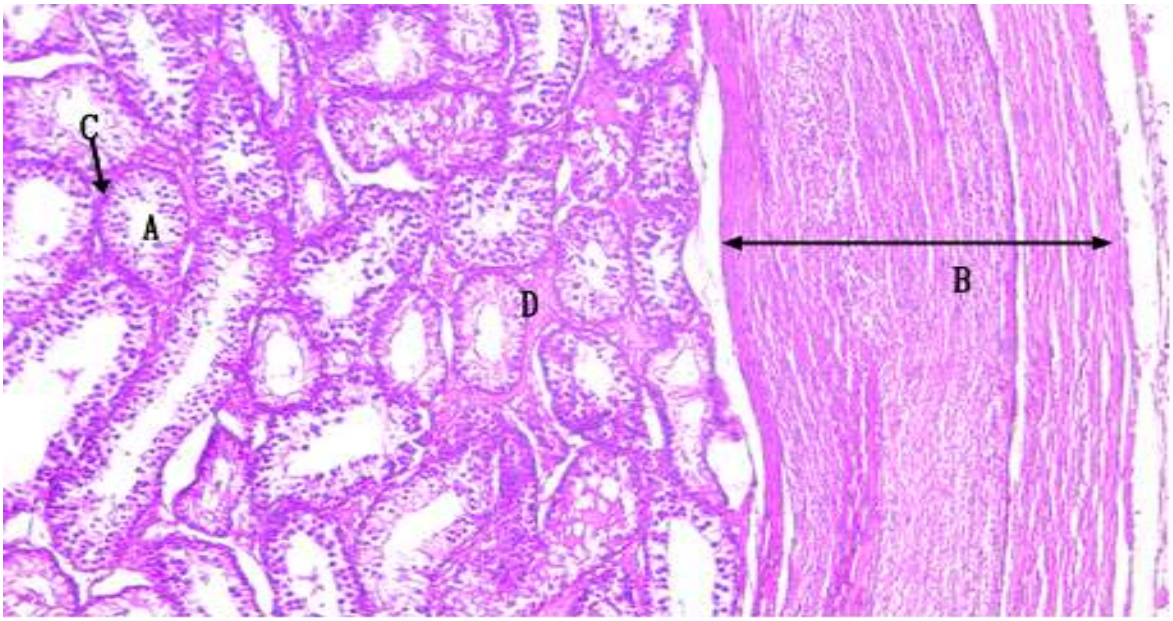

Figure (5): A transverse view of the testis in a juvenile male goat at 9 months of age. It is observed that there are seminiferous tubules with sperm (100 H&E) (D), interstitial tissue (C), a basement membrane (B), and a testicular capsule (A(

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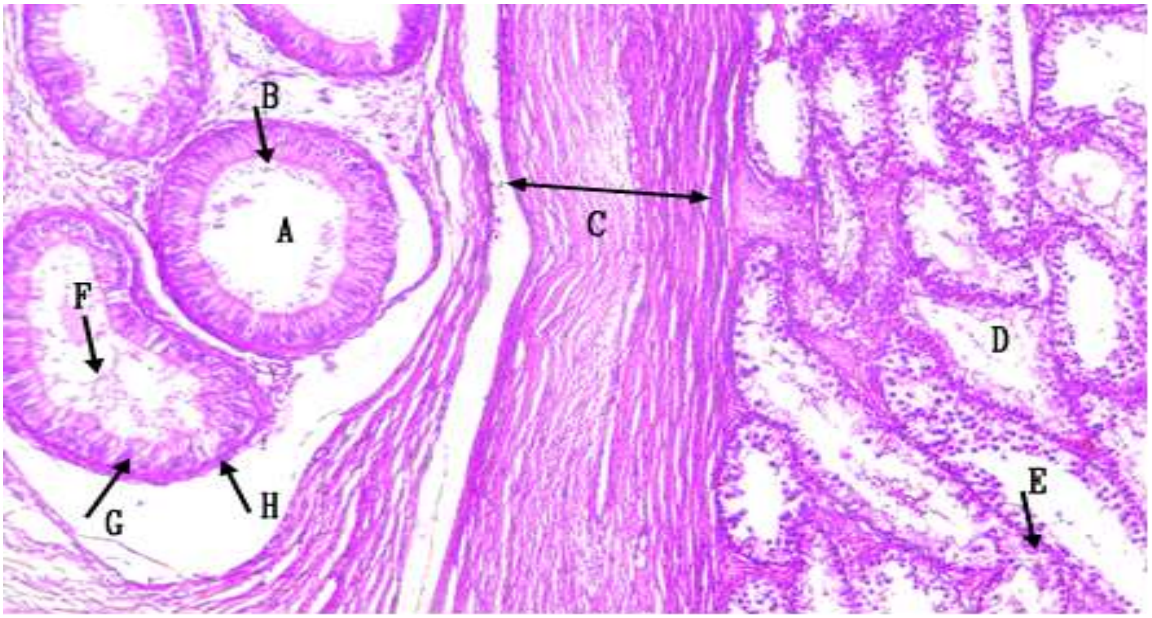

Figure 6 displays a cross-section of the testicle of a 9-month-old male goat. Observed are the epididymal ducts (A), the pseudostratified columnar epithelium that lines the epididymis (B), the tunica albuginea that separates the epididymis from the testicle (C), the seminiferous tubules (D), and the membrane. Basophils (E), mature sperm (F), columnar cells (G), basophils (H), stained with hematoxylin and eosin (H&E), magnification 200x.

Histopathological observations of goat testes at the age of 10-12 months

During these stages of development, there is a noticeable progression in the seminiferous tubules (Figure 10), which house a significant quantity of primary sperm cells, secondary sperm cells, spermatocytes, and fully developed sperm.

The testicle is consistently enveloped by the tunica albuginea throughout its lifespan. The findings align with the research conducted by [15], [16], who investigated testicular development in goats. This capsule provides protection for the testicle.

Cells that are anchored undergo differentiation into Sertoli cells, which produce inhibitory substances that hinder the formation of the female duct. The extratesticular cells adjacent to the spermatic cords divide into two sets of interstitial cells. One set directly produces androgens, while the other set postpones the production of androgens until sexual maturity. Androgens, in turn, promote the development of the reproductive system both during fetal development and in adulthood [17], [18.[

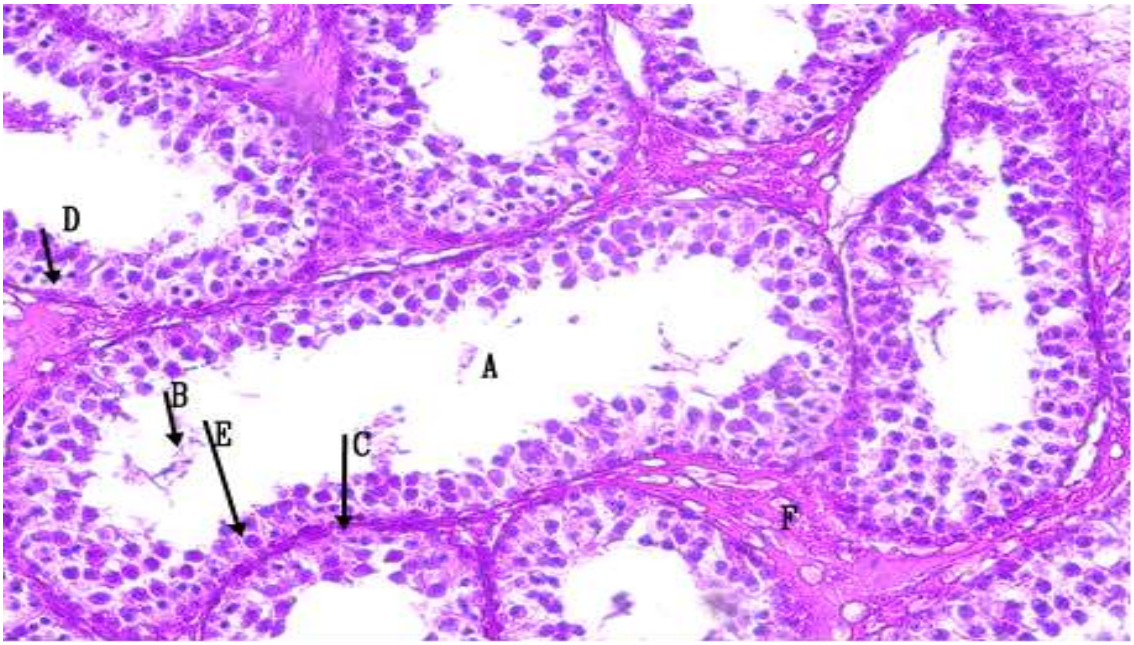

Figure 7 This image depicts a cross-section of the testicle of a 10-month-old male goat. It shows the seminiferous tubules (A), which contain sperm at various stages of development. The Leydeck cells (D), basement membrane (C), smooth muscles, and blood vessels (F) are also visible. The image was captured using H&E staining and magnified 400 times.

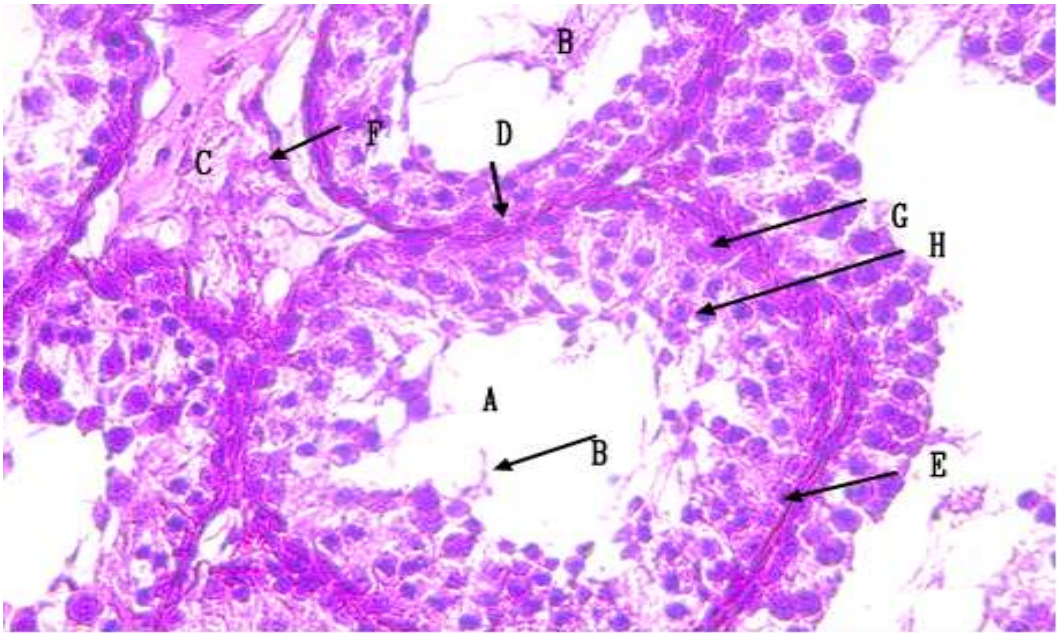

Figure 8: A transverse view of the testis in an 11-month-old male goat. Observed in the image are the following structures: seminiferous tubules (A), sperm (B), connective tissue (C), basement membrane (D), Sertoli cells (E), Leydeck cells (F), secondary cells (G), primary cells (H). The image was stained with H&E and magnified 400 times.

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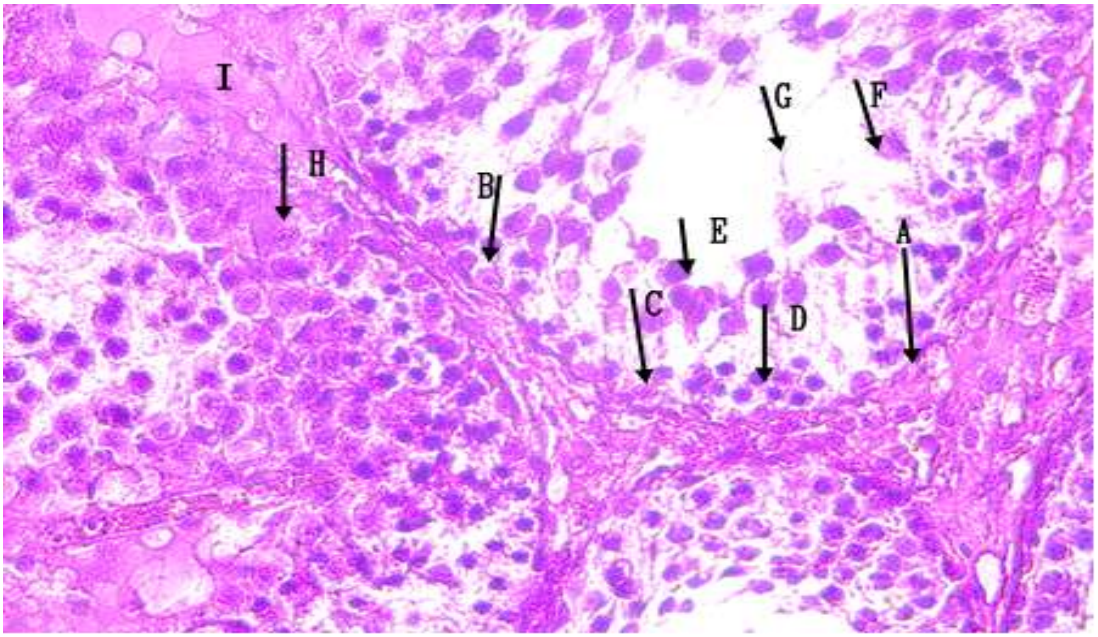

Figure (9): A transverse view of the testis of a juvenile male goat at 11 months of age. Observations include the growth of the seminiferous tubules, the basement membrane (A), the septum cells, Sertoli (B), the spermatogenic cells (C), and the primary spermatocytes (D). Additionally, secondary sperm cells (E), spermatids (F), adult sperm (G), Leydeck cells (H), interstitial tissue (I), and H&E 400 staining were observed

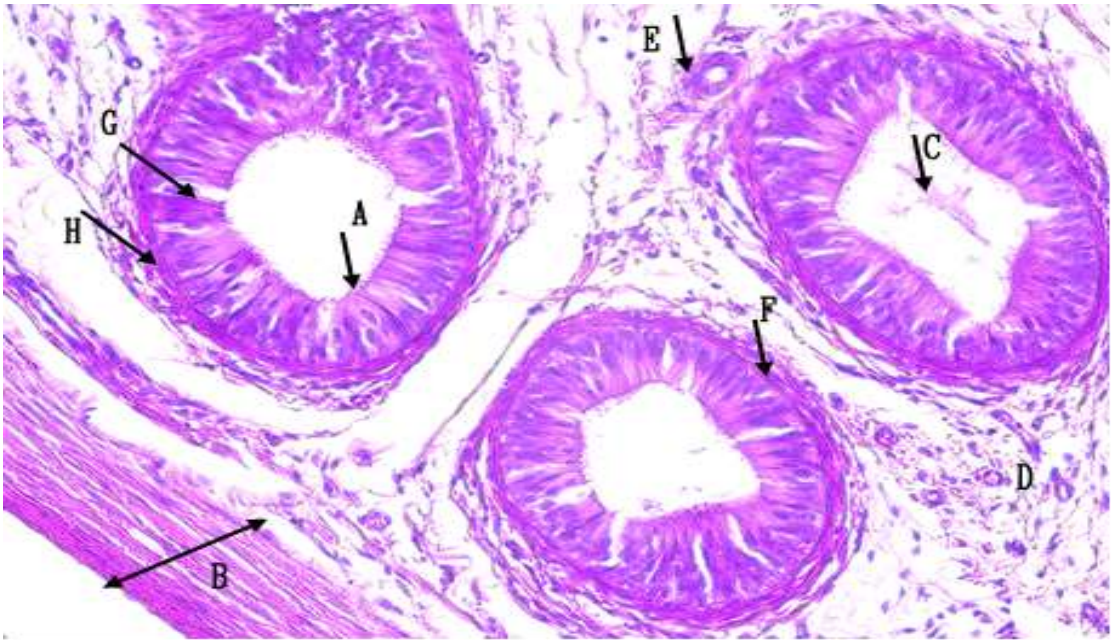

Figure 10 The image shows a cross-section of the epididymis in the testicle of an 11-month-old male goat. The following structures are observed: the epithelium of the epididymis with cilia (A), the tunica albuginea (B), sperm present inside the epididymis (C), connective tissue between the epididymal ducts (D), a blood vessel (E), the basement membrane (F), columnar cell nuclei (G), basal cells (H), and the staining used is H&E200.

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Conclusions

Animals in the age group of 4-6 months did not exhibit any indications of sexual maturation, as determined by their anatomical traits. The findings about the anatomical features of testicular sections in animals aged 6-8 months revealed the existence of early indicators of sexual adolescence, including the presence of immature sperm that had not fully developed. The findings regarding the anatomical features of the testes in animals aged between 8 and 10 months. Clear indicators of sexual puberty are evident, including an enlargement of the seminal tubules and the existence of primary spermatocytes, secondary spermatocytes, spermatids, and mature spermatozoa. Between the ages of 9 and 12 months, the anatomical findings indicated complete sexual puberty, with the existence of sperm at all stages, Leydic cells, smooth muscles, and the basement membrane.

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