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A Review of Anatomical and Histological Features of the Thyroid Gland In Different Species of Animals

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Abstract

This study includes main morphological features such as, the shape of glands, location and dimensions. These features to provide data for the medical and surgical science. In the anatomical structures that appear similar in laboratory animals, but are different in some histological features, in domestic animals, the thyroid gland is encased in a thin or thick capsule of dense, irregular connective tissue. The follicular cells have different shapes depending on the gland's functional ability both during maturation and in response to external influences. In addition. The thyroid gland demonstrated a seasonal change in the amount of colloidal matter and the height of the follicular cells. The follicles are huge and the follicular cells are flattened while the gland is dormant, but they are tiny when it is active due to the abundance of colloid. In the thyroid gland of different species, the parafollicular cells are not generally distributed diffusely throughout the gland but tend to be concentrated in the central part of each lobe and are not present in the isthmus.

Keywords: follicular cells, colloid, Morphology, Histology, thyroid glands

Introduction

Anatomical description of the thyroid gland

For the same animal and within the same species, the two lobes' anatomical positions differed. In the frontal portion of the trachea, between the first and the twelve tracheal rings, there were thyroid lobes. In most species, the thin, narrow isthmus is not easily distinguished. The way the isthmus attaches to the lobe and where it crosses the trachea varies between species [1,2]. Rats and mice were used to demonstrate an isthmus at the caudal end of the lobe [3,4]. The thyroid gland is a tiny organ that is present in rats and is located beneath the sternohyoid and sternothyroid muscles, lateral to the trachea. Each sides forms a bridge over the ventral and anterior parts of the trachea, respectively, and is connected by a thin isthmus. In mice, it often stretched across the initial three or four tracheal cartilage rings, while in rats, it typically extended along the first four or five tracheal rings [5]. In the native breed of rabbits of both sexes from Iraq, Oryctologus cuniculus, the thyroid gland was located cranial to the trachea at the first tracheal rings connected to the cricoid cartilage of the larynx [6]. [7]

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Reported that the African Giant Rat's thyroid gland was made up of two lobes that were situated on the front side of the trachea. At the cranial end, an isthmus united the two lobes. According to [8], the thyroid gland of guinea pigs has two lobes, each of which has a rounded cranial head that tapers into a thin tail. They extended to the sixth tracheal cartilage caudally and were situated adjacent to the caudal portion of the larynx. Just six males and seven female displayed an isthmus [9,10].It was asserted that cats' thyroid glands had two lobes, each lobe was said to be located at the first few tracheal rings on the lateral side of the trachea. The sterno-thyroideus and sternothyroideus muscles, which are deep in the neck muscles, were deeply embedded in the right thyroid lobe of the thyroid. The right lobe's cranial end was at the thyroid cartilage's caudal border level, while the left lobe stretched from the third to eighth tracheal rings. The gland's dorsal border is thicker than its ventral border.

1.1. Anatomy of the thyroid glands

1.2. Shape and dimensions of the thyroid gland

The shape and size of thyroid gland lobes vary from one species to another. It is oval in shape, triangular, elongated, or irregular [1]. Each lobe of the thyroid gland consists of two surfaces, two extremities, and two borders, a concave medial surface and a convex lateral surface. The thyroid gland had two borders, the dorsal border is in contact with the esophagus and the carotid artery, whereas the ventral border is less or more convex and had an isthmus attached to it in the same area [15].

The thyroid gland was measured transversely and vertically in the vertebrates at about 1.25 cm, its sizes and shape varied widely [16]. Nonetheless, it was shown that female adult Wistar rats had a greater relative gland weight than male Wistar rats, and this sex dimorphism in the rat thyroid gland is dependent on the males' bigger cells than the females' mean size of total follicular cells [17]. [18] who noted that the African Giant Rat's thyroid glands were reddish, and long with smooth oval surfaces, weighing 1.28 0.03 g for males and 1.16 0.01 g for females. According to [19,20], the thyroid gland of adult mongooses is dark brown, and the thyroid gland lobes of female mongooses are flat, oval, and elongated in shape. The left lobe's length and width are 9.3 mm and 4.4 mm, respectively, while the right lobe's parameters are 8.4 mm and 4.9 mm, respectively. Because of this, the left lobe is longer and thinner than the right lobe. [21] showed that the right and left thyroid lobes in adult Weasel *Herpestes javanicus* were oval-shaped, the mean length and width of right lobes were 0.770 ± 0.0517 cm and 0.380 ± 0.0389 cm, for left lobes, were 0.850 ± 0.0453 cm and 0.340 ± 0.0371 cm in males. The means length and width for the right lobes were 0.860 ± 0.0427 cm and 0.350 ± 0.0342 cm, and for the left lobe, they were 0.680 ± 0.0611 cm and 0.720 ± 0.0153 cm in females, respectively.

The thyroid gland appeared reddish brown in the indigenous male gazelle *Gazella subgutturosa*, and the shape of both lobes appeared as an elongated oval or compact elliptical mass with a rounded cranial end and a narrow caudal end with smooth two surfaces. The mean weight of the whole thyroid gland was 1.47 g, [22].

The internal jugular vein, lymphotracheal ring, sympathetic vagus trunk, common carotid artery, and dorsolateral sides of the two lobes were all connected [11]. A study on the thyroid gland in European bison (12) proved that the gland has two lobes connected by a short, somewhat thin glandular isthmus. The thyroid gland of sheep from South Iraq (provenance of Basra) had a pair of oval lobes joined by an isthmus that was situated in the neck near the cranial region of the

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trachea.. There is an isthmus connecting the thyroid glands two lobes. The isthmus was present

in adult goats, but it wasn't always present in kids. The camel's thyroid gland, which is located on the lateral side of the trachea, is reddish brown in hue. The right lobe was considerably cranial to the left lobe, and an isthmus connected the ventral tracheal surfaces of the two lobes [13]. The isthmus was absent in a few fetal thyroids but consistent in The thyroid gland was located anteriorly in the neck, beneath the larynx, and was connected ventrally to the proximal section of the trachea in female donkeys. The gland has two lobes that are joined by an isthmus [14].

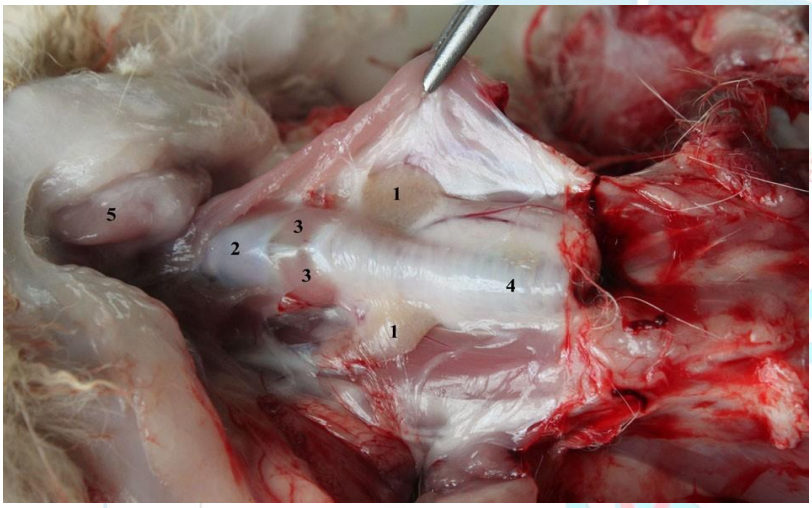

Figure. 1: A photograph illustrates the anatomical position of the thyroid gland in rabbits. Thyroid gland's topography in a rabbit (1), larynx (2), ring-shaped muscle (3) and rings of trachea (4) submandibular salivary gland (5). [23].

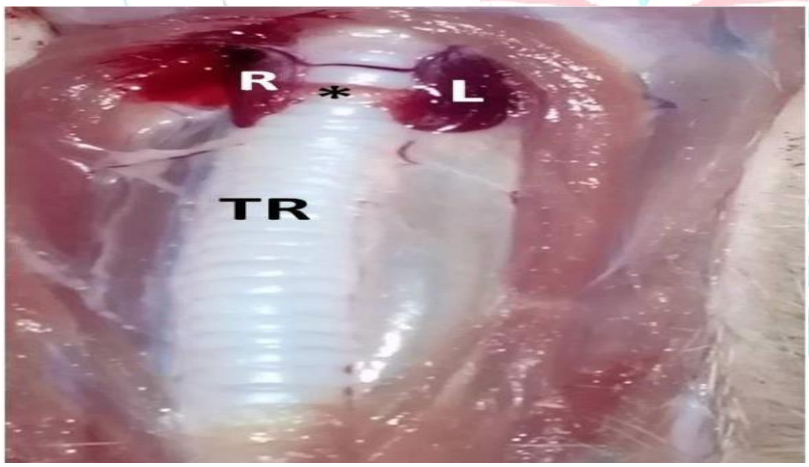

Figure. 2: A photograph illustrates the anatomical position of the thyroid gland in gray mongoose. Right lobe (R), left lobe (L) and trachea (TR) [24].

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2 .1. Histological and Histochemical of the thyroid gland

The thyroid gland is varied in different animal species in its histological structure and morphometry, these variations may be associated with adaptive physiological changes caused by nutrition, environment and even climatic factors. Also the animal age, reproductive cycles and physiological factors such as pregnancy, feeding and seasonal variations are different among animal species, but there is no gender-related differences in their histological structure [25].

2.2. Capsule

A thin or thick capsule of dense irregular connective tissue surrounded the thyroid gland in domestic animals [26]. In rats, the thyroid gland was covered by a thin connective tissue capsule that sent thin septa dividing the thyroid gland into small lobules, adipose tissue, sinusoidal that are incessant in the stroma, and collagenous tissue made up the majority of the capsule [27]. [28] found that the thyroid gland capsule of the African grasscutter was connected to fibroblasts, blood arteries, and a layer of adipose tissue. The parenchyma of the gland was encircled by a reasonably thick layer of connective tissue in white New Zealand female rabbits. The capsule septa were used to split the gland's parenchyma into incompletely lobulated sections [29]. The capsule consisted of two layers in Weasel, an outer fibrous layer of elastic fibers, collagen fibers, and fibroblasts while the inner layer has a few elastic fibers and smooth muscle fibers. The capsules spread through the trabeculae to the tissue which divided the parenchyma into small lobules [30].

In cats, a connective tissue capsule that consists of collagen fibers, fibroblasts, and blood vessels surrounds the thyroid gland. The trabeculae are extended from the capsule into the gland's parenchyma where they were subdivided into several lobules

The capsule of the thyroid gland was composed of two layers in Iraqi buffalo Bubalus subalis, the outer layer consisted of loose collagen fibers mixed with a large amount of adipose tissue and a few elastic fibers. The inner layer consisted of bundles of collagenous and elastic fibers with few muscle cells [31].

In camels, the thyroid gland was covered by a thick or thin capsule from which the trabeculae were extended into the parenchyma of the gland to divide the gland into numerous follicles of different sizes with the presence of the blood vessels in both the capsule and the trabeculae [32].

2.3. Thyroid follicles

The thyroid gland consists of the structural unit which is the thyroid follicle that appears as hollow spheres that vary in size and shape. The colloid, which is typically loaded with a mucilaginous substance termed the thyroid gland's many

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follicles (20-500 m in diameter), serves as a storage form for the follicular mucosal secretory products under varied

physiological situations. The simple follicular epithelial cells show different shapes, the epithelium is surrounded by a basement membrane [33,34].

The shape of the follicular cells varies depending on the functional state of the gland both during maturation and in reaction to external factors. The thyroid gland is made up of follicles of varying shapes, including tiny, medium, and big follicles. Also, follicles had various shapes such as spherical, oval, tubular, polygonal, and irregular shape. The small type was predominantly diffused at the periphery while the large follicles were displayed in the center of the gland [35].

The endocrine system displayed seasonal changes in the amount of colloid and the thickness of the cells. The colloid is plentiful, the follicles are large, and the follicular cells are flattened when the gland is inactivated, but the follicles are small, the follicular cells are simple cuboidal or simple columnar, and the edges of the colloid are scalloped, forming numerous small re absorptive lacunae when the gland is active [33].

In mice were equally sized, oval in shape, and lined with columnar epithelium in young mice. Mice, particularly females, have two different types of follicles: smaller active follicles bordered by cuboidal or columnar epithelium with microvilli, and slightly more than half of them are inactive follicles with flattened epithelium and greater levels of colloid [36,37]. The follicles within the thyroid gland of Rat are separated by connective tissue septa. The larger follicles tend to be peripherally located and spherical, measuring up to 270 µm in diameter. The smallest follicles tend to be centrally located and have a diameter of up to about 120 µm. The follicular epithelium is based on the follicle's functional state, the epithelium is cuboidal in resting state, while it is usually columnar in active state [38].

[39,40] noted that the thyroid follicles vary widely in morphology but are often roughly oval to ellipsoid in shape, with bigger follicles being located in the perimeter and smaller ones in the center. Shorter follicles with little colloid and more swollen cuboidal epithelial cells lined the thyroid gland in mature rats.

[29] showed that for the grasscutter Thryonomys swinderianus the mean diameter of the small rounded follicles is 96.001 µm, and that of the medium round follicles measured 180 µm, whereas that of the large rounded follicles is 240.01 µm, the tiny, medium, and big sized follicles have follicular cells that are 7.52 mm, 7.31 mm, and 7.12 mm in height, respectively.

In the Golden hamster, Cricetus auratus thyroid follicles were connected without open communication of follicular networks and chains formed by their cavities. Large follicles were distributed in the gland's peripheral zone and small follicles in the central zone. The large follicles were more irregular in shape, the small follicles were round to oval and relatively regular in shape. Follicles with a diameter of more than 50 µm were considered large follicles and very small follicles between 12 and 15 µm [41,42]

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In the thyroid gland of Weasel Herpestes javanicus the diameter of the small follicle was 0.2205 ± 0.1323 µm in males and 0.2110 ± 0.01183 µm in females while the diameter of the middle follicle was 0.180

± 0.00824 µm in male and 0.1985 ± 0.00693 µm in female.

In koalas Phascolarctos cinereus the thyroid glands had many large distended macro-follicles lined with either low cuboidal or flattened epithelium forming (69%) of the thyroid gland and 6% forming small colloid-filled follicles lined by cuboidal epithelium [43]. In Hipposideros lankadiva (kelaart), the thyroid gland consisted of three follicle types, large follicles ranging from 100 µm – 150 µm in diameter and is located mainly at the periphery of the gland lined by squamous epithelium, medium follicles had ranged from 60 µm -100 µm in diameter situated in the central portion of the gland lined by cuboidal epithelium and small follicles ranged from 30 µm – 60 µm in diameter [44,45].

2.4. Colloid

Colloid is a semifluid or gel-like substance in contact with the follicular epithelium, but the colloid may shrink creating a continuous, and often irregular space between the colloid and the epithelium. In the colloid spaces or vacuoles, it may also be [47].

The colloid in mice is homogenous, somewhat eosinophilic, and tends to be semifluid in texture. It typically interacts with the follicular epithelium [48]. In the thyroid follicles, there was colloidal material that was all the same color and droplets of colloidal material around the edges. The colloid is positive for PAS. Pig follicular cells have many colloid droplets and thick granules, which occasionally appear to collide and combine. In Rabbits, thyroid follicles contained a clear gelatinous material (colloid) that stained positively with PAS [41].

In white crossbred pigs, some follicles contained slightly stained colloid-like materials especially in the small follicles. These follicles with colloid-like materials were weakly PAS positive. In sheep, Periodic Acid Solution used to identify carbohydrates in glands shows positive for glycoprotein distribution in follicles that appear red showed that strong PAS reactions were found in non-castrated cattle follicle lumens and pubertal cattle follicles developing, negative or weak reactions in the castrated cattle were found compared to other groups [50].

2.5. Parafollicular Cells or C-cells or clear cells(light cells)

Although the light cells are few, they are important endocrine cells that existed between the epithelial cells or inter epithelial cells and parafollicular cells either individually or in groups of two or three cells, they are about one and a half larger than the follicular cells and contained light stained cytoplasm and large nuclei [51].

In the thyroid gland of Rats, the para-follicular cells are not generally distributed diffusely throughout the gland but tend to be concentrated in the central

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part of each lobe and were not present in the isthmus. They are frequently seen within the periplasmic space or in the space between epithelial cells. Nevertheless, these frequently remain in touch with the colloid and are situated between the follicular epithelium and the basal lamina [52].

In the thyroid glands of golden hamsters, the parafollicular cells were located close to the follicle walls alone or in groups,

When collected as a bud in a group and sometimes formed cell plates connected to the follicle wall immediately. Some of the parafollicular cells directly bordered the cavity of the follicle. The parafollicular cells were found evenly distributed in small numbers in follicles of the central area of the gland [53].

These cells were in the interfollicular stroma and a few in the epithelium follicular. The C-cells or calcitonin-forming cells in the bison thyroid most often occur individually or in small groups in parafollicular locations, sometimes forming large groups between interfollicular cells [54]. In cats, Large numbers of parafollicular or C-cells have been presented in the thyroid gland between the follicles, they are larger and the cytoplasm is lightly stained. In the dog, most parafollicular cells were in the thyroid's upper poles; they appeared as relatively uniform size cells in clusters, with about one and one-half to two times the size of follicular cells. They were confined within the follicular basement membrane but did not reach the colloid [55].

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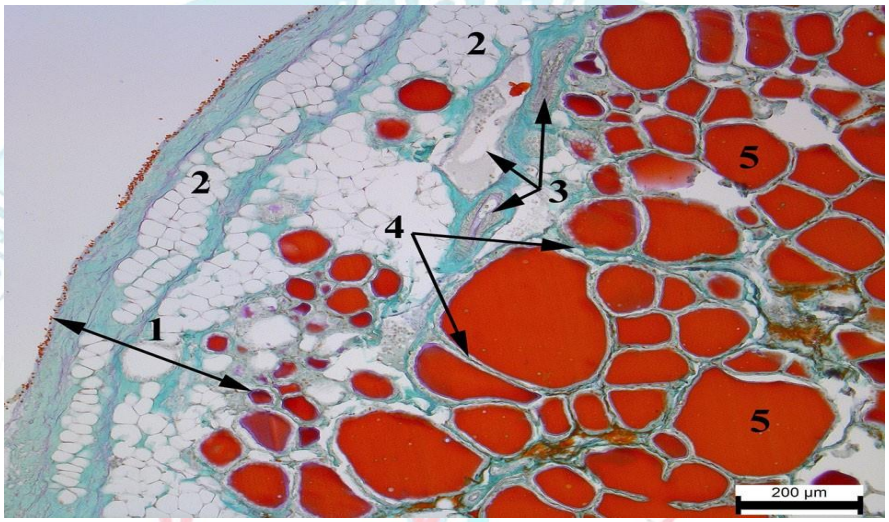
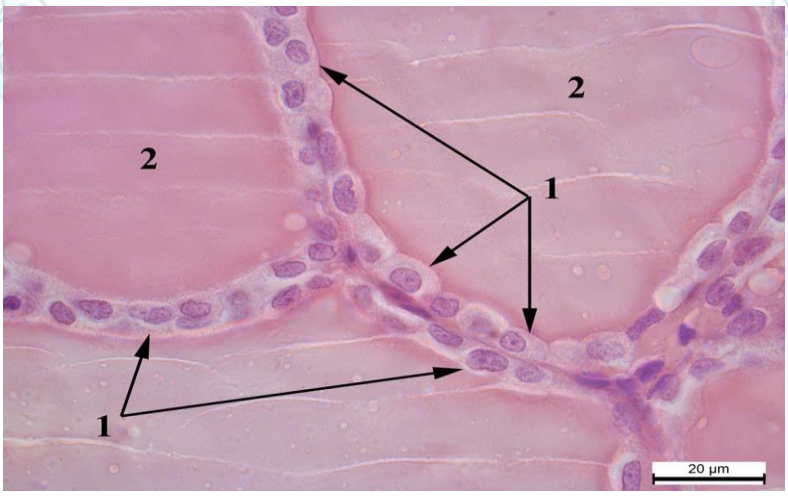


Figure. 2: A photomicrograph illustrates the histological section of the thyroid gland in rabbits. 1. capsule, 2 fatty tissue, 3. blood vessels, 4 .connective tissue hives, 5. colloid. [23].



Figrue. 3: A photomicrograph illustrates the histological section of the follicles of the thyroid gland in rabbits: 1. Follicular cells, 2 .colloid. [23].

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Conclusion

This investigation revealed that the thyroid gland, which is situated behind the larynx and has two lobes joined by an isthmus, is enclosed in a capsule with an inner and an outer layer. There is a distinctive cuboidal epithelial layer surrounding each of the numerous thyroid gland follicles. Epithelial and parfollicular cells, two distinct cell types, constitute the thyroid gland. Colloid is present in certain follicles in greater amounts than in others. These variations rely on gland activity and seasonal fluctuations.

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