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Cellular histology of immune organs in Turkey

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Abstract
This study was proposed to unfold the cellular details of different immune organs in turkey. The primary immune organs of turkey are the bursa of Fabricius and thymus whereas the secondary immune organs are spleen and harderian gland. The structural framework of immune organs was constituted by reticular cells in which other cellular population was seen. The immune cells of these organs were formed by lymphoblast, lymphocyte, plasma cell, dendritic cell and macrophages. Along with this other cells such as heterophil, erythrocyte, myoepithelial cell, myoid cell, mast cell in parenchyma were observed. The fibroblast and fibrocyte in stroma were also noticed in various immune organs.

Keywords: Turkey, cellular details, immune organs

Introduction
Avian immune system is unique and differs from mammalian immune system since they lack organized lymph nodes, neutrophils and functional eosinophils. Lymphoid organs play a major role in birds immune response. Bursa of Fabricius and thymus are the primary lymphoid organs of birds which produce B-lymphocytes and T-lymphocytes respectively. These functional immune cells (B-cells and T-cells) leave these organs and accumulate in secondary lymphoid organs (Penchev, 2020) [18]. Spleen, bone marrow and Harderian gland are the secondary lymphoid organs. Apart from these, mucosa associated lymphoid tissue like BALT (Bronchus associated lymphoid tissue) and GALT (Gut associated lymphoid tissue) are also present in the birds. Though histological data of various lymphoid organs are available for chicken and few avian species, the cellular detail of immune organs is meagre.

Materials and Methods
The immune organs viz., thymus, bursa of Fabricius, spleen and Harderian gland were collected from the slaughtered birds of different age groups. The tissue samples were fixed in 10% Neutral Buffered Formalin and processed by routine paraffin technique. The tissue sections were stained by routine Haematoxylin and Eosin (Bancroft and Stevens, 1996) [2]. The cellular histology of different lymphoid organs was studied and photomicrographs were done using Leica image analyser software.

Results and Discussion
Lymphoblasts
The lymphoblasts were varied from small to medium sized cells which had oval to round nucleus occupied almost eighty percent of cell. Loosely distributed chromatin with one or two nucleoli was noticed in the nucleus. The cytoplasm appeared basophilic and was agranular. The lymphoblasts were more in younger age groups (Banks, 1993) [3] (Plate 2).

Lymphocytes
As reported by Banks (1993) [3] in avian species, Mishra *et al.* (2010) [16] in chicken and Tadjalli *et al.* (2013) [20] in ostrich the lymphocytes in turkey were round cells with round to slightly indented nucleus that almost occupied the entire cell and the cytoplasm was basophilic. The dense clumped chromatin was noticed in the nuclei and had no visible nucleoli (Plate 1).
The small lymphocytes were entirely occupied by round compact nucleus with a thin rim of cytoplasm as described in chicken (Mishra *et al.*, 2010) [16], Kadaknath chicken (Kanasiya *et al.*, 2018) [10] and Rhea (Gallo *et al.*, 2015) [8].
The large lymphocytes were larger cells with basophilic cytoplasm and centrally located nucleus in turkey (Ali, 2016) [1].

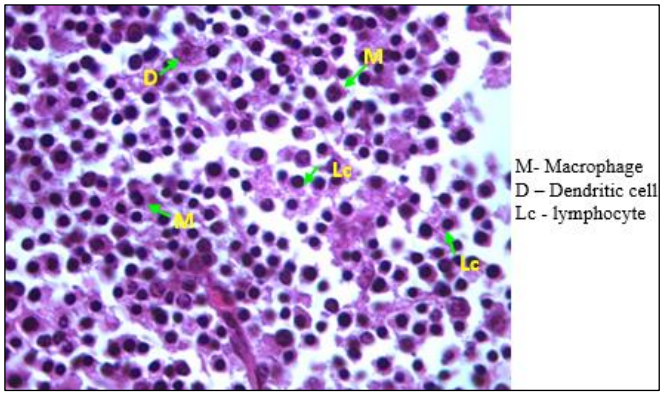

Plate 1: Photomicrograph showing the cellular population of bursa of Fabricius in seven months old tom turkey H&E x 1000

Reticulo-epithelial cells

Four types of reticulo-epithelial cells were differentiated in turkey. They were named as type I, type II and type III cells based on their cell morphology.

The type I cells were large cells with large round vesicular nucleus and had acidophilic cytoplasm as observed by Mishra *et al.* (2010) [16] in chicken. The type II cells were pale and showed oval vesicular nucleus, the cytoplasm was lightly stained with eosin. Nucleolus was clearly visible. The type III cells were pale and displayed elongated vesicular nucleus. The cytoplasm was eosinophilic and these were most frequently noticed in the Hassall's corpuscles (Plate 2).

In contrary, Mishra *et al.* (2010) [16] in chicken noticed that the reticular cells were round to polyhedral in shape with eccentrically placed round vesicular nucleus and had acidophilic cytoplasm. Also, Roshdy and Derbalah, (2017) [19] in Egyptian water buffalo identified four types of thymic reticulo-epithelial cells. The type I cells had lightly stained elongated to oval shaped nuclei with few chromatin clumps. It showed lightly stained cytoplasm with vacuoles. The type II cells were irregular shaped with pale vacuolated cytoplasm and had large spherical nuclei. The type III was irregular cell with deeply stained elongated to indented nuclei and cytoplasm had vacuoles. The type IV cells were largest cells noticed in the Hassall's corpuscles with condensed nuclei and cytoplasm had small and large spherical vacuoles.

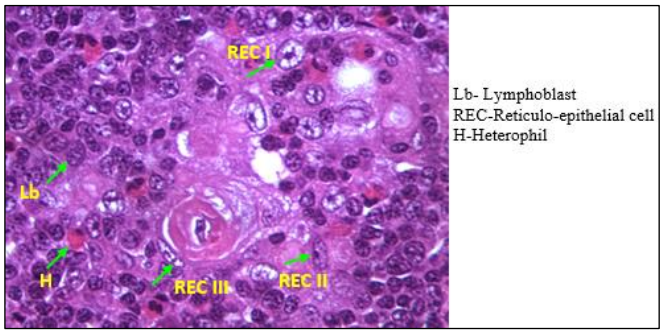

Plate 2: Photomicrograph showing the cellular population of thymus in five months old tom turkey H&E x 1000

Macrophages

In turkey, macrophages were appeared as large cells with condensed round to oval nucleus with indentation or kidney shape and basophilic cytoplasm (Dahariya *et al*., 2020) [5]. But, Mishra *et al.* (2010) [16] reported that in thymus of chicken, the macrophages were large ovoid to polyhedral cells with round vesicular nucleus at periphery and had acidophilic cytoplasm. Some of the macrophages showed phagocytosed fragments in cytoplasm (Plate 1).

Plasma cells

As reported by Mishra *et al.* (2010) [16] in chicken and Dahariya *et al*. (2020) [5] in various chicken genotypes, the plasma cells of turkey were observed as round to ovoid cells with basophilic cytoplasm and had eccentrically placed round nucleus. The nucleus showed radially arranged chromatin granules in cart wheel appearance as described in plasma cells of mammals (Eurell and Frappier, 2006) [6]. Some of the plasma cells had Russell bodies which displayed homogenous eosinophilic round to globular granules in the cytoplasm as in laying hen (Bejdic *et al.* 2014) [4] (Plate 5).

Dendritic cells

The dendritic cells were observed as large irregular cells with long cytoplasmic projections and irregular nucleus as reported by Dahariya *et al*. (2020) [5] in various chicken genotypes and by Eurell and Frappier (2006) [6] in mammals (Plate 1).

Heterophils

As reported by Banks (1993) [3] in avian species and Gallo *et al.* (2015) [8] in rhea, the heterophils of turkey appeared as round cells and had two or more lobed basophilic nucleus with condensed chromatin. The cytoplasm was obscured by deep pink small oval, spherical and rod-shaped granules as in ostrich (Tadjalli *et al.*, 2013) [20] (Plate 2).

The heterophils were numerous and appeared as heterophil clusters or nests at the reticular structures of medulla whereas only very few were noticed in the cortex of thymus. They were also numerous at sub capsular zone of spleen as in quail (Liman and Bayram, 2011) [14].

Erythrocytes

As in ostrich (Tadjalli *et al.*, 2013) [20], the erythrocytes in turkey were oval shaped with large oval nucleus. The cytoplasm was more pinkish in turkey whereas it appeared bluish gray in ostrich. The nucleus of erythrocytes had a uniform clumped chromatin as described by Gallo *et al.* (2015) [8] in rhea (Plate 3).

Fibroblasts and Fibrocytes

Large elongated or spindle shaped fibroblasts with fine processes were noticed within the connective tissue component. It had centrally placed large elongated nucleus with chromatin granules and the cytoplasm was eosinophilic in turkey whereas in mammals basophilic cytoplasm was reported by Eurell and Frappier (2006) [6].

As observed by Gartner and Hiatt (1997) [7], small spindle shaped fibrocytes with small elongated condensed nucleus was noticed in the stroma and fibrous clumps of bursa during its involutory phase and also throughout the stroma of thymus.

In turkey, capsule and septa of the thymus, capsule, inter and intralobular septa of harderian gland (Nawrot *et al.*, 2016) [17] had numerous fibroblasts and fibrocytes. But in various chicken genotypes (Dahariya *et al*., 2020) [5], fibroblasts were numerous in connective tissue stroma of bursa of Fabricius and in layer chicken (Kannan *et al.*, 2012) [11] it was more in the capsule whereas ostrich and kestrel (Kozlu *et al.*, 2011) [12] had fibroblasts in their splenic capsule.

Myoid cells

The myoid cells appeared as long slender muscle like cells (Mestanova and Varga, 2016) [15] with slightly expanded head end in the parenchyma of thymus as in native geese (Gulmez and Aslan, 1999) [19] whereas in thymus of chicken (Mishra *et al.*, 2010) [16], large elongated, spherical to wedge shaped myoid cells were reported. Myoid cells had a round nucleus at the expanded end in thymus of guinea fowl (Tamilselvan *et al.*, 2017) (Plate 3).

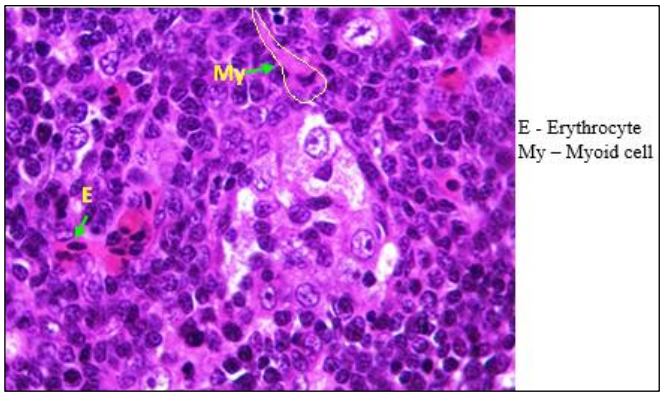

Plate 3: Photomicrograph showing the cellular population of thymus in four months old tom turkey H&E x 1000

Myoepithelial cells

Myoepithelial cells were flattened cells with elongated processes and small elongated vesicular nucleus. They were found around the secretory units of harderian gland. Kozlu and Altunay (2011) [13] mentioned that in the harderian gland of quail, the myoepithelial cells were oval shaped and had pale nuclei (Plate 4).

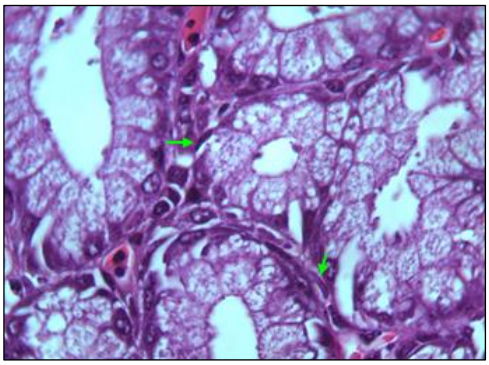

Plate 4: Photomicrograph showing the myoepithelial cells (Arrows) in harderian gland at one month old female poult H&E x 1000

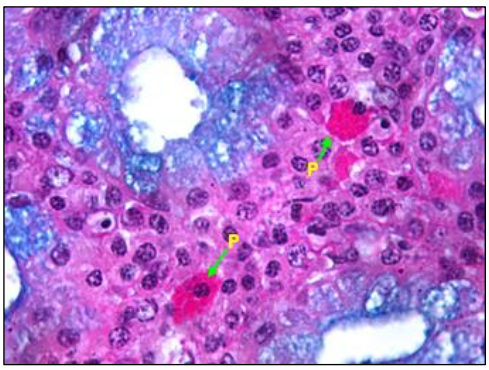

Plate 5: Photomicrograph showing the plasma cells with Russell bodies in harderian gland at nine months old when turkey Combined Alcian blue-PAS x 1000

Adipocytes

The adipose cells appeared as polyhedral shaped cells with clear cell boundaries and flat nucleus at the periphery of cell. They had thin rim of cytoplasm and cells appeared like empty rings. They formed clusters in the connective tissue regions of bursa of Fabricius and thymus during involution Gartner and Hiatt (1997) [7].

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