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MANUAL

OF

PATHOLOGICAL HISTOLOGY

BY

CORNIL AND RANVIER

SECOND EDITION, RE-EDITED AND ENLARGED

Translated with the Approbation of the Authors

By A. M. HART

Vol. II.

SPECIAL PATHOLOGICAL HISTOLOGY

LESIONS OF THE ORGANS

PART I.

WITH 125 FIGURES INTERSPERSED IN THE TEXT

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CONTENTS.

PART III.

DISEASES OF THE ORGANS.

Section I.—The Respiratory System.

CHAPTER I.

CHAPTER II.

GENERAL PATHOLOGICAL HISTOLOGY OF THE RESPIRATORY SYSTEM.

CHAPTER III.

SPECIAL PATHOLOGICAL HISTOLOGY OF THE RESPIRATORY SYSTEM.

Section II.—The Digestive System.

CHAPTER I.

THE MOUTH.

CHAPTER II.

THE TONSILS.

CHAPTER III.

THE SALIVARY GLANDS.

CHAPTER IV.

THE PHARYNX AND ŒSOPHAGUS.

CHAPTER V.

THE STOMACH.

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CHAPTER VI.

THE INTESTINE.

MANUAL
OF
PATHOLOGICAL HISTOLOGY.

PART III.
DISEASES OF THE ORGANS.

Section I.—The Respiratory System.

CHAPTER I.

NORMAL HISTOLOGY OF THE RESPIRATORY SYSTEM.

The different parts of the respiratory system are named **the larynx, the trachea, the bronchi,** and **the lungs.** The latter are enveloped by the pleuræ. In entering the larynx air passes by way of the nasal fossæ, or the mouth, through the pharynx. The mouth and the pharynx belong to the alimentary canal, the lesions of which we shall study later. We shall treat here the nasal fossæ, as we consider them to belong to the respiratory apparatus. We will first briefly recall in a few words the normal histology of these different parts.

The nasal fossæ consist of different parts, the structure of which varies; first, the vestibule of the nasal fossæ, which is furnished with rather coarse hairs and lined with a stratified pavement epithelium; secondly, the nasal fossæ properly so called, which may be divided into a respiratory and an olfactory region, which latter corresponds to the upper part of the septum, the superior turbinated bone, and part of the middle turbinated bone; thirdly, and finally, the sinuses.

The whole mucous membrane of the respiratory tract—that of the sinuses as well as of the nasal fossæ—is lined by a ciliated cylindrical epithelium. It is very thick and highly vascular, except in the sinuses, where it is thin and intimately attached to the bony surfaces, which it covers. It contains numerous mucous glands. The olfactory region is particularly remarkable for the terminations of the olfactory nerves, which are peculiar epithelial cells, elongated, nucleated, and terminating in a rod-like extremity (*Schultze*). These olfactory cells are situated between ordinary cylindrical cells, and in this region the mucous membrane is thicker than in others. It is yellowish in colour, and contains simple or ramified utricular glands, generally elongated in shape, the cells of which are infiltrated with yellow or brown pigment granules.

The larynx, trachea, and **bronchi** present for study a mucous membrane which lines their internal surfaces, a fibro-cartilaginous framework, smooth and striated muscles, and vessels and nerves.

The mucous membrane is lined by an epithelium, which is tesselated and stratified on the epiglottis and on the inferior vocal cords, and cylindrical and ciliated in all the rest of the laryngeal cavity, in the trachea, as well as in the bronchi; and, finally, a squamous epithelium lines the pulmonary acini. The corium is composed of two layers. The first, situated immediately under the epithelium, is composed, in great measure, in the larynx and trachea of elastic fibres limited by a homogeneous layer 11 μ thick, called the basement membrane, in which are implanted the cylindrical cells of the epithelial lining. On the most prominent part of the inferior vocal cord the mucous membrane shows numerous papillæ. These papillæ, well described by Coÿne, are similar to those on the palmar suface of the fingers; the epithelium covering them is tesselated, and beneath the epithelium is a limiting membrane. Elsewhere the superficial part of the corium of the larynx is formed of retiform tissue (Coÿne); this latter contains a certain number of lymphatic follicles, situated in man in that part of the mucous membrane which lines the ventricles of the larynx: their number is from thirty to fifty, and their form is variable, often ovoid. The second layer of the mucous corium is composed of connective and elastic tissue which unites it to the muscular and cartilaginous layers, and in it are lodged the acinous glands. The numerous **mucous or acinous glands** of the larynx, trachea, and bronchi are racemose glands.

Their openings are easily distinguished even with the naked eye. A large number of them are arranged in the form of the letter L, the horizontal arm of which envelopes the cartilage of Wrisberg, and the longitudinal arm is pushed into the larynx in front of the arytenoid cartilages. The round saccules of these glands contain mucous cells, with a flat nucleus at their base. Their ducts are lined by cylindrical epithelium.

The fibro-cartilaginous framework of the larynx consists of the thyroid, cricoid, and arytenoid cartilages, formed of ordinary cartilaginous tissue, and of the epiglottis and the cartilages of Santorini and Wrisberg, composed of reticulated cartilage. The elastic fibres of the matrix of these various cartilages are continuous with those of the mucous membrane. The rings of the trachea, as well as the angular and irregular plates of the bronchi, are composed of ordinary cartilaginous tissue. All the cartilages of the larynx in children are also composed of the same tissue. The ligaments which unite the various parts are chiefly composed of elastic tissue. The middle crico-thyroid and the inferior thyro-arytenoid ligaments owe their yellow colour to the great abundance of this tissue.

The muscles which move the various parts of the respiratory apparatus are striated in the larynx and smooth in the trachea and the bronchi. They complete the circle of the trachea, and posteriorly are inserted into the ends of the cartilaginous rings. In the bronchi they form complete circles, which are still visible in bronchi 0·2 mm. in size. Moleschott even asserts the existence of smooth muscle-fibres in the walls of the pulmonary vesicles, a fact which is denied by Kölliker and most anatomists. The distribution of the blood-vessels in the various layers of the respiratory mucous membrane is in no way peculiar; they form a superficial capillary network. The inferior laryngeal nerve is chiefly composed of large nerve-tubes, and the superior laryngeal nerve of small nerve-tubes. The latter terminates in the mucous membrane, and forms a deep and a superficial network of pale fibres, among which small microscopic ganglia are found.

The bronchi may be divided as follows:—1. Large bronchi continuous with the trachea. 2. Bronchioles, which are more than 1 mm. in diameter. 3. Sublobular and intralobular bronchi, which penetrate into the lobules and break up into terminal alveoli. The large and medium-sized bronchi have four coats, an external fibrous coat, which contains the bronchial cartilages and the glands, a muscular coat, an internal fibrous coat;

and, finally, the mucous coat lined by cylindrical ciliated epithelium. In the intralobular bronchi the external coat is thinner, and contains neither cartilaginous plates nor glands. It is in immediate relation with the fibrous tissue of the neighbouring alveoli; the muscular coat is relatively rather thick; the internal fibrous coat is rich in elastic fibres, and is continuous with the mucous coat. This latter, in a condition of semi-dilatation or contraction of the bronchial tubes, falls into longitudinal folds, so that in transverse sections the lumen of the tubes shows a festooned edge. In all these divisions of the bronchi the mucous corium is bounded, as in the trachea and larynx, by a rather thick, transparent and homogeneous basement membrane, in which are implanted the cylindrical cells. The intralobular bronchi divide dichotomously to form the terminal bronchi. These contain only a few muscle-fibres scattered in a single coat which is rich in elastic fibres. The epithelium here loses its cilia, and becomes cubical and more and more flattened. When it reaches the lobule the ultimate bronchus becomes suddenly contracted, then swells out in the shape of a funnel, which is called the infundibulum. From the latter spring three to five divisions, which are the alveolar ducts into which the pulmonary alveoli open. The whole, composed of the ultimate bronchus, the infundibulum, the air-tubes, and the alveoli, is called a **pulmonary lobule.**

The lungs are composed of lobes and of lobules. The latter are nothing else than a group of pulmonary infundibula in which the intralobular bronchi terminate; hence the most important part of the lung structures are the ultimate bronchial ramifications and the infundibula. An infundibulum is composed of a group of alveoli opening into a common cavity, in which an ultimate bronchus terminates. The alveoli, the mean diameter of which is 0·20 mm., are round or polygonal. They may be found not only grouped round an infundibulum, but isolated, and suspended to the short terminal bronchus. In a delicate section made from an inflated and dried lung, the alveoli appear in the form of round cavities, limited by septa composed of connective tissue and elastic fibres. This fibrous framework of the lung is very extensible; it is continuous with the wall of the ultimate bronchi, and serves to support the vascular network and to give insertion to the epithelium which lines the alveoli.

The pulmonary epithelium is composed in the terminal bronchi of small tesselated cells, very regular in size and easily seen; and on the surface of the alveoli of squamous cells, the

presence of which can be easily demonstrated in preparations stained with nitrate of silver. By means of this reagent (figs. 1 and 2) the epithelial cells of the lung in the frog, in mammalia, and in new-born infants can be plainly demonstrated. These cells line the whole extent of the alveoli, but their nuclei are always situated within the meshes of the capillary network.

The blood-vessels of the lung are derived from two sources, the bronchial arteries, whose rôle is principally nutritive, and the pulmonary artery, which is more particularly destined to carry on hematosis. The ramifications of the pulmonary arteries accompany the divisions of the bronchi and penetrate with them into the lobules. There they divide into capillaries and form in the

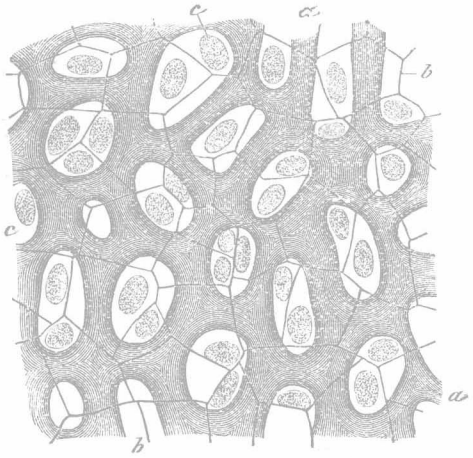

FIG. 1.—SEPTA AND EPITHELIUM OF THE LUNG OF THE FROG, AFTER KÖLLIKER.

a, injected pulmonary vessels; *b*, borders of the epithelial cells stained black with nitrate of silver; *c*, nuclei of the cells. Magnified 200 diameters.

interalveolar septa a network of very fine meshes, 4 to 18 μ in diameter, the vessels of which measure from 6 to 11 μ in width. When the alveoli contract or partly dilate, these vessels become tortuous, and project into the alveolar cavity, raising the epithelium.

The lymph-vessels of the lung are very numerous; the deeper spring from the bronchial mucous membrane, the adventitious coat of the blood-vessels, particularly of the pulmonary arteries, and also, according to Wiwodzoff, from the walls of the pulmonary vesicles. They surround the bronchi and the pulmonary arteries, forming more or less complete sheaths. On the surface of the

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normal lung the pulmonary veins and the lymph-vessels may be seen in the form of polyhedral figures which correspond to the base of the lobules. These vessels are surrounded by a certain amount of connective tissue. In sections of the lung the lobules, limited by their envelope of connective tissue, may be recognised under a low power. In these perilobular sheaths the pulmonary veins and the lymphatics ramify. In the centre of the lobule may be found, on the other hand, the intralobular bronchus and its ramifications; the lobular division of the pulmonary artery is attached to it as well as the lymph-vessels. These vessels are surrounded by a certain amount of connective tissue, which forms a sheath and accompanies them in their divisions and subdivi-

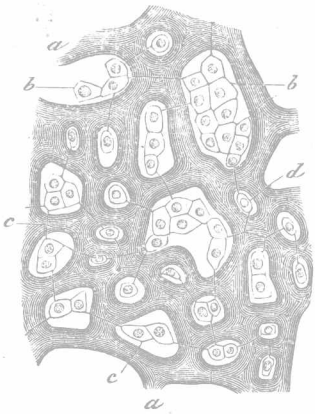

FIG. 2.—SEPTA AND EPITHELIUM OF THE LUNG OF A SMALL MAMMAL, AFTER KÖLLIKER.

sions into the interior of the lobule. It is important to understand this arrangement, so as to localise the lesions of bronchopneumonia and to understand the position of pulmonary tubercles, as we shall see later on.

The pleura, the serous membrane of the thoracic cavity, is composed of two parts. The first or visceral covers the surface of the lung; it is thin and composed of a layer of loose connective tissue, and is lined on its external surface by flat epithelium cells; the other or parietal has on its free surface similar cells, and on its deep surface it adheres to the ribs and intercostal muscles. The parietal pleura is thick, and is composed of two layers of connective tissue. The first, composed of loose connective tissue, is situated under the epithelium; the other, distinctly fibrous, contains

a large quantity of elastic fibres. On the edges of the lung the visceral pleura has villous processes. This membrane contains blood-vessels. Its lymph-vessels, which are abundant, have been studied by Dibkowski; they communicate directly with the serous cavity by open pores between the endothelial cells; these pores or stomata are particularly met with in the parietal pleura between the ribs.

To recapitulate, the essential part of the lung, where the exchange of gas between the air and the blood takes place, is the pulmonary alveolus. From the most accepted morphological point of view the pulmonary alveolus, lined with flat cells and formed of a connective tissue and elastic membrane, corresponds to a mesh of connective tissue or to a small serous cavity, which may be considered as identical. Though the alveolar cavity is in contact with the atmospheric air, the cellular elements which constitute its walls do not become decomposed, for it is never completely empty and always contains air saturated with vapour; hence the epithelial cells of the lung never become dry. The pathological anatomy of the lung is reduced essentially to that of the pulmonary alveolus.

CHAPTER II.

GENERAL PATHOLOGICAL HISTOLOGY OF THE RESPIRATORY SYSTEM.

BEFORE proceeding to give a description of each of the diseases of the respiratory system, the histological changes in their essential parts should first be studied from a broad point of view. From this point of view the respiratory system may be divided into two distinct portions, the air-tubes and the lung. The diseases of the air-tubes, from the nasal fossæ to the termination of the bronchi in the pulmonary alveoli, are for the most part independent of diseases of the lung. The latter, however, always attack the final terminations of the bronchi in the same degree and in the same way as the pulmonary alveoli; the ultimate bronchial ramifications belonging in reality to the lung by their structure and their pathology. There are, moreover, diseases which, like tubular pneumonia or broncho-pneumonia, affect at the same time the lung and the bronchi of all sizes, even their final divisions. Finally, infectious diseases and generalised neoplasms invade in different degrees all segments of the respiratory tract. With these exceptions the lesions of the air-tubes (nasal fossæ, larnyx, trachea, and bronchi) may be considered apart from those of the lung.

I. General Pathological Histology of the Air-tubes.

We will now pass in review the changes of the most essential parts composing these tubes—the epithelial lining, the glands, the mucous corium, and the smooth muscles.

A. Histological changes in the epithelial lining of the air-tubes.—The epithelial cells which line the mucous corium of the air-tubes are almost always cylindrical throughout. In the greater part of these passages—in the larnyx, the trachea, and the large bronchi, for example—it may be observed in mammals and in man that, above the basement membrane of the corium, there is nor-

mally a layer of small round cells and a superficial layer of cylindrical cells furnished with a plate surmounted by cilia; between these latter cells caliciform cells are disseminated. Fig. 3 shows the arrangement of the epithelial lining of the normal mucous membrane of the trachea in the rabbit.

Experimental inflammation.—Changes which take place in the epithelial lining of the air-tubes may be easily studied in inflammation experimentally induced in animals. To this end cantharidin[1] is injected under the skin. This irritating substance has the advantage of inflaming the tissues by means of the blood, hence its action is exercised on the deep layers in contact with the capillaries, and extends to the superficial layers. The conditions of spontaneous inflammation are by this means better realised than when irritating agents are applied to the surface of the mucous membrane. Two hours after the injection of a sufficient quantity of cantharidin into the subcutaneous cellular tissue of the rabbit, the mucous membrane of the trachea becomes uniformly red, but shows no abnormal secretion of mucus. In fine sections of the preparation hardened by the successive action of Müller's fluid,

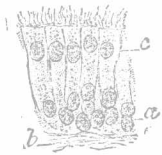

FIG. 3.—SECTION OF THE EPITHELIAL LAYER OF THE TRACHEA OF THE RABBIT IN THE NORMAL CONDITION.

b, superficial part of the mucous corium; *a*, layer of small cells in contact with the mucous corium; *c*, cylindrical ciliated cells. Magnified 250 diameters.

gum, and alcohol, the first phases of inflammation may be observed. The epithelial lining of the tracheal mucous membrane will be seen to be thicker than normally, and almost everywhere many layers of small round cells may be seen at its base, instead of the single layer which exists there normally. The superficial cells still retain the cylindrical form. In the parts where the inflammation is more intense all the epithelial lining is composed of cells, round or polyhedral by reciprocal pressure, about the size of lymph cells, and the cylindrical cells of the surface have disappeared. The superficial round cells still almost always retain

[1] In employing subcutaneous injections of cantharidin we use a solution of this substance in acetic ether. With 4 to 6 grammes of the solution at the degree of concentration which is obtained at the temperature of 20° centigrade—that is to say, with a dose of from 5 to 8 mgrs. of cantharidin—symptoms of intense poisoning are induced in the rabbit, and death occurs in a few hours.

their cilia (see *c*, fig. 4); these, however, are not arranged regularly on the plate of a cylindrical cell, but are inserted without order. When the inflammation is intense the epithelial lining is much thickened, and appears in sections in the form of tumefied projections. At the base of these projections above the basement membrane are seen many close layers of round cells, then vacuoles filled with a fluid containing granules and lymph cells. Fusiform flattened cells with ovoid nuclei, everywhere mixed with lymph cells, limit these vacuoles. The epithelial surface is composed of cylindrical or round ciliated cells (see fig. 5). It is evident that the round or lymph cells, derived in a great measure from the capillaries of the mucous and submucous tissue, have displaced forwards and separated the pre-existing and fusiform cylindrical cells. The ciliated cylindrical cells have themselves become changed in shape; after division of their nucleus and protoplasm

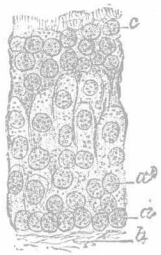

FIG. 4.—SECTION OF THE MUCOUS MEMBRANE OF THE TRACHEA IN A CASE OF INFLAMMATION INDUCED BY CANTHARIDIN. THE SECTION WAS MADE AFTER HARDENING THE PREPARATION IN OSMIC ACID.

b, surface of the mucous corium; *a*, round cells situated at the base of the epithelial lining; *a'*, the same cells occupying almost the whole extent of the section of the epithelial lining; *c*, layer of round cells furnished with cilia. Magnified 250 diameters.

they are transformed into round cells, the most superficial of which still preserve their cilia.

When the artificially induced inflammation is more intense, instead of simply causing an accumulation of cells on the surface of the mucous membrane, the epithelium is rapidly desquamated. Its place is taken by a layer of lymph cells, which, mixed with the fluid exuded from the vessels, form a muco-purulent secretion on the surface of the mucous membrane. If, for example, 50 centigrammes of a 1 per cent. solution of nitrate of silver be injected into the trachea of a rabbit, and if two hours afterwards the trachea be placed in a hardening fluid, so that sections can be cut, a layer of lymph cells, more or less pressed together, and taking

consequently the shape of small cubic blocks, will be found in the place of the normal epithelial lining. In this experiment the irritating nitrate of silver first attacks the superficial cells, and it is natural that they should be desquamated more quickly and thoroughly than in the previous experiment. The irritation caused by the nitrate of silver being, moreover, more intense, the superficial layer of the mucous corium is infiltrated by a great number of lymph cells. If the artificially induced inflammation caused by cantharidin or by nitrate of silver be exerted, not on the trachea or on the larger bronchi, but on the small bronchi, the

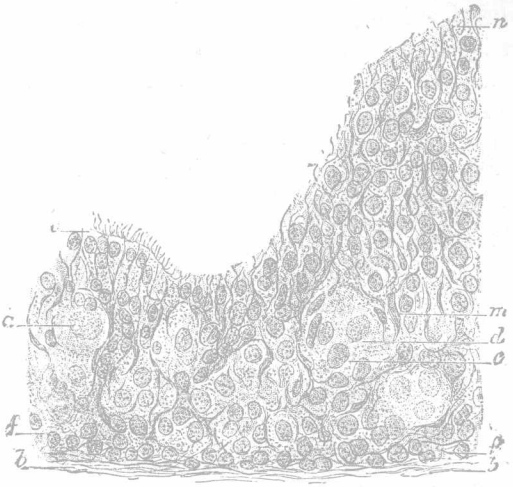

FIG. 5.—SECTION OF EPITHELIAL LINING OF THE TRACHEA OF THE RABBIT, FROM A CASE OF POISONING BY CANTHARIDIN, OBTAINED AFTER HARDENING THE PREPARATION IN OSMIC ACID.

b, superficial part of the mucous corium; *f*, small cells in contact with the latter; *d*, *e*, lymph-cells contained in the vacuoles, round which may be seen flattened fusiform cells, or cylindrical cells, *m*; *c*, cylindrical superficial cells furnished with cilia. Magnified 250 diameters.

newly formed cells, instead of simply causing a thickening of the epithelial lining, as in the large tubes, completely fill the lumen of the small bronchi.

Catarrhal inflammation of the air-tubes.—The preceding experiments have enabled us to understand what takes place in the epithelial lining in catarrhal or superficial inflammation in man. The phenomena observed vary according to the intensity of the inflammation. In slight inflammation, when only an increase of the mucous secretion and congestion of the corium are observed by the naked eye, the epithelial lining remains intact, and no

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