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Part First.

ORIGINAL COMMUNICATIONS.

ARTICLE I.—*On the Pathology of the Bronchio-Pulmonary Mucous Membrane.* By C. BLACK, M.D., Chesterfield, Bachelor of Medicine, and formerly Medical Scholar in Physiology and Comparative Anatomy in the University of London; Fellow of the Royal College of Surgeons of England, etc. etc.

THE extent of the bronchio-pulmonary mucous membrane, the relation which it bears to the important function of respiration, and the pathological condition to which, like all living structures, it is subject, indicate the importance which attaches to a correct knowledge of the mode in which morbid action influences its structure and particular function. Until the microscope became one of the principal aids in demonstrating the minute structure of organs, and in tracing the very minutiæ of disease as affecting organic atoms, pathologists had perhaps arrived, as nearly as it was possible, at the then highest obtainable knowledge of the intimate nature of disease affecting, in its various forms, the bronchio-pulmonary mucous membrane—of the modification of function arising therefrom—of the bearing of these conditions on the maintenance of life—and of the curative indications to be observed. But since that instrument has been added to the means of pathological research, the knowledge of the past generation of physicians seems to comprise but a fractional part of pathological science, which now developes an extensive field for investigation, in which many valuable and important discoveries are yet to be made. But, whilst to the microscope we owe our improved method of investigating the physical alterations of structure effected by disease, we are no less indebted to organic chemistry, for enabling us to detect those metamorphoses of living atoms, and the various organic and inorganic products arising therefrom, which characterise the various deflections from health in the different tissues and organs of the body. Of both these means of investigation, then, I shall avail myself in my endeavour to advance our knowledge of the pathology of the bronchio-pulmonary mucous membrane. But a correct knowledge of diseased structure and of diseased action predicates a perfect acquaintance with healthy structure and with healthy action. Let me, then, linger for a short time on the threshold of this investigation, to take a cursory view of the intimate structure and arrangement of the membrane under consideration, and of the different purposes which it serves in the healthy condition of the organism.

Structure of the Bronchio-Pulmonary Membrane.

The bronchio-pulmonary mucous membrane, like every other mucous structure, consists of :—

1. An epithelium, which covers its free surface.
2. A basement, primary, or germinal structure, on which the epithelium rests.
3. A layer of simple, fibrous tissue, vessels, and nerves, subjacent to the basement membrane.

The Epithelium.—This structure consists of flattened cells, forming scales, which unite by their edges, and thus constitute a continuous layer, which extends throughout the bronchi and the ultimate cells of the lungs. These epithelial cells are sometimes oval, more frequently polygonal, nucleated (the nucleus occupying as nearly as possible the centre of the cell), and have their free surface set with delicate cilia. In contradiction to the statement, that the epithelium is not continued into the ultimate cells of the lungs, it may be observed, that if a very thin slice of pulmonary tissue be taken from the surface of the lung, macerated for a short time in distilled water, to decolourise it, and be afterwards subjected, between two slips of glass, to the microscope, each pulmonary cell is seen to have a perfect lining of epithelium, as shown in the adjoining figure.

Fig. 1.

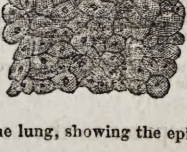

Fig. 1.—Section from the surface of the lung, showing the epithelial lining of the pulmonary cells.

If the same section be now exposed for a few minutes to the action of a weak solution of potash, the continuous layer of epithelium is, in a great measure, broken up into patches, which may be easily demonstrated either by inclining the instrument, and thus collecting them at the lower edges of the slides, or by separately subjecting a drop or two of the fluid to the microscope. They measure from $\frac{1}{700}$th to $\frac{1}{2500}$th of an inch, and are mingled with granules from $\frac{1}{7000}$th to $\frac{1}{10,000}$th of an inch, around which a faint, light cell-wall is still visible, thus showing them to be the nuclei of epithelial cells.

Fig. 2.

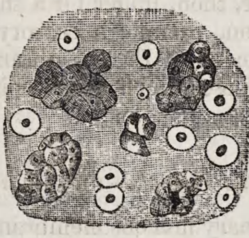

Fig. 2.—Epithelium broken up into patches and isolated cells, by the action of a solution of potash.

Not unfrequently the action of liq. potassæ detaches portions of the basement membrane itself, some of which have epithelium attached to their free surface; whilst others are destitute of epithelium, the solution of potash having effected a separation. Those portions of basement membrane which are free from epithelium have a slight grayish appearance, resemble a thin layer of tremulous jelly, and present no structural appearance beyond darkish-coloured points, set at regular distances from each other, which form the germinal centres of the epithelial cells.

Fig. 3.

Fig. 3.—C, Epithelial patch detached by liquor potassæ.
D, Fragment of basement membrane, showing two nuclei in process of development.
A, Fig. 1 after the action of liquor potassæ, showing the basement membrane, except at one point,
B, Where the epithelium is still attached. The areolar fibres of the mucous membrane are also seen through the basement structure.

These cells serve two purposes in the economy; one of which has for its object the protection of the basement membrane, by the continuous layer which they form; and the other, the secretion or elimination of a viscid fluid, termed mucus, which lubricates the free surface of the membrane, and thus protects it from irritation. Such, then, are the uses of the epithelium in the healthy condition and action of the organism. We shall, however, hereafter see, that under certain morbid conditions of the system affecting the bronchio-pulmonary membrane, the epithelial cells act the part of true excretory organs, and thus eliminate from the blood the elements of disease, in the same manner as the renal epithelium is believed to eliminate the scarlatenic poison in acute desquamative nephritis.[1] But there is this difference between the eliminative action of the two epithelia—the morbid products of one (the bronchio-pulmonary epithelium) are physical, tangible, and chemically determinable; whilst those of the other (renal epithelium) are, in the particular instance cited above, assumed, and as yet elude our most delicate means of research.

The Primary or Basement Membrane.—Beneath the bronchio-pulmonary epithelium the basement membrane is spread out, as before stated, in a thin, delicate, structureless layer, which is continued into the ultimate air-cells, constituting a part of their walls. Its thickness, in the larger bronchi, measures from $\frac{1}{18,000}$th to $\frac{1}{20,000}$th of an inch; whilst, in the pulmonary cells, its sectional diameter is about $\frac{1}{23,000}$th of an inch. It is studded, at almost equal distances, with small projecting points, which measure on an average $\frac{1}{8000}$th of an inch, and which are evidently the germinal nuclei of the epithelial cells, as is proved by the fact, that in patches of the basement membrane liberated by a solution of potash, and from which the epithelium has been dissolved, these points or nuclei are occasionally observed to be undergoing a process of development into cells, some of which have already obtained a growth, varying from $\frac{1}{5000}$th to $\frac{1}{6200}$th of an inch.

Fig. 4.

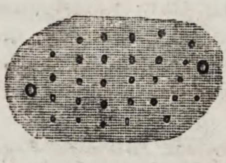

Fig. 4.—Basement membrane, showing several of its nuclei in the process of development into cells.

It would seem that the composition of the basement membrane is similar to that of the blood-plasma, after coagulation of the latter;

[1] *Vide* Dr G. Johnson's admirable work on "The Diseases of the Kidney"—a work which, in conjunction with the excellent papers of Dr William Gairdner of Edinburgh, of Professor Gluge of Brussels, and of Messrs Simon and Toynbee of London, on the same subjects, has given a new era to renal pathology.

that its existence is very temporary, and that it is being continually disintegrated at its epithelial surface in the maintenance of cell-growth; whilst its opposite surface is as continually receiving increments of addition from the nutritive plasma, which is incessantly supplied by the vital operations of the capillaries which ramify in the areolar tissue beneath. Hence the difference between healthy nutrition and that morbid process which is designated "inflammation," is one of degree rather than of kind. In the one, the elements of nutrition are supplied gradually, continuously, and in quantity proportioned to the absolute requirements of the part; in the other, they are poured forth suddenly, copiously, and greatly in excess of all natural demand. To use a homely comparison, the basement membrane may be likened to a field, well tilled and sown, in which the nuclei of the membrane represent the seed; the intervening structure, the soil; and the fluid which is continually permeating this structure from the vessels beneath, the moisture, which latter, together with heat, forms a necessary condition for germination and growth. The nuclei, like the impregnated seed, are impressed with a vitality by virtue of which they are enabled, under the combined influence and co-operation of the natural temperature of the part, and of the fluid portions of the blood which are continually passing from the areolar to the epithelial surface of the basement membrane, to assimilate to themselves the intervening basement-structure, and thus to develope themselves into cells. This intervening substance is generally so proportioned that its most superficial layer is exhausted by the growth of the different nuclei into fully developed cells; but should any of the nuclei prove abortive, or should circumstances conspire to detach the growing nuclei from their nutritive matrix, which is frequently the case in both instances, the intervening superficial layer of basement substance is not exhausted, but cast off, as epithelial or basement patches, in the secretion of the part. Hence the secretion of the bronchio-pulmonary membrane consists essentially of epithelial cells, or mucus-corpuscles, disseminated through a homogeneous fluid menstruum; but owing, as before-stated, to the operation of accidental causes, all the nuclei of the basement membrane do not attain perfect cell-development, and thus patches of its superficial layer appear in almost every specimen of the fluid examined.

The Fibrous Tissue of the Bronchio-Pulmonary Membrane.—Subjacent to the basement membrane, we find a fibrous tissue, which, together with capillary vessels and filaments of nerves, forms a third layer entering into the composition of the bronchio-pulmonary membrane. These fibres are of two kinds, and are known as the white and yellow fibrous tissue. The diameter of the former varies from $\frac{1}{18,000}$th to $\frac{1}{22,000}$th of an inch; whilst the latter measure from $\frac{1}{8000}$th to the $\frac{1}{12,000}$th of an inch. The white fibres appear to pursue a definite, isolated direction, without branching or uniting with accompanying fibres; whilst the yellow send out branches in their course, which unite with those of neighbouring fibres of the same character. The latter are far more numerous than the former, and to their property of elasticity may be ascribed the expansive and contractile power of the pulmonary cells; whilst to the former is probably owing the property of maintaining the patency of the cells during complete inactivity of the lungs.

Fig. 5.

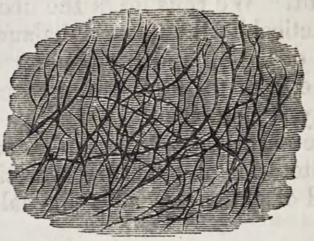

Fig. 5.—Fibrous tissue of the bronchio-pulmonary membrane.

Such then appears to be the particular structure and the individual uses of the different tissues which compose the bronchio-pulmonary membrane. Together they constitute a structure which forms innumerable involutions in the production of the pulmonary cells, the aggregate surface of the walls of which is calculated by Haller to be fifteen times greater than that of the exterior of the body. The diameter of these cells varies from $\frac{1}{200}$th to $\frac{1}{65}$th or $\frac{1}{70}$th of an inch, the former measurement being that of the cells situated towards the middle of the substance of the lungs, whilst the latter measurements more particularly represent that of the cells near the surface of the lungs, where the superjacent pressure of pulmonary tissue is less. The extent of surface obtained by this arrangement, and the free distribution of capillaries on the exterior of the cell-walls, have, for their special object, the exposure of the venous blood of the latter to the air contained in the pulmonary cells, by which an interchange of oxygen and carbonic acid gas takes place in extent proportionate to the healthy requirements of the system. In the healthy development of the body, the means, in this respect, are exactly proportioned to the ends required; nothing is deficient; nothing is in excess. We thus, by simple induction, infer, that these conditions cannot be altered without producing a corresponding modification of function of the affected part or organ, and through it a corresponding effect on the system at large, in proportion to the importance of the organ to the maintenance of life. But were life dependant on a strict maintenance of these exact conditions, disease would, in every instance, prove fatal. To obviate this, we find that life may be maintained, although perfect health may not be enjoyed, within a certain range of excess or deficiency of action of the different organs which contribute to the preservation of life, by virtue of the similarity of action of the different parts of the same organ, and of a kind of compensatory action of organs exercising a totally different function in the system. Hence the complete abolition of the function of a portion of lung rendered useless by disease is endeavoured to be compensated for by an excess of action of the other portions of the same organ which are yet entire, in which effort the skin and liver may be made to unite. But this defective action of one, and excessive action of another, organ can only take place within certain limits, beyond which death must inevitably result. We thus learn the necessity of preserving, as far as may be practicable, the natural balance or equilibrium between the capability of action and the amount of function required, of an organ. Our efforts to do this must be based on a proper knowledge of healthy structure and of healthy action, coupled with a just estimate of the nature and effects of disease, as manifested in the modification or alteration of structure, secretion, and vital endowments generally, and of the power of remedial agents to affect the living body.

Now, preparatory to the pathological consideration of the bronchio-pulmonary membrane, the structure and uses of the tissues entering into its formation have been described. There yet remains to be considered the secretion with which its free surface is, in the healthy condition of the part, slightly besmeared, and by which it is, under ordinary circumstances, protected from causes of irritation, which would otherwise affect it from without.

This secretion, in the healthy state of the bronchio-pulmonary membrane, is more or less transparent, colourless, grayish, or slightly yellow, viscid, not entirely coagulable by heat,[1] precipitated by alcohol, and by the acetic and mineral acids, and not miscible with water, in which it floats, owing to the bubbles of air which it imprisons. Its chemical reaction is alkaline, and its composition involves the following organic and inorganic constituents.

	In 100 parts.
Water,	99·20
Organic matter,	·68
Chlorides of Sodium and Potassium, Alkaline Sulphates and Phosphates,	·12
Lime,	a trace
	100·00

It will thus be seen that it contains 0·68 per cent. of organic matter, of which the chief animal constituent is mucin, to which allusion will again be made.

Microscopically considered, mucus consists of definite, isolated, granular cells, floating in a viscid, homogeneous fluid, which latter is the contents of cells that have already attained their full growth,

[1] If a quantity of mucus be examined under the microscope, then subjected, between two slips of glass, to the flame of a spirit-lamp, and afterwards be re-examined, the cells will, from coagulation of a part of their contents, be found to be more granular than before the application of heat.

and have liquified in the process of natural decay. Hence, as an accidental, although an almost invariable, constituent of the bronchio-pulmonary secretion, we find shreds or debris of the cell-walls, with which a few superficial basement patches, the origin of which has already been explained, are generally associated. The granular cells, or mucus-corpuscles, when they have attained their full development, measure from $\frac{1}{1500}$th to $\frac{1}{2500}$th of an inch, whilst their granules, on an average, equal $\frac{1}{18,000}$th of an inch. In this condition they are isolated, present a dark, well-defined outline, and are more prominent than pus cells, with which they are frequently confounded, but from which they are distinguishable by the last two characters, and by the greater average diameter of their granules.

Fig. 6.

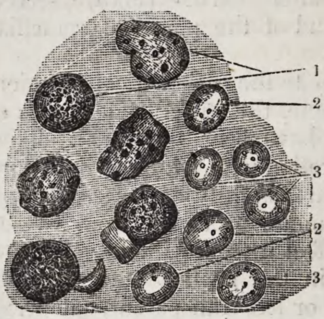

Fig. 6.—1. Corpuscles as seen in tough gray mucus.
2. Corpuscles as seen in ordinary mucus.
3. Fully developed pus-cells.

They are evidently the epithelial cells of full growth, and their contents are not so much the result of any absolute secretory power which they possess, as of an endosmotic property, which allows the gradual imbibition of surrounding fluids to take place into their cavity, in proportion to the growth and vital extension of the cell-walls. This statement is in accordance with the doctrine, that growth and secretion do not take place at the same time—only growth.[1]

Thus the nuclei of the basement membrane germinate, grow, and develop a cell-wall at the expense of the molecules of fibrine which surround them, and which form a part of the basement membrane; whilst the albumen, the other chief constituent of that membrane, rendered soluble by the watery and saline constituents of the blood, which, as before stated, are continually permeating it, passes by endosmosis into the cavity of the cells. The nuclei and cell-walls, therefore, consist of fibrine, whilst their contents are no other than albumen in combination with the various saline constituents mentioned in the table above.

[1] Professor Goodsir.

The proofs that such is the chemical composition of the mucus-corpuscles, may be found in the separate application of acetic acid and liquor potassæ to different portions of the secretion itself, as well as to the epithelium and basement membrane. Before, however, detailing the action of these re-agents on the structures just named, it is necessary to remark, that acetic acid, contrary to the opinion expressed by physiologists, does not *dissolve* albumen, but, like other acids, *coagulates* it.

The following simple experiment, which I have frequently repeated with the same result, will prove the truth of my position. If to the white of egg acetic acid, free from all trace of sulphuric, hydrochloric, and nitric acids, be added, and the mixture be stirred with a glass rod for a few minutes, distinct flocculi of coagulated albumen will immediately form. If more acetic acid be now added, and the mixture, after stirring, be allowed to stand for a short time, the whole will pass into a firmly coagulated mass, in which condition it may be dried and preserved almost any length of time.

To determine the different degrees of coagulation, the following experiment was performed. Two drachms of the white of egg were measured, and one drop of pure acetic acid was added. A small, distinct, and isolated coagulum was immediately formed on stirring the mixture with a glass rod. At intervals of a few minutes the acetic acid was still added until fifty drops had been used. The coagulum increased at each addition of the acid, and when fifty drops had been added, it occupied the whole fluid. After remaining at rest for an hour, other sixty drops were added, in ten-drop quantities, at an interval of a few minutes, when a firm coagulum formed, and was not displaced on inverting the glass containing it.

On this point Dr Carpenter ("Manual of Physiology," page 101) says :—" Nitric acid is particularly efficacious in occasioning coagulation (of albumen) ; on the other hand, acetic acid and common tribasic phosphoric acid do not precipitate it, these acids having the property of dissolving pure albumen." Again (page 102 of the same work), in speaking of caseine, the same author remarks, that caseine " differs from albumen, however, in this, that it does not coagulate by heat, and that it is precipitated from its solution by acetic acid." In his " Principles of Human Physiology" (3d edition), page 78, he further states, that albumen " is thrown down from its solution in a coagulated state by alcohol, creosote, and by most acids (particularly nitric), with the exception of the acetic."

Kirkes and Paget (" Handbook of Physiology," p. 14), state that " coagulated albumen,—*i.e.*, albumen made solid with heat is soluble in solutions of caustic alkali and in acetic acid, if it be long digested or boiled with it."

With a view of ascertaining how far this statement was correct, I subjected two scruples of albumen, coagulated by heat, to the action of a drachm of pure acetic acid for five days, at the expiration of which time not the slightest change had occurred in it. When, however, the same quantity of coagulated albumen was boiled with acetic acid, it underwent solution in little less than half an hour. Liquor potassæ had also the effect of causing perfect solution in about twelve hours.[1]

From the foregoing experiments it is clear, that acetic acid coagulates albumen, and that liquor potassæ dissolves it, whether it be semi-solid, as we find it in the egg, or coagulated by heat.

Fibrine, on the other hand, swells up, becomes spongy, semi-transparent, and of a light yellowish-brown colour, from the action of acetic acid; whilst by liquor potassæ it is charred, shrivelled, and somewhat hardened, rendering, however, by a very slow disintegration, the fluid in which it is immersed of a brown colour, like water impregnated with burnt sugar.

Now, proceeding upon these data, we shall find, in the application of these tests to the bronchio-pulmonary membrane and its secretion, that acetic acid, by rendering the cell-walls more transparent, and by precipitating, in small granules, the albumen of the mucin within the cells, gives an increased transparency to the epithelium generally, and an increased distinctness to the cell-nuclei and granules. When applied to the basement membrane, it expands the nuclei and the molecules of fibrine which form a part of that structure, owing to which the basement membrane is rendered lighter and more transparent. This effect is not counteracted by any chemical action on the albumen of the basement membrane, because the experiments before detailed prove that cold acetic acid has no effect on coagulated albumen. Hence, the basement membrane is simply rendered lighter by the action of acetic acid, by virtue of the chemical effect of the latter on the fibrine alone. Acetic acid, added to a quantity of mucus, causes it to run together, and to assume a kind of ropy, tenacious, semi-membranous structure, which is the result of the coagulation of the free albumen of cells which have already liquified and passed to decay.

Now the immediate action of liquor potassæ on the bronchio-pulmonary epithelium is manifested by,—

1. An increased transparency of the cells, owing to complete liquefaction of their albuminous contents.

2. A more or less breaking up of the epithelium, owing to solution of the albumen which, as a part of the basement membrane, intervenes between the edges of the epithelial cells.

Sometimes these cells are separated in patches; at other times they are isolated, or have a small fragment of the intervening basement structure attached to them. When liquor potassæ is applied to the basement membrane itself, that structure undergoes partial solution, owing to the albumen of which it is in great part composed;

[1] Dr Pereira, in his "Materia Medica," vol. i., p. 399, propagates the above mentioned errors, with respect to the action of acetic acid on albumen.

and the nuclei and granules of fibrine are set free; but if the action of liquor potassæ be prolonged, they too are gradually charred, and ultimately dissolved, and in this way the whole of the basement membrane is destroyed.

If liquor potassæ, or any other alkali, be added to the mucous secretion of the bronchio-pulmonary membrane, the granular cells at first become more transparent, owing to the solution of the substance which intervenes between the different granules, then a number of the granules themselves disappears, and subsequently some of the smaller cells appear so globular, from distension of their cavity by the liquor potassæ, that none of the granules can be seen. By and by they again collapse, and now a dark central nucleus is visible, around which, at some little distance, a faintly dark outline of a cell-wall can be distinguished, the space between which and the central nucleus is of a light colour, as shown in figure 2.

If the specimen under examination be set aside for two or three hours, and then re-examined, each nucleus will be found to have spread, which is no doubt owing to the charring and gradually disintegrating action of the liquor potassæ; for a drop or two of distilled water being added, they wash away the loosened molecules of the nucleus, and show it to have undergone a reduction in its original size.

(*To be continued.*)

ARTICLE II.—*Case of Acute Rheumatism, succeeded by Chorea and Affection of the Heart.* By J. WARBURTON BEGBIE, M.D., Fellow of the Royal College of Physicians, and Physician to the New Town Dispensary.

(*Read to the Medico-Chirurgical Society of Edinburgh, November 24th,* 1852.)

THE relation subsisting between the two diseases, rheumatism and chorea, has now for some time been recognised by the profession, while from many of its members the subject has received much attention and study. That an amount of obscurity, however, still exists in regard to it is evident from the various explanations which have been advanced to account for the association of the rheumatism with the nervous disorder; and although the subject has engaged, and does still engage, the notice of many fully qualified for its investigation, it will not, I think, be considered that the recording of any accurately observed case is to be looked upon as superfluous or uncalled for. Acting on this belief, I beg to submit to the Society the following case, and the few remarks which succeed it:—

J. O., æt. 10, daughter of a groom, was placed on the roll of the New Town Dispensary on the 7th June last. I saw her that afternoon, in the house of her grandmother, in Jamaica Street. She