VI. *An examination into the structure of the cells of the human lungs; with a view to ascertain the office they perform in respiration.* *By Sir* Everard Home, *Bart. V. P. R. S. Illustrated by microscopical drawings from the pencil of* F. Bauer, *Esq. F. R. S.*

Read February 8, 1827.

No subject connected with physiological enquiry has more excited the attention of the anatomist and chemist, than respiration; but the association between this subject and animal heat, which has so long been supposed to exist, has led to the belief, for the last century, that both enquiries belong more particularly to chemistry than anatomy, and I may probably be considered as going out of my province in taking up this investigation. On the other hand, I see reason to believe that the process of respiration is in itself more simple than is imagined, and more within the reach of discovery by means of accurate anatomical knowledge of the parts employed, than by means of acquaintance with the intricacies belonging to chemical affinities: I carry this so far as to contend that no explanation of respiration upon chemical principles is to be depended on, unless it accord in all respects with the anatomy and physiology of *the lungs*, by which the assumed process takes place.

The present theory respecting respiration adopted by the chemists, is, that this process decarbonises the blood in the following manner; at every inspiration a compound of oxygen and nitrogen, mixed together, is received into the lungs, and in every expiration, the same volume is returned, measure for measure exactly, with this only difference, that what entered as oxygen is returned in the form of carbonic acid gas, which, according to *their* theory, proves that no part of the inspired atmospheric air has been retained in the lungs, but a quantity of carbon, equal to that of the oxygen inspired, has been extracted from the blood by the oxygen, making it become carbonic acid gas.

Nothing could be more ingenious than this theory, were it supported by the structure of the lungs themselves, and it could be proved that the blood requires no other changes for its purification ; since all the leading facts on which it is founded, are completely established upon the firm basis of experiment.

When this theory was formed, the structure of the air cells of the lungs had never been examined, the more minute structures in animal bodies being at that time considered beyond the reach of examination ; and it is the object of the present communication, to bring forward an explanation of the mechanism of the cells of the lungs, as well as of the different distributions of the vessels that ramify through those organs, acquired from Mr. BAUER's microscopical observations, and to see how far they are fitted for the process, which by this theory is allotted to them.

In this investigation, I began by an enquiry into the circulation of the blood through the lungs, in the labour of which I have been very ably assisted by Mr. RUSSELL, a very intelligent student of St. George's Hospital, at present filling the highly respectable and important office of senior House

Surgeon. To him I am indebted for having taken the trouble of making injections of the arteries, the veins, and of the cells of the lungs, with different substances, so as to enable Mr. BAUER to expose and examine them on the field of the microscope.

The first new fact discovered in the course of this enquiry was, that although the common minute injection used by anatomists for filling the blood vessels, when thrown in by the trunk of the pulmonary artery, while the cells of the lungs are empty, returns again by the trunks of the pulmonary veins, yet when thrown in by the veins, it is not returned by the trunks of the arteries.

Another fact was discovered; that during the momentary distention of the air cells, an interruption is produced between the arterial and venal circulation in the lungs, the blood being carried no farther than the small arterial branches surrounding the air cells.

The following description of the air cells, and the parts surrounding them, is taken from the annexed microscopical drawings of Mr. BAUER.

As accurate representation surpasses all verbal description, I shall not have occasion to do more, to make myself understood, than to mention the parts themselves, and the circumstances under which they are represented.

The cells of the lungs were filled with quicksilver, to show their utmost capacity, and the parts were afterwards immersed in rectified spirit, to prevent the cells from collapsing, when the quicksilver was allowed to escape.

When the internal cavity of a single cell was exposed, immediately behind its internal membrane, the branches of the pulmonary artery, injected with red wax, were seen ramifying, as arteries do in common; these were accompanied by branches of the pulmonary vein, larger in proportion than those of the arteries, more numerous, and having valves, at apparently regular intervals, to prevent regurgitation of their contents. Besides the arteries and veins, there were innumerable absorbents opening into the cavity of the cell; their valves were at very short distances, and, in their course in the interstitial substance between the cells, they accompanied the veins. When the terminal branches of the pulmonary artery were traced, the injection was found to have stopped someway before the artery's termination, and the space beyond was filled with gas. The substance of the lungs, interstitial to the cells, when dried became transparent, and was found to be composed of a smaller order of cells, with transparent coverings, that freely communicated with one another, as well as with the cavity of the large cell they surrounded.

I cannot finish this description of an internal view of one of the cells of the human lungs, without expressing the obligations I am under to Mr. Dollond, who from a zeal for science, and the peculiar interest he has taken in these physiological enquiries, has fitted up the microscope (from the field of which the representations were taken), possessed of advantages beyond all the others that Mr. Bauer has met with, not excepting the achromatic microscope, as improved by Mr. Chevalier of Paris. This of Mr. Dollond, from the superiority in the clearness of the different glasses, and the facilities which are given to the variations of the nicer adjustments of the instrument, has enabled Mr. Bauer to give a more distinctly defined outline to all the parts, than he thought it possible to produce, when objects are so highly magnified.

From this account of the anatomical structure of the lungs, it is evident they are calculated not only to receive supplies from the atmosphere, but to convey a part of them, with the greatest rapidity, as well as facility, to the heart; since the momentary interruption to the passage of the blood from the arteries to the veins, and the numerous valves in the absorbents, as well as those in the veins, are admirably fitted for that purpose; which is at variance with the theory of decarbonising the blood.

As carbonic acid gas has been occasionally detected by Professor BRANDE, both in the urine and perspirable matter, it must have been formed in the blood circulating through the arteries; and the supply of oxygen which enables this to take place, is now shown to be derived from the lungs.

This mode of decarbonising the arterial blood, by a portion of its oxygen uniting with the carbon, and carrying it off in the form of carbonic acid gas by the urine and perspirable matter, is extremely simple, and appears to require no elaborate chemical process.

Having ascertained upon a former occasion, that soon after digestion has been begun, the oxygen employed in that process unites with carbon, and the quantity of carbonic acid gas, met with in the venous blood, is greater than at any other time; this will sufficiently account for the blood in the branches of the pulmonary artery always containing a sufficient quantity of this gas to replace the oxygen that is removed from the cells of the lungs, and carried to the heart;

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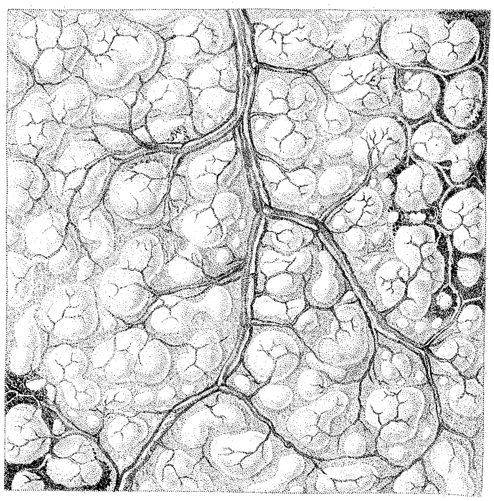

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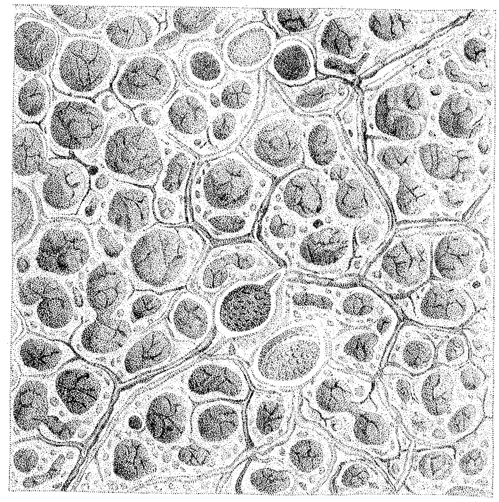

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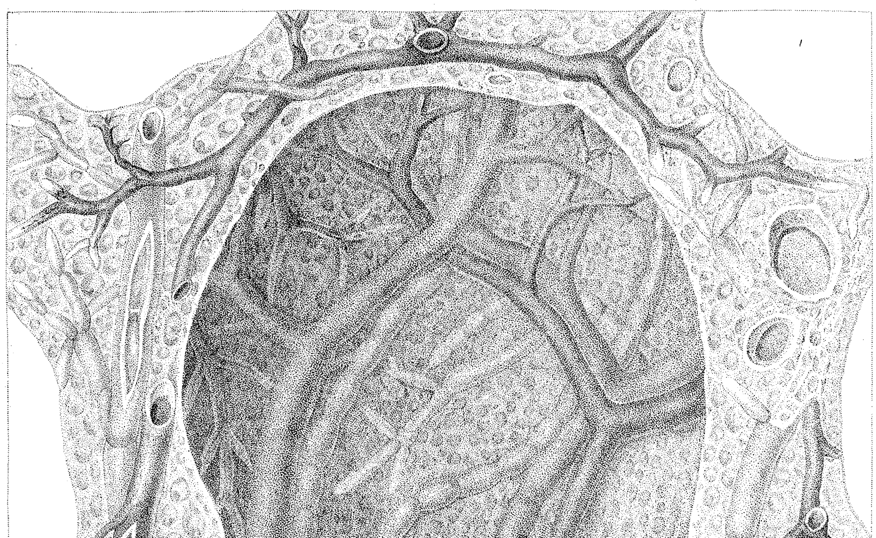

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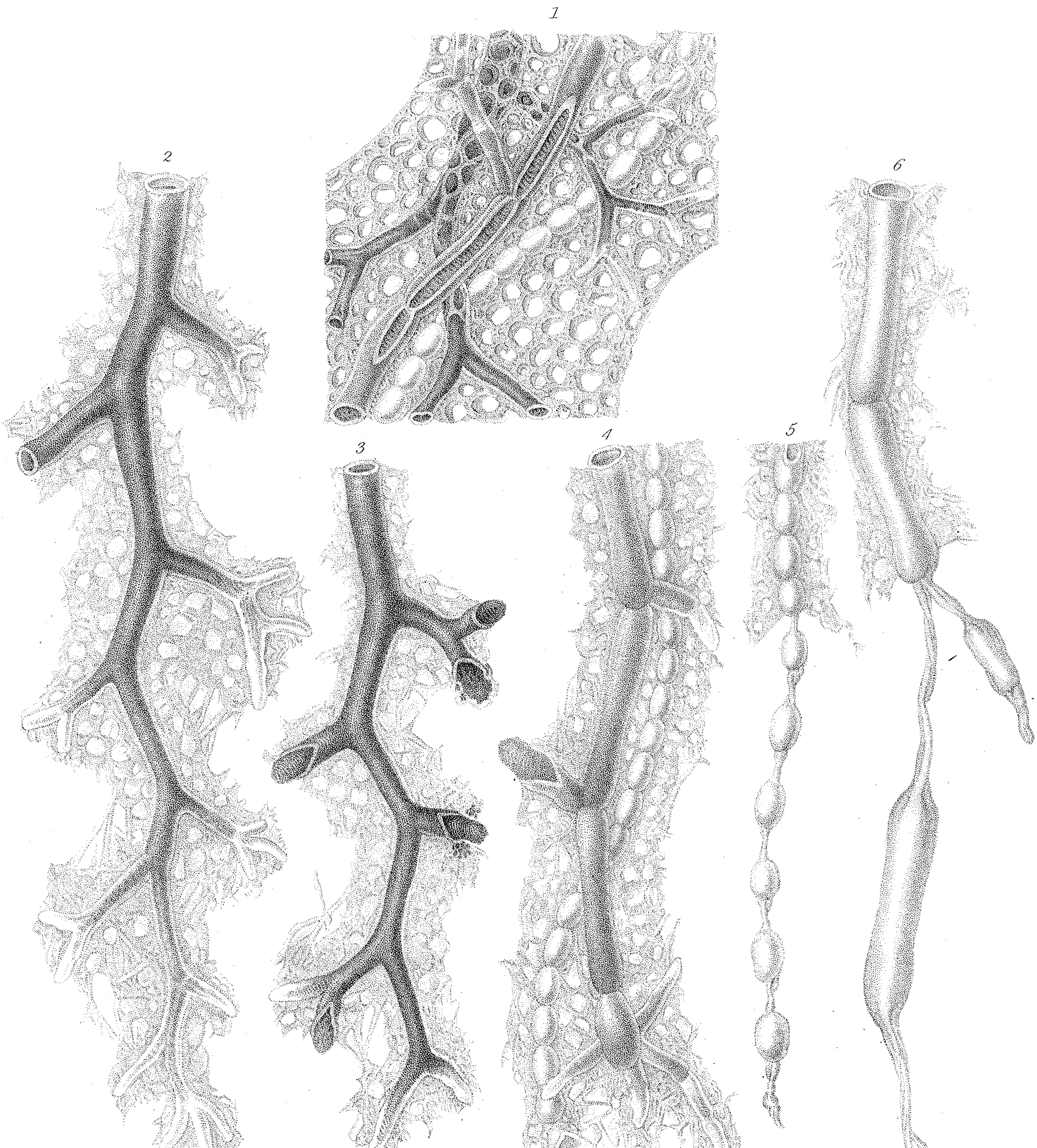

Franz Bauer, del. *Js. Basire, sc.*

so that it is only such blood that is decarbonised by the carbonic acid that is carried off by expiration.

Respiration is necessary for carrying on the functions of life, by a supply of oxygen, and the removal of the excess of carbon; but it is not required for the simple support of the principle of life when no action is going on.

The garden snail excludes the atmospheric air from the lungs, by means of an operculum formed of mucus, during the winter season; and remains alive sealed up hermetically, till the warmth and the moisture of the spring dissolve the operculum, and expand a globule of air that had been shut up in the cavity of the lungs, the escape of which opens the communication with the outer air and restores respiration.

EXPLANATION OF THE PLATES.

Plate VIII. Shows the cells of the human lungs as they appear on the field of the microscope.

Fig. 1. represents $\frac{1}{64}$th part of an inch of the external surface of the human lung, the cells of which are filled with quicksilver; magnified 20 diameters.

Fig. 2. a transverse section of $\frac{1}{64}$th part of an inch of the human lung, in which the arteries are filled with red, and the veins with yellow minute injection; magnified 20 diameters.

Fig. 3. the transverse section of a single cell from fig. 2. with the parts immediately surrounding it; magnified 400 diameters.

Plate IX. Shows the structure of the human lungs immediately surrounding the air cells.

Fig. 1. the interstitial substance between the cells, in a

recent state, consisting of small cells every where opening into one another, and communicating with the large one; the arteries and veins injected; magnified 400 diameters.

Fig. 2. a portion of a terminal branch of the pulmonary artery at the air cell of the lungs, in which the injection has not reached the termination, and the remaining portion is distended with gas; magnified 400 diameters.

Fig. 3. a portion of an injected terminal branch of the pulmonary artery, into which the injection has been too much forced, which has occasioned extravasation through the terminating ends of the branches; magnified 400 diameters.

Fig. 4. a portion of an injected vein, accompanied by an absorbent vessel. At one terminating branch of the vein the injection has also been forced out; magnified 400 diameters.

Fig. 5. a portion of an absorbent vessel, in a dried state, in which some of the intervalvular portions are inflated, others collapsed; magnified 400 diameters.

Fig. 6. a portion of a vein dried, in which some of the intervalvular portions are distended with gas; magnified 400 diameters.