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On respiration

Prof. Magnus

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not be immediately shown if this is +ve and less than the remaining terms; but we may make k as great as we please, and $z > y$ will always possibly render this factor negative, without restricting the generality of the original equations, $\therefore$ we may always assume when $n > 1$, $0 =$ sum of exclusively negative real quantities; the absurdity of which proposition shows that n cannot exceed unity.

Case 2.—Page 288, line 9, is derived from division, and by line 12,

$$\frac{p^2}{q^2} = \left(\frac{z+y}{z-y} \right)^2 \left\{ \frac{4g+1}{4h+2}, \text{ or } \frac{4g+2}{4h+1} \right\},$$

$\therefore$ the bracketed factor can evidently never become a square.

Line 21.—The introduction of $\sqrt{-1}$ follows from Euler, ch. xii.

Line 26 to 28, deduced from the binomial theorem.

Page 289, line 2, add respectively.

Page 289, line 8 (after magnitude), from the symmetry of the binomial expansion, setting out from either extreme.

P.S. This case is immediately deducible from the first, by considering x^2 , y^2 and z^2 as raised to the odd m th power.

Are Fermat's papers preserved in no *château* or *bibliothèque*?

S. M. D.

November 21, 1845.

LXXX. Intelligence and Miscellaneous Articles.

ON RESPIRATION. BY PROF. MAGNUS.

IN a paper read before the Royal Academy at Berlin, the author first enumerated the different views on the nature of respiration which had been proposed, and especially urged against all those theories which suppose that a chemical combination takes place in the lungs between the oxygen and the blood, that they do not explain how it is that blood, after having been darkened by agitation with carbonic acid, is again rendered of a bright red by oxygen or atmospheric air, and is capable of again assuming its former arterial colour, if its arterial tint depends upon oxidation; for carbonic acid cannot deoxidize the blood, and how can it be conceived that blood which has once been oxidized can be again oxidized a second or third time, and so on, without having been deoxidized? This objection appears to the author so conclusive, that he considers it sufficient to refute any theory which supposes chemical combination of oxygen with the blood to occur.

He then alluded to the theory which he had proposed in 1837, according to which the inspired oxygen does not combine chemically with the blood, but is only absorbed, and thus arrives in the capillary vessels, where it is applied to the oxidation of certain sub-

stances, converting them into carbonic acid, and perhaps also into water. The carbonic acid, instead of oxygen, is then absorbed by the blood, and reaches the lungs with it, to be removed by contact with the atmosphere; a fresh quantity of oxygen is then absorbed instead of it, and undergoes the same changes.

The quantities of oxygen which were then separable from the blood by the air-pump were but small. The author has now endeavoured to procure larger quantities from it, and has been occupied with an examination of the general absorbent properties of the blood, especially with regard to oxygen. With this object, the blood was agitated with continually renewed portions of atmospheric air, and to ascertain subsequently how much air it contained from absorption, it was placed in a vessel filled with mercury, and which was closed with an iron stop-cock. This was then screwed upon a second vessel, likewise closed with a stop-cock, and containing carbonic acid. On opening the cock, the mercury fell out and the carbonic acid ascended to the blood. The vessels were then separated, and the blood continually agitated with the carbonic acid. The vessel was then screwed upon another completely filled with mercury, and the gas was allowed to collect in this. Carbonic acid was then in the same manner again mixed with the blood, which was then agitated and the gas also conveyed into this vessel; and this process was repeated several times. Finally, the collected gas was examined, the carbonic acid being absorbed by caustic potash, the oxygen being detonated with hydrogen, and the remainder considered as nitrogen.

Although these experiments appear so simple, it was at first impossible to carry them out, because the time which it was requisite to allow for the subsidence of the froth after each agitation was so great that decomposition commenced in the blood before the completion of the experiment.

This difficulty was subsequently removed by adding a drop of oil, which when placed on the surface of the blood soon caused the disappearance of the froth.

Numerous and repeated experiments, made in this manner, on the blood of calves, cattle and horses, have yielded tolerably uniform results, the minimum of oxygen being 10 per cent. and the maximum 12.5 per cent. of the volume of the blood, and the minimum of nitrogen being 1.7 per cent. and the maximum 3.3 per cent. reduced to the temperature of 32° F. and the mean barometric pressure.

The proportion in which the oxygen and nitrogen found in the gas obtained from the blood are, affords another indirect proof that no air had entered the vessels from without during the experiment. Had this been the case, the quantities of the two gases found would have been more nearly in the proportions existing in the atmosphere, whilst the oxygen ordinarily amounted to 3 and frequently 4 and 5 times as much as the nitrogen.

Although the difference between 10 and 12.5 per cent. is not inconsiderable, still it might appear remarkable that the experiments agree so well with one another, especially as they do not liberate the

whole of the absorbed gas; but the more frequently fresh carbonic acid is added to the blood, the greater must be the quantity of gas. This is also true in practice; but after renewing the carbonic acid 3 or 4 times, the increase in the quantity of gas was found to be so small, that it fell within the limits of error of observation. Moreover, all the experiments were carried out under the same conditions. About 400 cubic centimetres of blood were usually employed; a smaller quantity was only used for some experiments. Too small a quantity could not be applied, as the amount of gas obtained is very small. The volume of carbonic acid, which was each time shaken with the blood, was never less than that of the blood itself; nor could much larger quantities be taken, because the vessels when completely filled with mercury would be managed with too much difficulty, and would be readily broken. Even in their present size containing about 700 cubic centimetres, they must be made of exceedingly strong glass. They are tall and cylindrical, with a narrow neck, and are graduated in cubic centimetres.

The quantity of oxygen which, as shown by these experiments, the blood was capable of absorbing, is, as the author has proved, sufficient to allow of the supposition that the whole quantity of air inspired is absorbed by the blood; but it is doubtful whether the arterial blood contains as much oxygen as that repeatedly shaken with atmospheric air, and whether the quantities obtained were but a small portion of the oxygen really absorbed.

To decide this, the experiments were varied, so that the blood was first agitated with constantly renewed quantities of carbonic acid, to remove the whole of the oxygen and nitrogen absorbed. The blood was then repeatedly shaken with measured quantities of atmospheric air, and the remaining air was again measured, and the quantity of carbonic acid, oxygen and nitrogen ascertained by the method previously described, when the quantity of oxygen and nitrogen absorbed was found. From numerous experiments conducted in this manner, the minimum amount of oxygen absorbed amounted to 10 per cent. and the maximum to 16 per cent. of the volume of the blood. In several experiments as much as 6·5 per cent. of nitrogen was absorbed. . .

In one of these experiments calves' blood was uninterruptedly shaken with atmospheric air; it was then repeatedly agitated with carbonic acid. By this treatment it yielded 11·6 per cent. of its volume of oxygen, but absorbed 154·9 per cent. of carbonic acid. This blood was then shaken with separate portions of a measured quantity of atmospheric air; it thus absorbed 15·8 per cent. of oxygen, yielding at the same time 138·4 per cent. of carbonic acid. Finally, it was again shaken with carbonic acid, and again yielded 9·9 per cent. of oxygen, whilst it absorbed 92·1 per cent. of carbonic acid.

It is thus evident that, by agitation with carbonic acid we can separate almost the whole of the oxygen absorbed by the blood, which would be the most striking proof that the oxygen is not chemically combined with the blood, but exists in it merely as absorbed.

These experiments show that the blood is capable of absorbing $1\frac{1}{2}$ times its volume of carbonic acid, a result which has also been obtained by other observers. They moreover show that it is capable of absorbing from 10 to 12·5 per cent. of its volume of oxygen from the atmosphere, consequently 10 to 12 times more than water under the same circumstances, and that the absorption of nitrogen amounts to 6·5 per cent.

Moreover, experiments similar to those above described were instituted on the real arterial blood of horses which were of advanced age. By agitation with carbonic acid there was obtained—

Oxygen.	Nitrogen.
10·5	2·0
10·0	3·3

whence it is evident that the oxygen exists in at least as great quantities in the arterial blood of horses.

The author then shows, that from some observations upon the quantity of the inspired air and of the blood which flows into the lungs in a given time, we may conclude that the blood does not absorb more than half the oxygen which the experiments above detailed have shown to exist in it. This portion is each time consumed in the capillary vessels, and the remainder, amounting to the other half, remains in the venous blood.—*Chemical Gazette*, No. 71.

ANALYSIS OF TITANIFEROUS IRON.

M. H. Rose remarks, that the earlier analyses of this substance are discordant, on account of the imperfect separation of the titanic acid and oxide of iron. The titaniferous iron of Egersund in Norway has been analysed by M. Mosander, M. Kobell and M. H. Rose; the results obtained by the two first agree pretty well, but differ considerably from those of M. Rose.

In three operations on the above-named mineral M. Mosander obtained the following results:—

	I.	II.	III.
Titanic acid	39·04	42·59	41·08
Peroxide of iron	29·16	23·21	25·95
Protoxide of iron	27·23	29·27	29·04
Protoxide of manganese	0·21		
Magnesia	2·30	1·22	1·94
Oxide of cerium and of yttria	...	..	0·58
Oxide of chromium	0·12	0·33	
Silica	0·31	1·65	0·07
	98·37	98·27	98·66

The results of M. Kobell's analysis are,—

Titanic acid	43·24
Peroxide of iron	28·66
Protoxide of iron	27·91
	99·81