
# Effect of local changes to shell permeability on the gas exchange of the avian embryo

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*Abstract*

The chicken embryo's ability to match the perfusion of its chorioallantoic membrane (CAM) to regional differences in shell conductance was investigated. Shell conductance was reduced locally by waxing one half of each egg. The impermeable shell area under the wax was balanced by an increase in the ambient oxygen fraction from 22.7% on day 10 to 31.0% on day 20 (wax/oxygen treatment). A second range of experiments (wax/hole treatment) was conducted at normoxia, where holes were drilled into the wax-free side, while overall shell conductance remained unchanged. They yielded very similar results. The resulting oxygen gradient indicated the low lateral diffusion under the shell.

Early chorioallantoic expansion was not altered by wax treatment. From day 10 to 15, the density of arterioles and venules ($\leq 25$ μm) was reduced under wax, independently of treatment timing. The free side of experimental eggs did not differ from controls. Similarly, capillary density and volume were reduced under wax, but did not differ between the free side of experimental eggs and controls. Barrier thickness during this time declined, apparently accelerated in experimental eggs. Capillary haematocrit was reduced under wax, possibly indicating a lower perfusion of these microvessels. On day 15, total blood volume under wax was somewhat greater than under the free side, which did not differ from the control eggs. The timing of the shell treatment had no effect on blood volume. Haemoglobin concentration of experimental eggs was lower than in the control eggs on day 15.

Although there was no observation of adaptation under the free side to compensate for the waxed side, the wax/oxygen treated embryos showed normal growth and respiration until day 20. Wax/hole treated embryos reduced mass and respiration in comparison to the control from day 15 and 16, respectively.

It appears that chorioallantoic blood flow in the CAM can be locally down-regulated, but not increased. As early embryos do not appear to reduce gas exchange and growth, adaptation may be unnecessary at this stage. Later oxygen uptake may then suffer, when vascular proliferation is inactive. The embryo may be relying on the even distribution of its shell conductance and is unable to adapt to regional changes.