Respiratory and Cardiovascular Responses in Internally Pipped Chicken Embryos

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Focus

• How do $O_2$ uptake at the lungs and $O_2$ uptake at the chorioallanotic membrane (CAM) interact during internal pipping?
Lung and CAM Respiration

Measure lung and CAM oxygen consumption separately

Air Cell Gas Mixture (AC)
- 12% O$_2$, 5% CO$_2$, 83% N$_2$

Egg
- Air

- Open flow respirometry
Air cell

Respirometer
The graph shows the relationship between $V_{O_2}^{\text{total}}$ (total oxygen uptake) and $V_{O_2}^{\text{lung}}$ (oxygen uptake by the lungs) in ml $O_2$ min$^{-1}$. There is a positive correlation between the two variables, as indicated by the upward trend of the data points on the graph. The x-axis represents $V_{O_2}^{\text{total}}$ ranging from 0.0 to 0.7, while the y-axis represents $V_{O_2}^{\text{lung}}$ ranging from 0.0 to 0.5. The scattered data points suggest that as the total oxygen uptake increases, the oxygen uptake by the lungs also increases, although the variation is significant.
Results

• There was a positive correlation between Vo₂ lungs and Vo₂ total.
CAM Oxygen Consumption (ml min$^{-1}$)
-0.3 -0.2 -0.1 0.0 0.1 0.2 0.3

Air Cell (Lung) Oxygen Consumption (ml min$^{-1}$)

-egg 21% : AC 5%
-egg 21% : AC 21%
-egg 15% : AC 12%
-egg 30% : AC 12%
-egg 15% : AC 5%
-egg 30% : AC 21%
-egg 30% : AC 5%
-egg 15% : AC 21%
Summary

- Embryos have the ability to use the CAM or lungs to compensate for each other.

- Exceptions:
  - Both CAM and lungs are hyperoxic → no tradeoff
  - Both CAM and lungs are hypoxic → both decrease

- Could response be due to changes in ventilation patterns?
Changes in ventilation after changing air cell $O_2$ and $CO_2$
Data presented as % of control

<table>
<thead>
<tr>
<th></th>
<th>AC 5% $O_2$</th>
<th>AC 21% $O_2$</th>
<th>AC 2.5% $CO_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tidal volume</td>
<td>103 ± 6</td>
<td>96 ± 7</td>
<td>55 ± 6*</td>
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<tr>
<td>Frequency</td>
<td>103 ± 3</td>
<td>105 ± 6</td>
<td>96 ± 7</td>
</tr>
<tr>
<td>Pulmonary</td>
<td>107 ± 8</td>
<td>101 ± 9</td>
<td>51 ± 6 *</td>
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<tr>
<td>ventilation</td>
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Ventilation

• At internal pipping:
  – Ventilatory oxygen chemosensitivity has little role in controlling $O_2$ exchange
  – Develops during external pipping
  – $CO_2$ chemosensitivity is functioning

• $\Delta$ in ventilation plays no role in controlling gas exchange in response to hypoxia or hypoeroxia
Conclusion

• During internal pipping, chicken embryos have two sites of respiration: CAM and air cell.

• When there is a change in oxygen level at one respiration site, the other site compensates.

• Changes in ventilation is not the mechanism for compensation.
  – Changes in blood flow
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