

④

□  $y_i = x_i^T b + u_i + e_i$  for animal

□ Aggregate over all animals in population and use matrix-vector notation

$y = Xb + Zu + e$

$\rightarrow$  length  $n$  with observations  
 $\rightarrow$  length  $p$  with fixed effects  
 $\rightarrow$  length  $q$  with random breeding values  
 $\rightarrow$  length  $n$  with random residuals

□ LME with random terms  $u$  and  $e$  as a consequence also  $y$  is random

□ In LME, expected values and variance-covariance matrices of all random terms must be specified

► vector  $u$  of breeding values are defined as deviations  $\Rightarrow E[u] =$

$$E[u] = \begin{bmatrix} E(u_1) \\ E(u_2) \\ \vdots \\ E(u_q) \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix} = \underline{0}$$

► residuals  $e$ :  $E[e] = \underline{0}$

$$\begin{aligned}
 E[y] &= E[Xb + Zu + e] = E[Xb] + E[Zu] + E[e] \\
 &= \underbrace{XE[b]}_b + ZE[u] + E[e] = Xb
 \end{aligned}$$