

Effects of dietary nitrogen content and intravenous urea infusion on ruminal and portal-drained visceral extraction of arterial urea in lactating Holstein cows

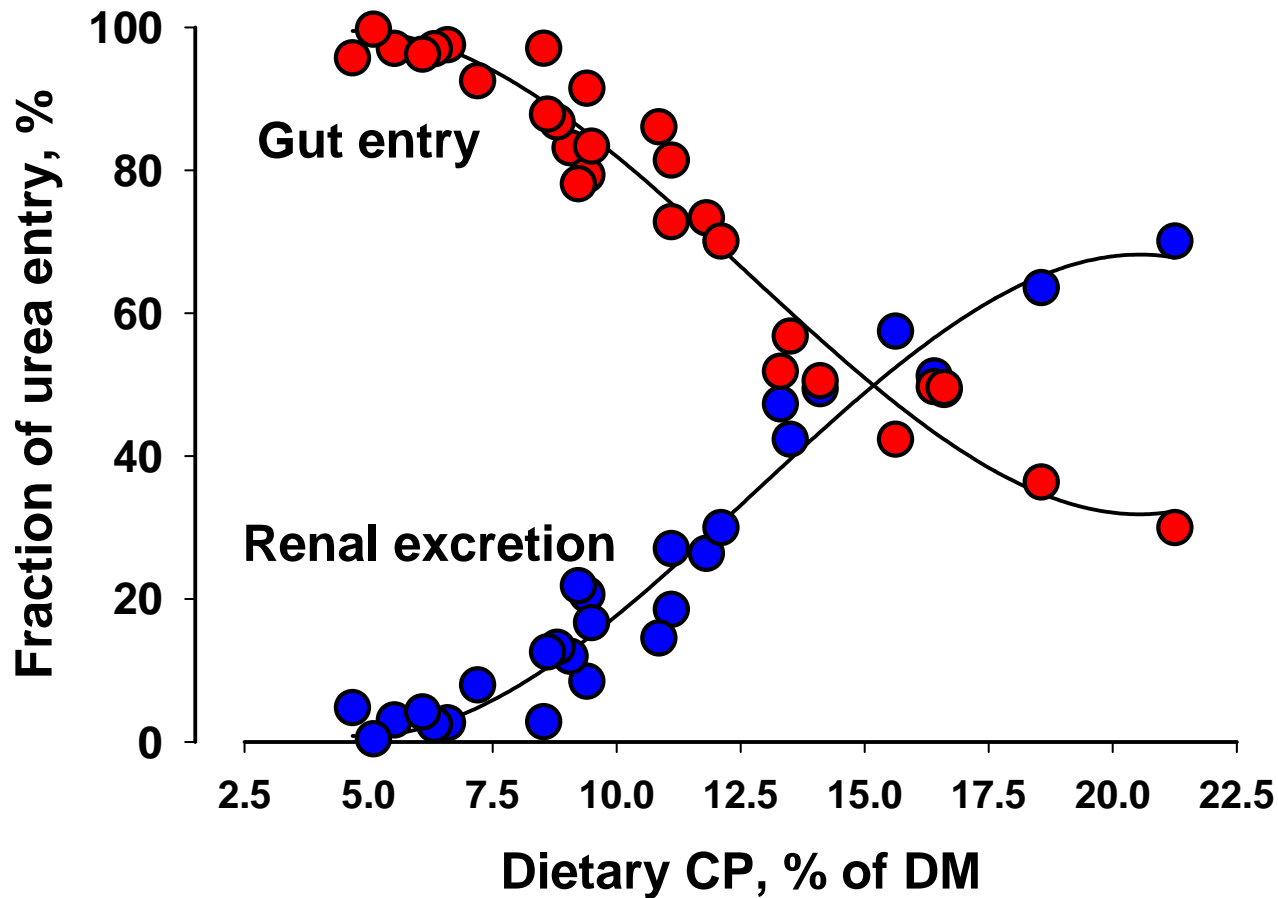
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ISEP 2010

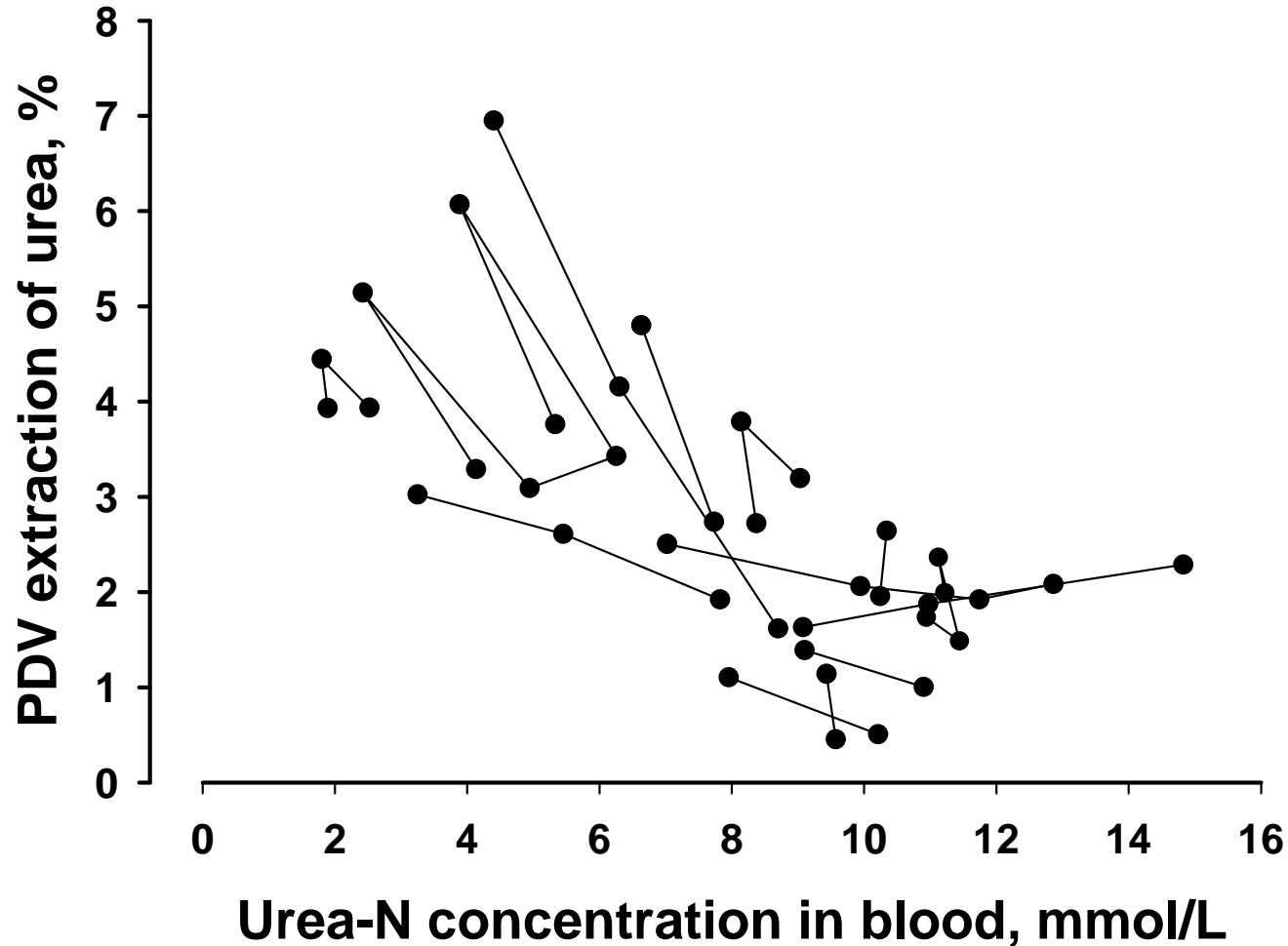
Parma (Italy) 6-10 Sept.



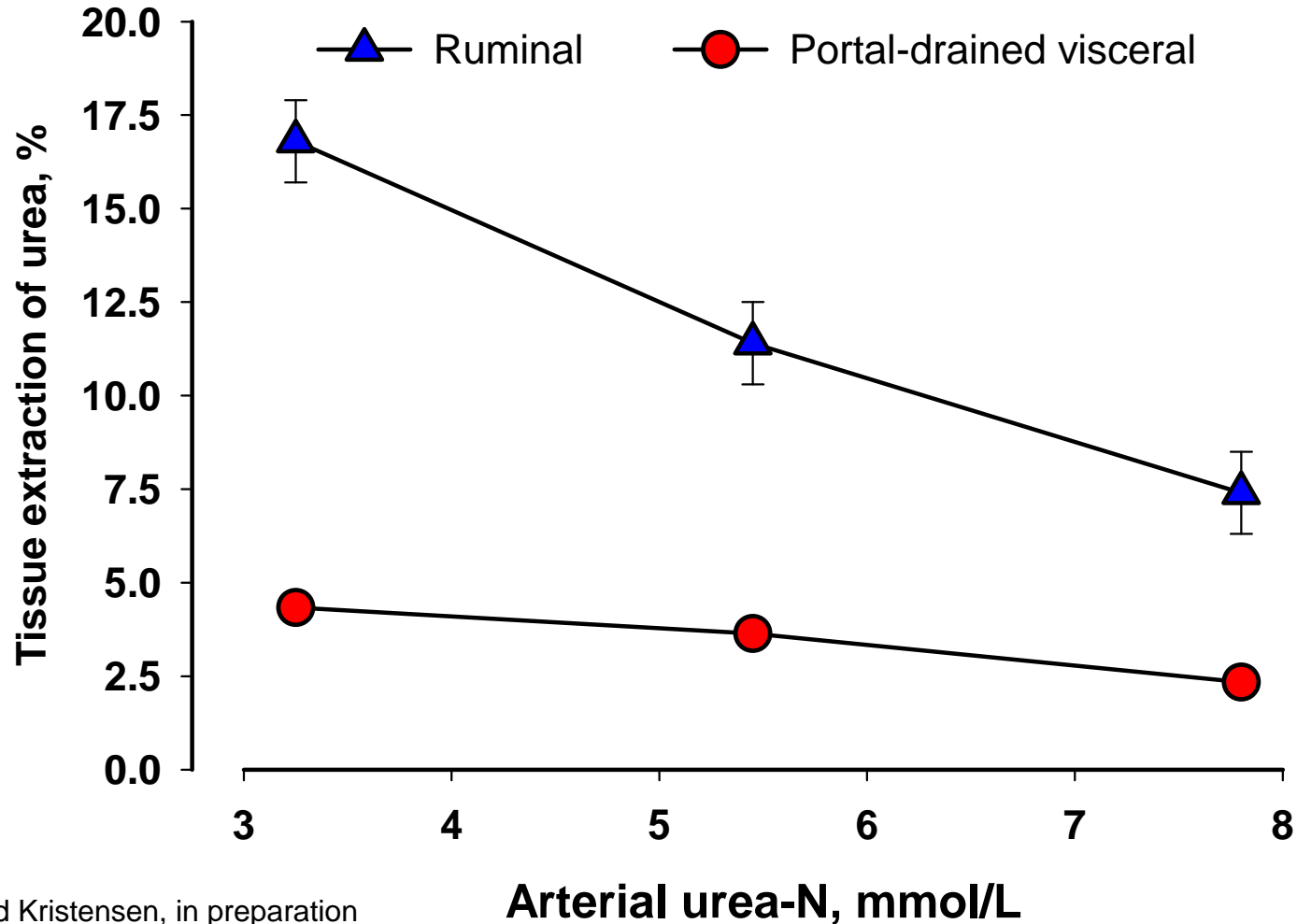
The concept of urea recycling looks promising from a relative point of view



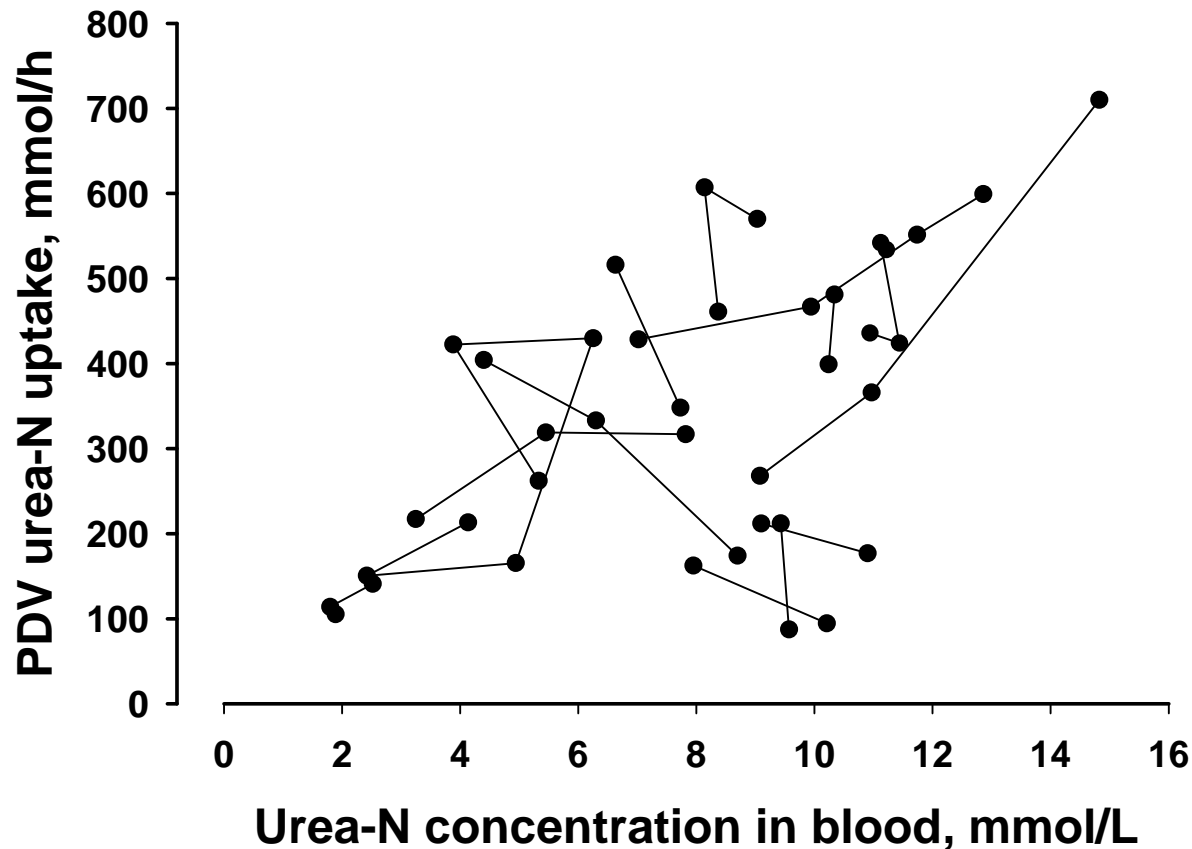
Dairy cattle: portal-drained visceral extraction of urea decreases with increasing blood urea



Ruminal urea extraction greater than PDV extraction



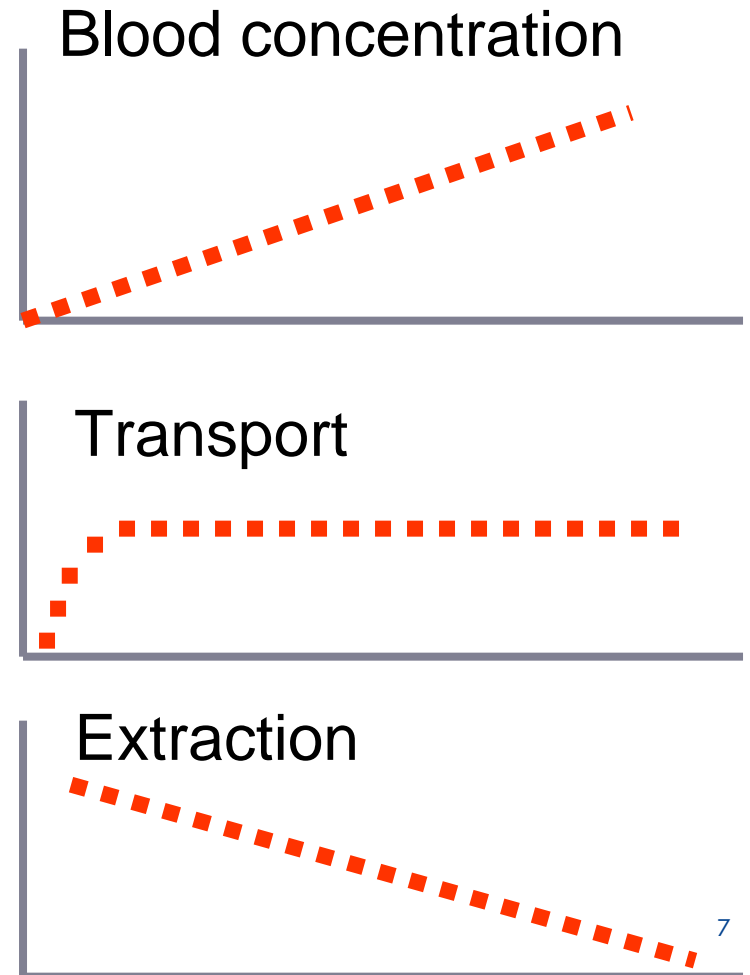
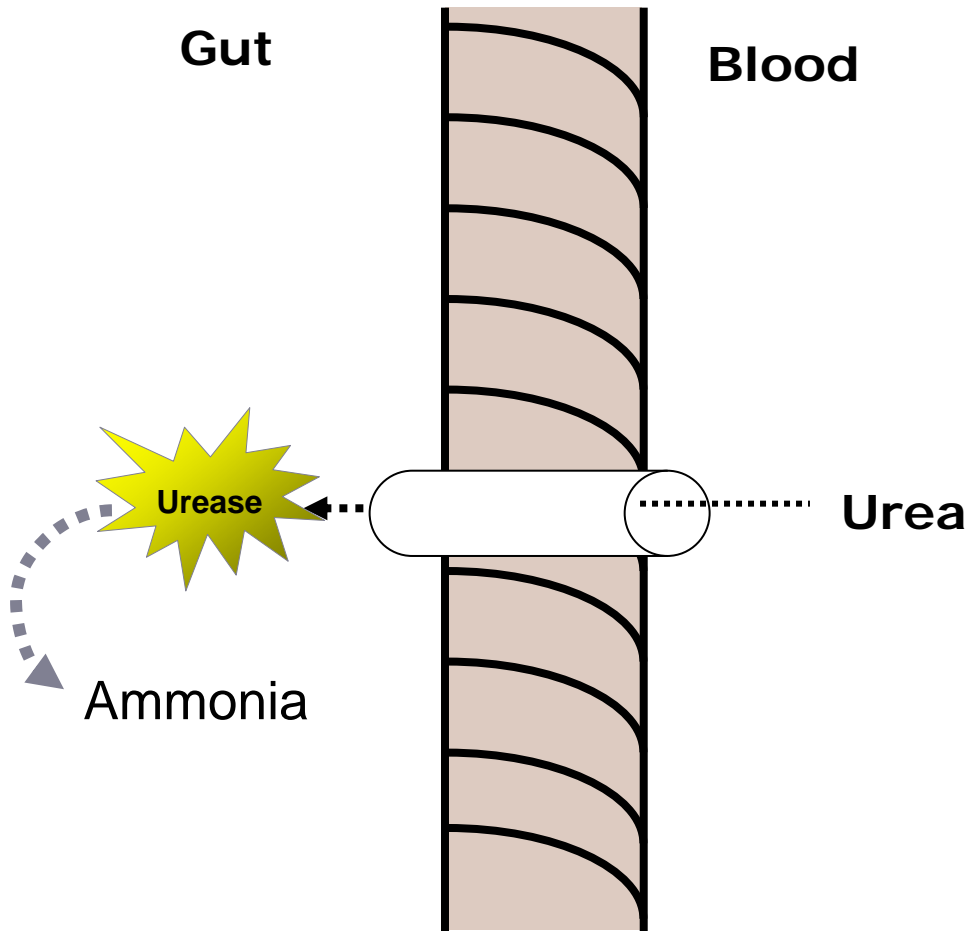
We are misled by the fractional view on recycling to think that urea recycling is an efficient mechanism to substitute dietary N



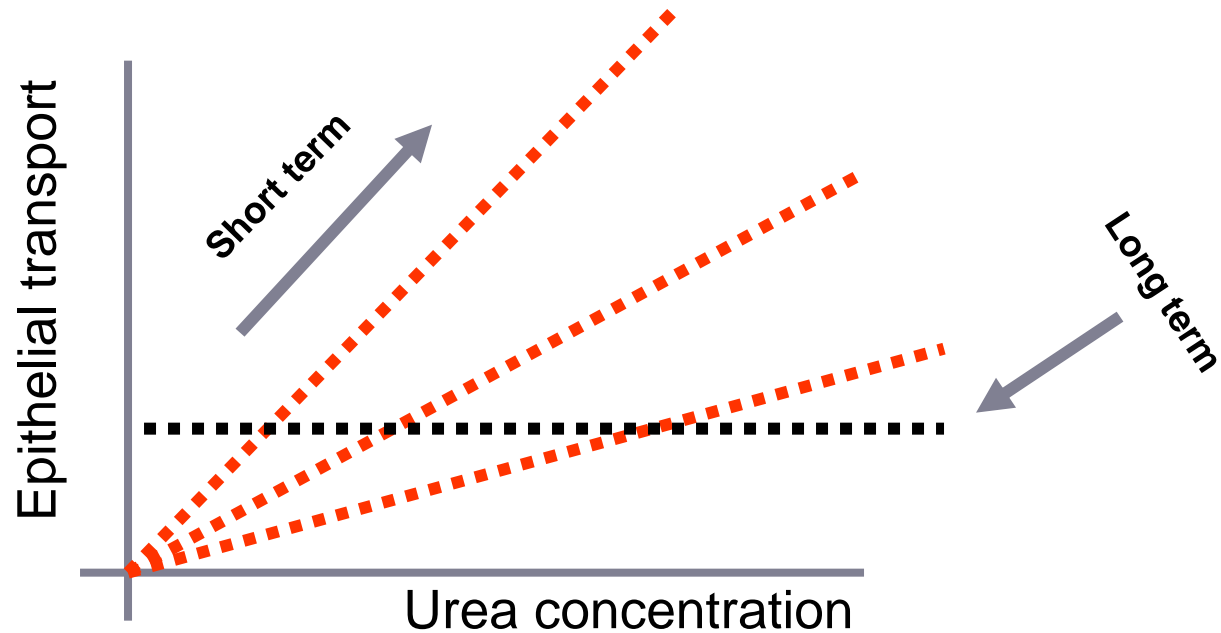


Kinetics of urea transport

Saturable urea transport?

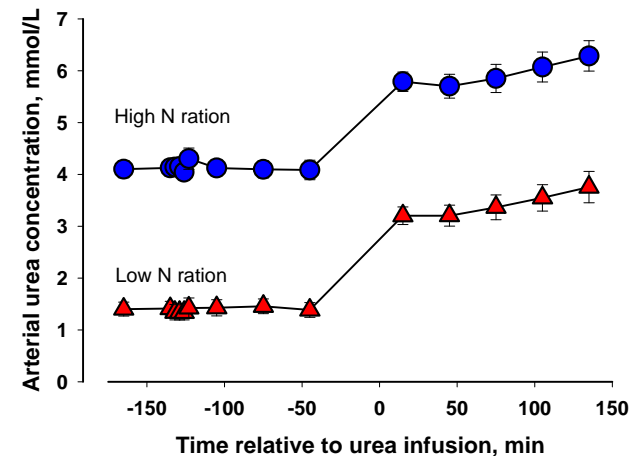
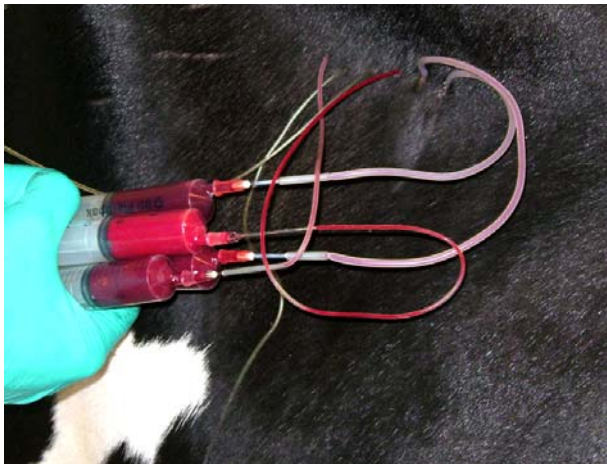


Mass action regulated transport (short term) combined with adaptation of epithelial function to N status (long term) will end up in similar phenotype



Nine multicatheterized Holstein cows

Hypothesis: short term regulation of urea transport would comply with mass action kinetics, but the permeability of PDV epithelia will depend on long term adaptation to N status/N intake

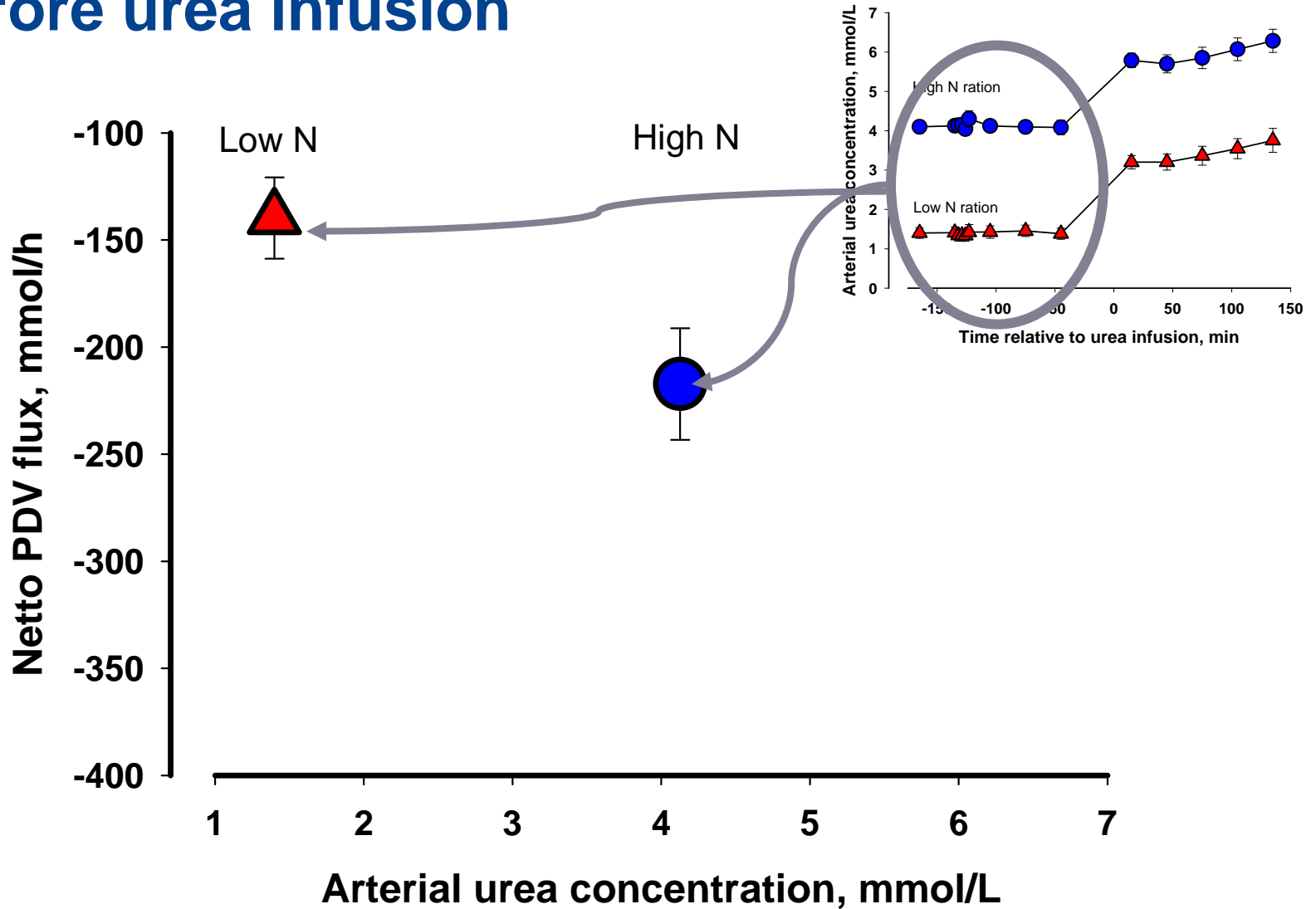




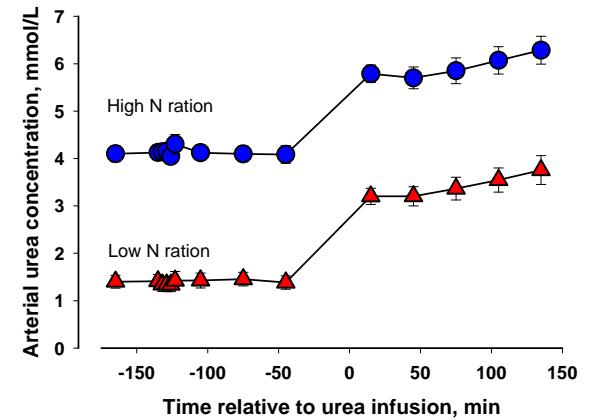
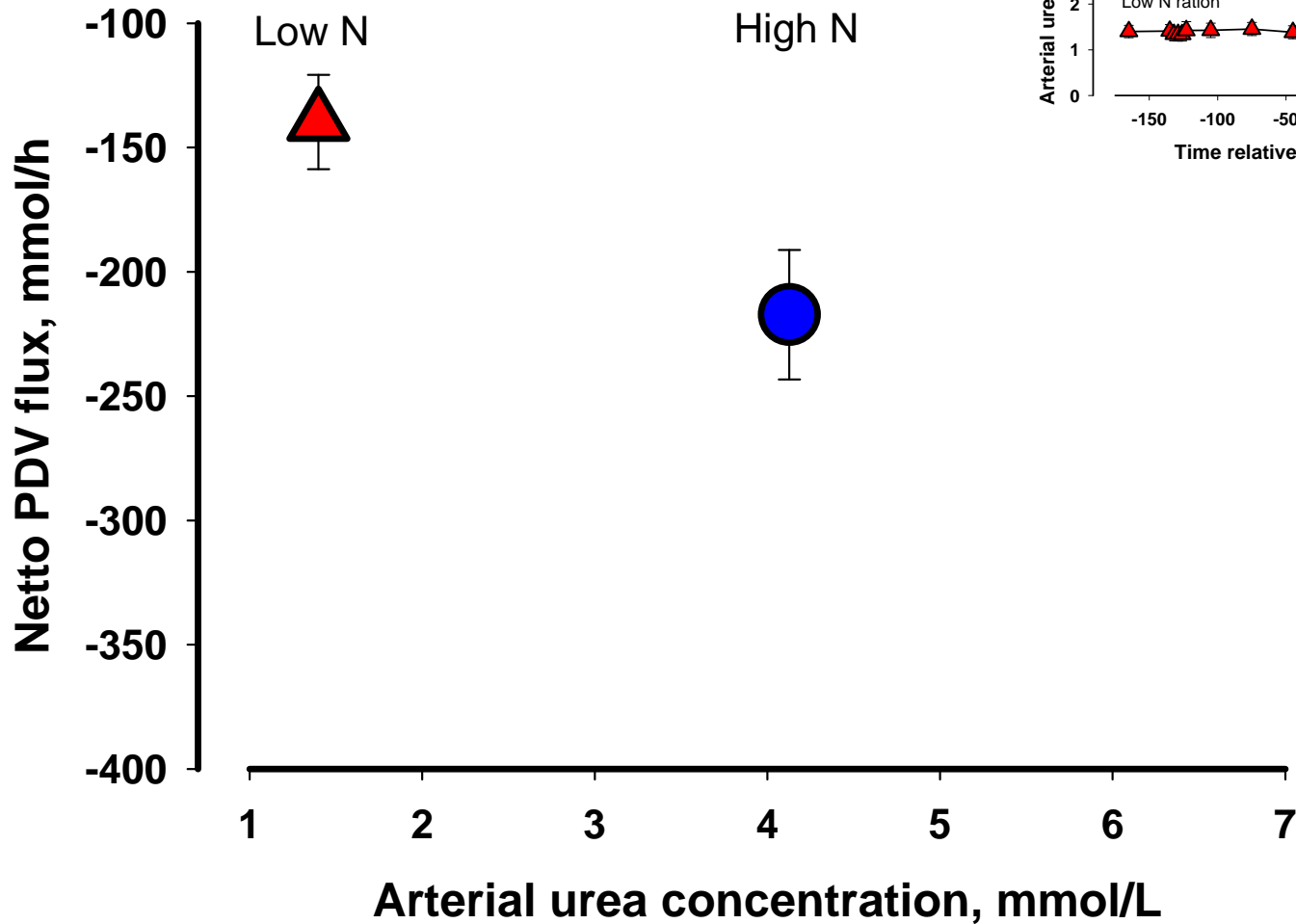
Experimental conditions

| Variable | Low N | High N | SEM |
|--------------------------------|-----------|------------|------|
| Dietary crude protein, % | 12.9 | 17.1 | - |
| Metabolizable protein, g/kg DM | 66 | 92 | - |
| Dry matter intake, kg/d | 18.3 | 20.5 | 0.5 |
| Milk yield, kg/d | 36 | 42 | 1 |
| Urea in milk, mM | 1.23 | 3.53 | 0.14 |
| Milk protein, g/d | 954 (45%) | 1161 (34%) | 47 |

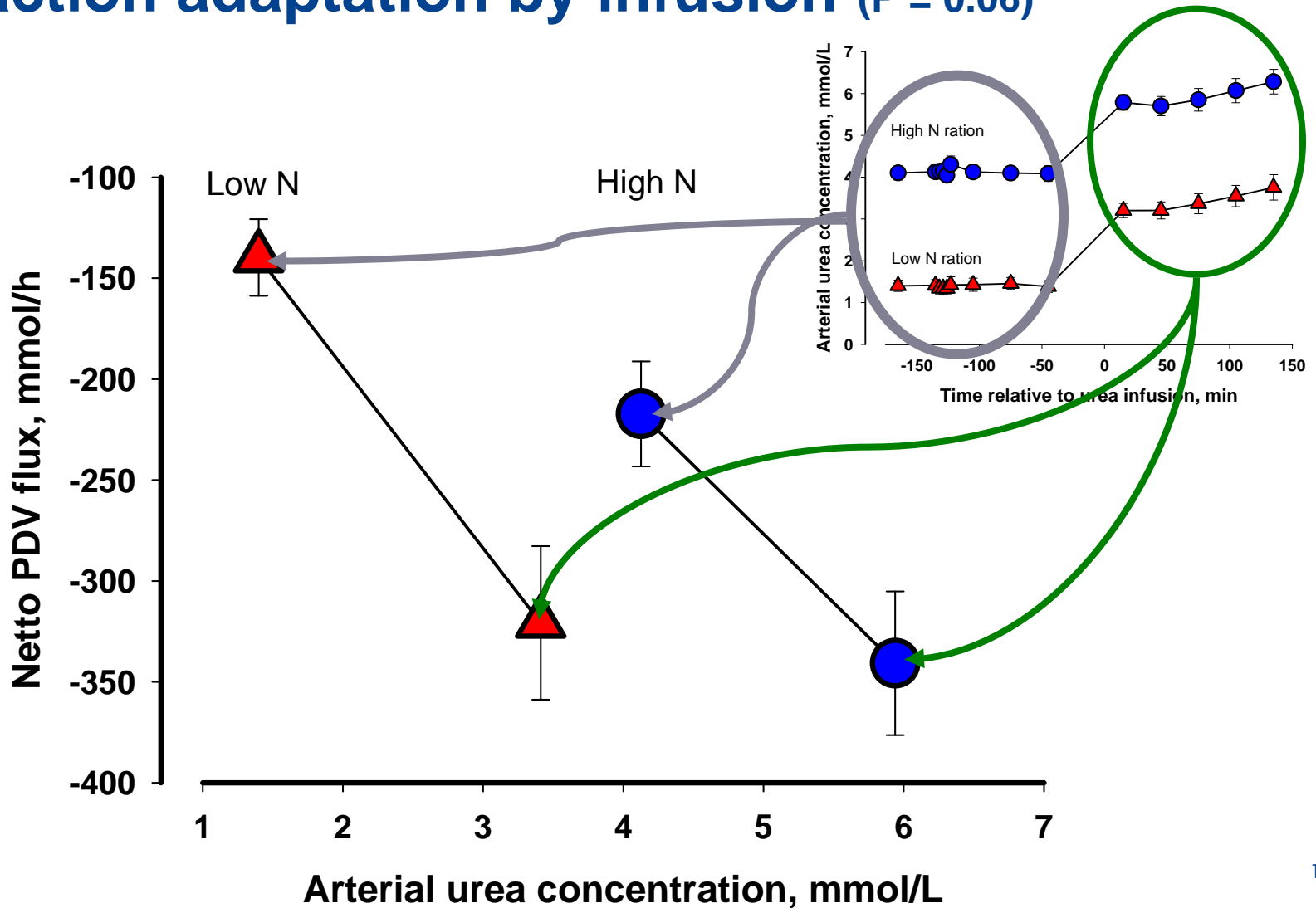
Before urea infusion



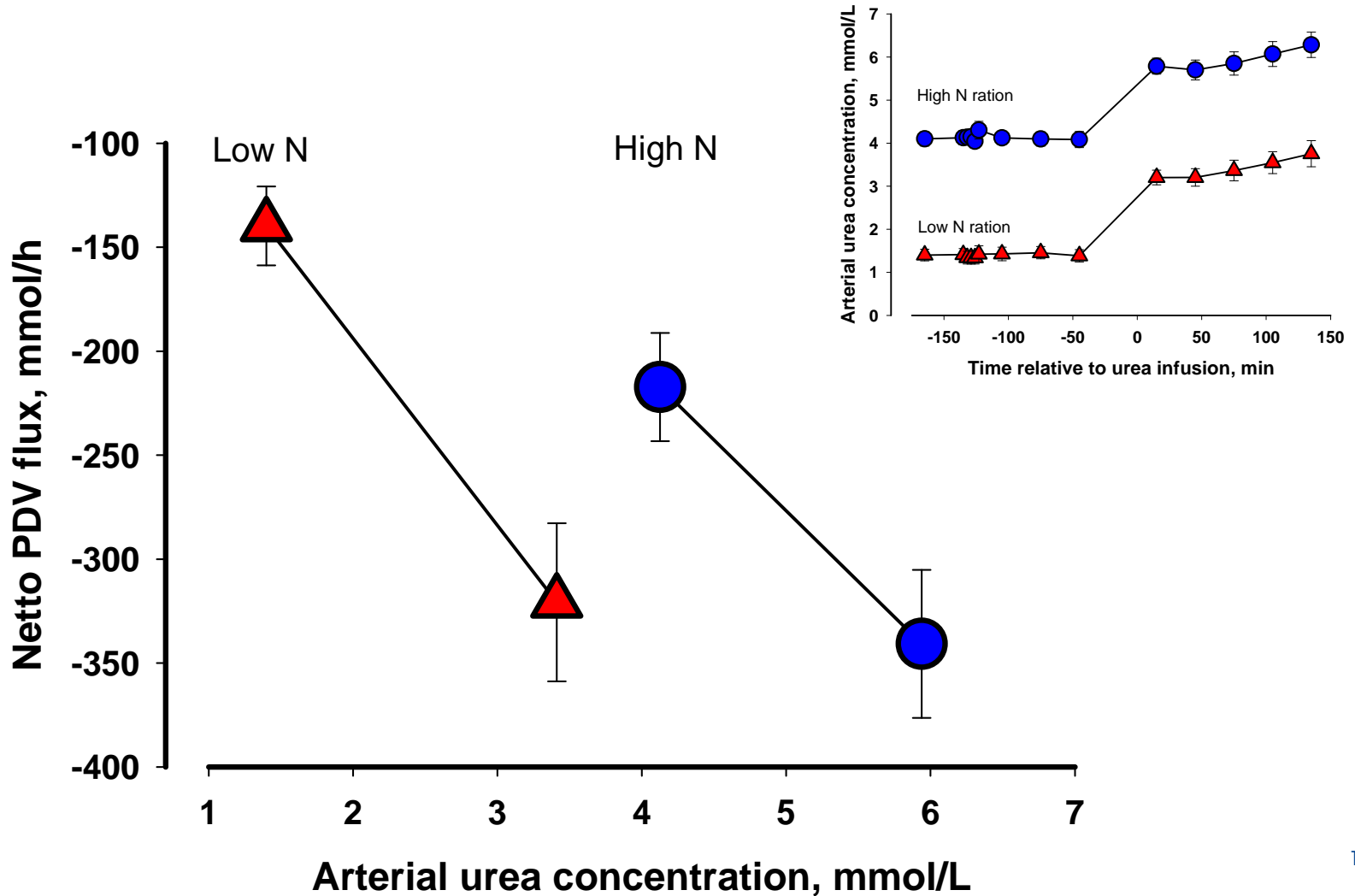
Before urea infusion



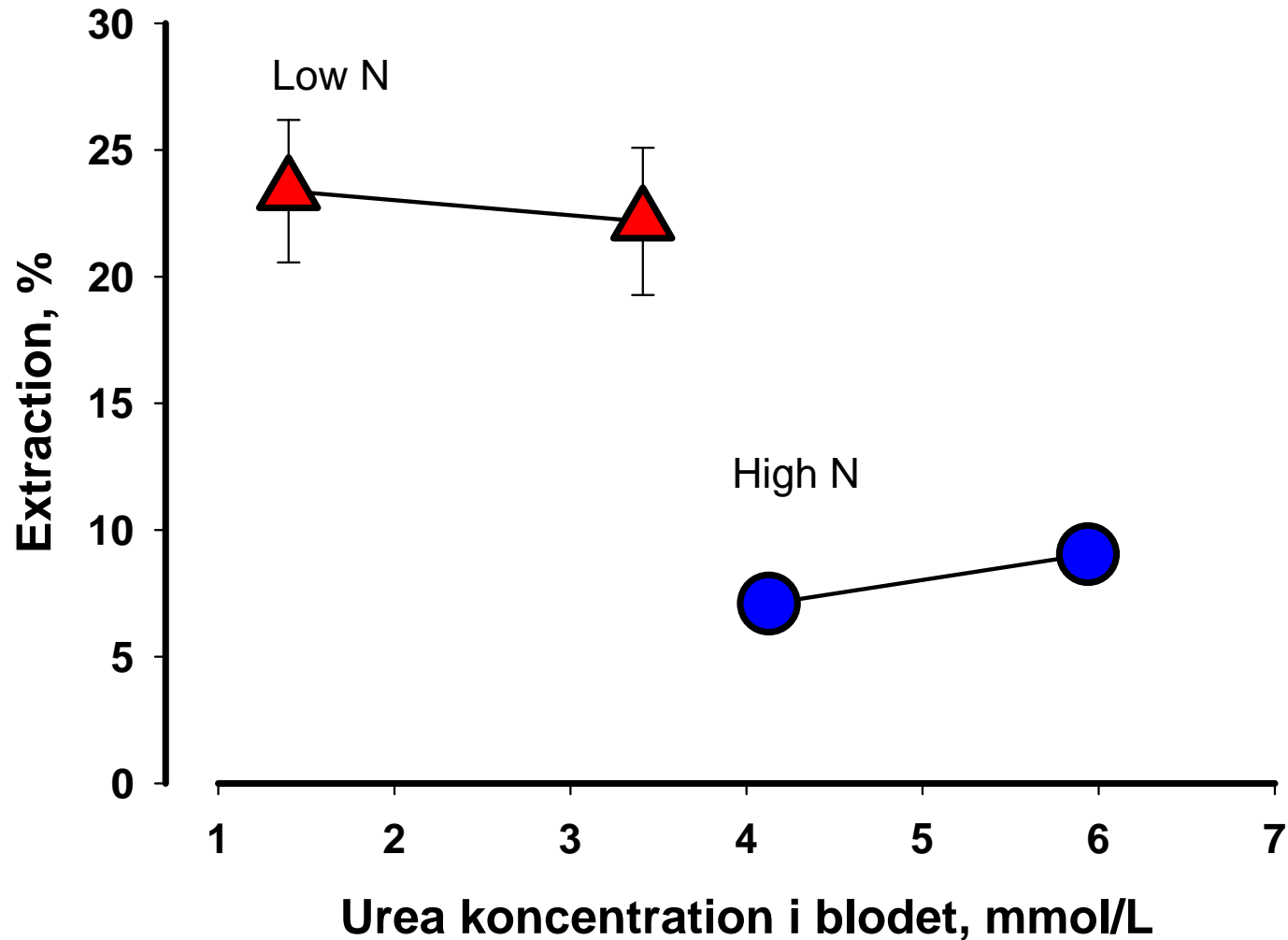
Interaction adaptation by infusion ($P = 0.06$)



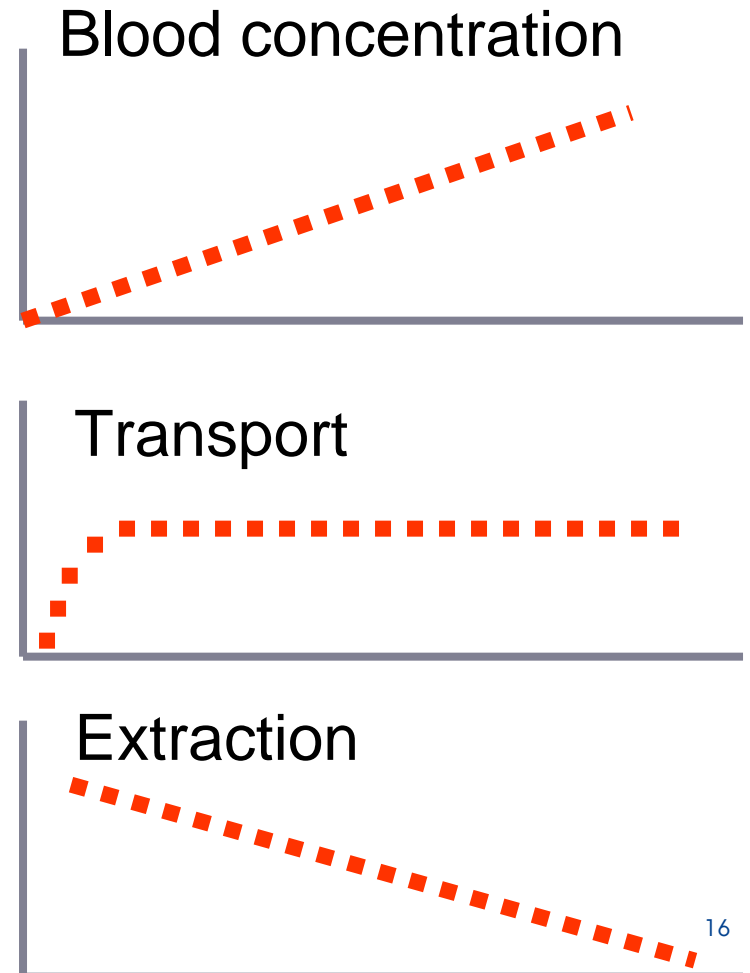
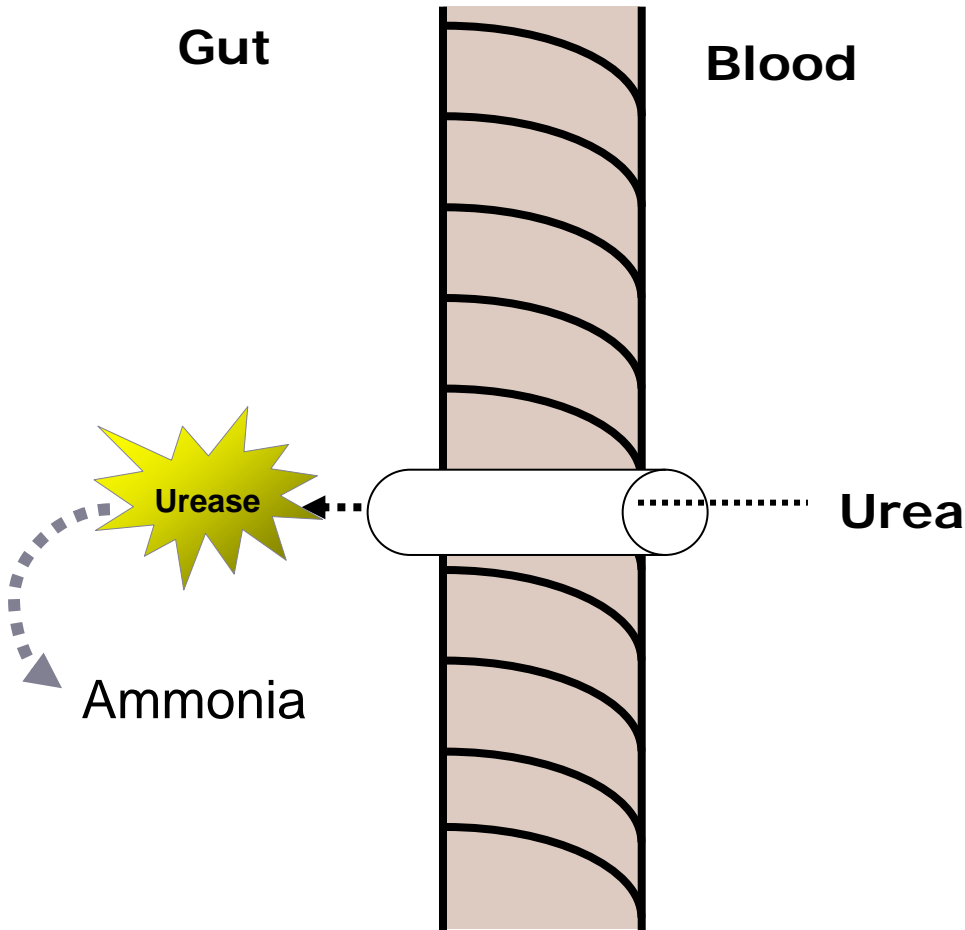
Interaction adaptation by infusion (P = 0.06)



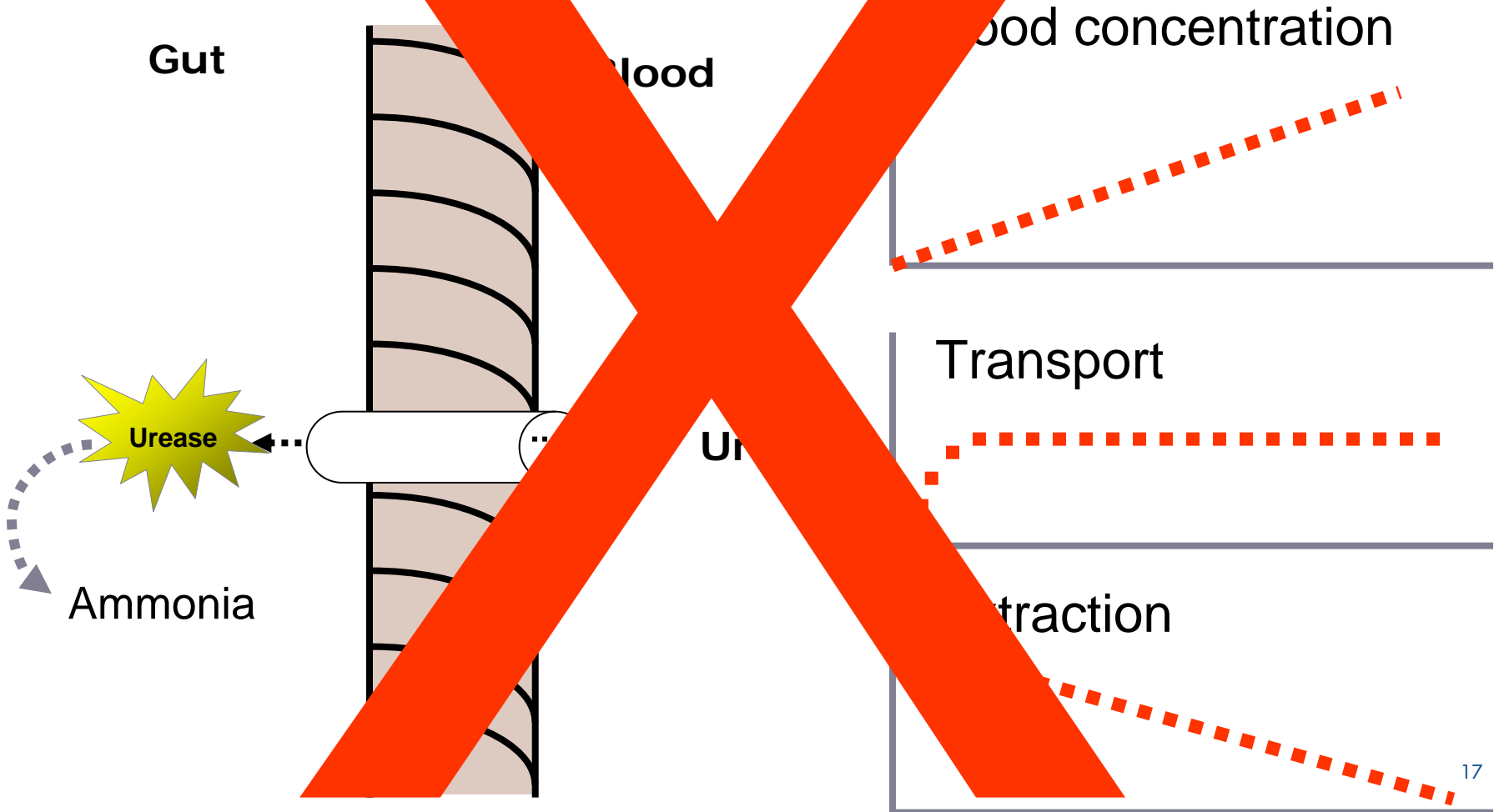
Effects of urea infusion on ruminal extraction



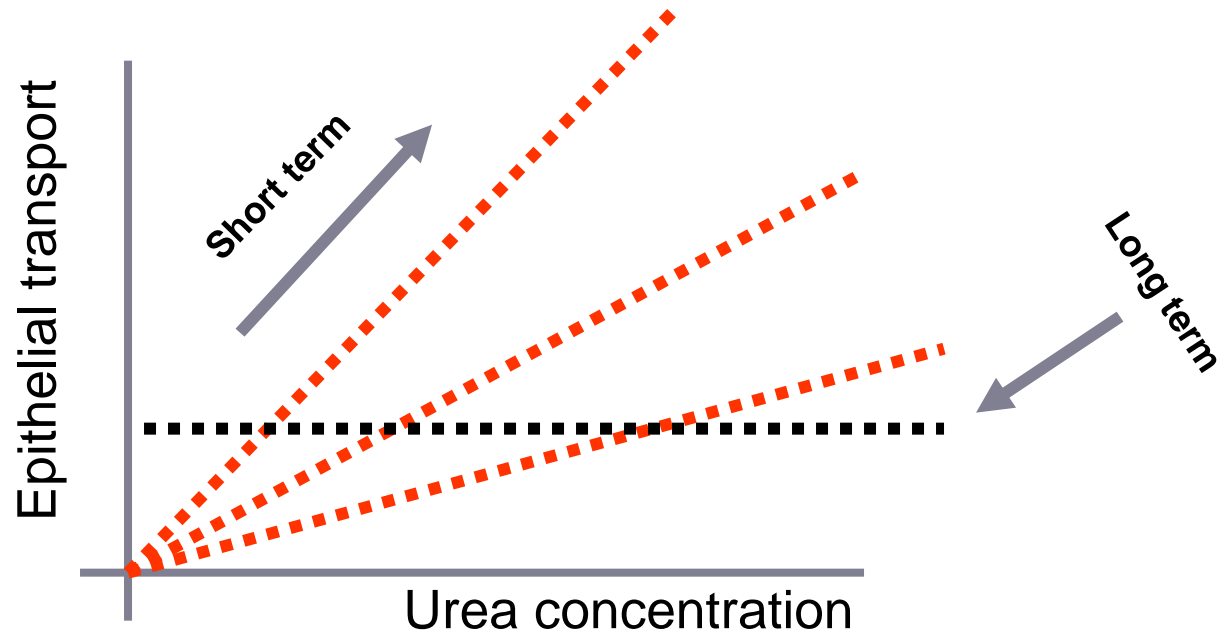
Saturable urea transport?



Saturable urea transport?



Data in agreement with: short term mass action regulation imposed on long term adaptation of permeability

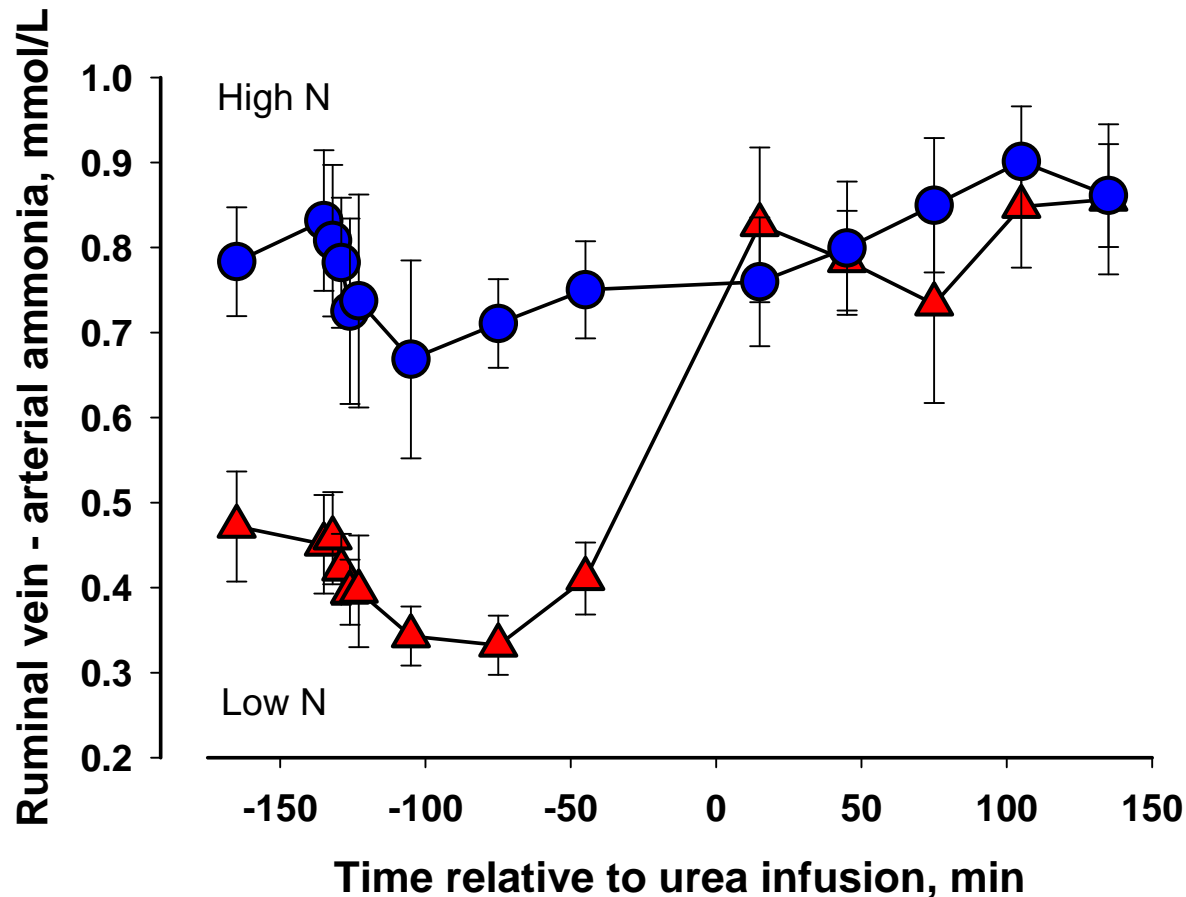




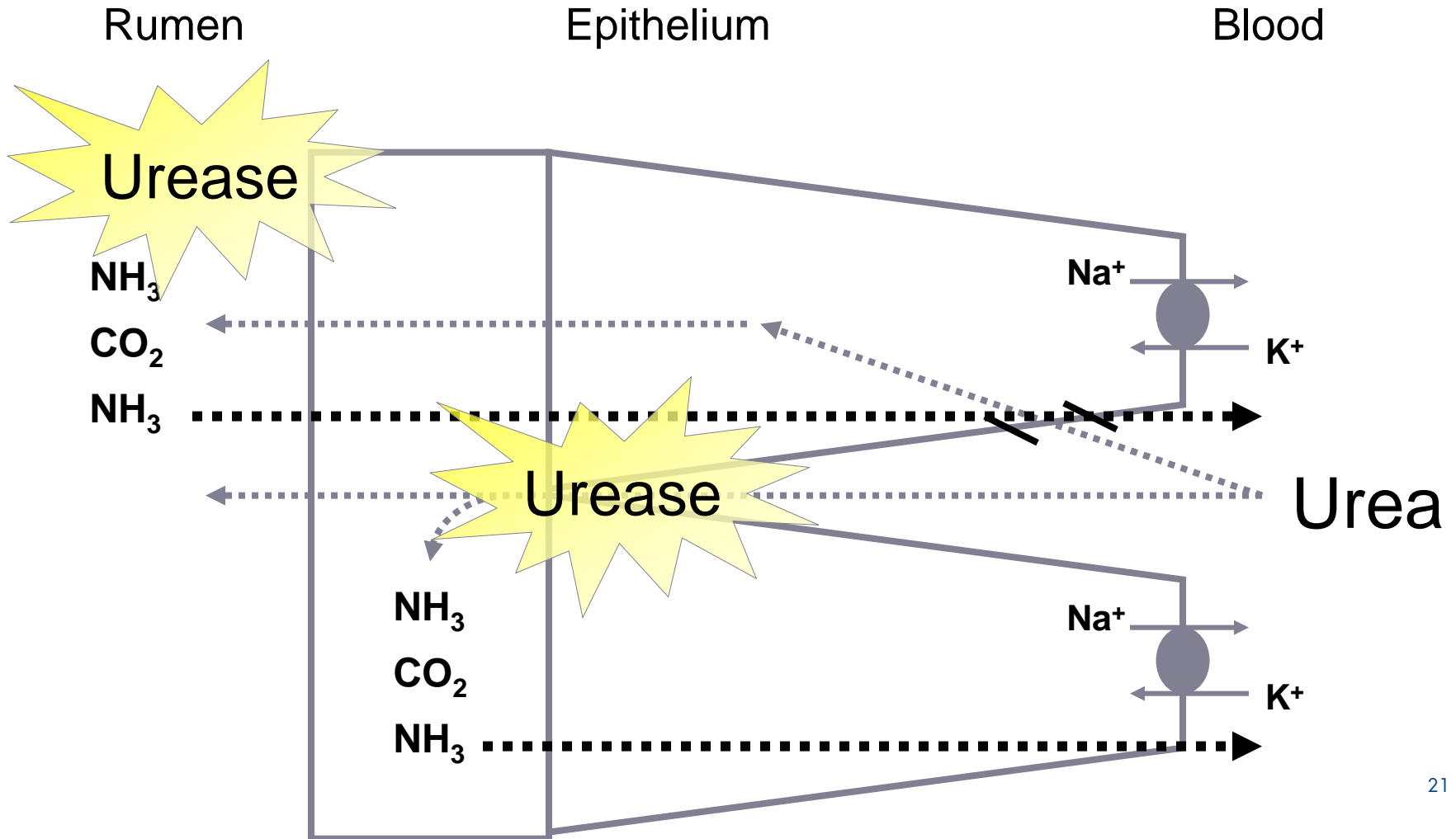
Is "recycled" urea an efficient N source for rumen fermentation?



PROBLEM: Ammonia absorption increased very rapidly after initiation of intravenous urea infusion

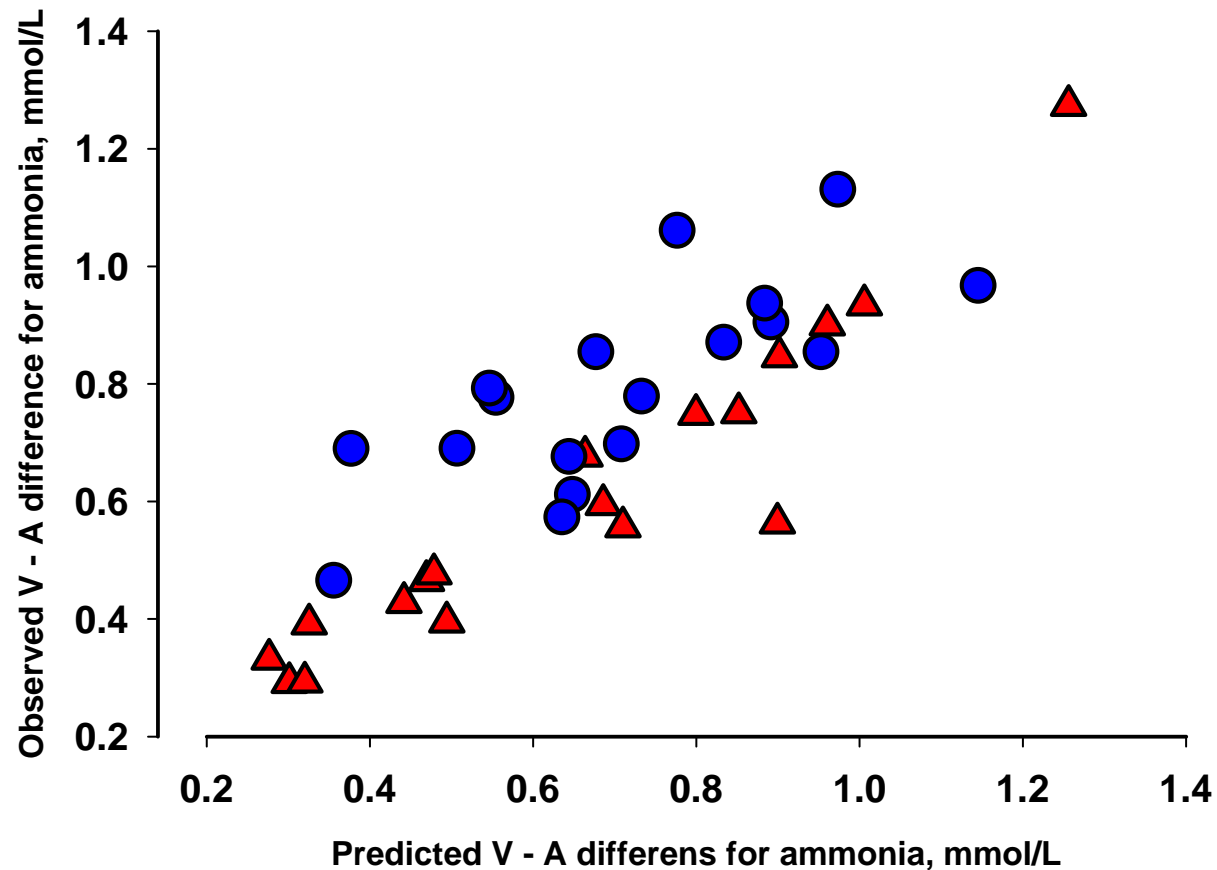


Half the urea is not recycled to the rumen



Simple model using ruminal as well as epithelial ammonia return fits observed data considerably better than a model predicting ammonia absorption as function of ruminal ammonia

$$V - A \text{ ammonia (mmol/L)} = 0.096 * \text{rumen ammonia (mmol/L)} + 0.884 * A - V \text{ urea (mmol/L)}$$

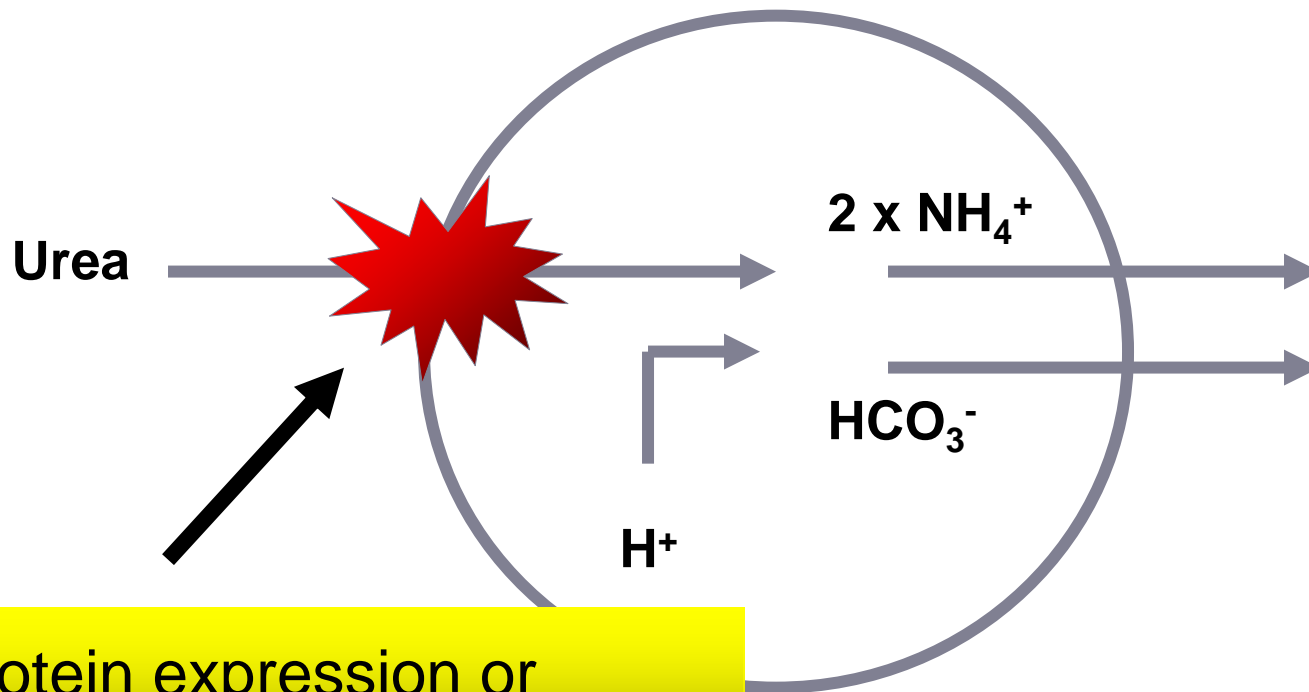




Conclusion

- Urea recycling is up-regulated only when considered relative to hepatic urea output
- Short term regulation of urea recycling follow mass action kinetics
- Long term adaptation to N status affect urea permeability of gut epithelia
- A large fraction (~45%) of apparently recycled urea never crossed the rumen wall, but was apparently hydrolyzed in the epithelium

Implication: pH not protein use



Protein expression or
regulation of activity?



Acknowledgements



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