

Factors determining the fresh colour of Australian lamb meat



Honor Calnan



Outline

- Importance of fresh lamb meat colour
- Opportunity to investigate relative influences
- Production factors account for greater variation
- pH strongly impacts redness, myoglobin lightness
- Implications for lamb meat industries



Importance of Lamb meat colour

- Consumers prefer **bright red** meat



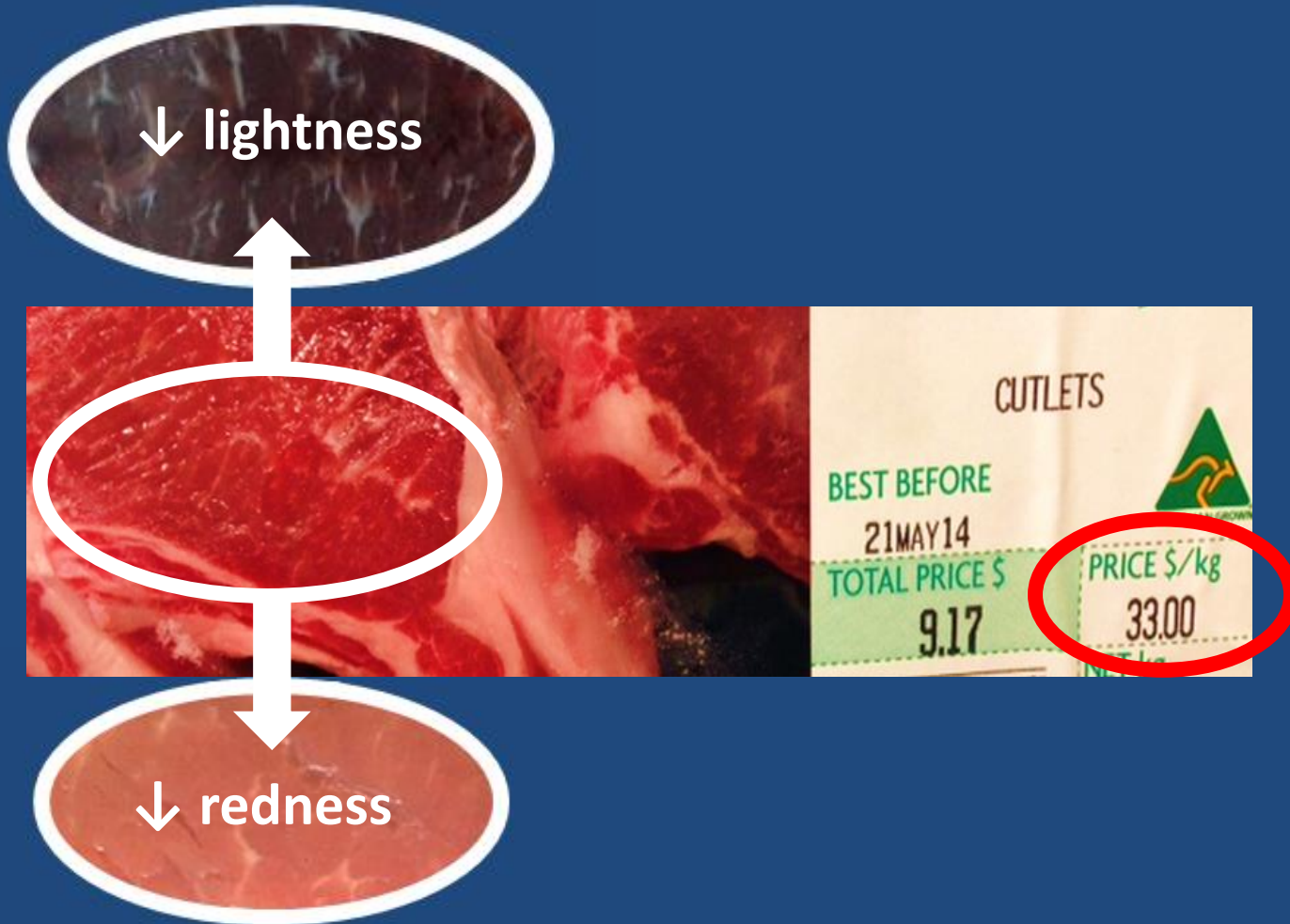
Importance of Lamb meat colour

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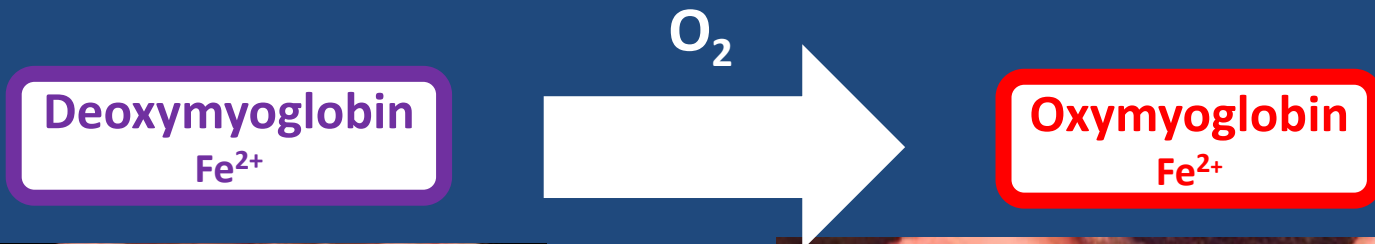
Fundamentals of meat colour

Deoxymyoglobin

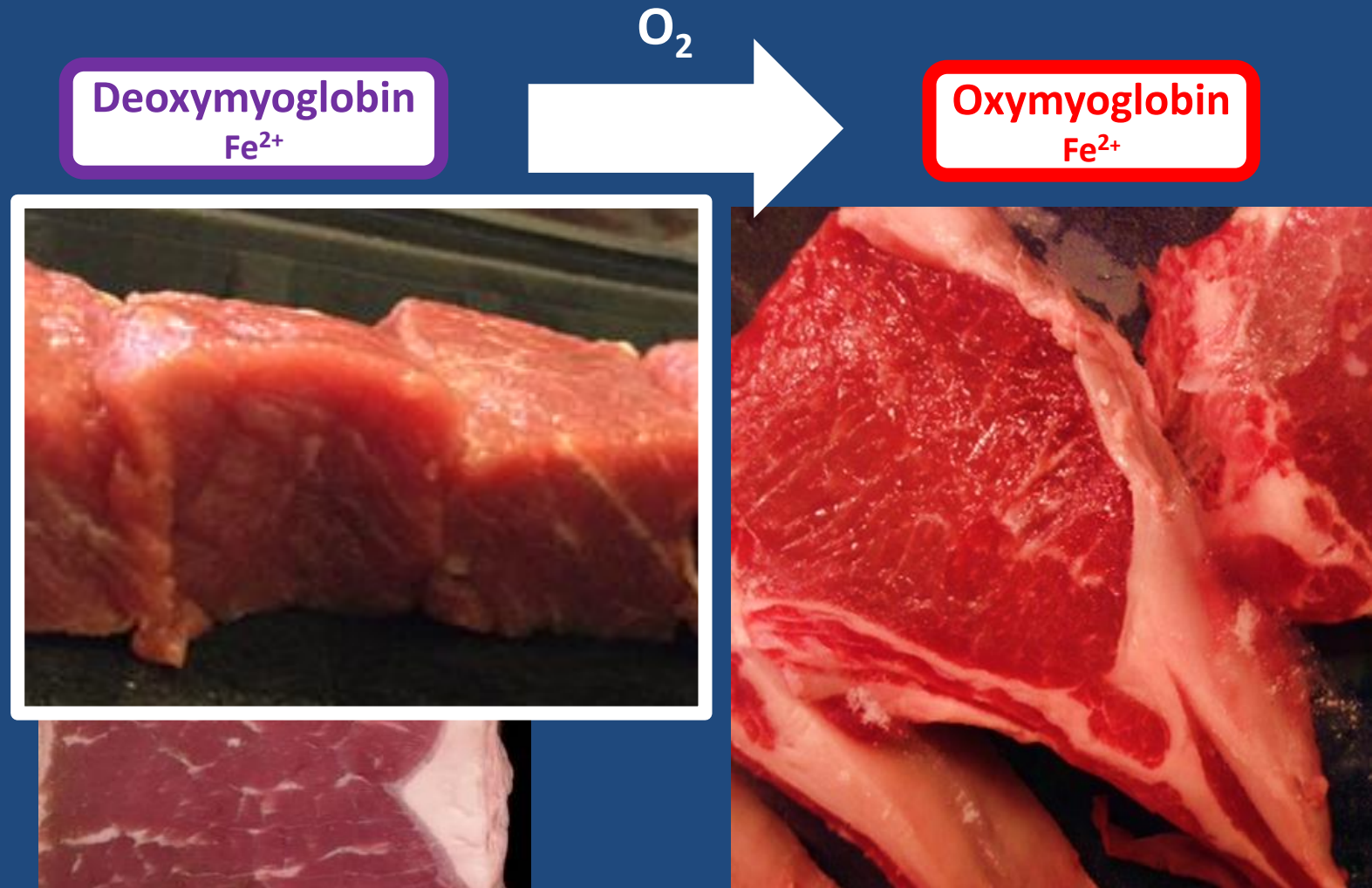
Fe²⁺



Fundamentals of meat colour



Fundamentals of meat colour

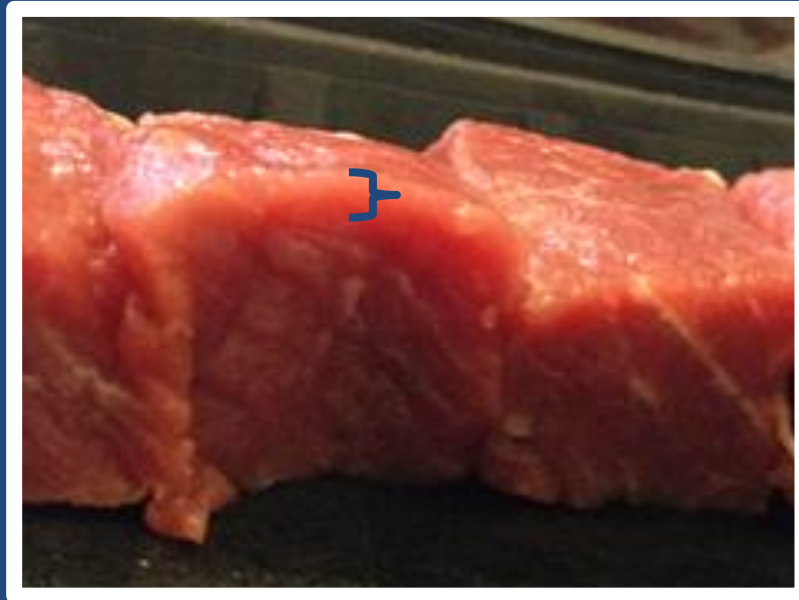


Fundamentals of meat colour

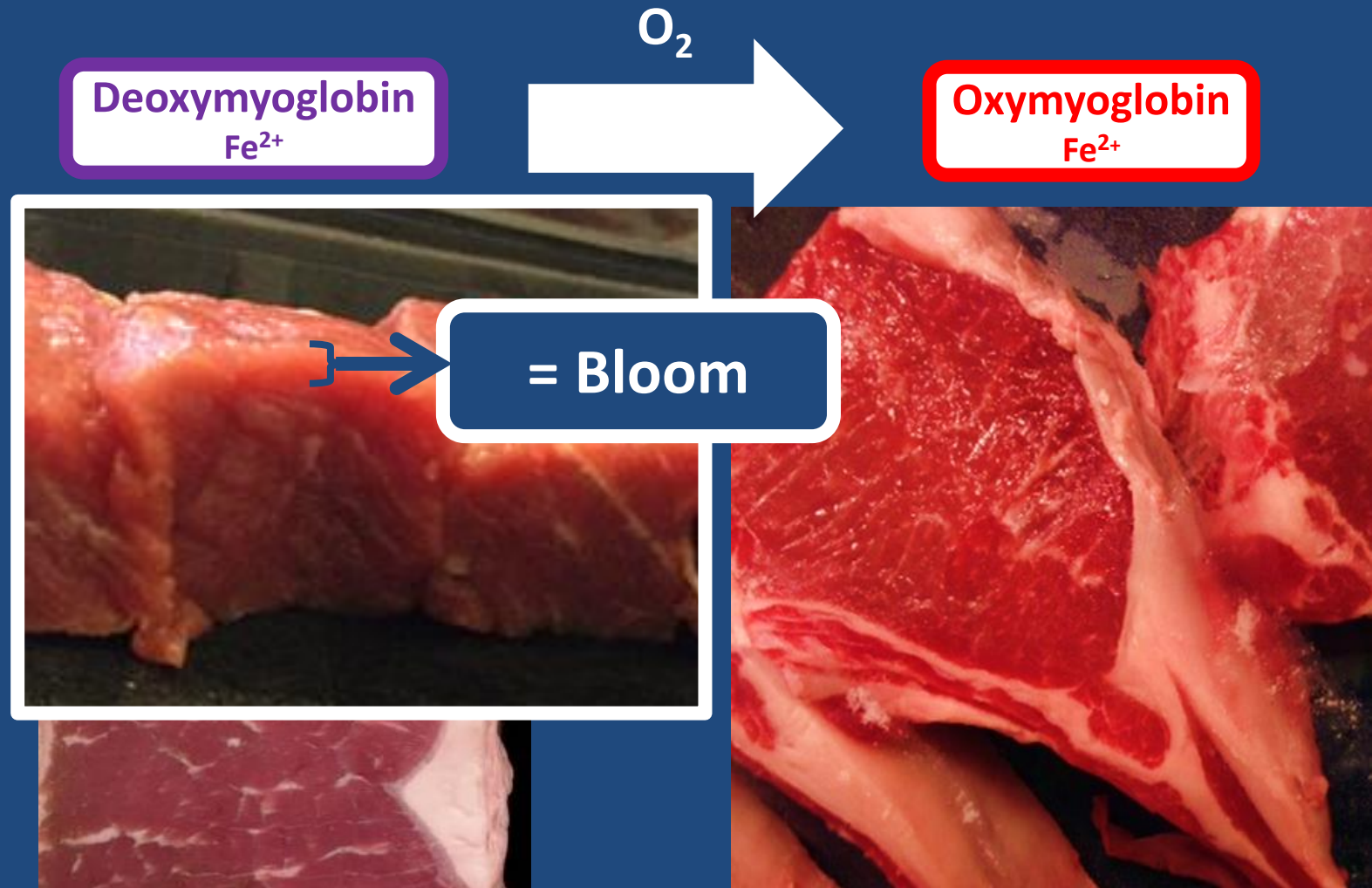
Deoxymyoglobin
 Fe^{2+}

O_2

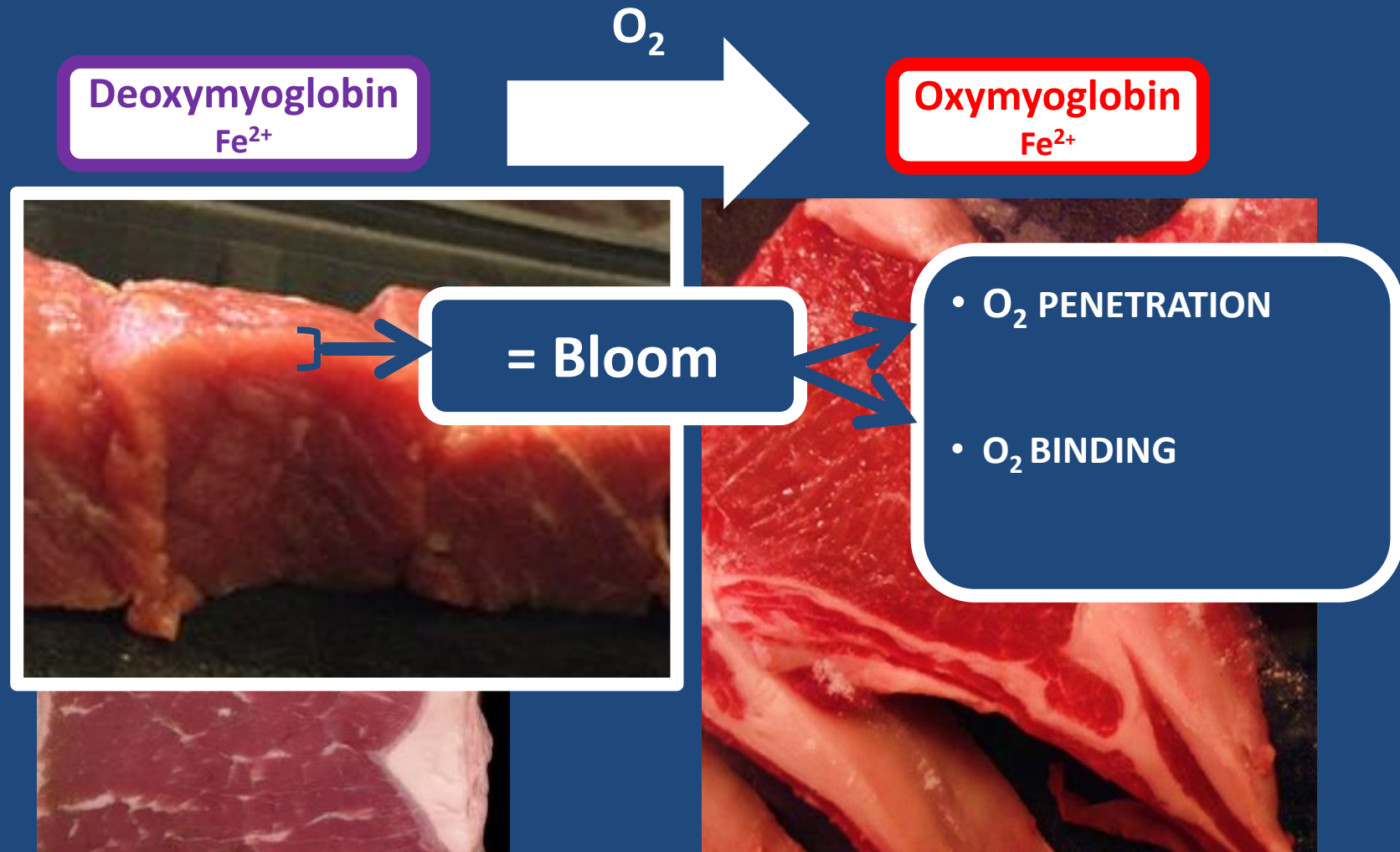
Oxymyoglobin
 Fe^{2+}



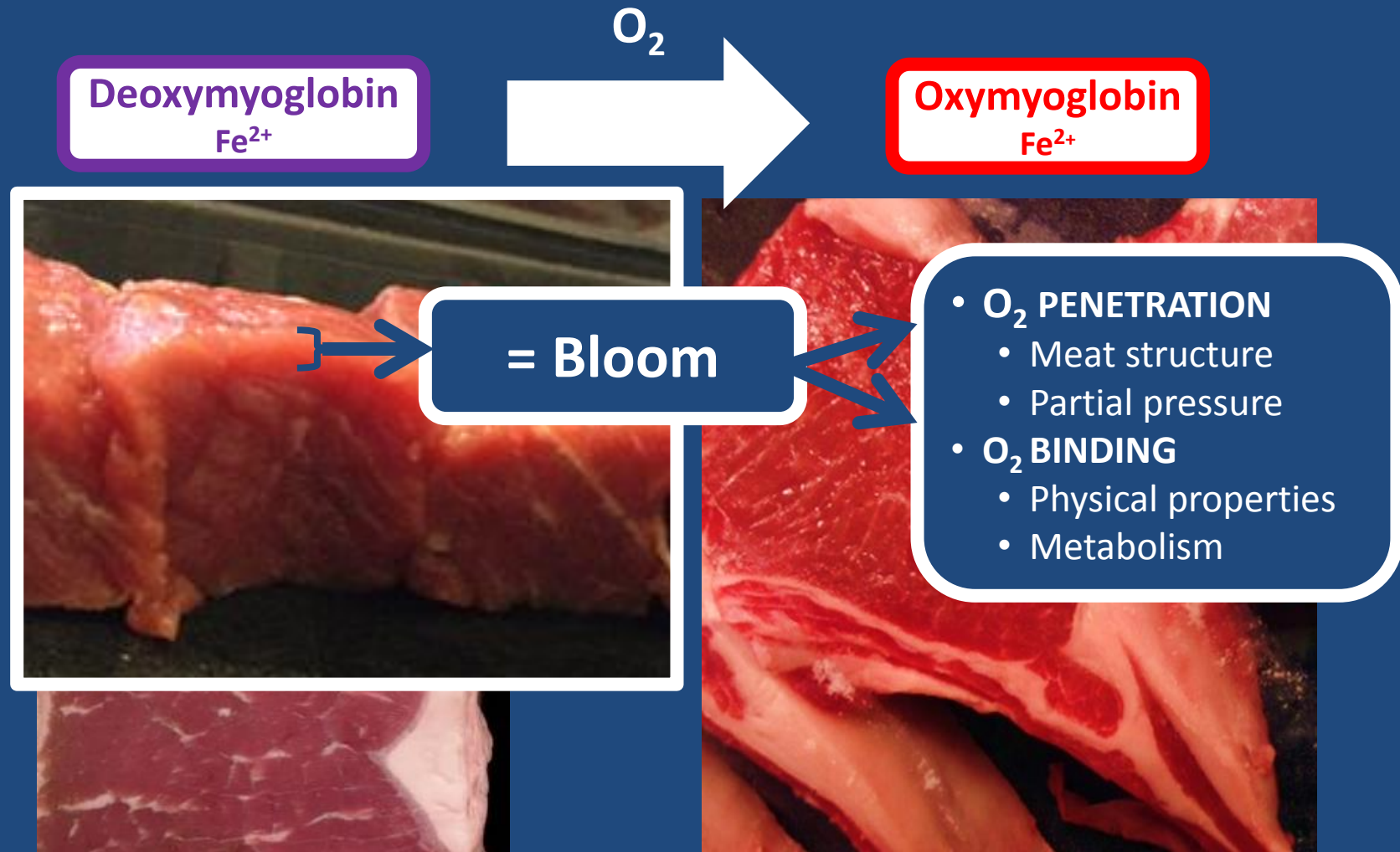
Fundamentals of meat colour



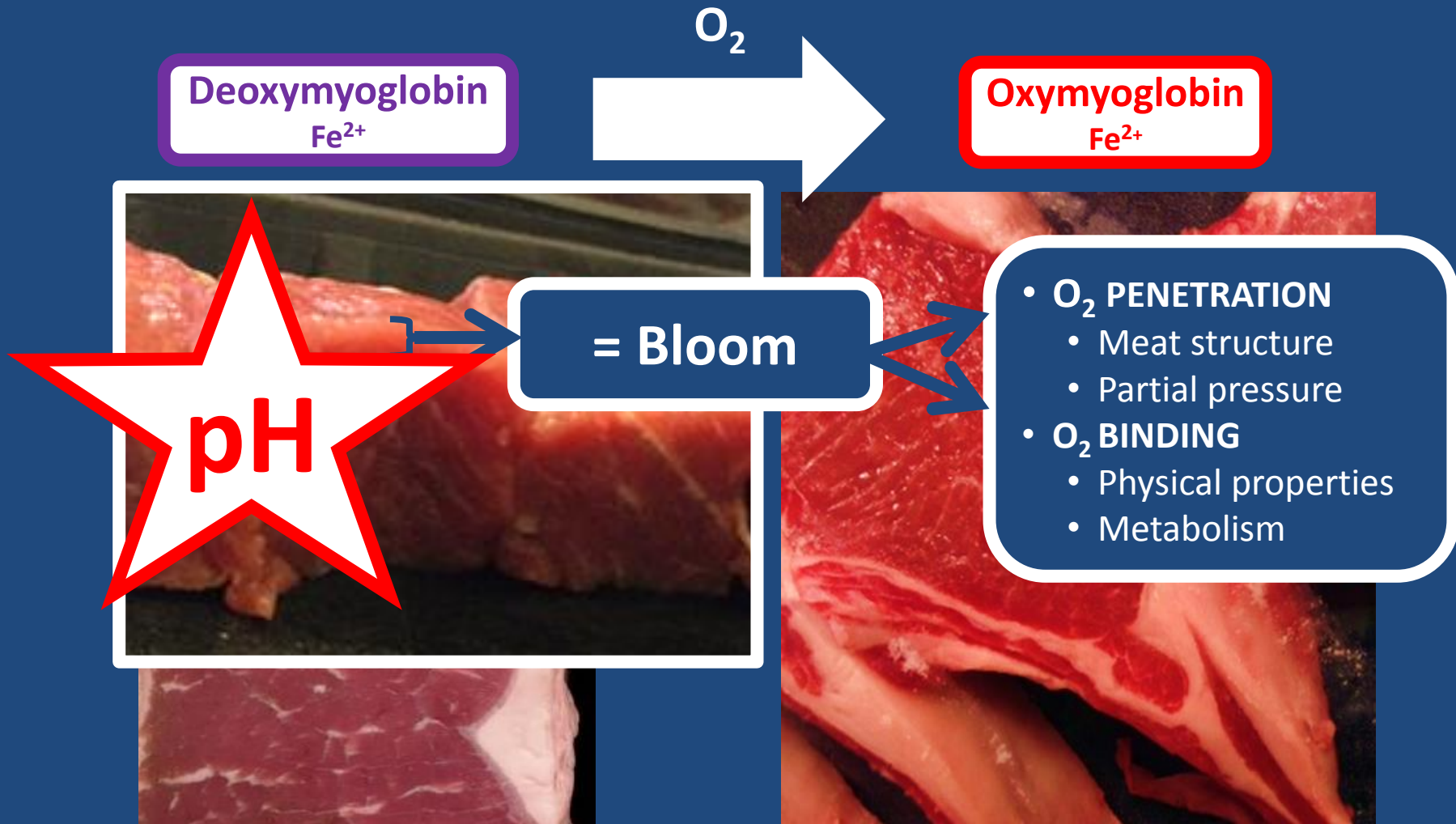
Fundamentals of meat colour



Fundamentals of meat colour



Fundamentals of meat colour



Determinants of meat colour



& ?

Determinants of meat colour



& ?

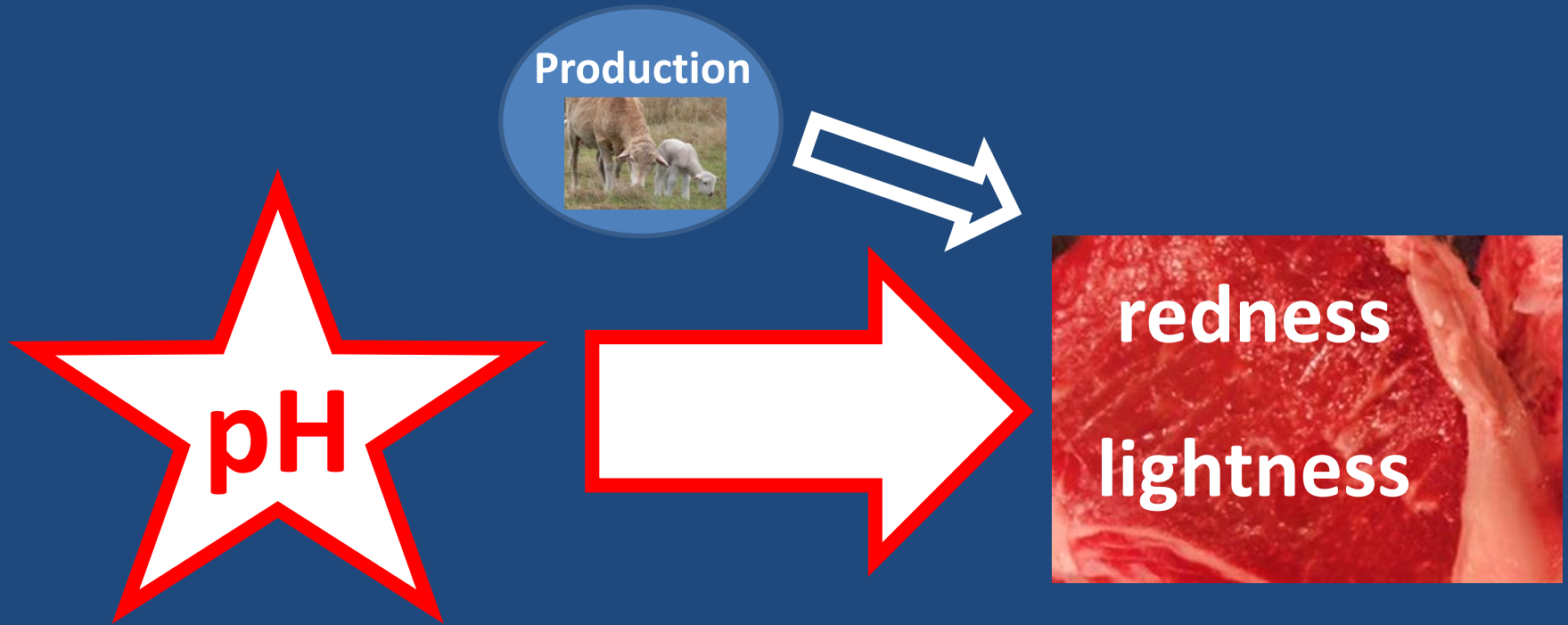


- Site / year
- Breed / sex
- Kill group
- Age

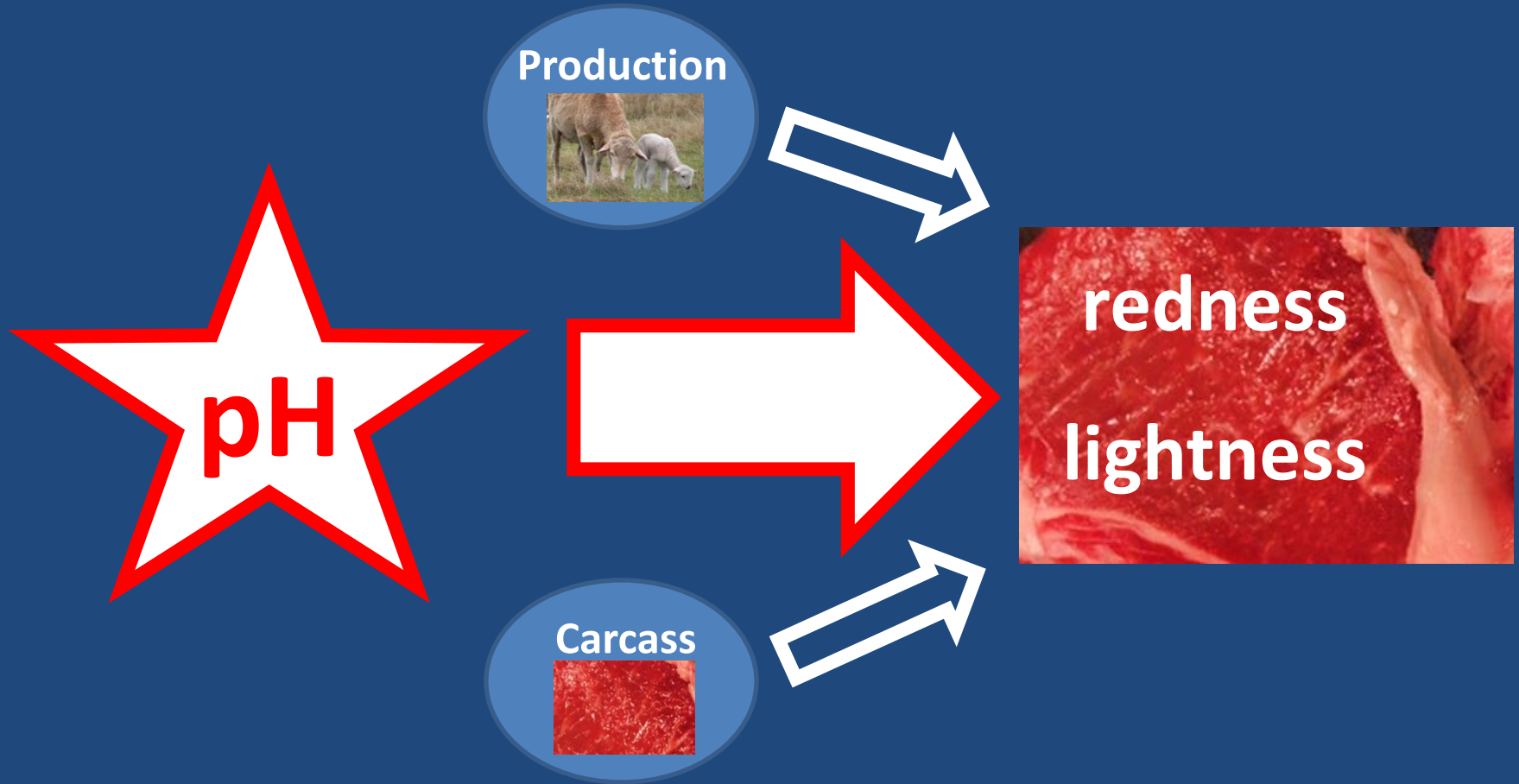


- Myoglobin
- Oxidative cap.
- Iron
- Zinc

Hypothesis

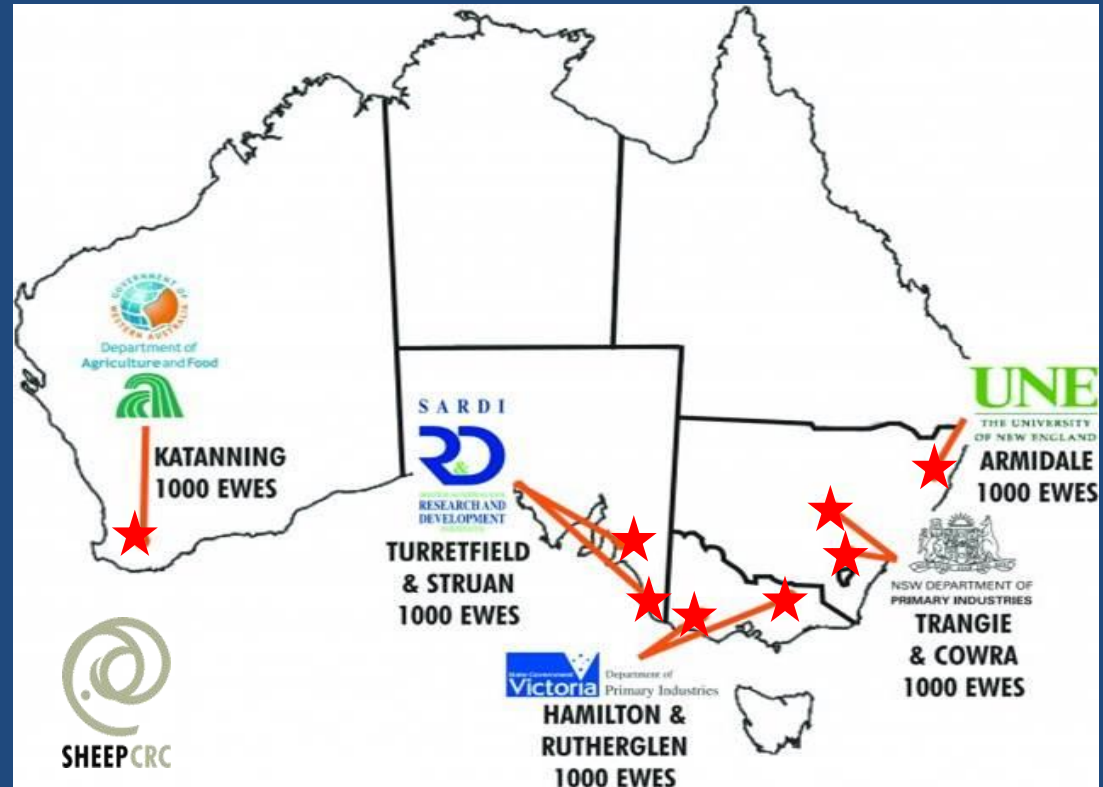


Hypothesis



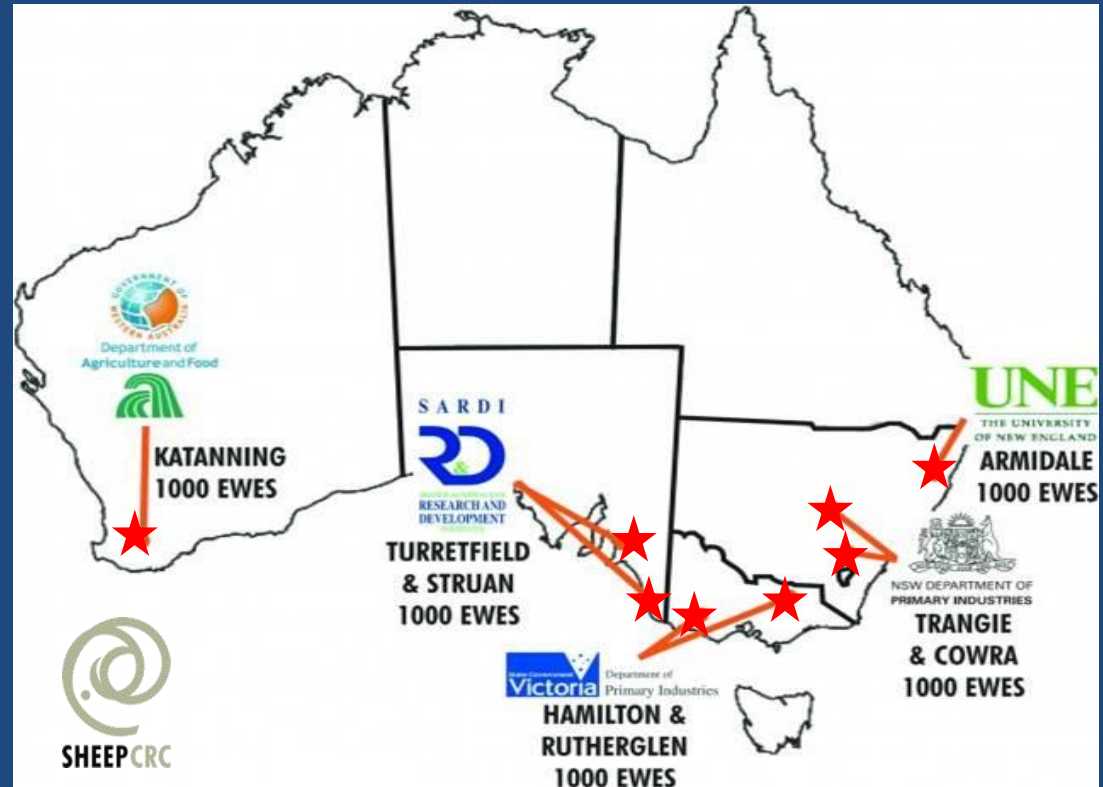
Experimental Design

- 8165 lambs
- 8 sites / 5 yrs



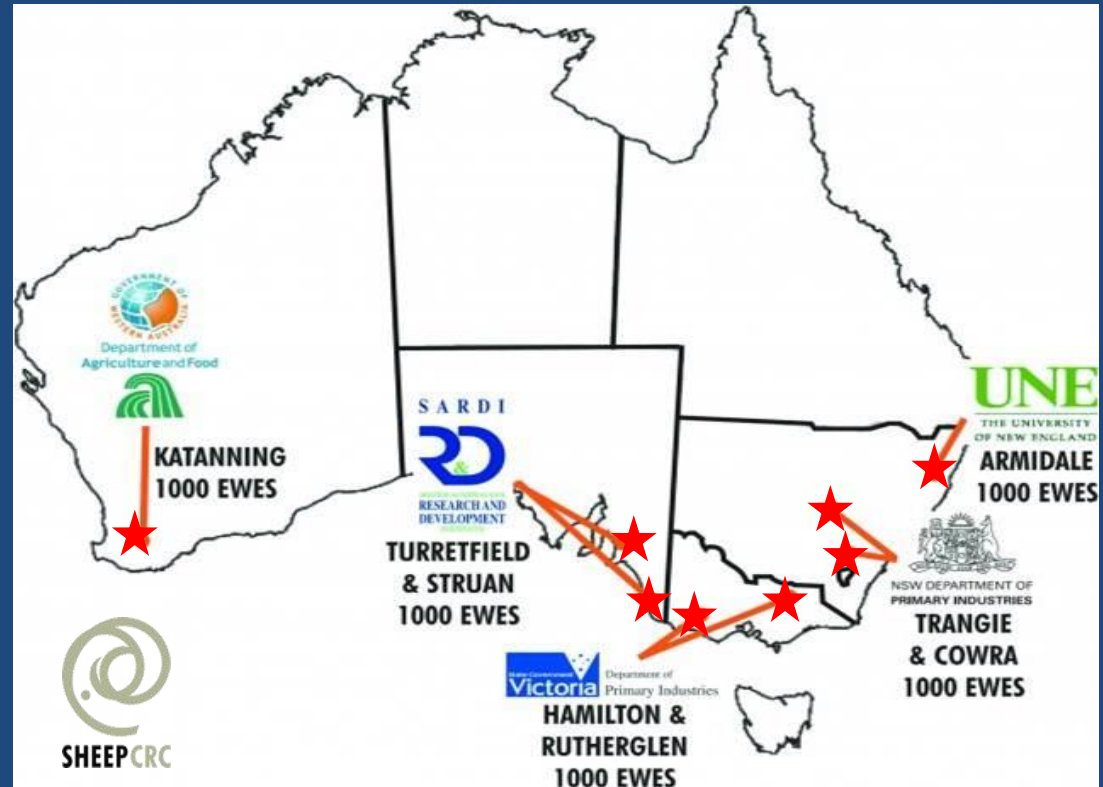
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Experimental Design

- 8165 lambs
- 8 sites / 5 yrs
- Sire types Dam breeds
- Merino → Merino
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 → Merino
- Maternal → Merino
- Extensive pasture grazing
- Killed at ~21 kg CW



Experiment – Carcass Measures

Loin muscle @ 24 hrs



Fresh Colour

L* : Lightness

a* : Redness

b* : Yellowness



- $\text{pH}_{24} \approx \text{pH}_u$
- myoglobin
- Isocitrate dehydrogenase activity
- Iron & Zinc concentrations

Colour Measurements



L*: Lightness



a*: Redness



Statistical Analysis

- Multivariate analysis of L^* , a^* & b^* -> Linear mixed effects model

- Random Terms: Sire Dam*year

	Range / units
Kill group (site year)	125 groups
Site	8 sites
Year	5 years
Sire type	3 types
Dam breed	2 breeds
Sex	2 sexes
Age	140 – 400 days
pH ₂₄	5.4 - 6
Carcass Weight	15 – 35 kg
Myoglobin	4 – 12 mg/g m.
Iron	15 – 30 mg/100g
Isocitrate dehydr.	3 – 9 umol/g/min
Zinc	15 – 30 mg/100g

Fixed Effects



Covariates



Results

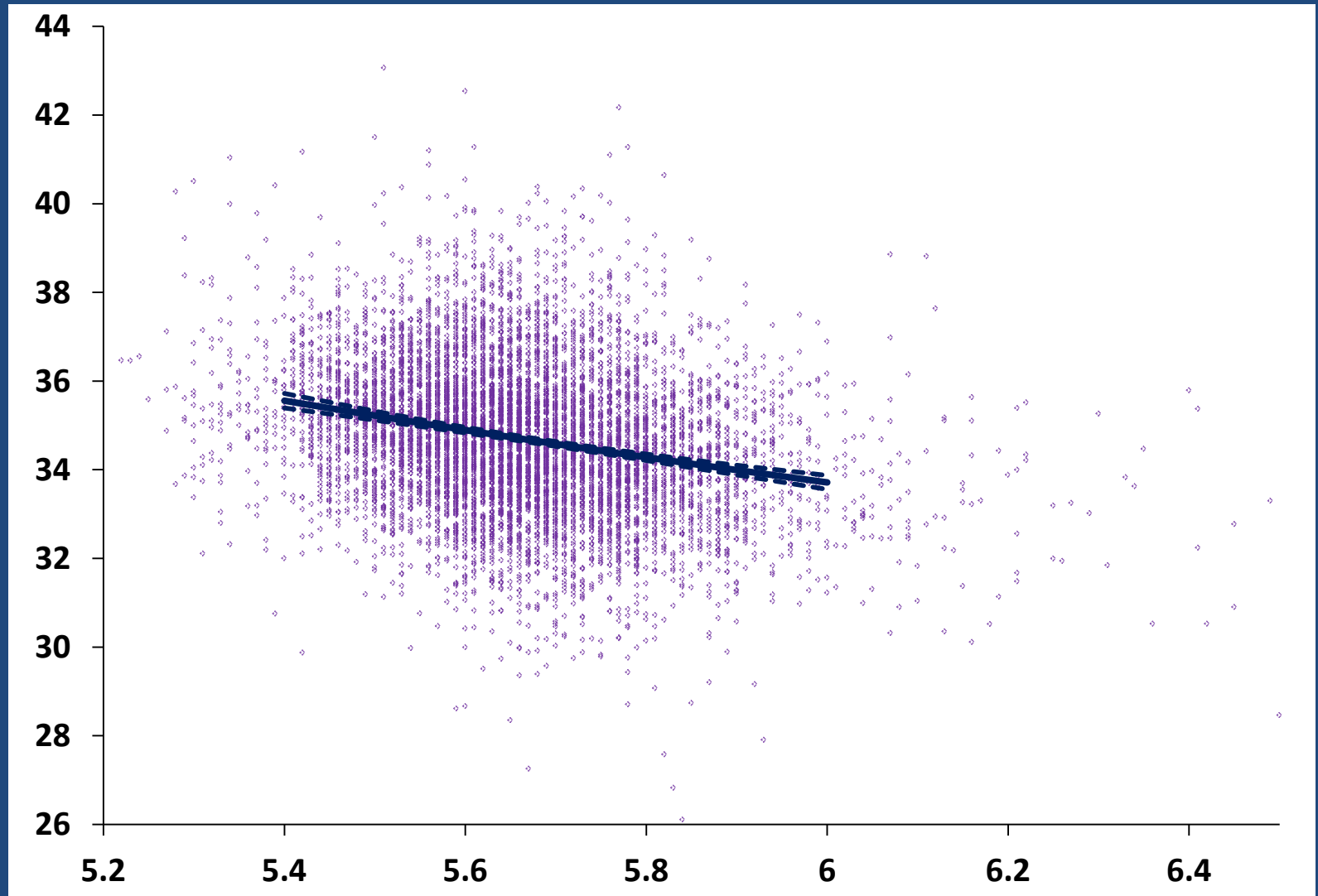
Meat lightness & pH



pH_{24}

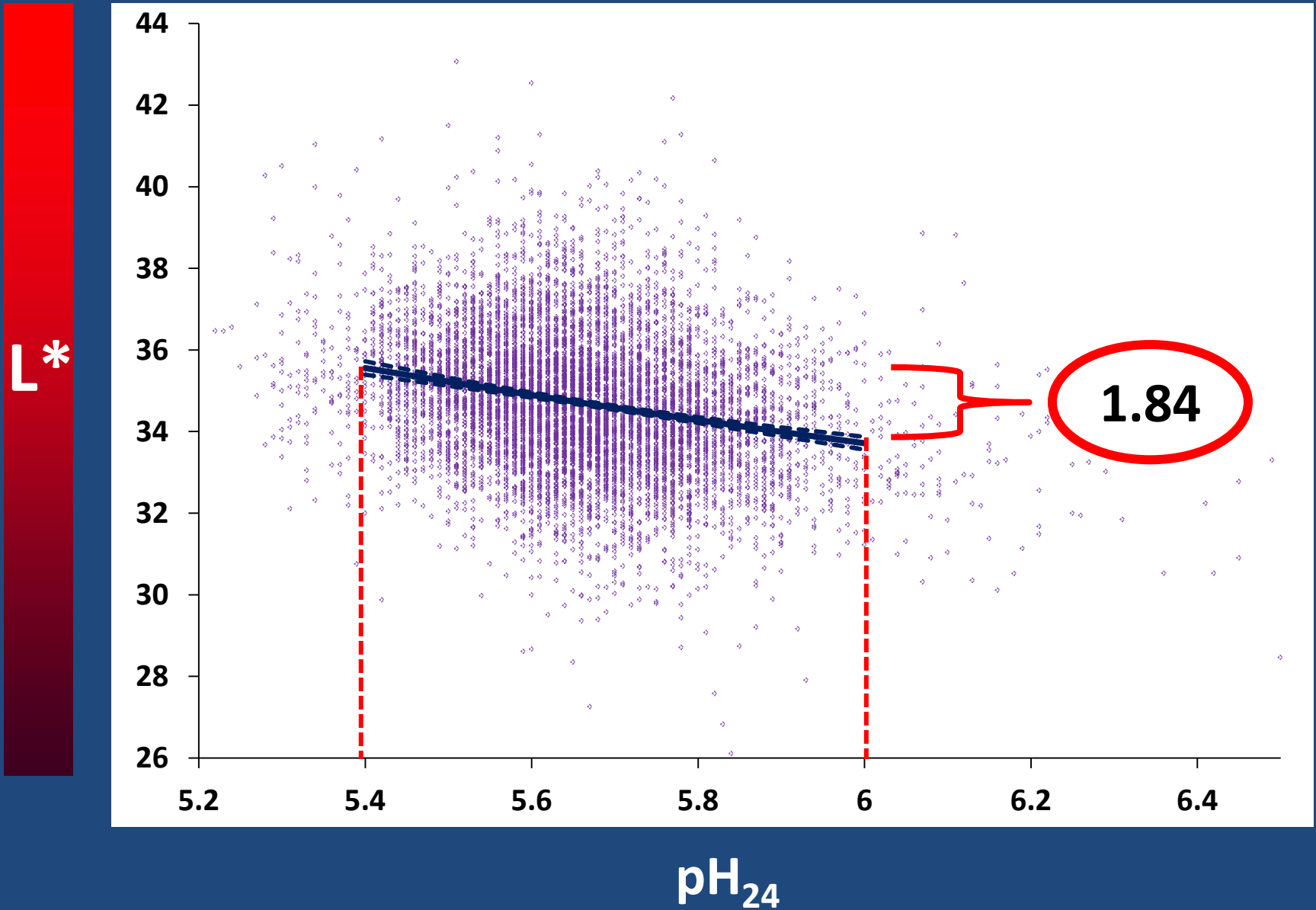
Meat lightness & pH

L*



pH₂₄

Meat lightness & pH



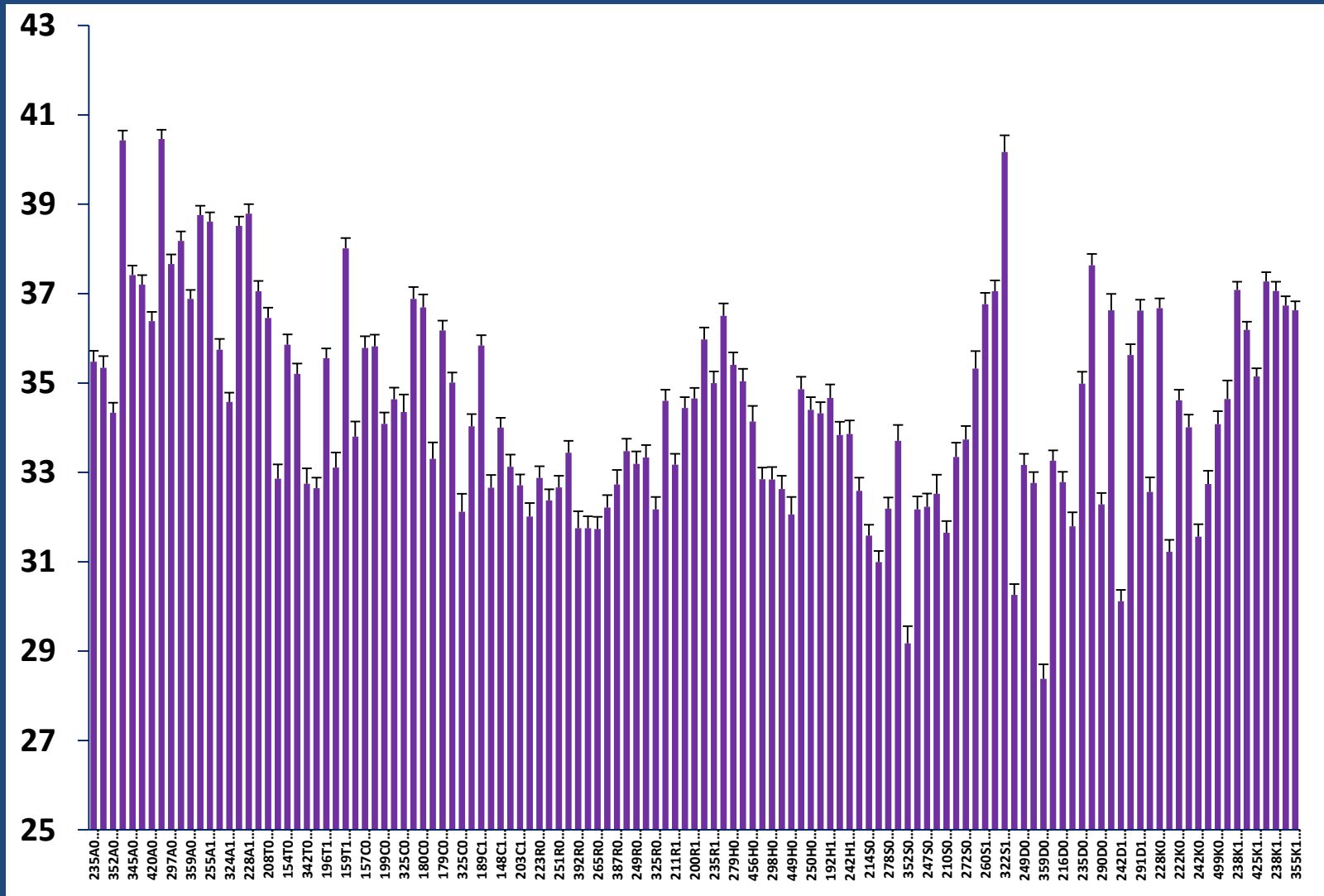
Meat lightness & kill groups



Kill groups

Meat lightness & kill groups

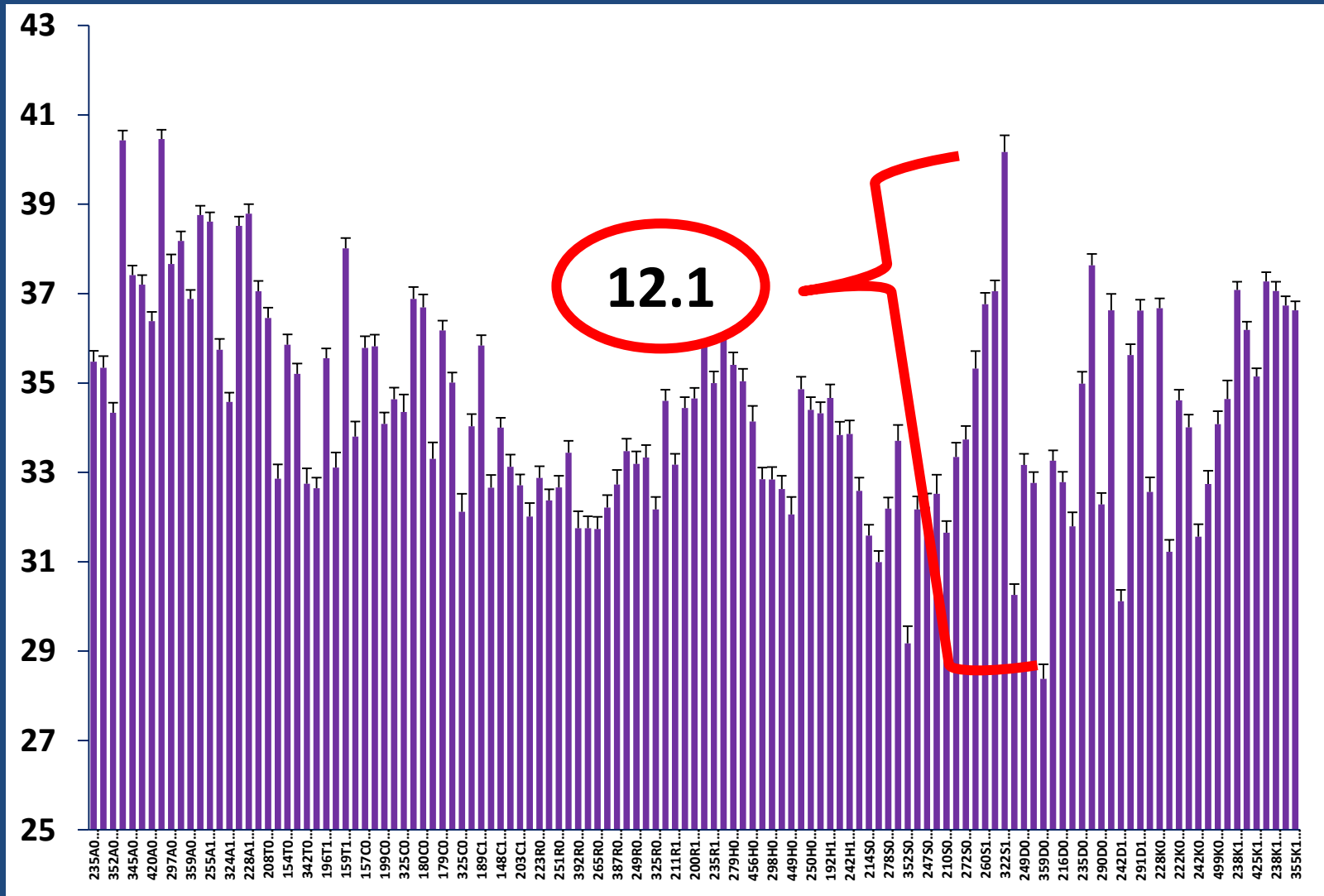
L*



Kill groups

Meat lightness & kill groups

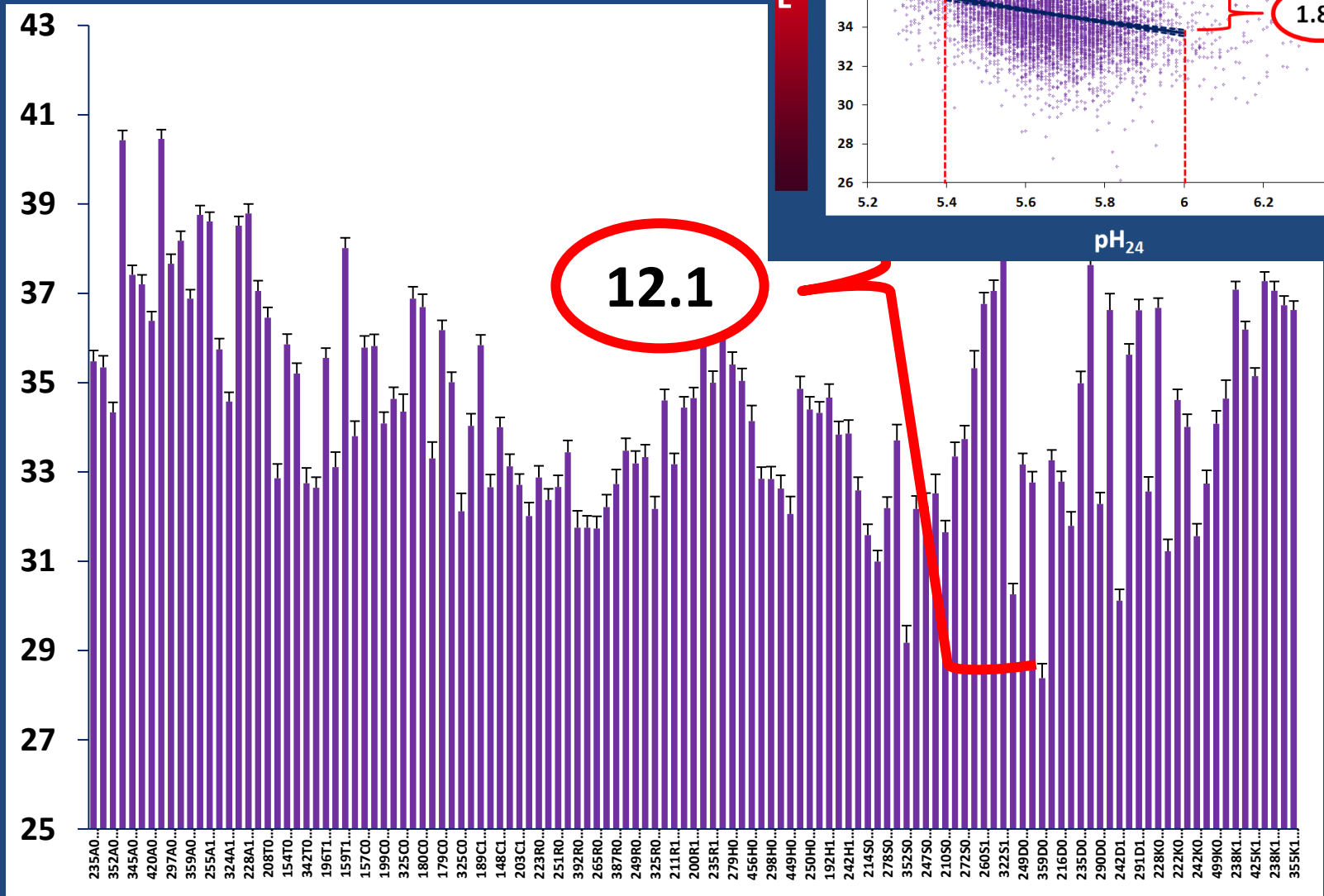
L*



Kill groups

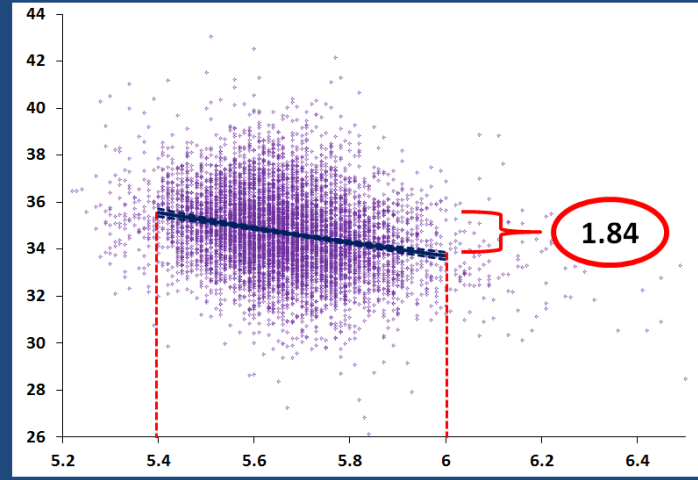
Meat lightness & kill group

L*



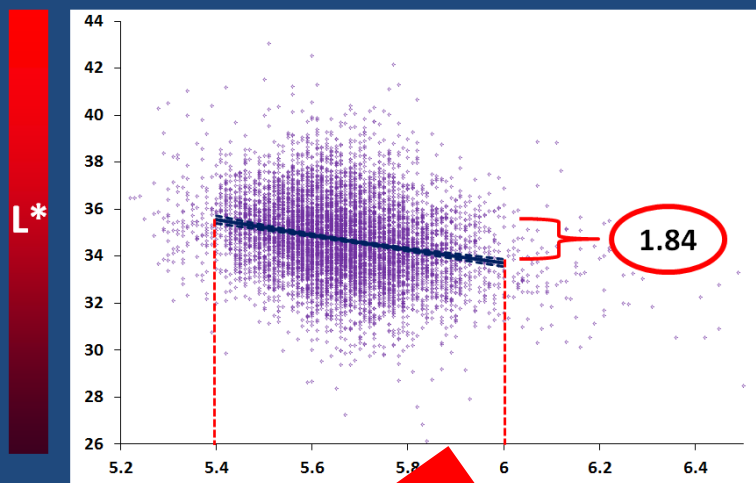
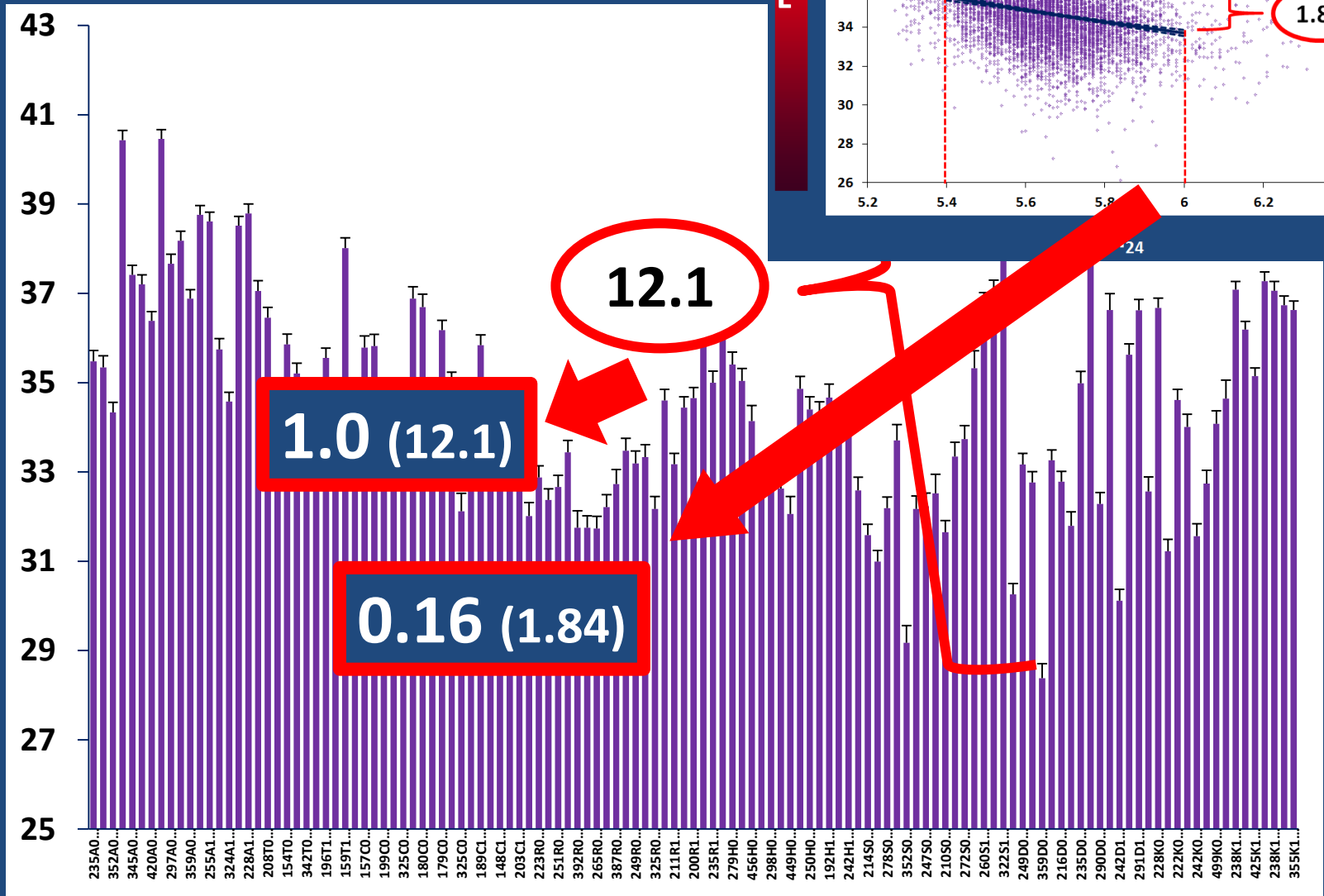
12.1

L*



Kill groups

Meat lightness & kill group



Kill groups

Relative effect on Fresh Colour

		L*	a*
	Range / units	Relative Effect	Relative Effect
Kill group	125 groups		
Site	8 sites		
Year	5 years		
Sire type	3 types		
Dam breed	2 breeds		
Sex	2 sexes		
Age	140 – 400 days		
pH ₂₄	5.4 - 6		
Carcass Weight	15 – 35 kg		
Myoglobin	4 – 12 mg/g m.		
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Isocitrate dehydr.	3 – 9 umol/g/min		
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Age	140 – 400 days	0.26 (3.1)	
pH₂₄	5.4 - 6	0.16 (1.84)	
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Dam breed	2 breeds	-	0.02 (0.2)
Sex	2 sexes	0.04 (0.4)	0.01 (0.1)
Age	140 – 400 days	0.26 (3.1)	0.16 (1.5)
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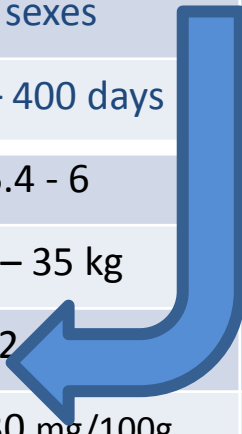
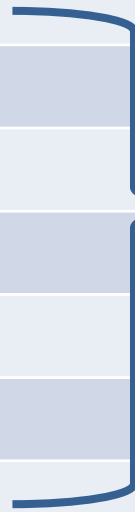
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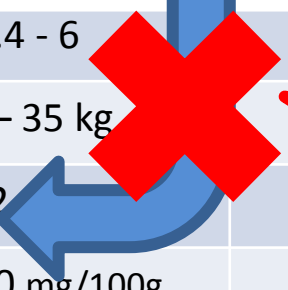
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Production impacts NOT accounted for by any muscle traits measured!

Mechanism of effect?

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Sex	2	0.04 (0.4)	0.01 (0.1)
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Exception of lamb age

Age



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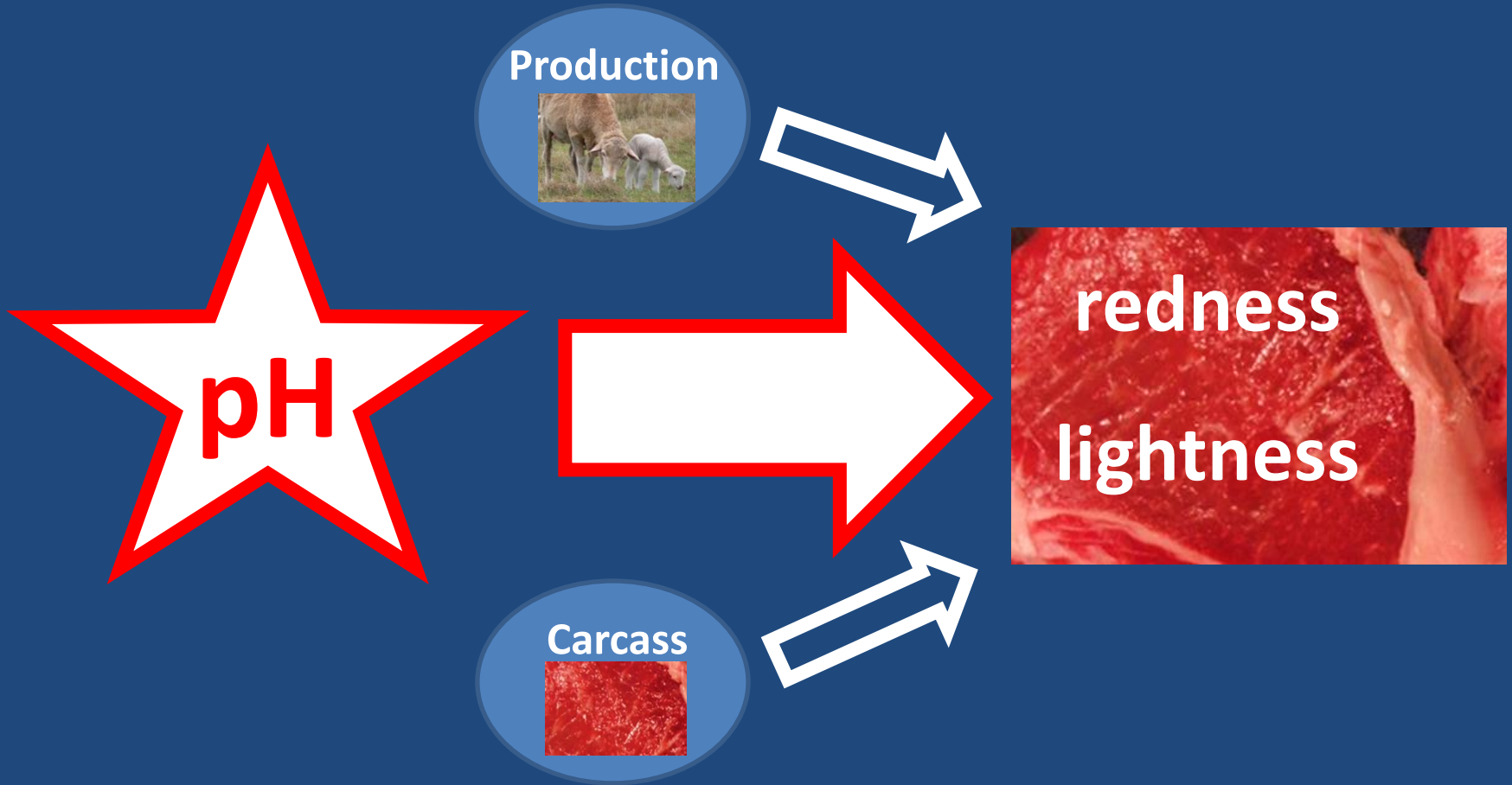
Age

Myoglobin

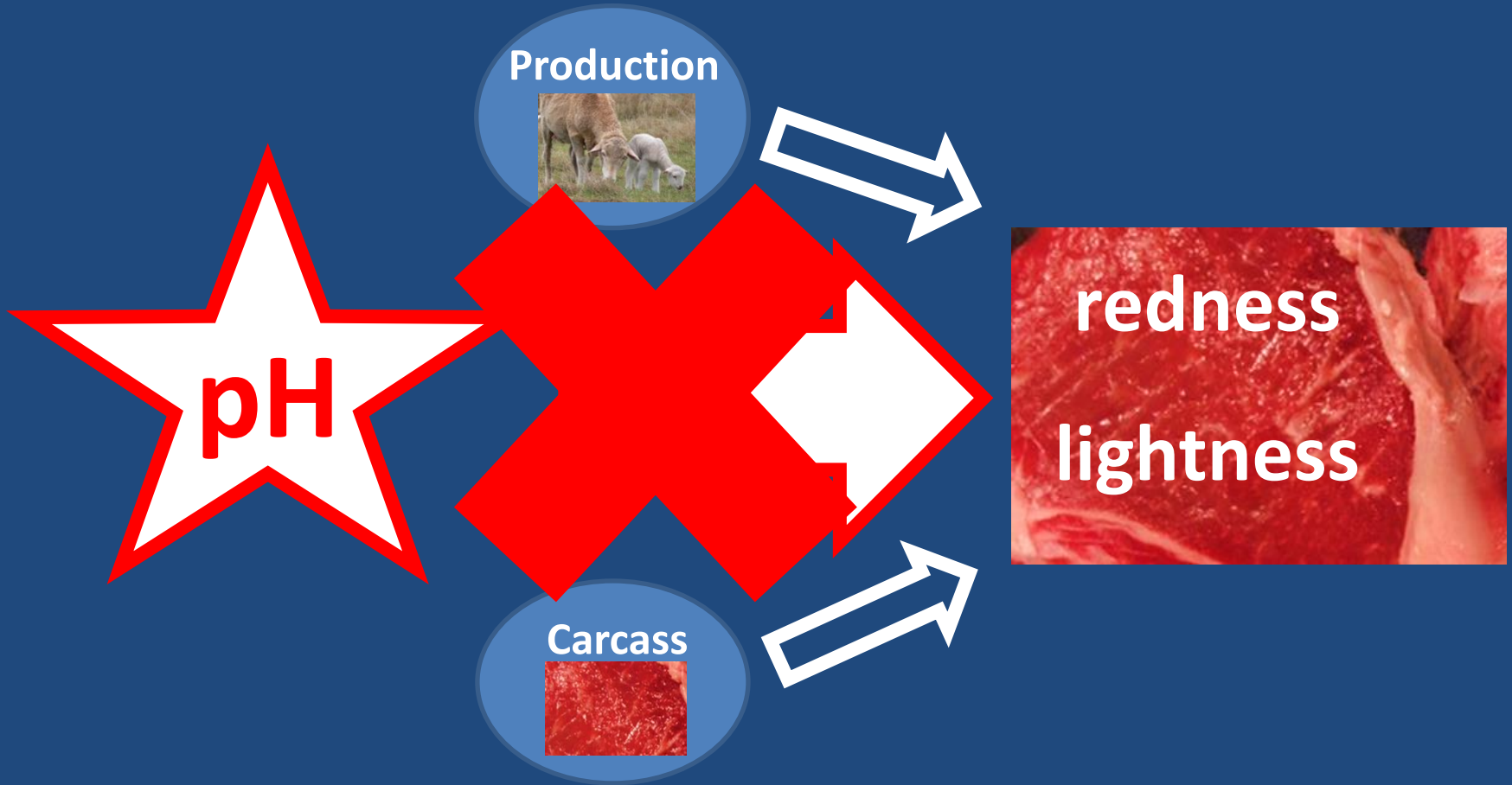
0.26 (1.1)

0.16 (1.5)

Hypothesis



Hypothesis

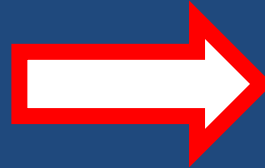


Hypothesis

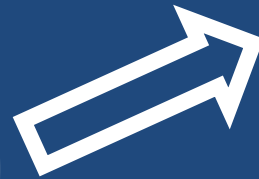
Production



pH



Carcass



redness

lightness



Interpretation?

Interpretation?

- Vast unknowns in meat colour!
- **Production factors**
 - not explained by any muscle factors measured
 - likely relate to differences in nutrition, & slaughter day effects
- **pH**
 - Remains an important factor influencing fresh colour
 - redness > lightness
- **Myoglobin concentration**
 - Similar magnitudes of impact as pH_{24}
 - lightness > redness
 - Pigment density rather than oxidative capacity

Conclusions

- pH should not be used as a proxy measure of fresh lamb colour
- More work is needed to elucidate the mechanisms by which production factors are impacting on fresh lamb colour → methods of control

Acknowledgements

Supervisors: Assoc. Prof. Graham Gardner

Prof. David Pethick

Dr Robin Jacob



The Australian Sheep CRC & all those involved with
the Information Nucleus Flock experiment

