Liver oxygen uptake, triiodothyronine and mitochondrial function vary with feed efficiency in cattle

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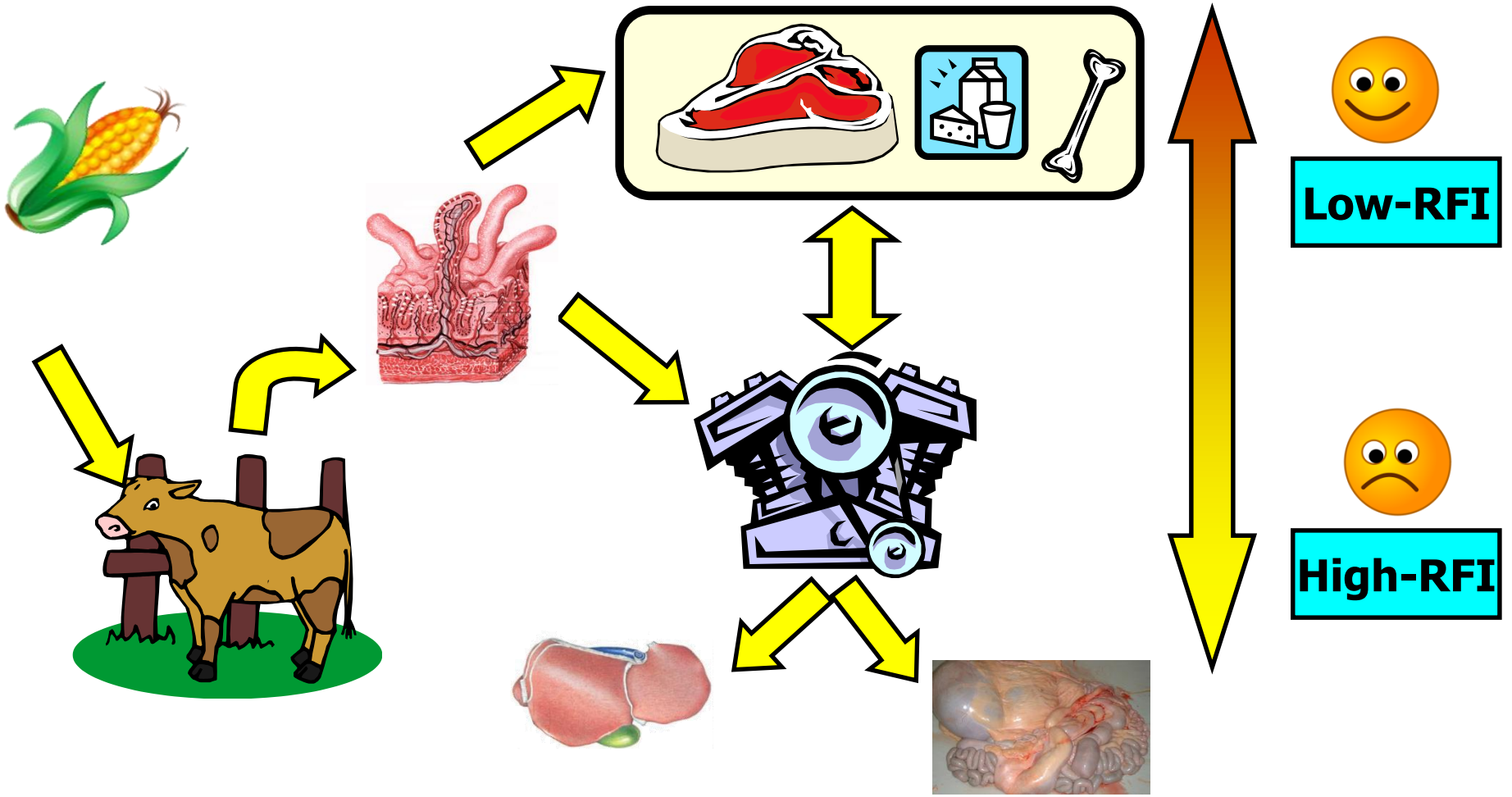
AGI

INTRODUCTION: Why efficiency?

$$$$$$

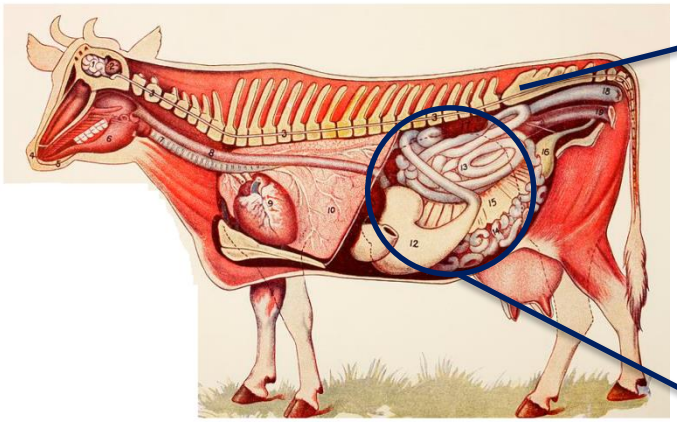
SOCIAL

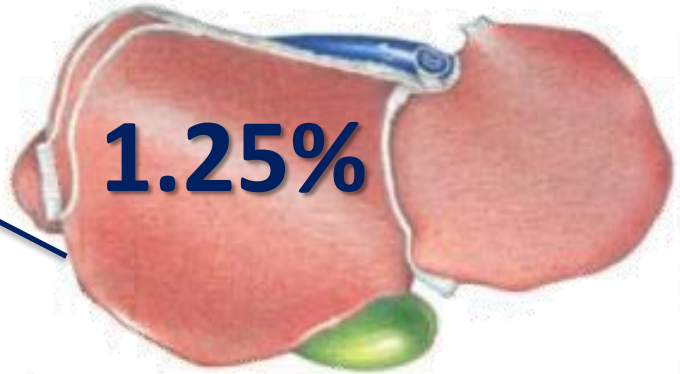
INTRODUCTION: Why RFI?



RFI (kg/d) = Feed Intake – Predicted Intake

INTRODUCTION: Why liver?





14 - 26%

O_2

INTRODUCTION: liver parameters

Chemical

Weight

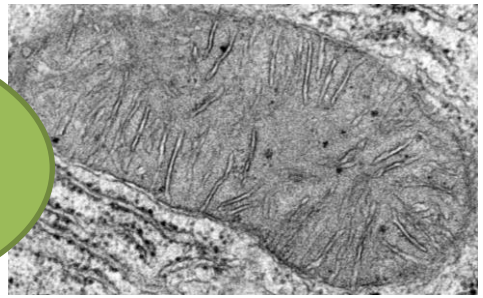
O_2 uptake

Blood

T_3

Organelle

Citrate synthase



HYPOTHESIS

The metabolic plasticity of the liver across plethora of biological workloads is also evidenced according to the individual variation in the efficiency of feed utilization.

OBJECTIVES

To determine the relationships between:

- **liver chemical composition,**
- **liver O_2 uptake,**
- **T_3 and**
- **citrate synthase activity**

with feed efficiency in young beef bulls.

MATERIAL & METHODS: bulls & feeding

64 crossbred yearling bulls – fattening phase

MATERIAL & METHODS: bulls & feeding

52.2%: High moisture corn

42.4% Alfalfa silage

5.0% Soybean meal

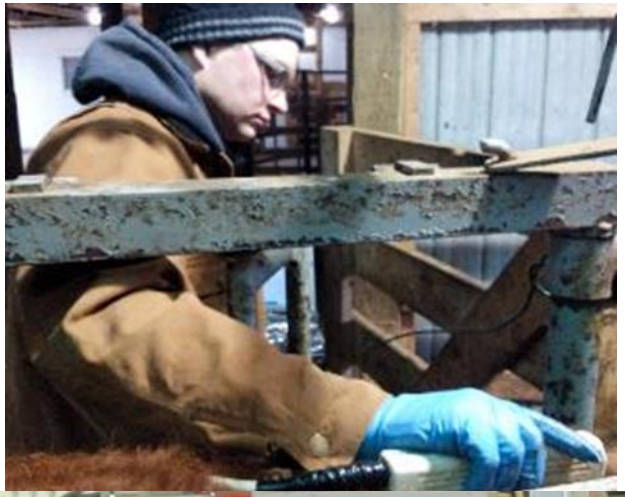
0.11% vitamin & mineral

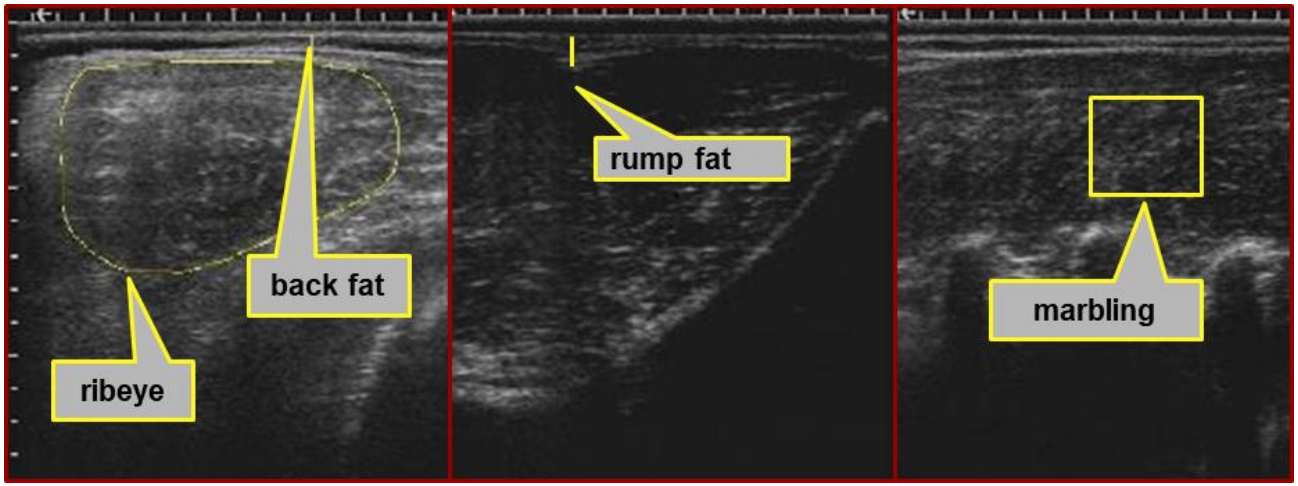
112 days performance test

44.8% starch

86.5% total digestible nutrients

MATERIAL & METHODS: performance test





US: body composition

BW: daily gain and size

Every 28 days

MATERIAL & METHODS: FE determination

Predictive Intake (kg/d) = β_0 +

β_1(BW) + β_2(ADG) + } Body size / Growth rate

β_3(Back Fat) + β_4(Rump Fat) + β_5(Marbling) + } Fatness

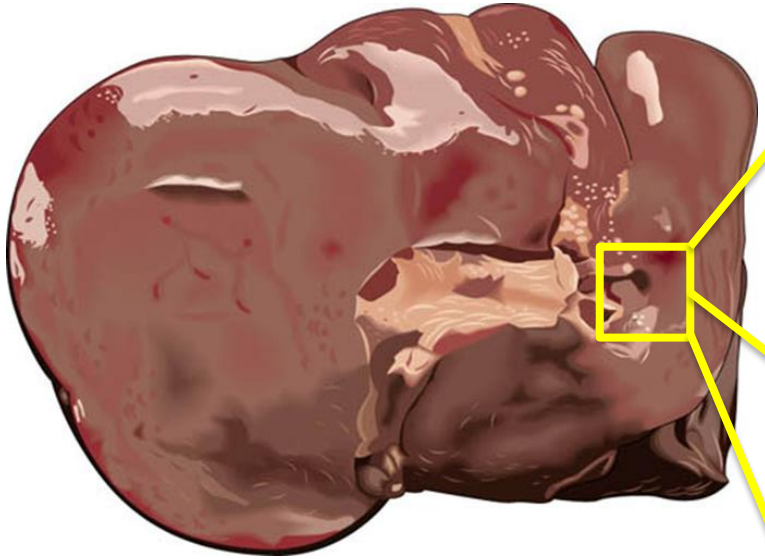
β_6(Ribeye Area) + } Leanness

RFI

R^2 = 0.63

RFI (kg/d) = Feed Intake – Predicted Intake

MATERIAL & METHODS: Liver sampling



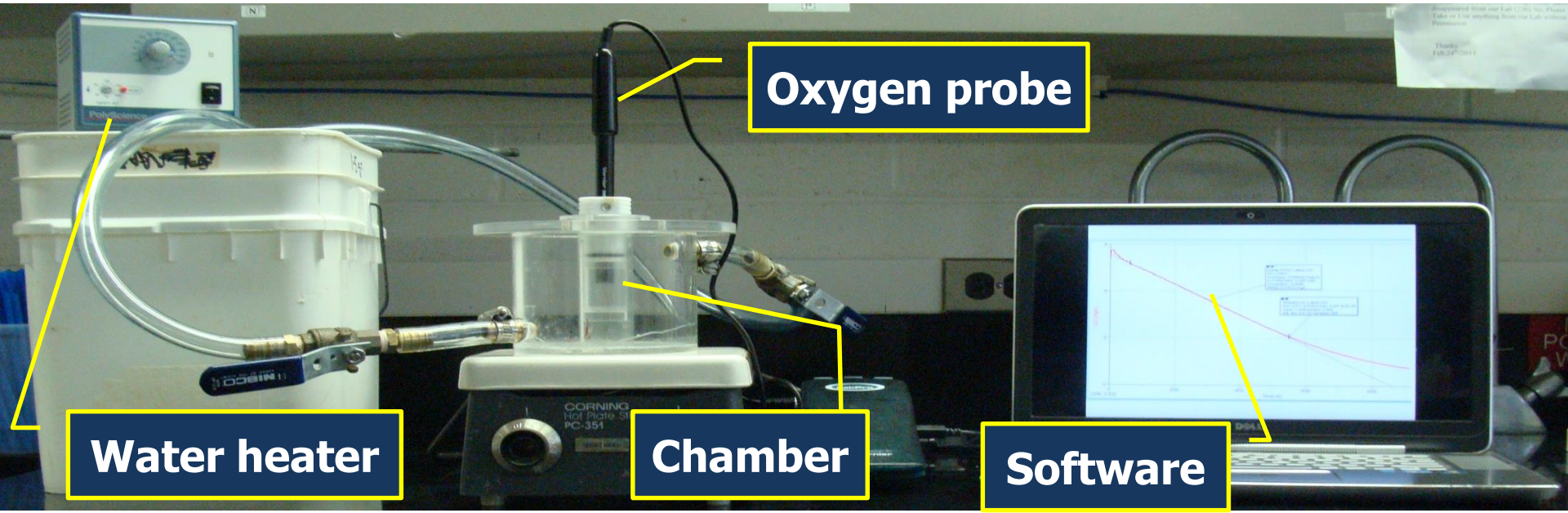
Krebs-Henseleit buffer: **Microcalorimetry**

N_2: Citrate synthase analysis

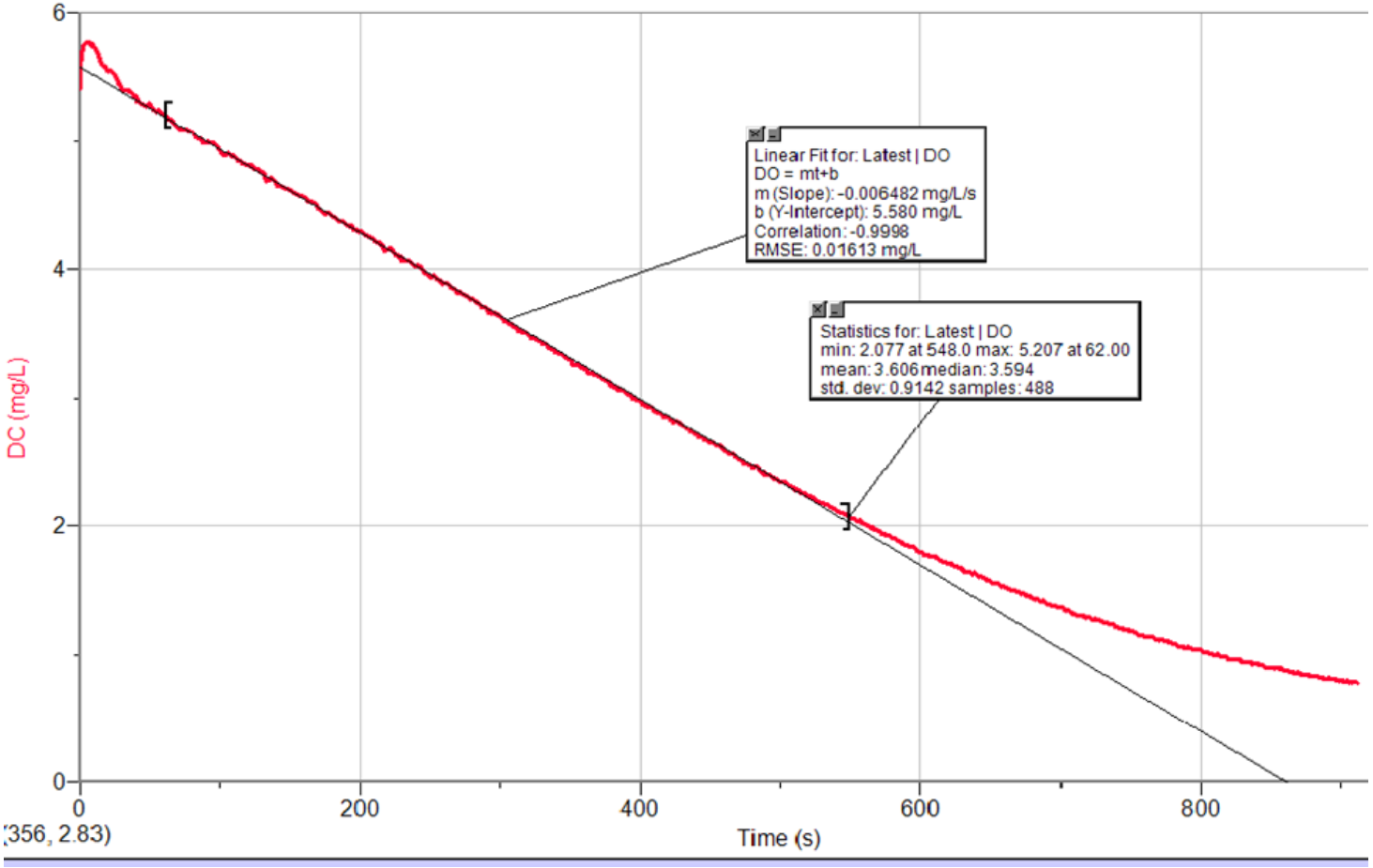
-20°C: Crude protein & fat content

Weight
Timing to sample

MATERIAL & METHODS: Liver microcalorimetry



MATERIAL & METHODS: Liver microcalorimetry



$$O2s = \frac{\Delta O_2}{\Delta t} \times \frac{(v - wm)}{m} \times \left(\frac{1\ mmol\ O_2}{32\ mg\ O_2}\right) \times \left(\frac{1000\ \mu mol}{mmol}\right)$$

MATERIAL & METHODS: Crude fat and protein

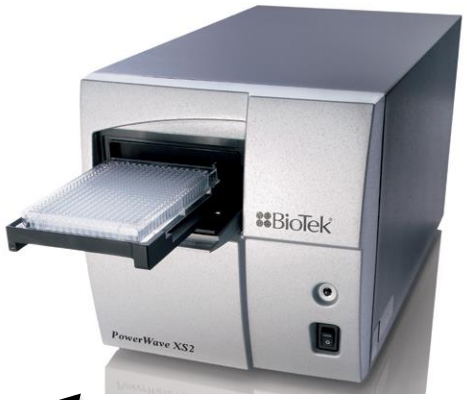
Crude protein:
BCA protein assay reagent

Crude fat:
Extraction with petroleum ether

MATERIAL & METHODS: Citrate synthase

+

Cell Lysis Reagent
& Protease
Inhibitor



- CS/ gram of tissue
- CS/ whole liver
- CS/ protein content

MATERIAL & METHODS: Total T_3 levels

Blood collection:
During exsanguination

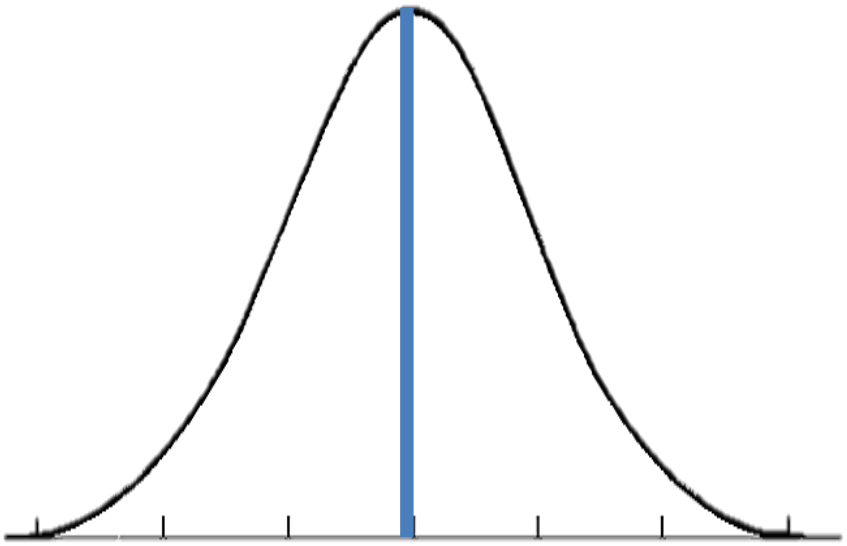
Blood processing:
Plasma extracted and frozen

Total T3:
solid-phase radioimmunoassay

MATERIAL & METHODS: Statistics

Categorical analysis:

- **Low-RFI vs. High-RFI**
- **Normality verification**
- **Least square means**



$$Y_{ijk} = \mu + R_i + B_j + \beta(A_K) + \varepsilon_{ijk}$$

Example:

Liver weight = μ + RFI Class + Breed + Age + Error

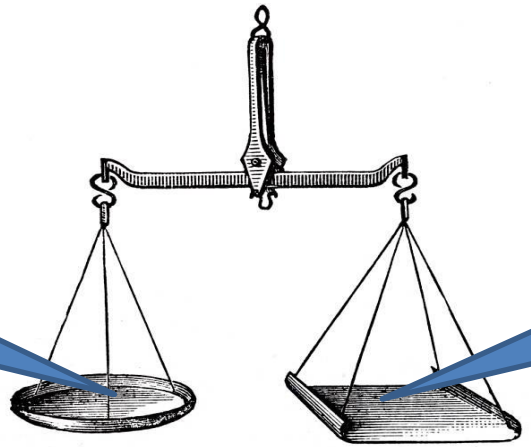
RESULTS & DISCUSSION: Performance

Trait (unit)	High-RFI	Low-RFI	P-value
Age (d)	395	405	0.16
Body weight (kg)	422	406	0.25
Daily weight gain (kg/d)	2.07	1.98	0.32
Backfat thickness (mm)	4.33	3.86	0.22
Rumpfat thickness (mm)	3.87	3.53	0.36
Ribeye area (cm^2)	71.2	70.2	0.62
Dry matter intake (kg/d)	10.1	8.60	0.01
Residual feed intake (kg/d)	0.54	-0.57	0.01

300 kg less feed/bull over 112 days

RESULTS & DISCUSSION: Weight & chemical

High-RFI
LW (kg): 7.55
LW (%BW): 1.29



Low-RFI
LW (kg): 7.24
LW (%BW): 1.26

P > 0.05

Trait (unit)	High-RFI	Low-RFI	P-value
Crude fat (%)	0.47	0.54	0.42
Crude protein (%)	10.16	10.07	0.66

RESULTS & DISCUSSION: micro-calorimetry

Oxygen uptake	High-RFI	Low-RFI	P-value
O_2 per g (µmol/min)	1.48	1.27	0.04
O_2 liver (mmol/min)	12.9	10.7	0.06

↑ Feed Efficiency = ↓ O2 uptake

RESULTS & DISCUSSION: citrate synthase

Citrate synthase (CS)	High-RFI	Low-RFI	P-value
CS per g (µmol/min)	2.30	2.59	0.001
CS per g protein (mmol/min)	22.6	25.6	0.001
CS liver (mmol/min)	18.7	22.9	0.001

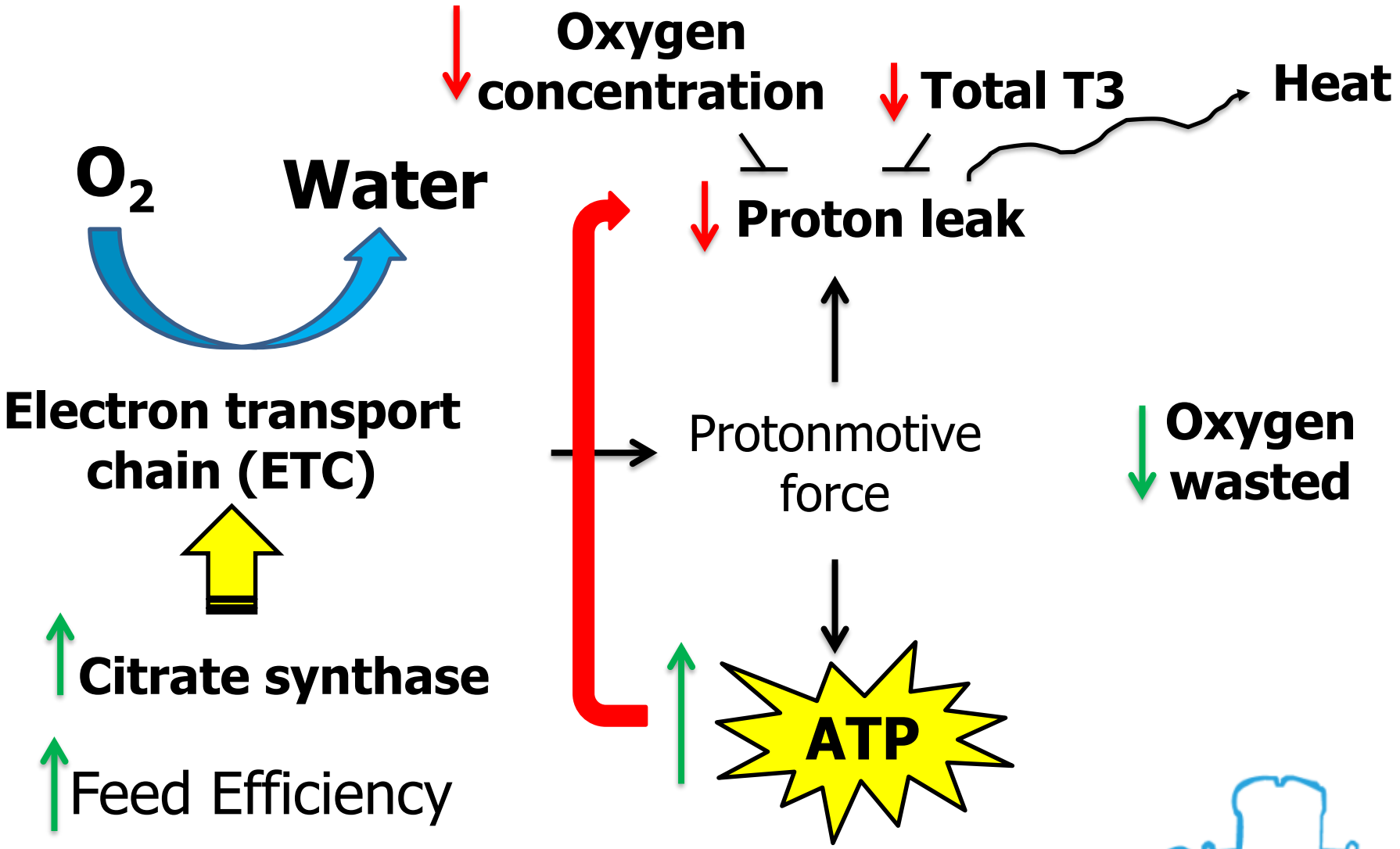
↑ Feed Efficiency = ↑ CS activity

RESULTS & DISCUSSION: T_3

Thyroid indicator	High-RFI	Low-RFI	P-value
Total T3 (ng/dL)	94.7	88.0	0.03

↑ Feed Efficiency = ↓ Total T3

RESULTS & DISCUSSION: General



CONCLUSION

The "feed efficient liver":

- **Lower O_2 uptake**
- **Greater CS activity**
- **Lower T3 levels.**

<u>Potential biomarkers</u>:

extensive validation

technique optimization

These evidence seems to support energy sparing metabolic pathways in feed efficient cattle to be further understood.

ONGOING RESEARCH

Whole body breath gas analysis

Liver biopsy

ACKNOWLEDGEMENTS

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MORE ON BIOMARKERS…

Cardiovascular monitoring towards novel proxies for feed efficiency in the bovine

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GOT INTERESTED?

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BosTaurus Efficiency

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