Response of blood nutrients to an LPS inflammatory challenge in pigs

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nutrient metabolism during inflammation

Specific immune response

- B cell (immunoglobulins)
- T cells (cytotoxicity)

→ Low nutritional cost

Non-specific inflammatory response

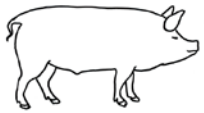
- Fever → Energy
- Acute phase response (complement, inflammatory proteins and lipoproteins) → Amino acids, lipids and energy
- Anti-microbial processes → Antioxydants (vit. C and E, glutathion, glutamine, Zn, Se…), amino acids, lipids and energy

nutrient metabolism during inflammation in pigs

- Inflammatory response to *E.coli* lipopolysaccharide (LPS)
  - Fever, anorexia (Johnsons and von Borell, 1994)
  - ↗ TNF-α, interleukine-1, -6 (Myers et al, 2003)
  - ↗ Cortisol and catecholamines (Collier et al, 2011)
  - ↗ Haptoglobin, SAA, CRP (Collier et al, 2011)

- Metabolic response to LPS:
  - ↗ muscle protein breakdown (Myers et al, 1999; Daiwen et al, 2008)
  - ↘ glycaemia and insulinemia (Leininger et al, 2000)
  - ↗ nonesterified fatty acids (Leininger et al, 2000)
  - Amino acid metabolism less described (Bruins et al, 2003)

Material and methods



32 finishing

Aims and measurements

- Blood nutrients:
  - Glucose
  - Lactate
  - Nonesterified fatty acids
  - Urea
  - amino acids

Automated colorimetric assays

UPLC

- Humoral mediators with a metabolic role:
  - Cortisol (immuno-assay)
  - Catecholamines (immuno-assay)
  - Cytokines (ELISA)

Immuno-assays

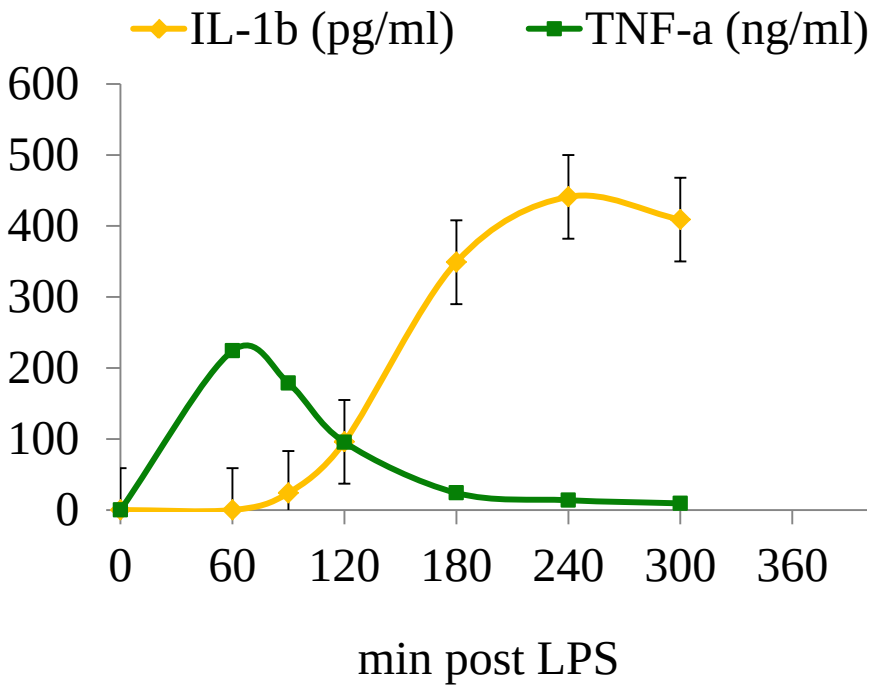
ELISA

- Data analysis by ANOVA using SAS

- Presentation of raw means in the following graphics

Inflammatory markers

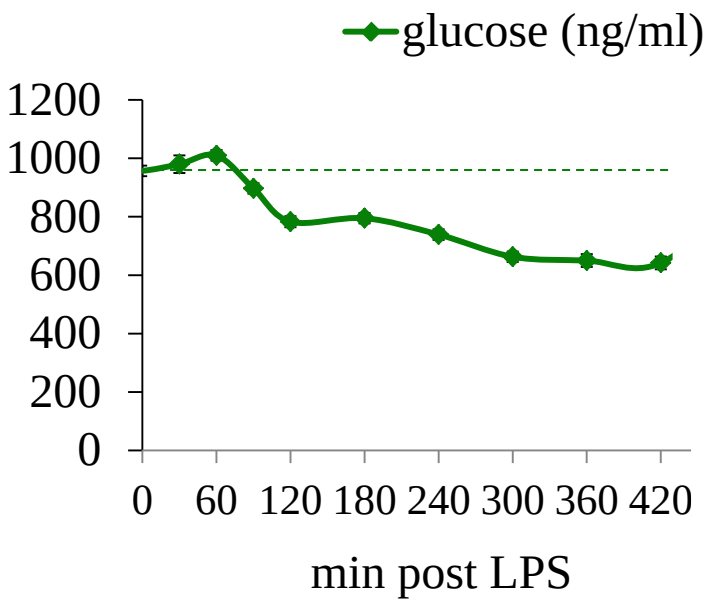
LPS induces an inflammatory response

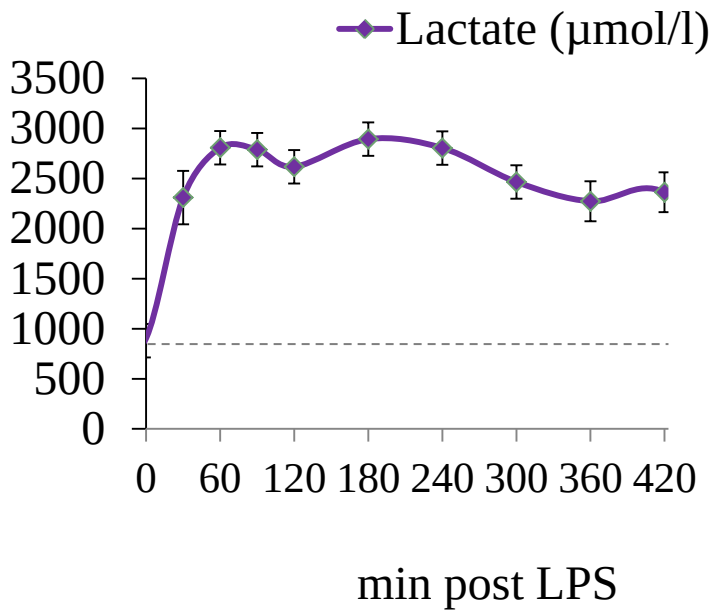


Glucose and lactate

hypoglycaemia

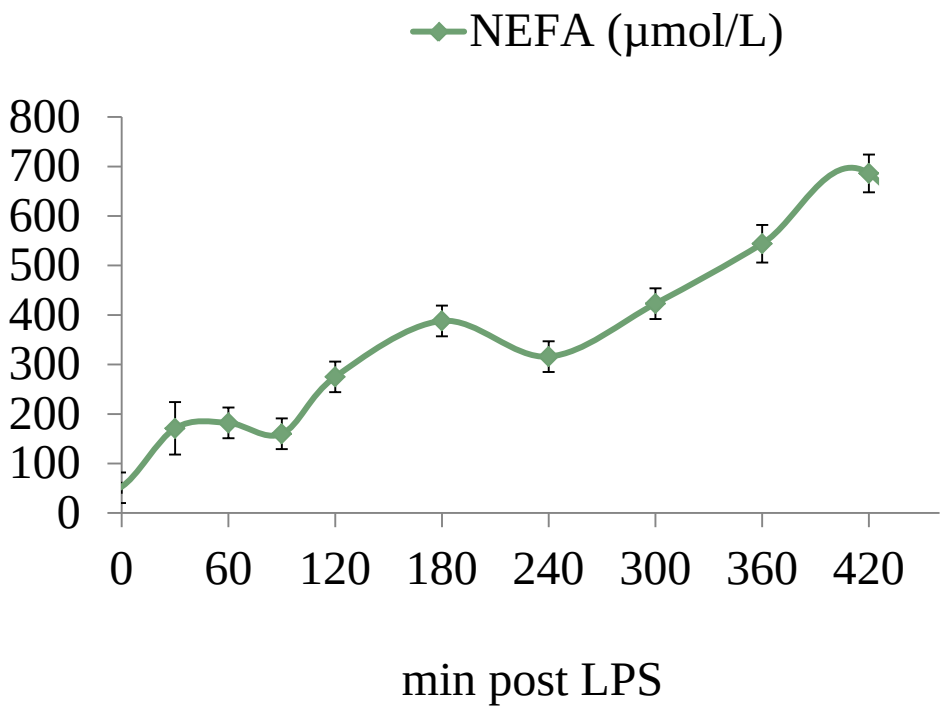
high anaerobic glycolysis



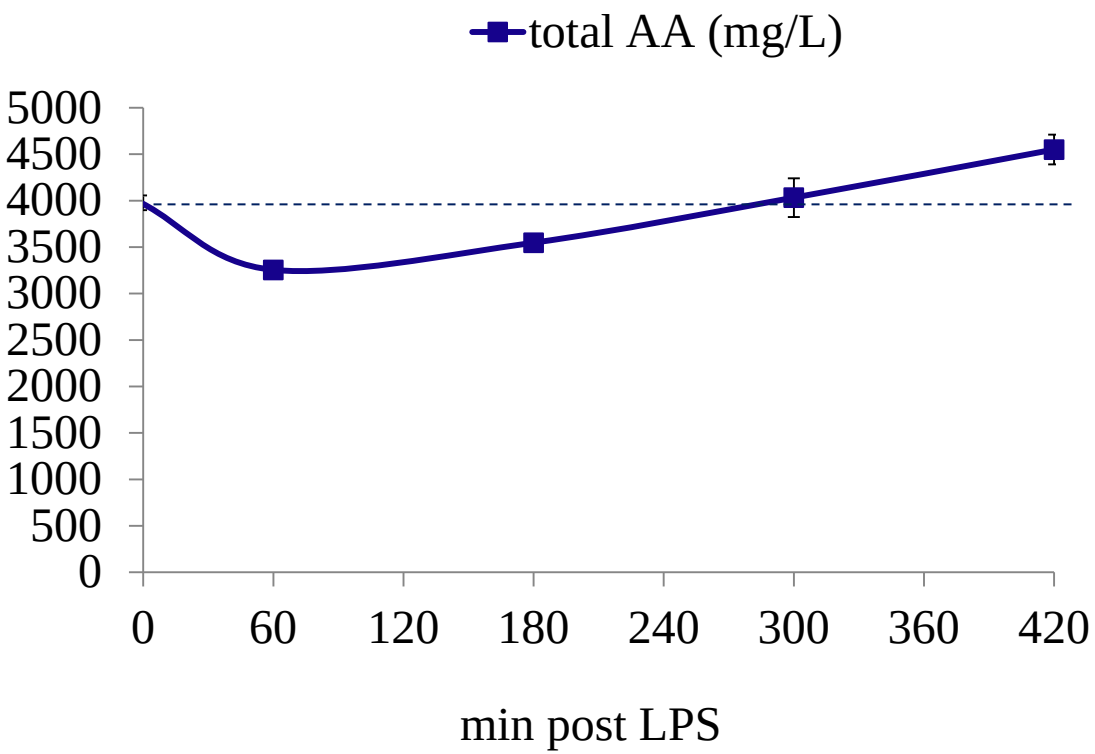


Non esterified fatty acids

=> Mobilization of lipid reserves



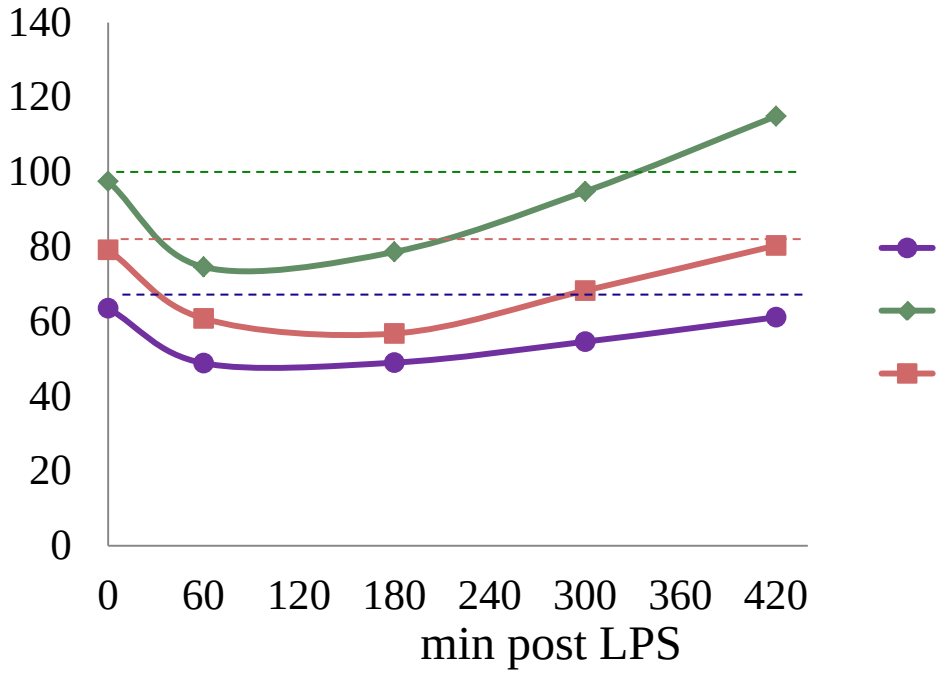
Amino acid metabolism



slight and transient variations in blood total AA:

-from 60 to 180 min: drop => uptake of AA for protein synthesis or energetic purpose?
-from 300 to 420 min: recovery => protein breakdown?
-But dissimilarities among AA

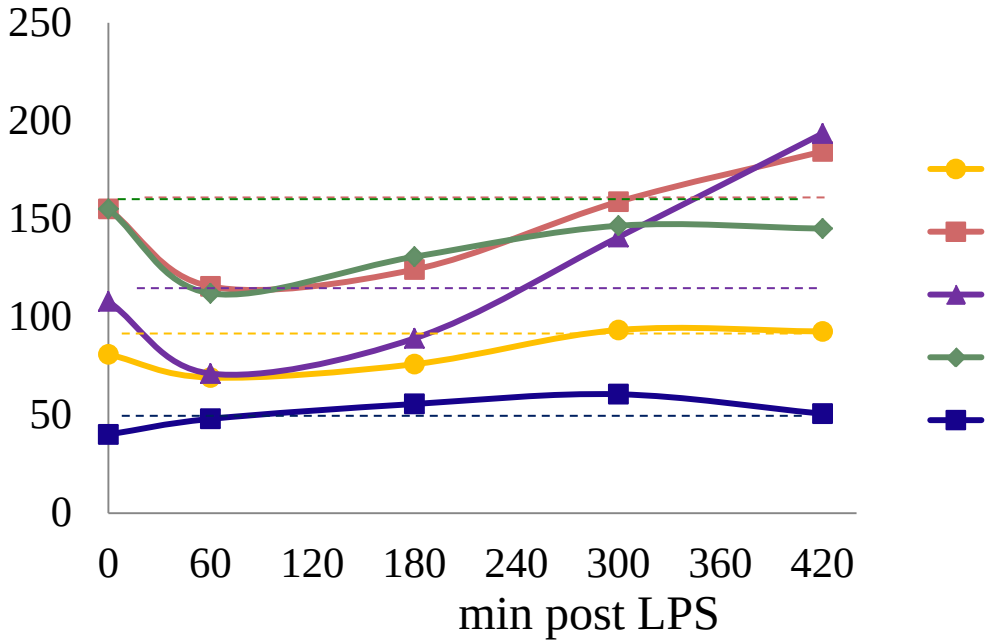
Concentrations of ketogenic AA are transiently altered:



-From 60 to 300 min: a decrease => use for glucogenesis or protein synthesis?

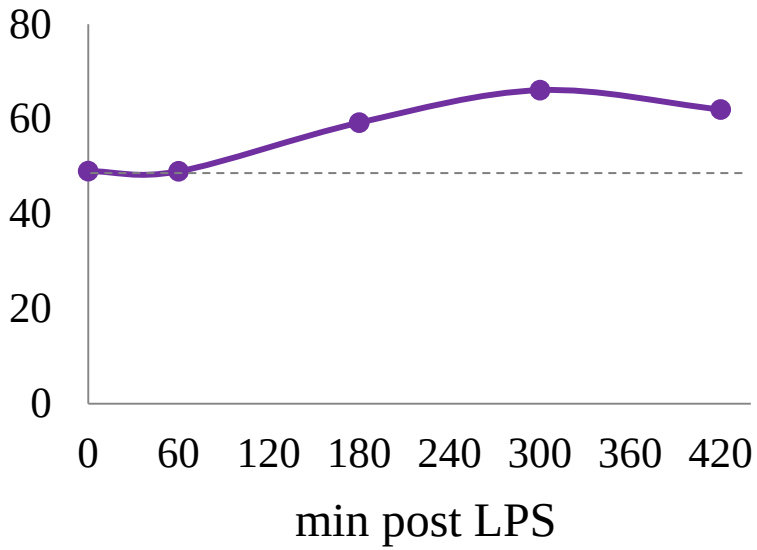
-At 420 min: a return to basal (or even above basal) levels => protein breakdown?

Concentrations of most of glucogenic AA are transiently altered:



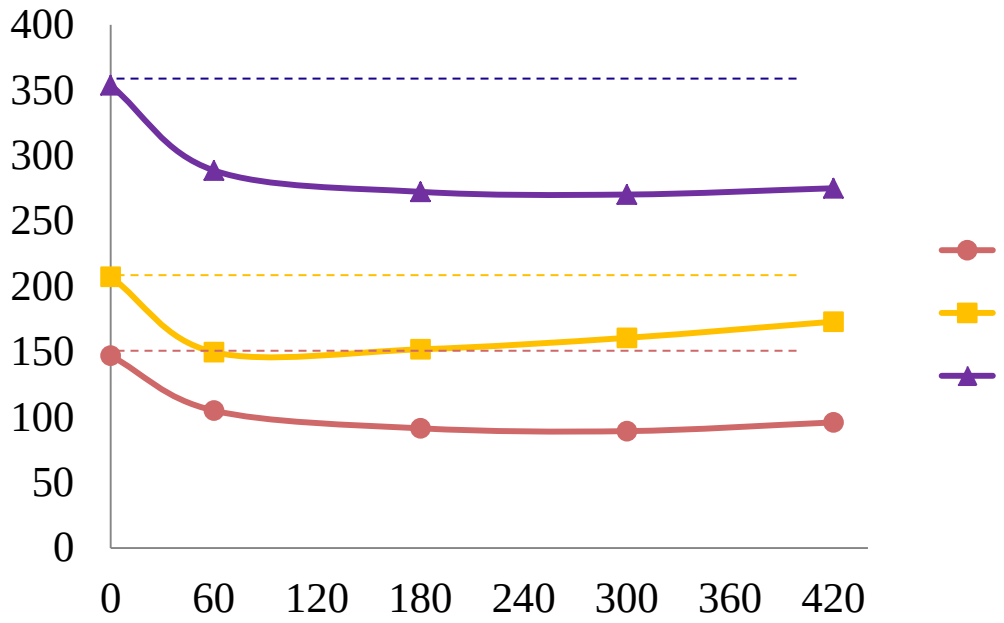
-From 60 to 180 min: a decrease => use for protein synthesis or gluconeogenesis?
-From 300 to 420 min: an increase => protein breakdown?
-Exception for glutamate

LPS induces protein catabolism



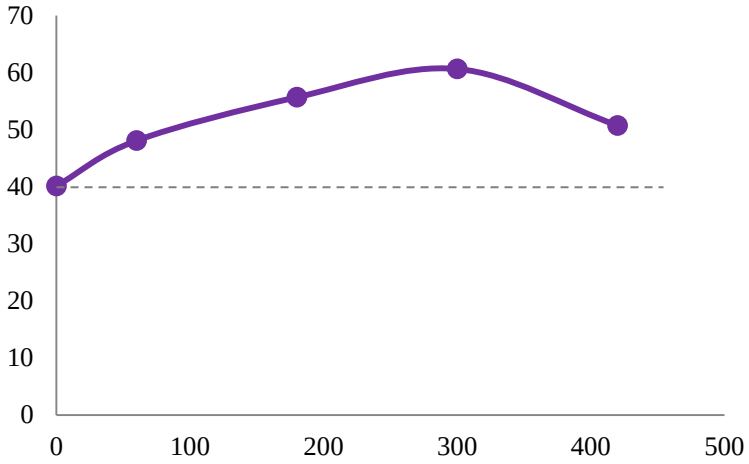
indicator of protein catabolism (collagen degradation due to inflammation?)

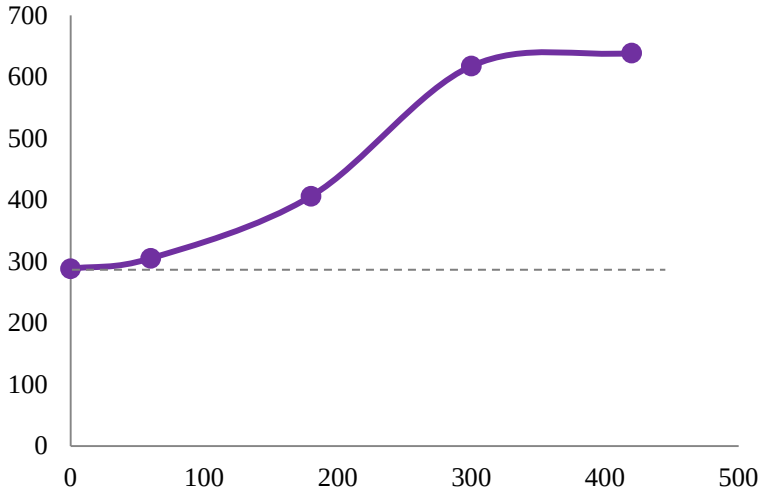
Concentrations of branched glucogenic AA are consistently decreased:



Are they used as a major substrate for gluconeogenesis?

Concentrations of some AA might result from glycolysis and gluconeogenesis





Glucogenogenesis from AA => production of α-ketoglutarate => production of Glutamic Acid

Gluconeogenesis from branched AA => Alanine

Glycolysis => production of pyruvate. Pyruvate + N (from degradated AA) => Alanine

Conclusion

- Inflammation generated
  - a high need in energy, supplied by glucose, NEFA and lactate
  - protein catabolism

- Protein catabolism probably provided AA for
  - the synthesis of inflammatory-related proteins (acute phase proteins and other inflammatory proteins)
  - Gluconeogenesis

- Future research for nutritional strategies: needs in branched AA in pigs during / after disease events ?

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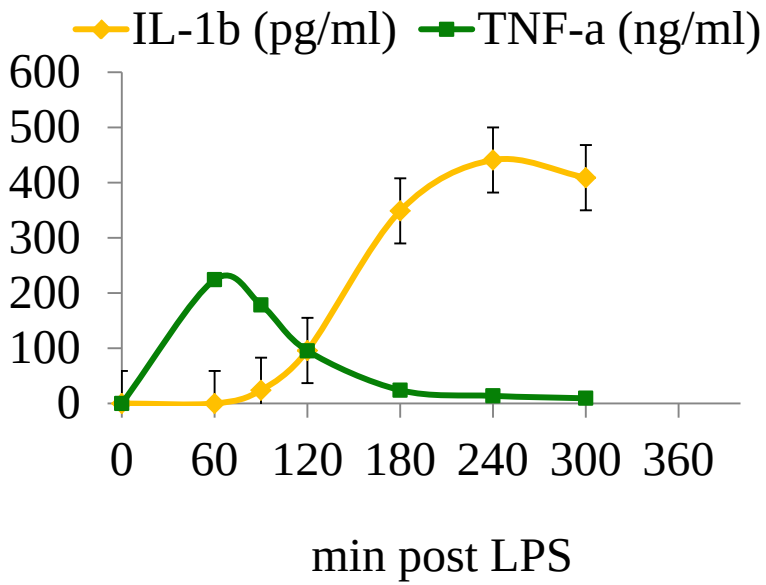
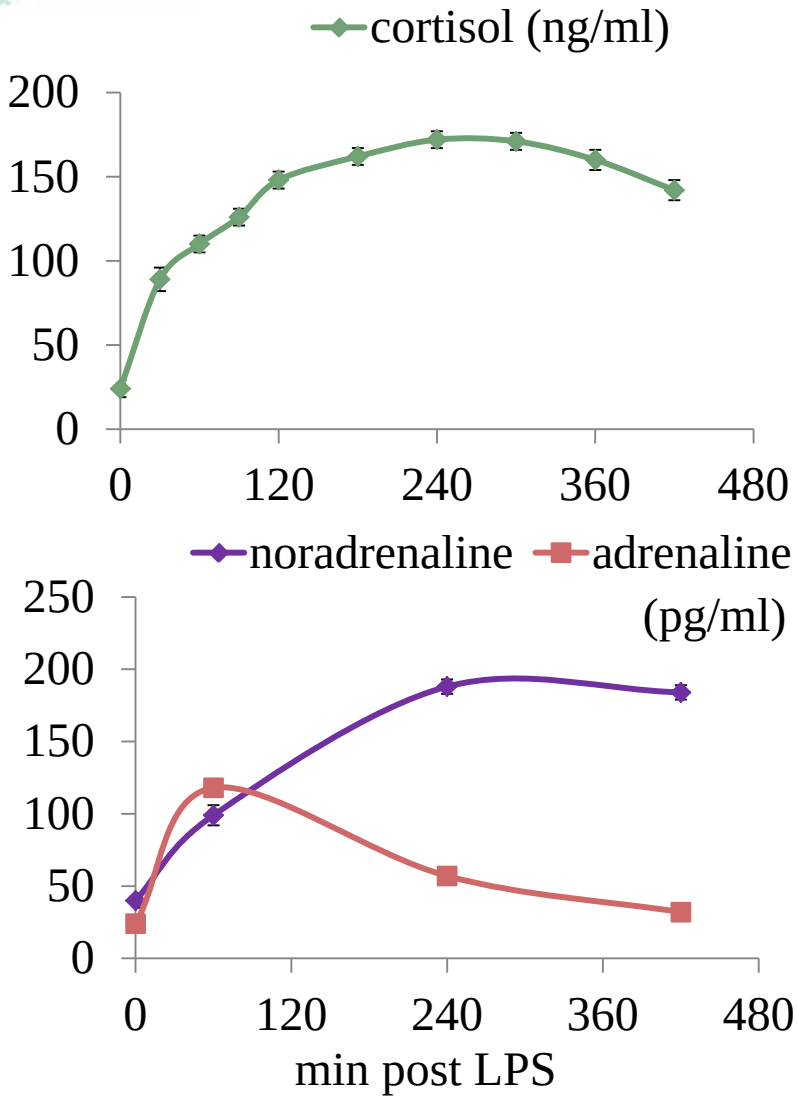
Thank you for your attention

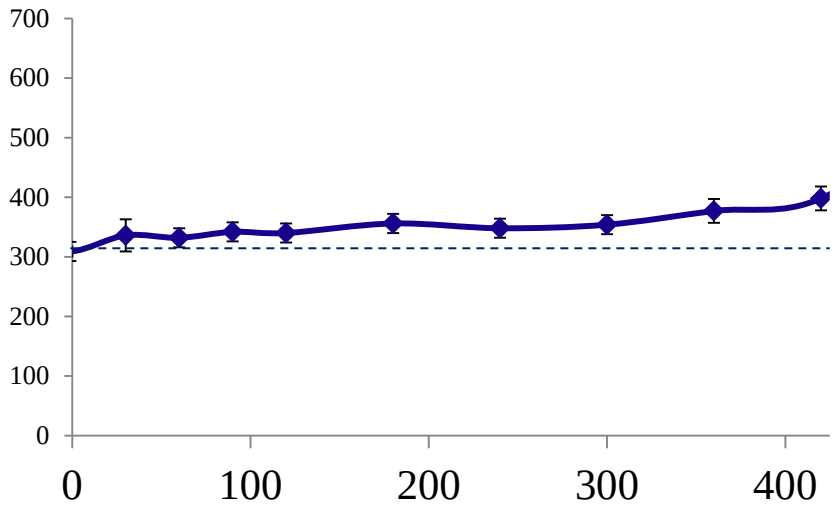
Inflammatory markers

LPS induces an inflammatory response

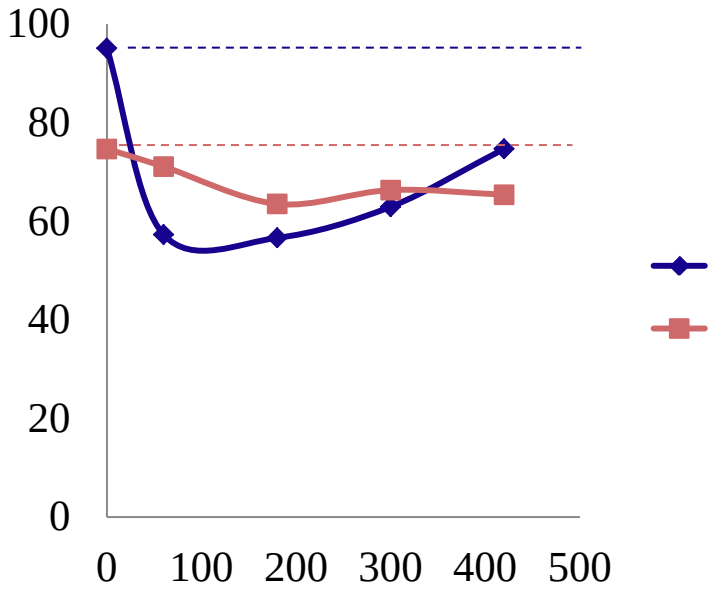


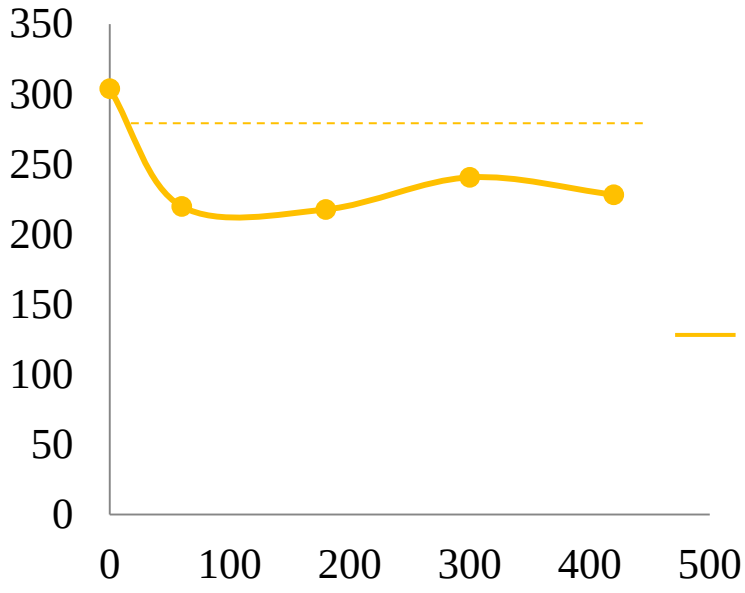


LPS induces protein catabolism



Other AA that drop until 420 min:





Plasma Arginine => Citrulline + NO
(inflammation-induced iNOS in macrophages)

Plasma Citrulline => Arginine (in the gut and kidney) ?

Plasma Proline => Arginine?
(Wu et al, 2007)

Other AA that drop until 420 min: