Effects of parity on metabolism, redox status and cytokines in early lactating dairy cows

Session 92: Inflammation and energy metabolism in young and adult livestock

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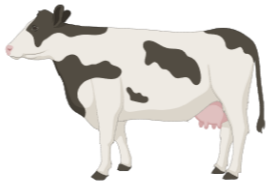
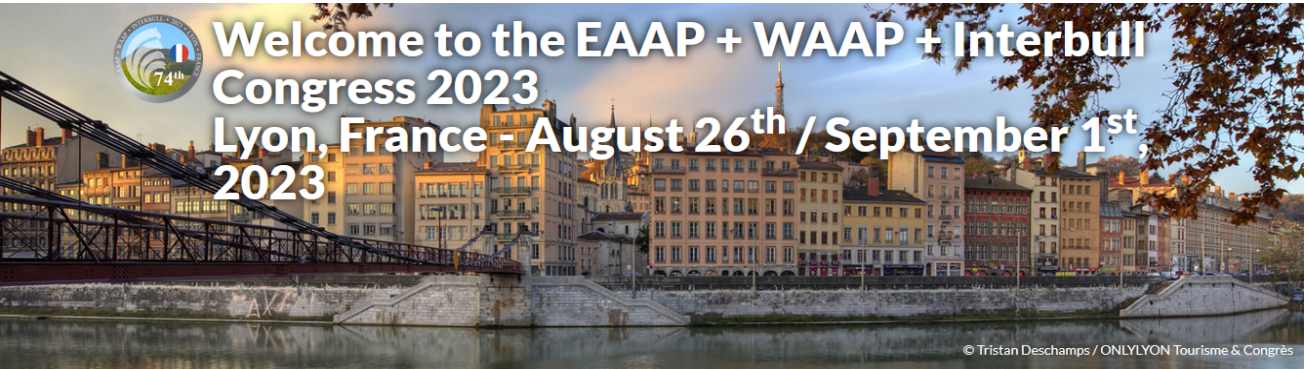
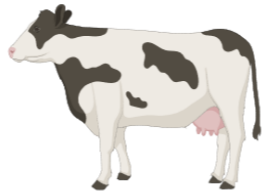




Context of dairy cows at early lactation



➢ Early lactation is a critical period for the health of dairy cows → period with <u>oxidative stress</u> & <u>inflammation</u>

Bernabucci *et al.*, 2005 Bradford *et al.*, 2015 Horst *et al.*, 2021

↗ milk yield

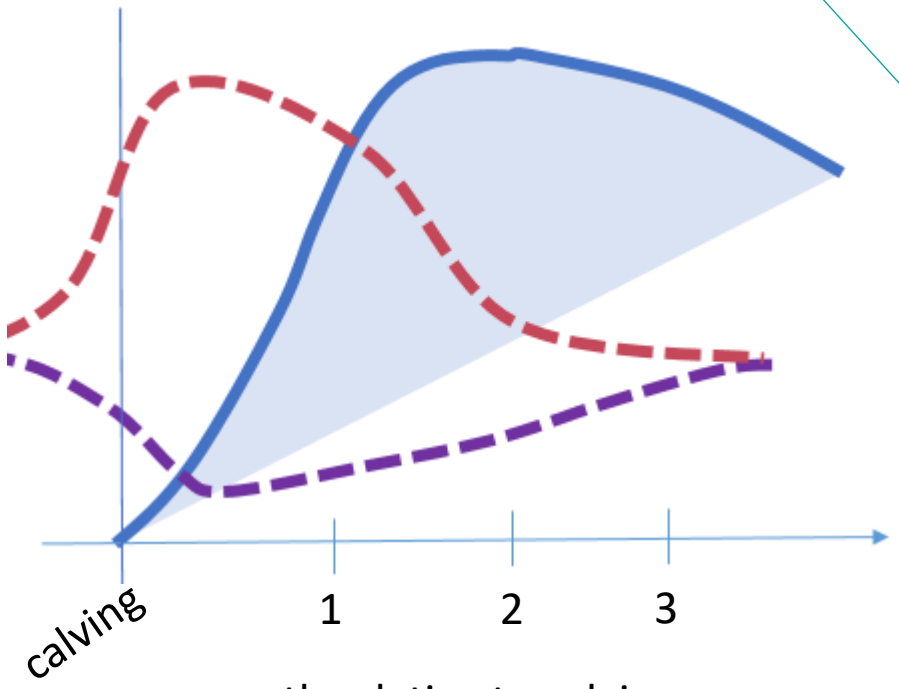
☑

MULTIPAROUS ≠ PRIMIPAROUS
because primiparous
↗ body development still in progress
↗ hormonal system for cow growth

Wathes *et al.*, 2007
Cattaneo *et al.*, 2023

↗ oxidative stress due to ↗ reactive oxygene species
Freitas Silva *et al.* 2018

↘ immune capacity LeBlanc *et al.*, 2019



?

MULTIPAROUS ≠ PRIMIPAROUS
conflicting results on oxidative stress between parity

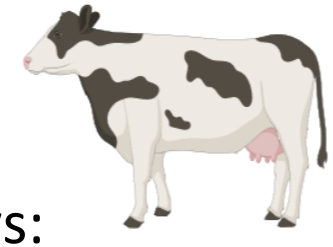
Yehia *et al.*, 2016 <u>*vs*</u> Elisher *et al.*, 2015
Urh *et al.*, 2019

?

MULTIPAROUS ≠ PRIMIPAROUS
↗ immunity activation in primiparous
BUT the boundary between inflammation & immunosuppression is sometimes thin

Moya *et al.*, 2008

The objectives of this study



❑ Study the physiological variations between primiparous and multiparous cows:

Part 1 – Metabolic biomarkers

Milk yield, NEFA, BHB, glucose

Part 2 – Redox balance

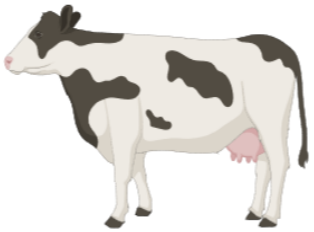
Oxidative stress index, antioxidant enzymatique activity, vitamin E

Part 3 - Immunity

Cytokines

What are the physiological differences between a dairy cow in first lactation and a multiparous dairy cow?

Material and method

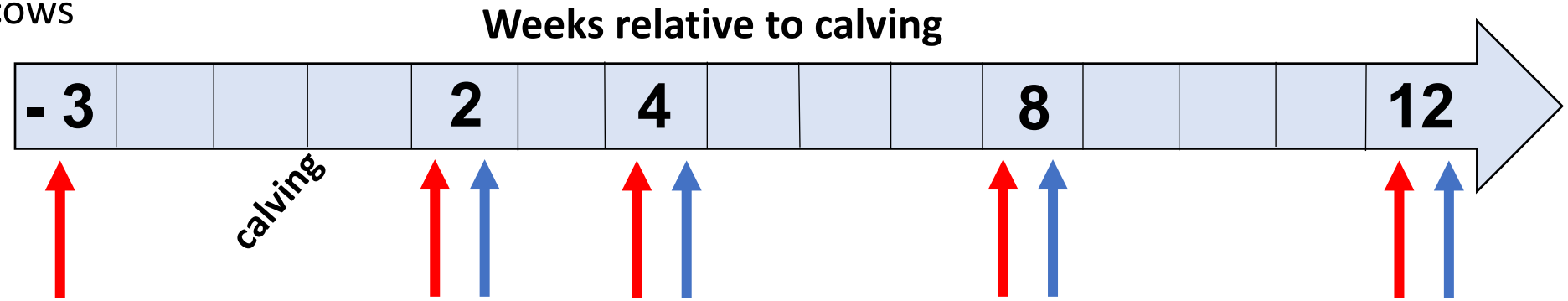


Sampling kinetics

15 Prim'Holstein dairy cows

8 multiparous

7 primiparous



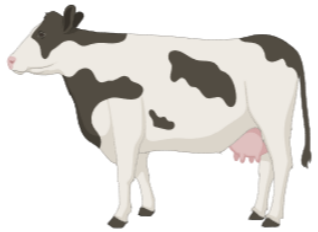
Blood samples
Metabolic biomarkers
Cytokines

Milk samples
milk leucocyte mRNA

Statistical analyses

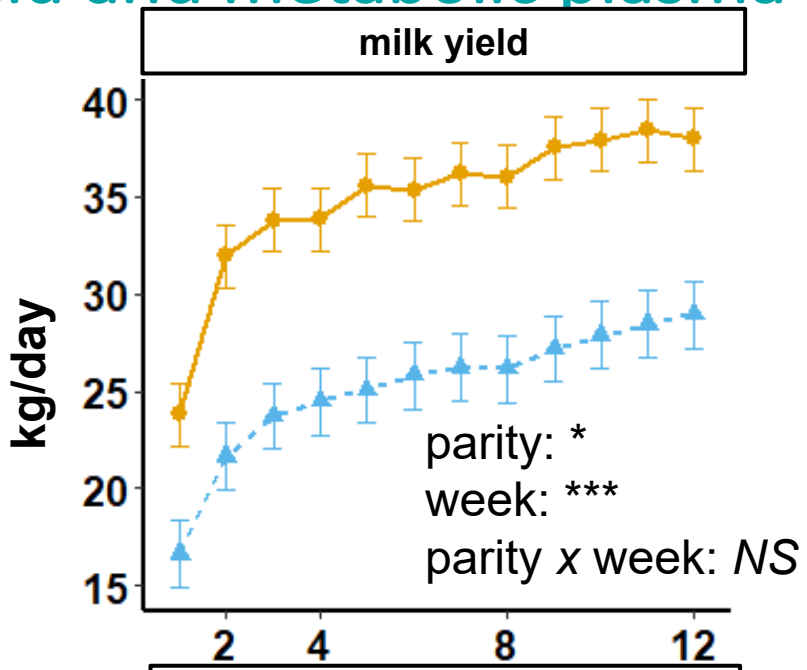
$$Y(ijkl) = \mu + \text{parity}_i + \text{week}_j + (\text{parity x week})_{ij} + 1\,\text{l cow}_k + \begin{matrix}\text{calving date}\\ \text{group}\end{matrix}_l + \varepsilon$$

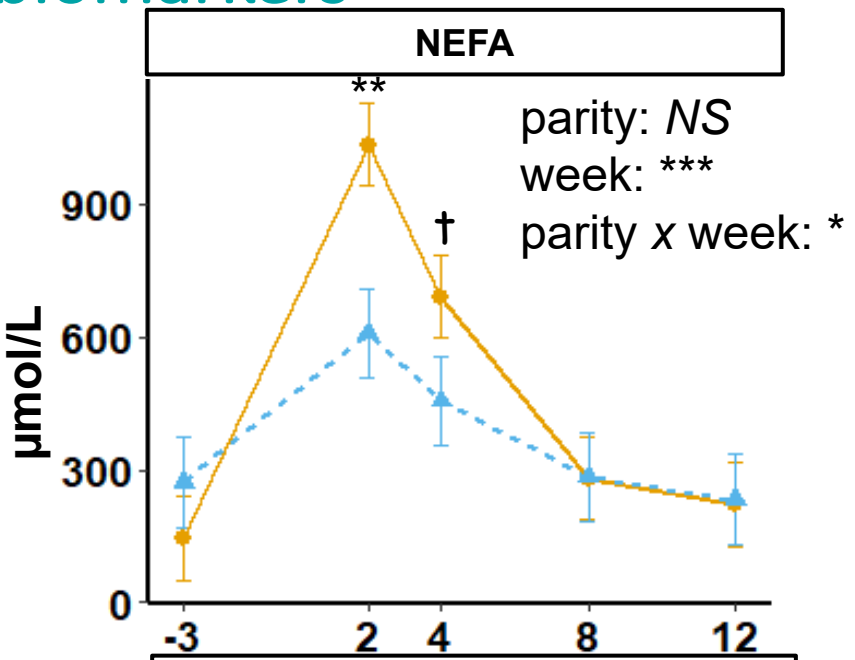
Milk yield and metabolic plasma biomarkers

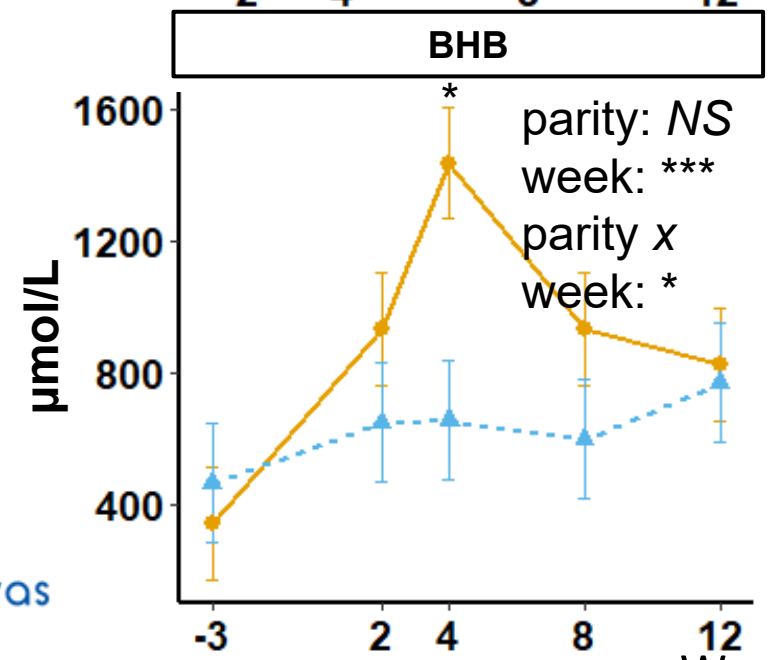


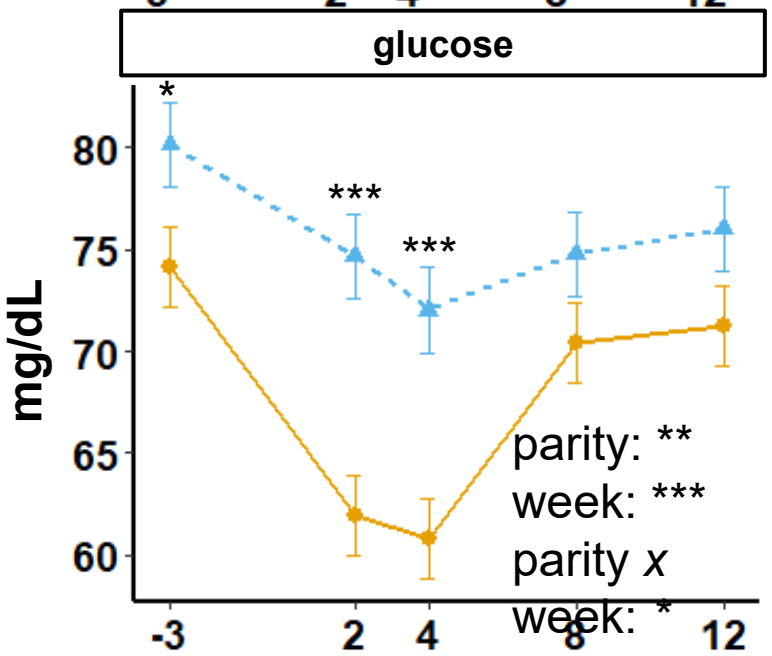
primiparous

multiparous





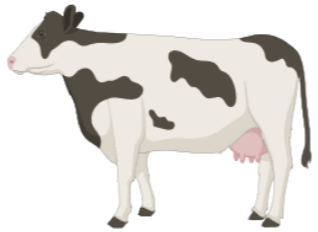




Weeks relative to calving

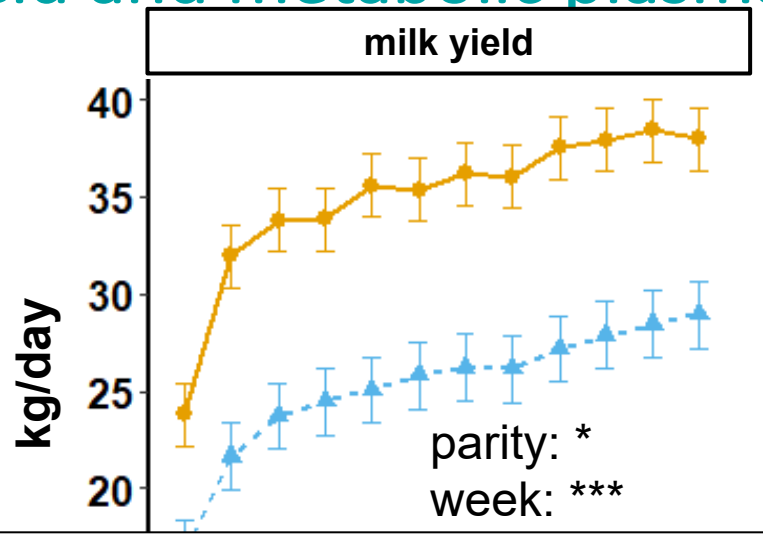
NEFA: Non Esterified Fatty Acids
BHB: beta-hydroxybutyrate

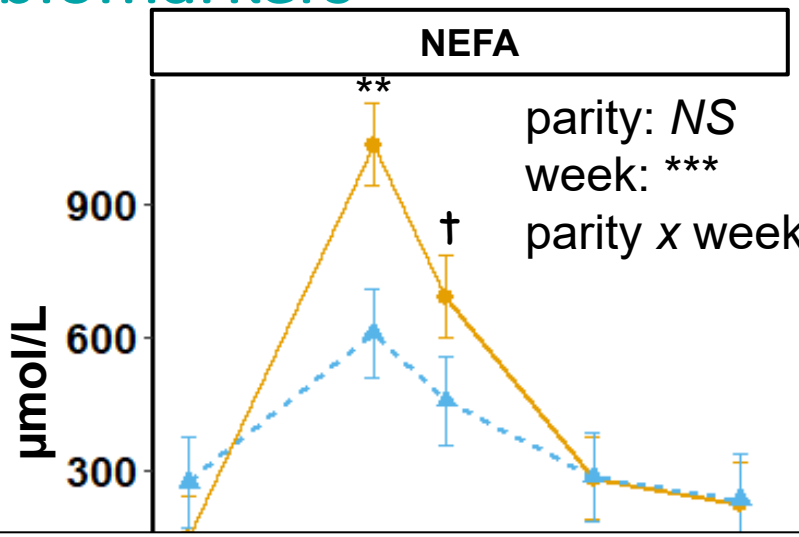
Milk yield and metabolic plasma biomarkers



primiparous

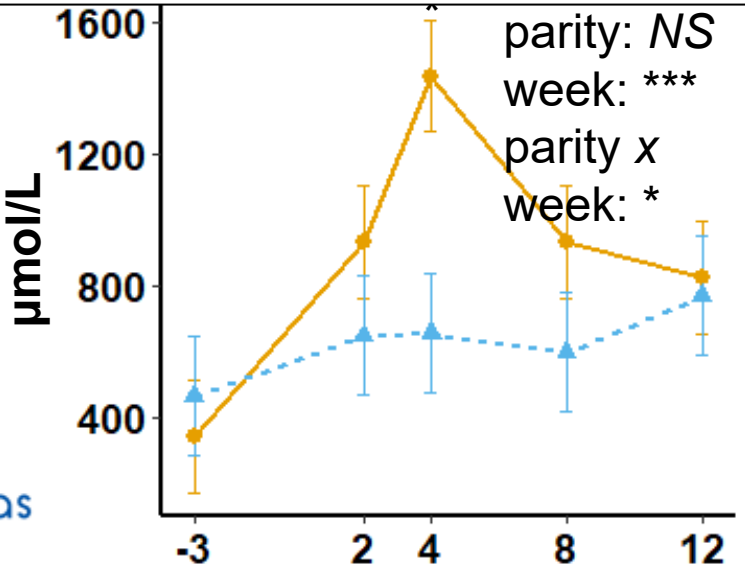
multiparous

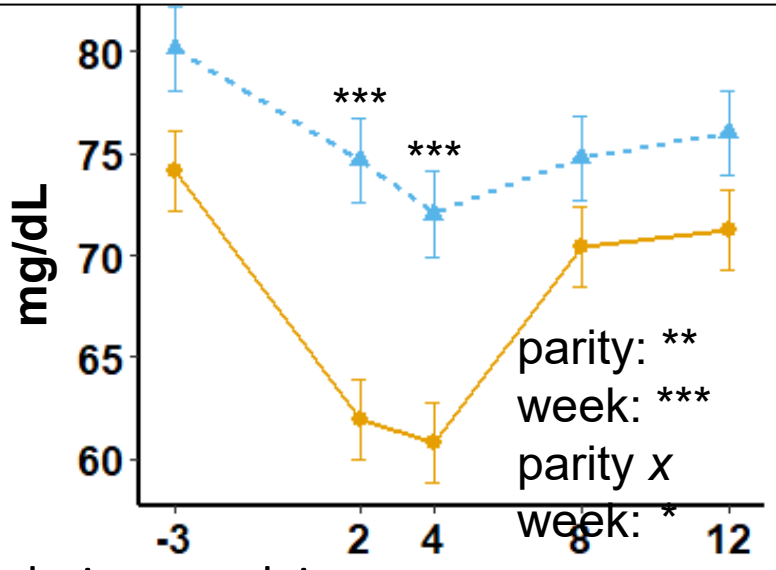




Multiparous cows have a higher mobilisation of energy reserves than primiparous cows, and a higher daily milk yield

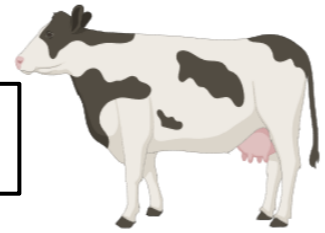
What are the effects of parity on redox balance and inflammation?





Weeks relative to calving

Redox balance plasma

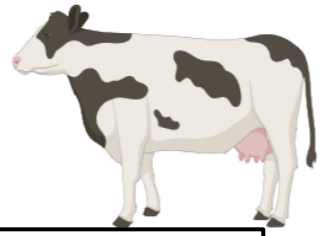


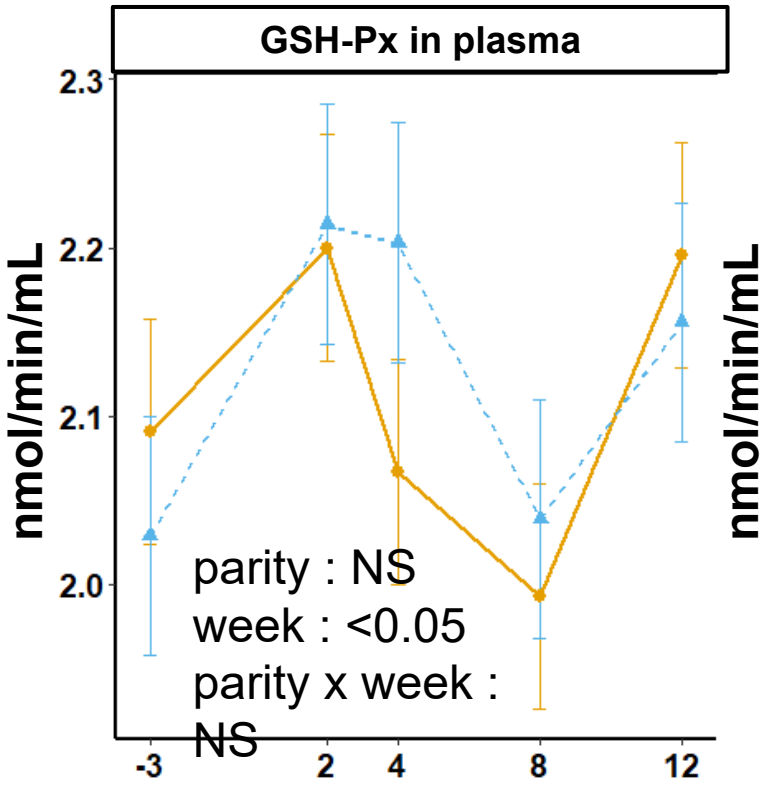
Multiparous: more reactive oxygen species in plasma at week 8 of lactation
Primiparous: lower oxidative stress index at week 8 of lactation

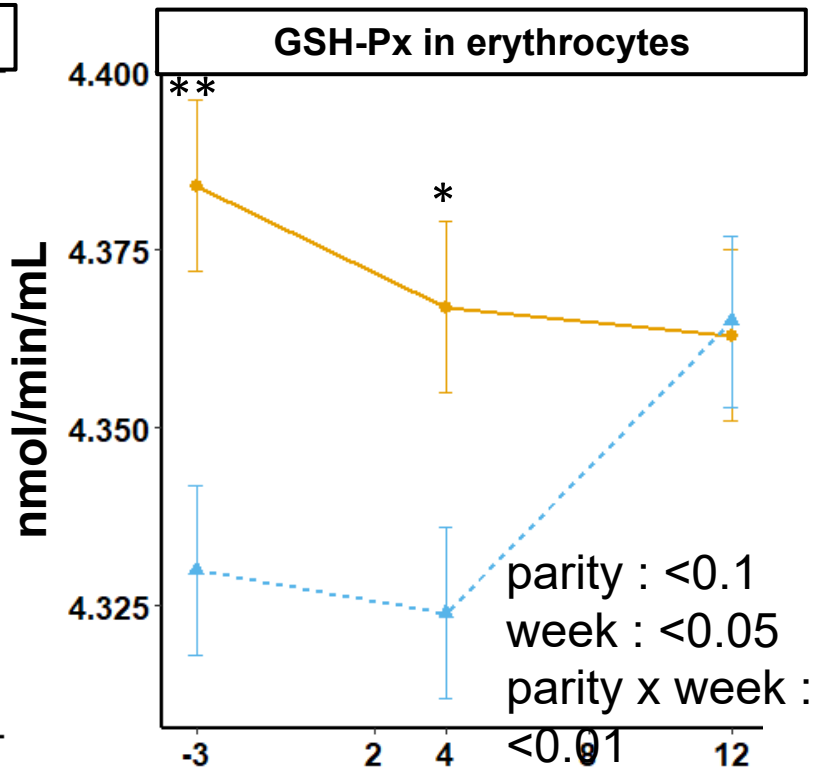
dROM: Reactive Oxygen Metabolite
FRAP: Ferric Reducing Antioxidant Power
OSI: Oxidative Stress Index

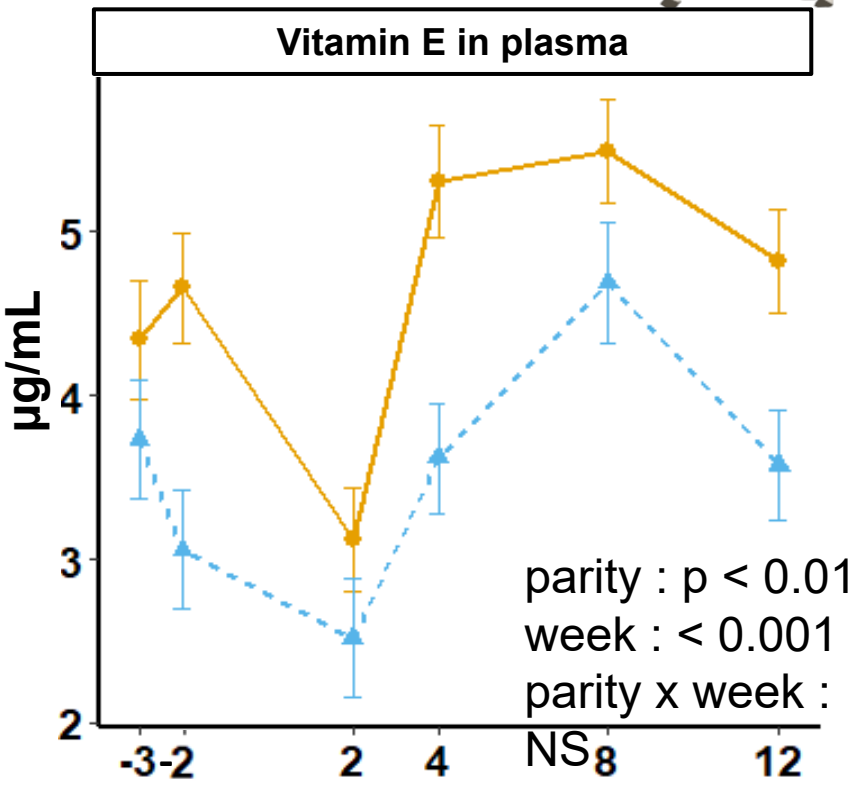
GSH-Px antioxidant activity & vitamin E in blood

primiparous
multiparous





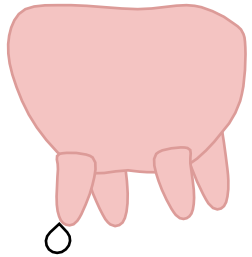


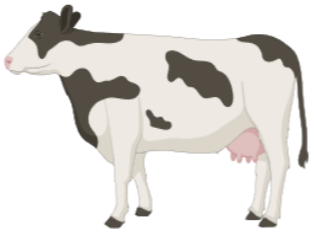


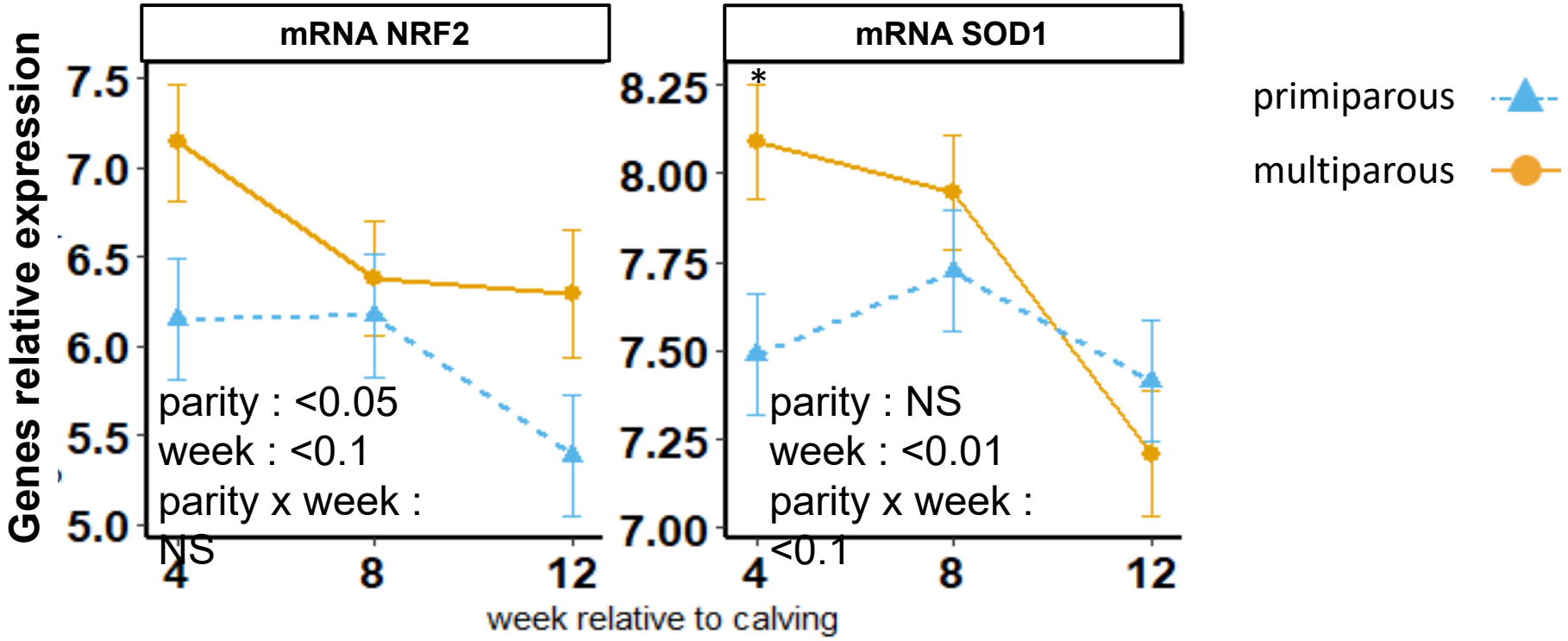
Weeks relative to calving

No difference in enzyme activity in plasma between primiparous and multiparous
Multiparous: more antioxidant activity of GSH-Px in erythrocytes in week -3 et 4 & more vitamine E in plasma

The mRNA-expression of genes related to antioxidant response in milk leucocytes







In leucocytes from milk, multiparous: a higher expression of genes involved in antioxidant metabolism

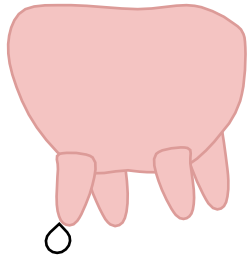
↗ mRNA NRF2

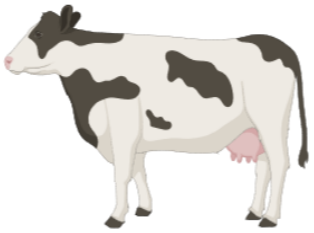
↗ mRNA SOD1 at week 4 (p=0.02)

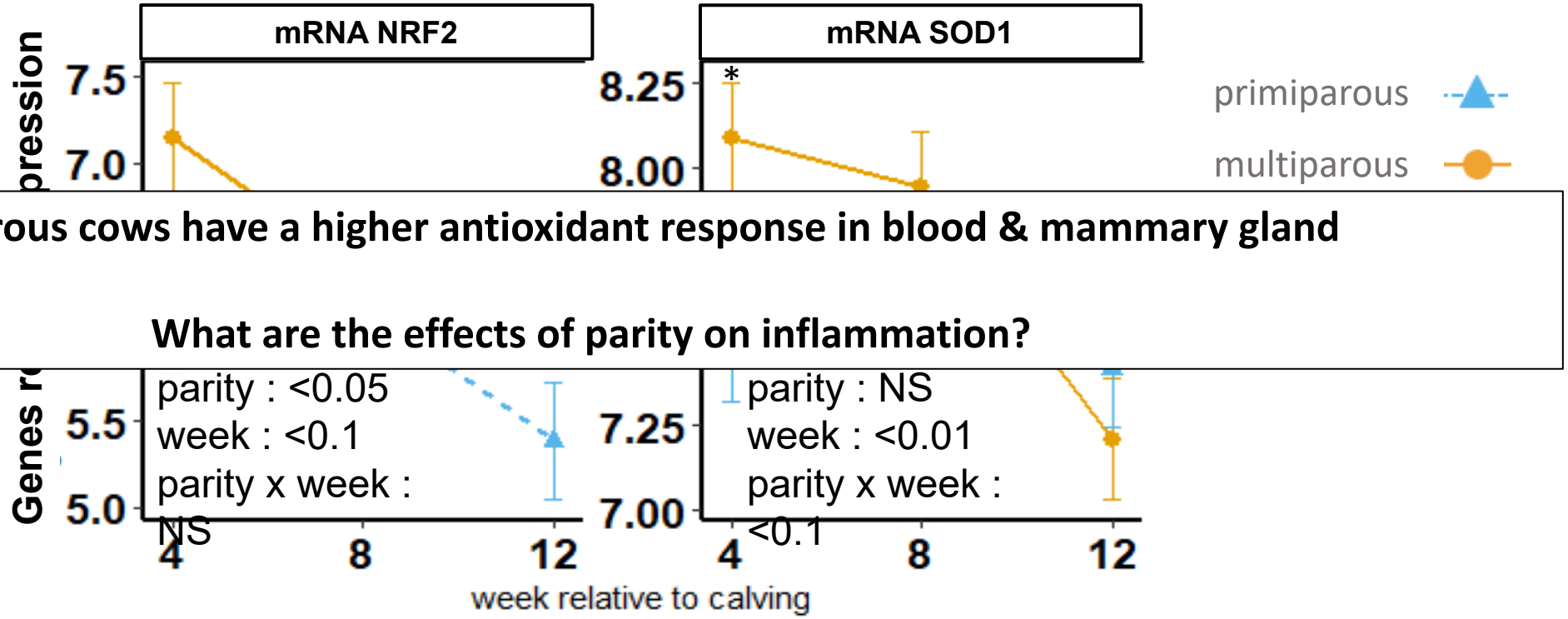
NRF2: nuclear factor erythroid-2-related factor 2

SOD1: superoxide dismutase 1 [Cu-Zn]

The mRNA-expression of genes related to antioxidant response in milk leucocytes







Multiparous cows have a higher antioxidant response in blood & mammary gland

What are the effects of parity on inflammation?

In leucocytes from milk, multiparous: a higher expression of genes involved in antioxidant metabolism

↗ mRNA NRF2

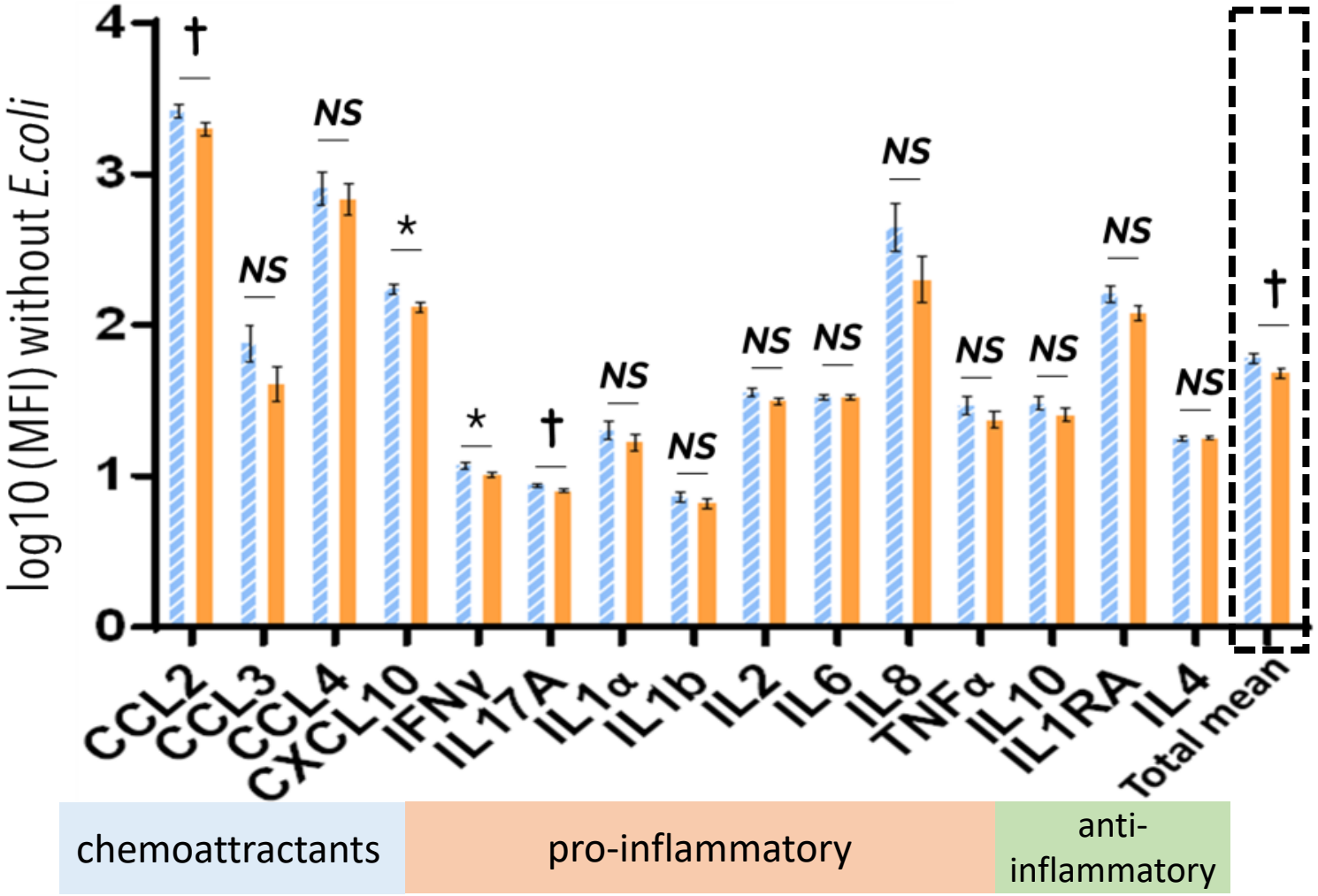
↗ mRNA SOD1 at week 4 (p=0.02)

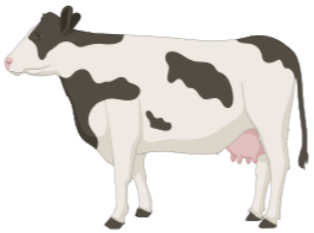
NRF2: nuclear factor erythroid-2-related factor 2
SOD1: superoxide dismutase 1 [Cu-Zn]

Cytokine production in blood <u>without</u> *ex vivo E.coli* stimulation

Cytokines <u>without</u> or <u>with</u> *Echerischia coli* in blood incubated in monovettes

Multiplexe technology
Lesueur *et al.*, 2022



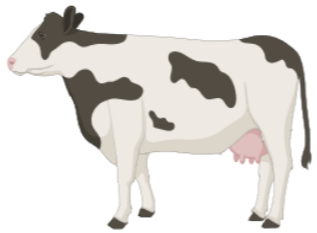


primiparous
multiparous

Over the experiment, multiparous produced **less chemoattractant** and **pro-inflammatory** cytokines than primiparous

No parity effect concerning the **anti-inflammatory** cytokines

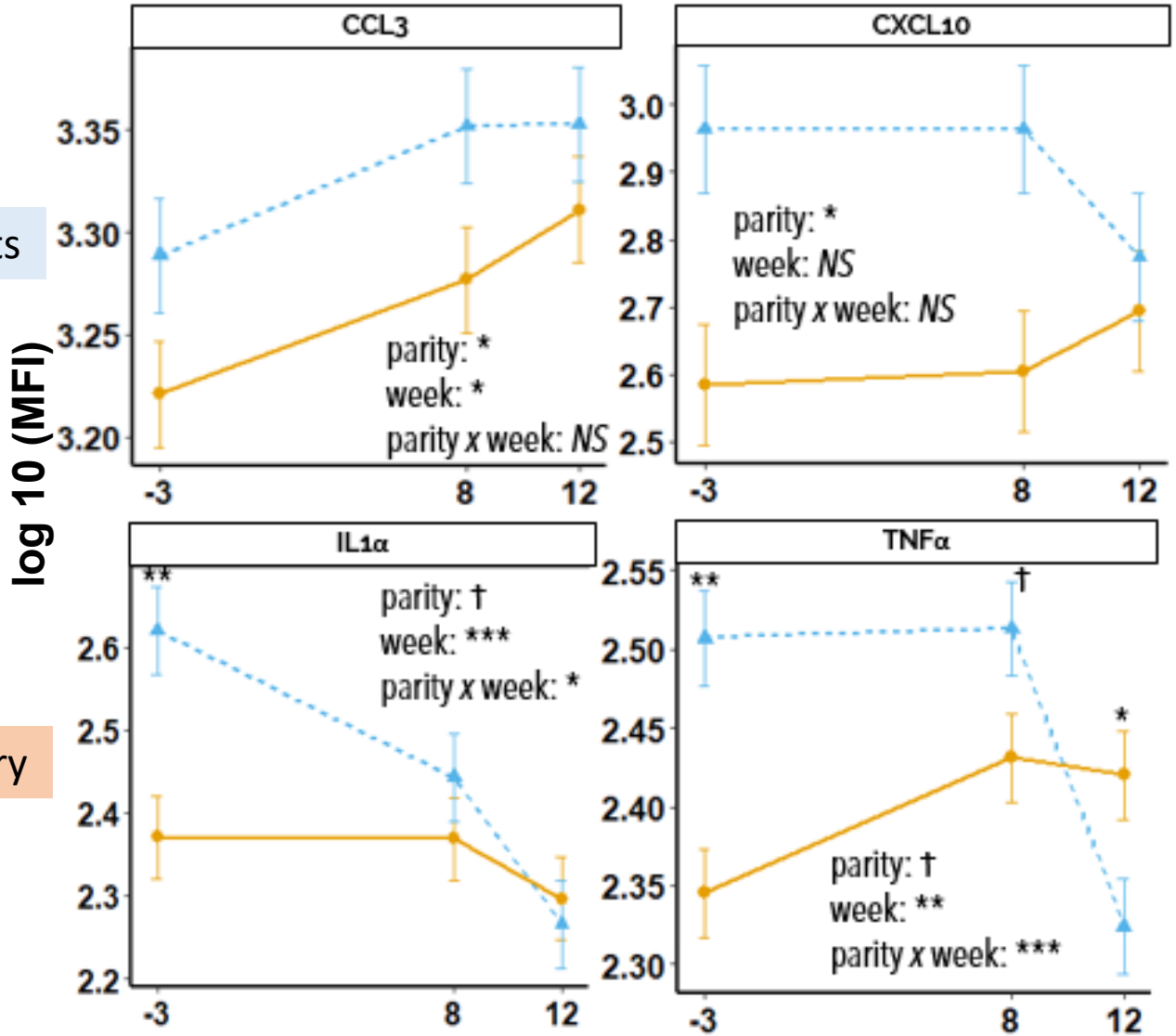
Cytokine production in blood with *ex vivo E.coli* stimulation

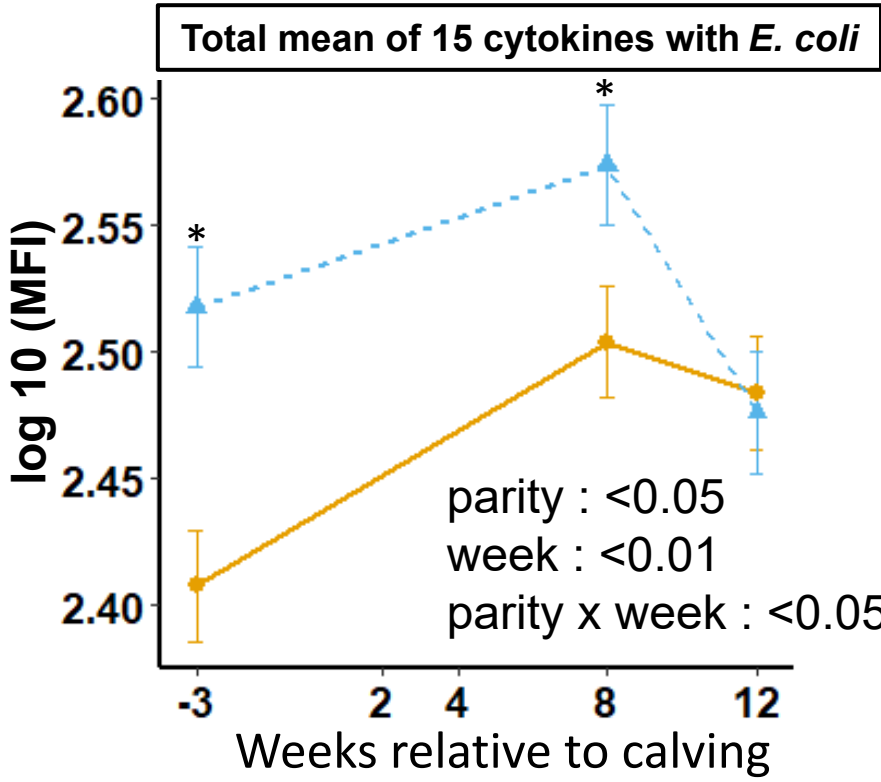


primiparous
multiparous

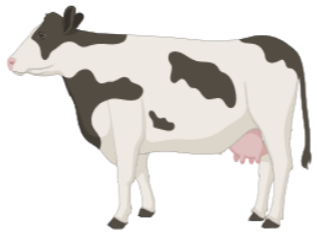
chemoattractants

pro-inflammatory



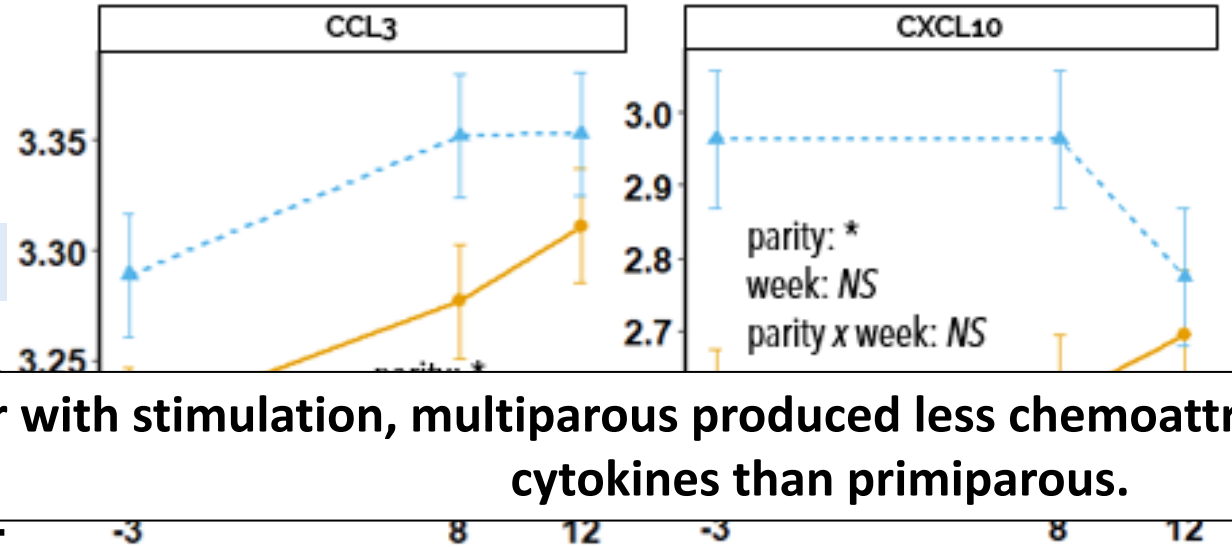


Cytokine production in blood with *ex vivo E.coli* stimulation



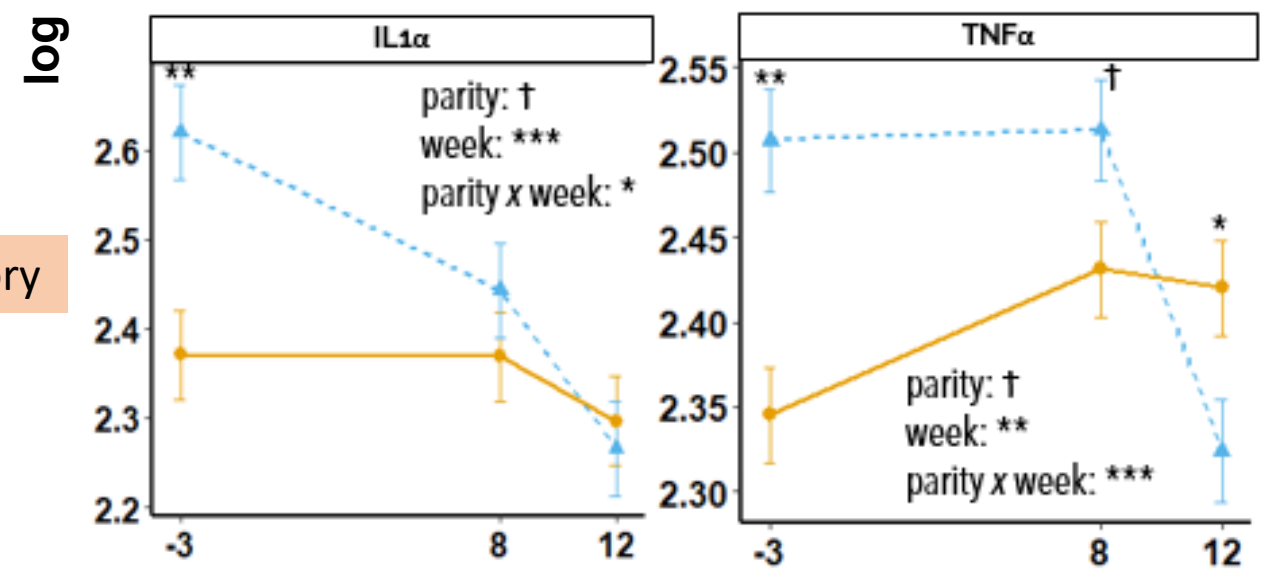
primiparous
multiparous

chemoattractants

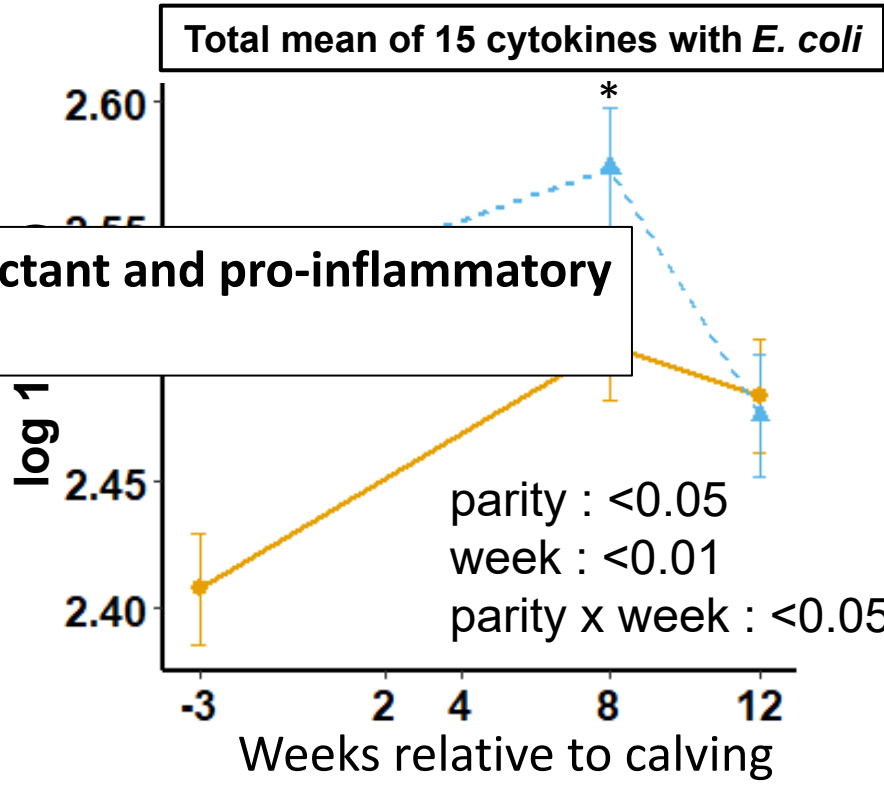


Without or with stimulation, multiparous produced less chemoattractant and pro-inflammatory cytokines than primiparous.

pro-inflammatory



Weeks relative to calving



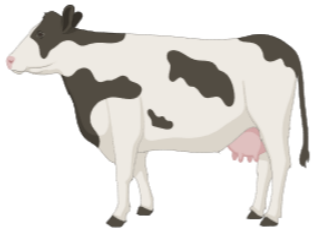
Take home message about the physiological differences between multiparous and primiparous

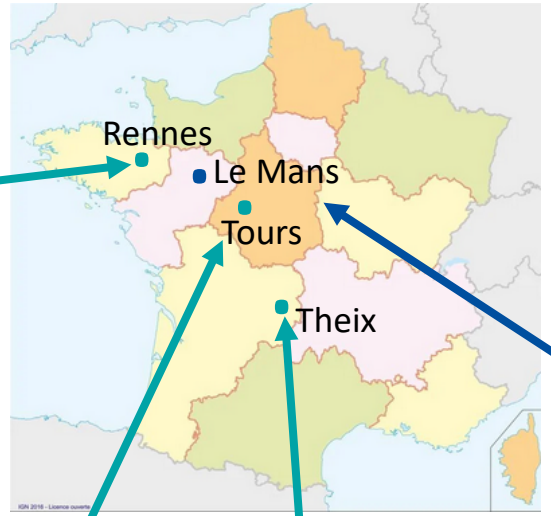
	multiparous	primiparous	
Metabolic biomarkers	+++ milk production	+	➔ Already shown in the litterature
Redox balance	+++ oxidative stress & antioxidant capacity	+	➔ Some studies did not always show this difference
Immunity	+	+++ immune capacity & inflammation	➔ 1st study to show an effect of parity on a panel of cytokines

Multiparous ≠ Primiparous

Perspective:
What **nutritional strategies** should be given **to multiparous and/or primiparous** to improve antioxidant and anti-inflammatory capacities and avoid **pathologies** during early lactation?

Thank you for your attention





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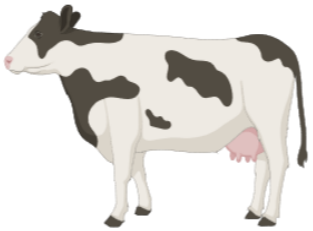
Supplementary data



primiparous
multiparous