



THE ESSENTIAL FATTY ACIDS

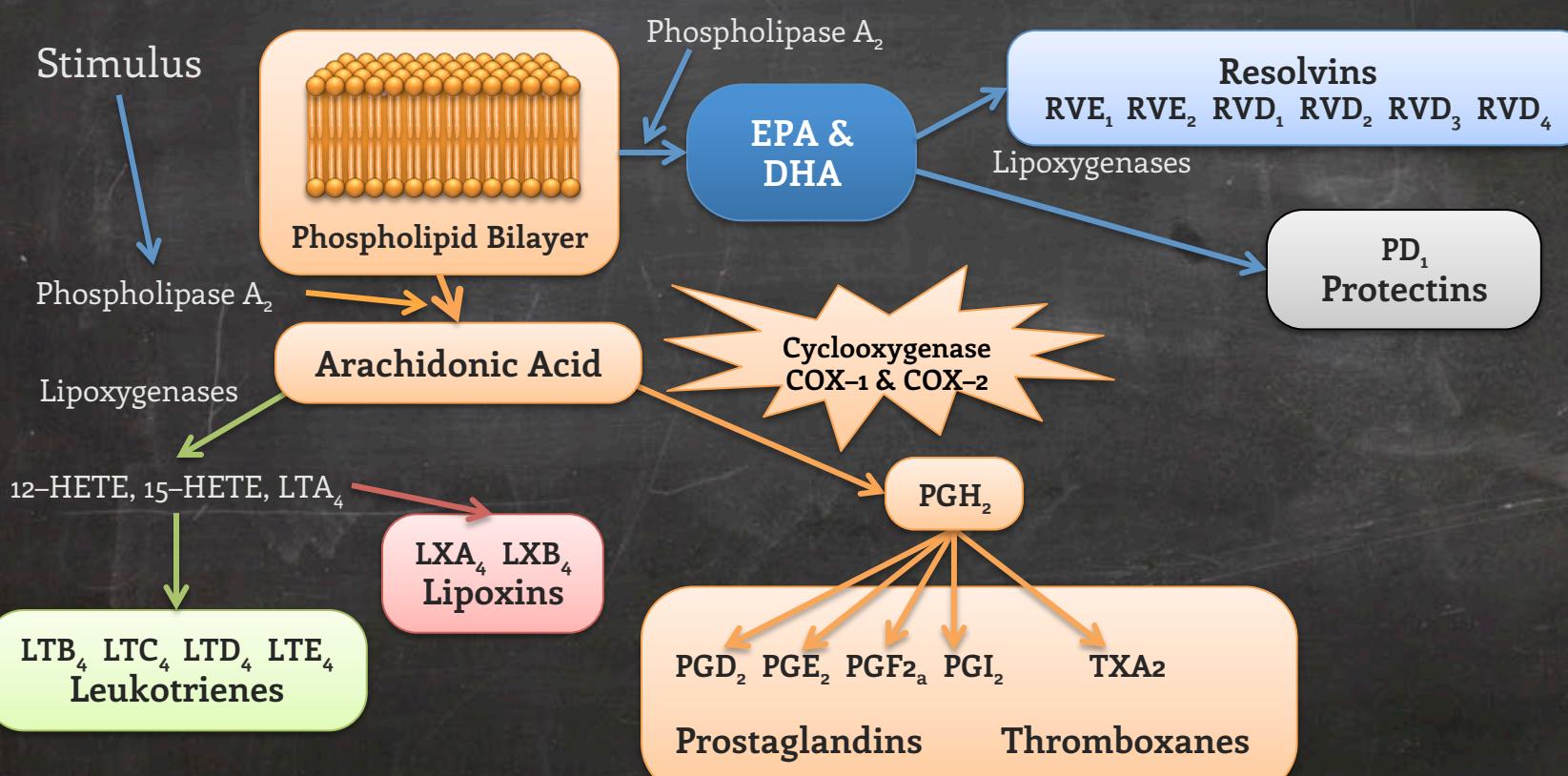
What are the Key Functions of Essential Fatty Acids in Bovine Tissues?

Charlie Staples, Professor
Department of Animal Sciences



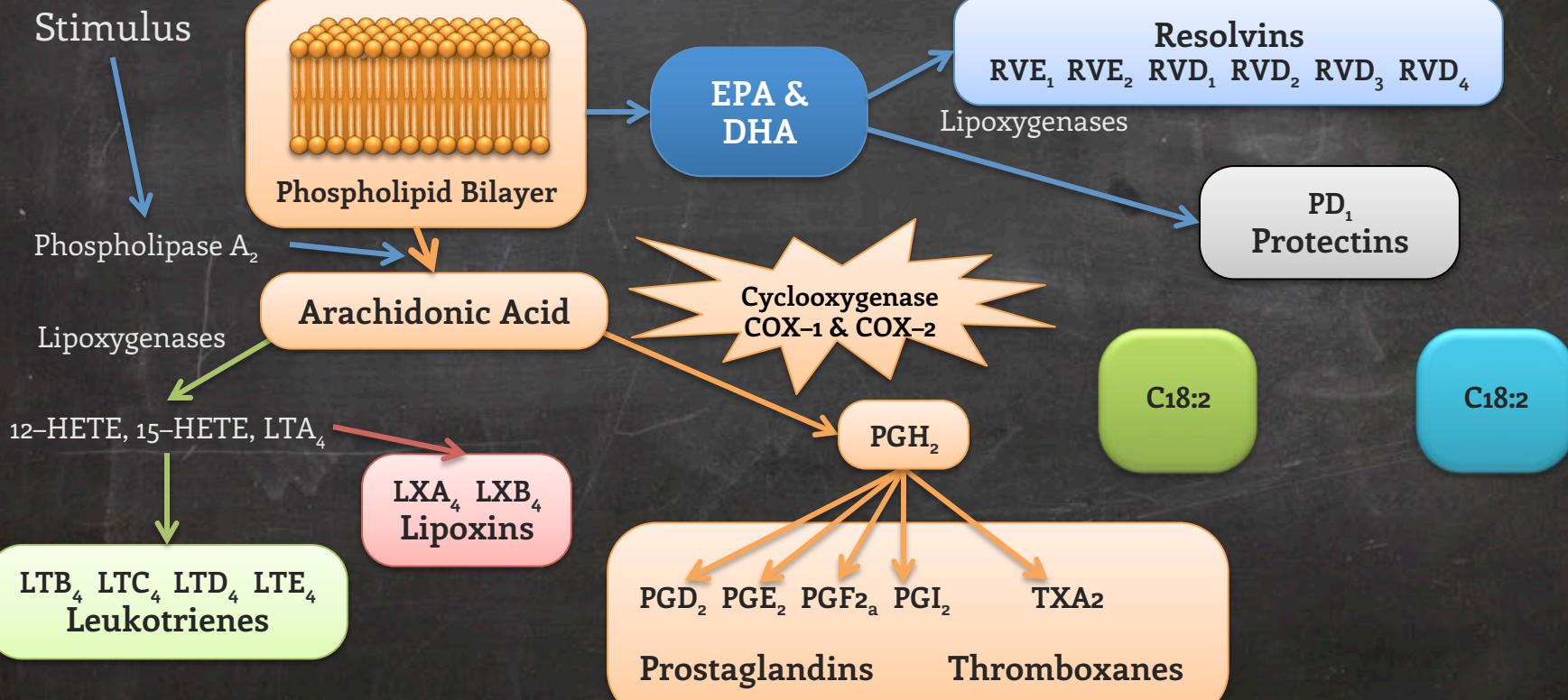
THE ESSENTIAL FATTY ACIDS

Essential Fatty Acids are Synthesized into Eicosanoids



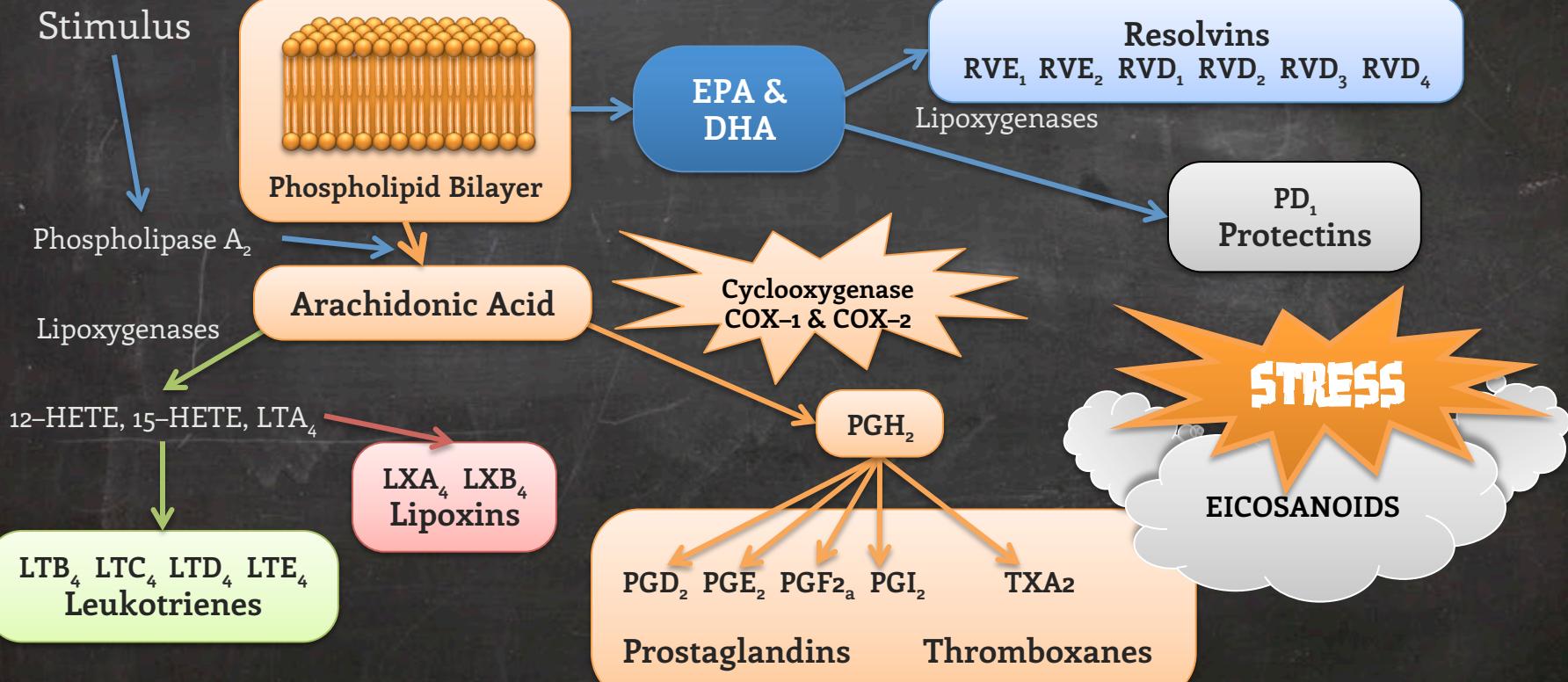
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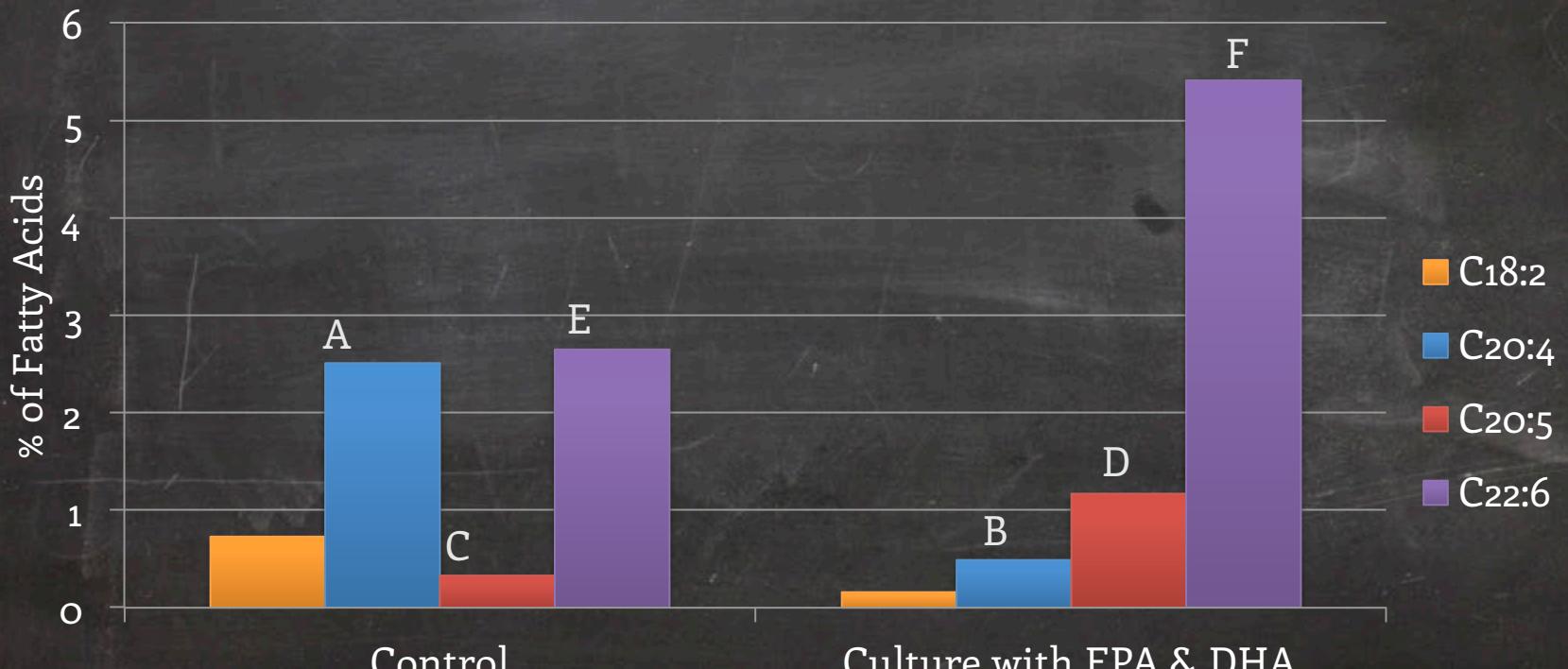
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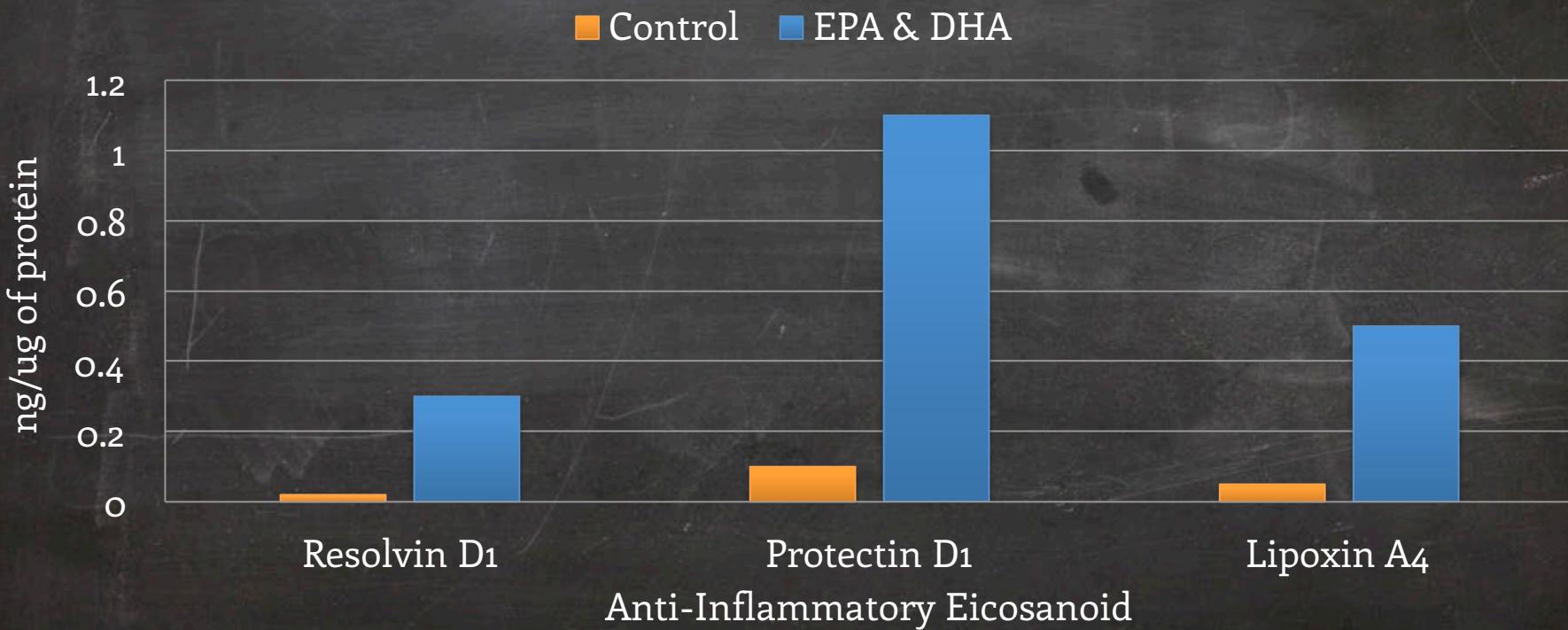
Fatty Acid Makeup of Bovine Aortic Cells Incubated Without or With EPA (C₂₀:5) & DHA (C₂₂:6)



Bars of the same color with different letters are different, $P < 0.05$

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Bovine Aortic Cells Cultured With EPA & DHA Produced More Anti-Inflammatory Eicosanoids

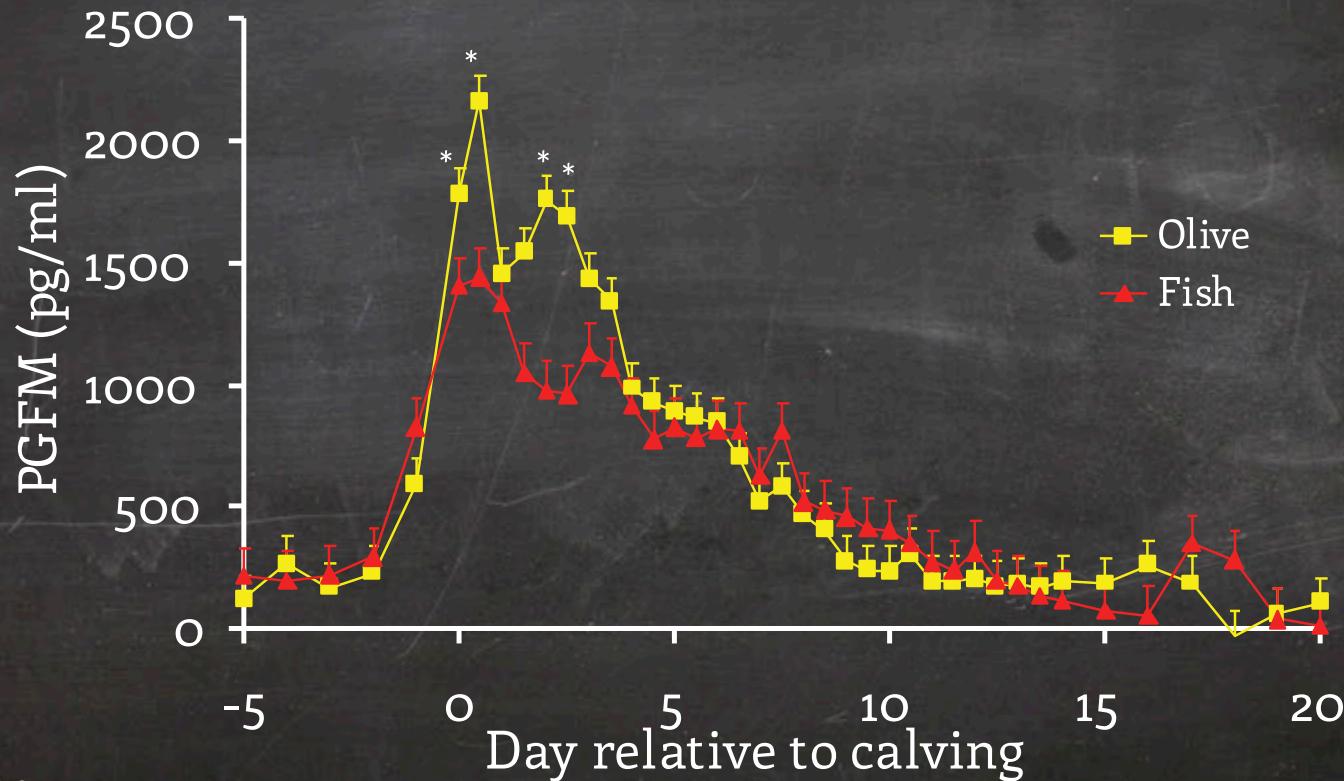


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Fatty Acid Profile of Caruncles of Dairy Cows Fed
Olive Oil or Fish Oil Starting 21 Days Prepartum

Fatty Acid	Olive Oil	Fish Oil
	% of Total FA	
C18:2	12.2 ^a	9.3 ^b
C20:5	0.2 ^a	1.7 ^b
C22:6	0.6 ^a	3.1 ^b

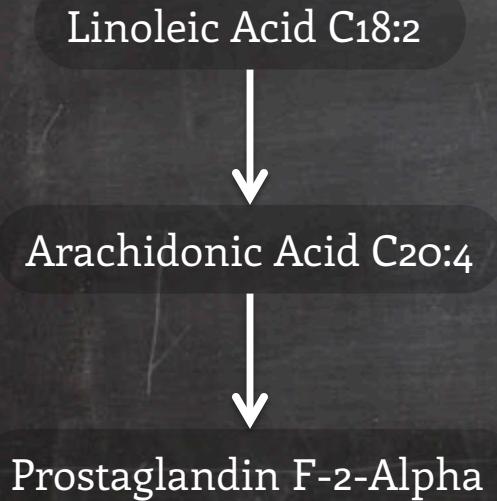
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Circulating PGF_{2 α} Was Suppressed Post-Partum When Dairy Cows Were Fed Fish Oil Pre-Partum



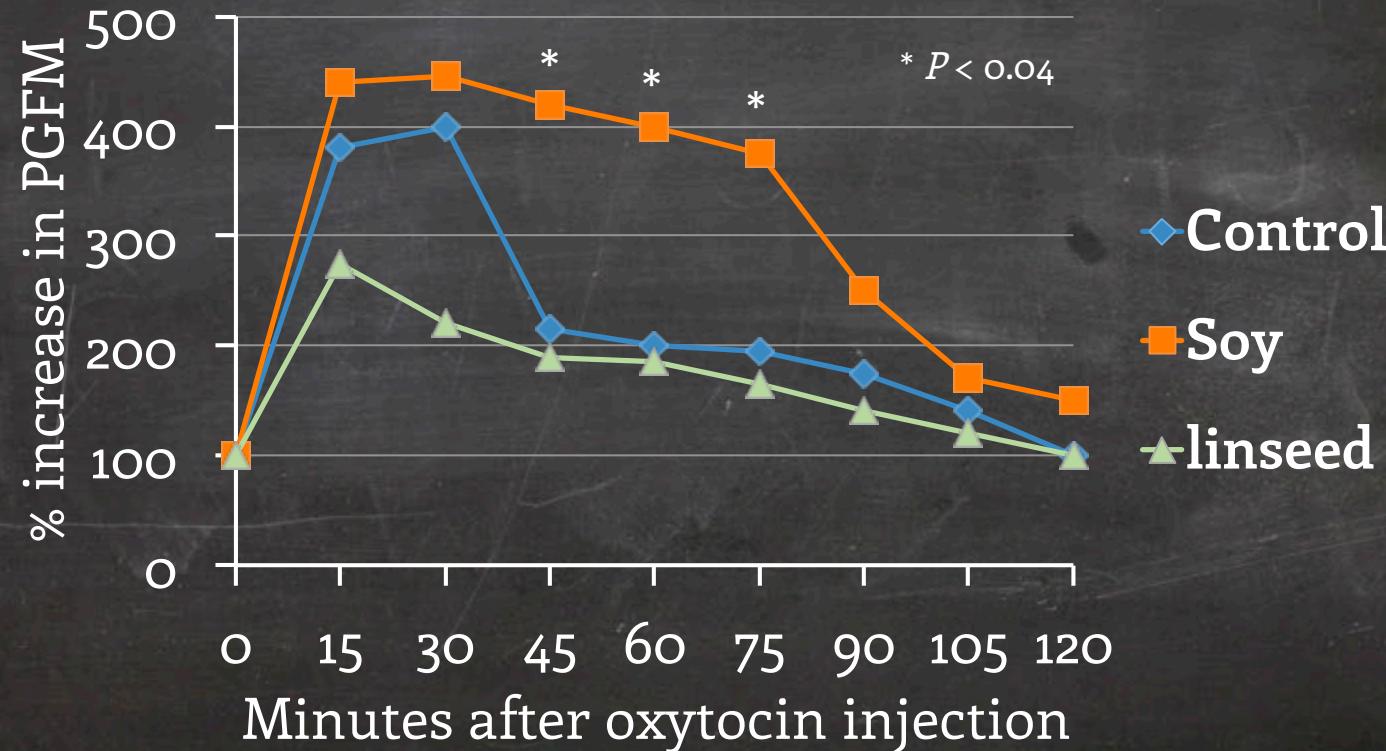
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Can Supplementation with Linoleic Acid Increase PGF_{2α}?



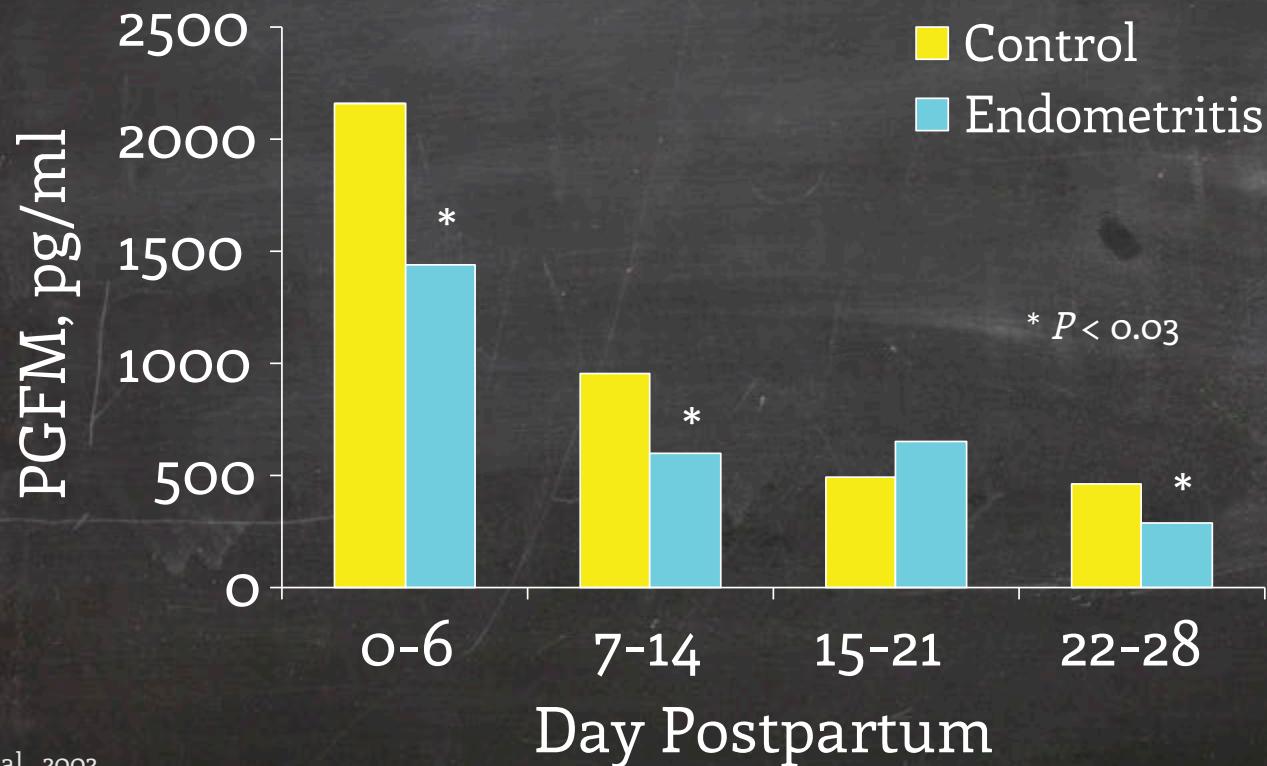
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Fat Source Influenced Response of PGF-2-alpha to Oxytocin Challenge of Dairy Cows



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Plasma Concentrations of Prostaglandin F Metabolite of Dairy Cows With or Without Endometritis



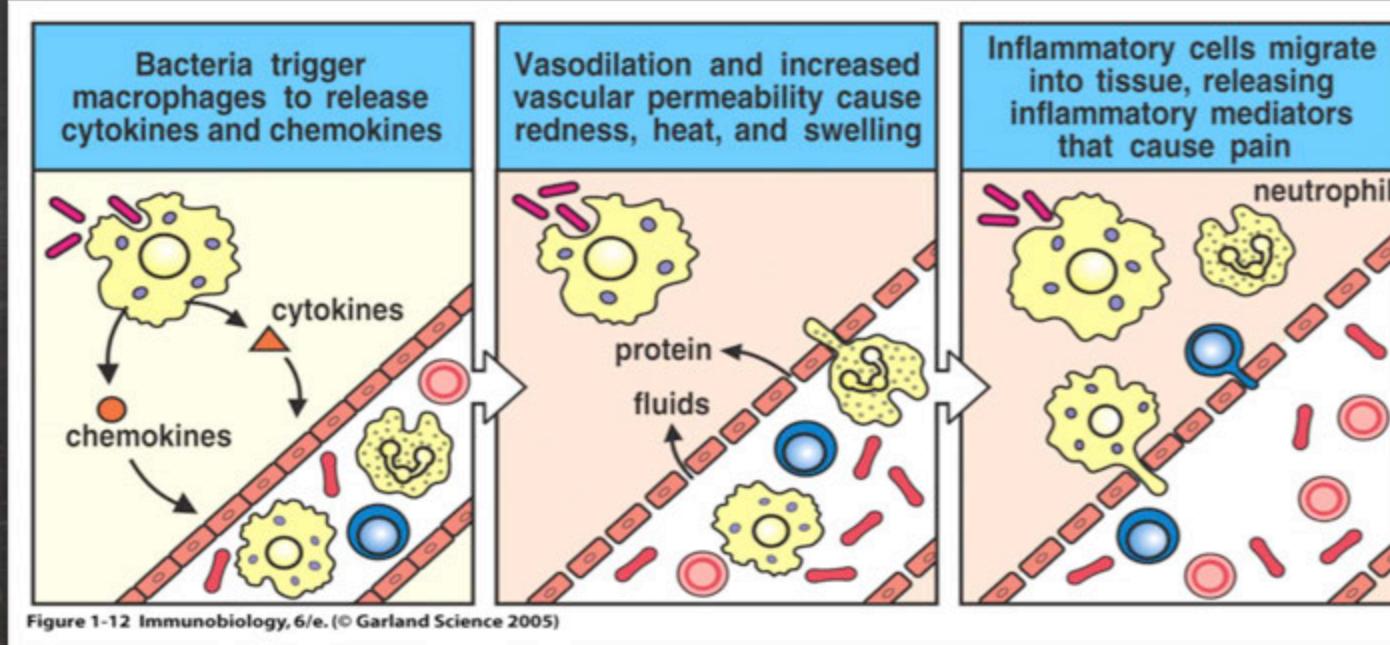
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Effect of Dietary Fat Source on Uterine Health

	Dietary Fat		<i>P</i> =
	Palm	Linoleic	
Cows, n =	246	255	
Plasma PGFM at 1 day in milk, nmol/L	6.0	16.5	0.07
Puerperal metritis, %	15.1	8.8	0.08
Uterine involution, day			
Primiparous	26.8	26.5	—
Multiparous	28.4	25.2	0.09

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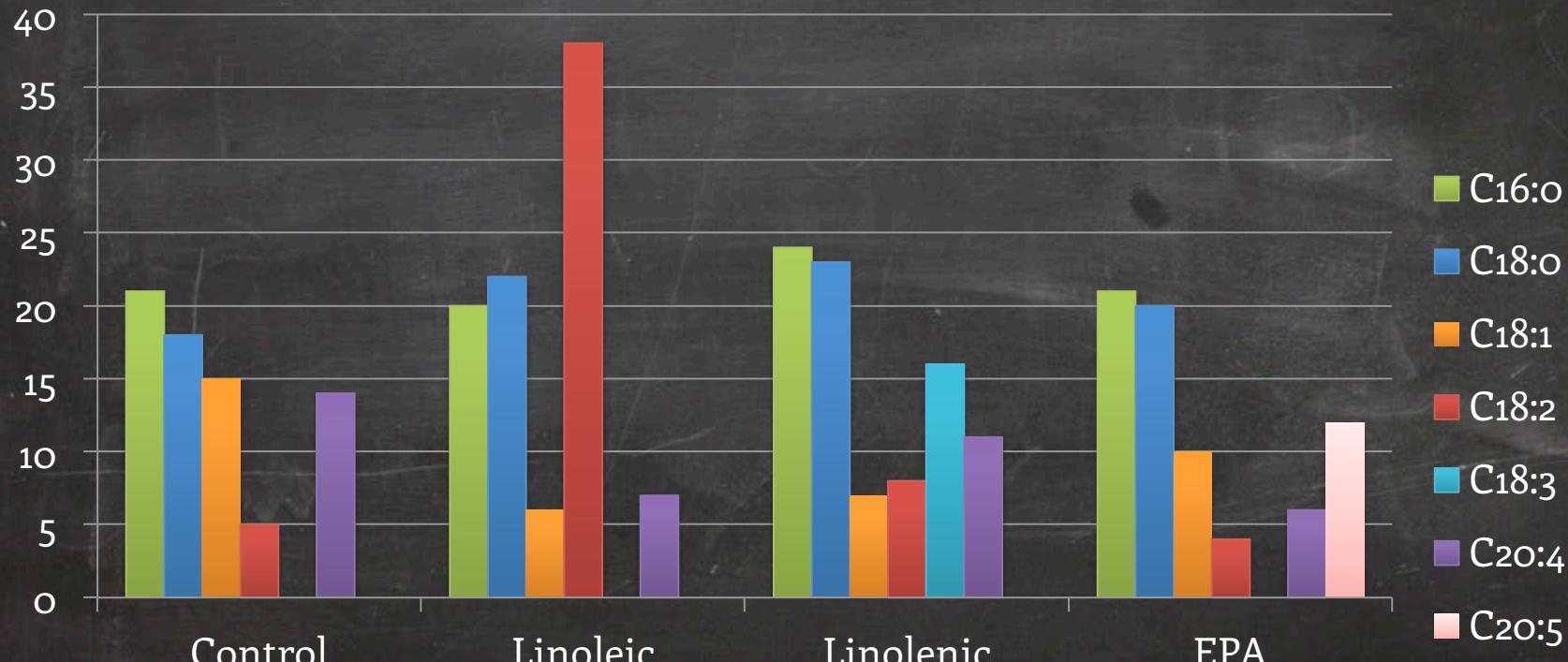
Eicosanoids and Cytokines are Rapidly Produced When Macrophages are Activated by Pathogens



Many Cytokines exist including Tumor Necrosis Factor-alpha (TNF α), several interleukins (IL), and interferon gamma (IFN γ)

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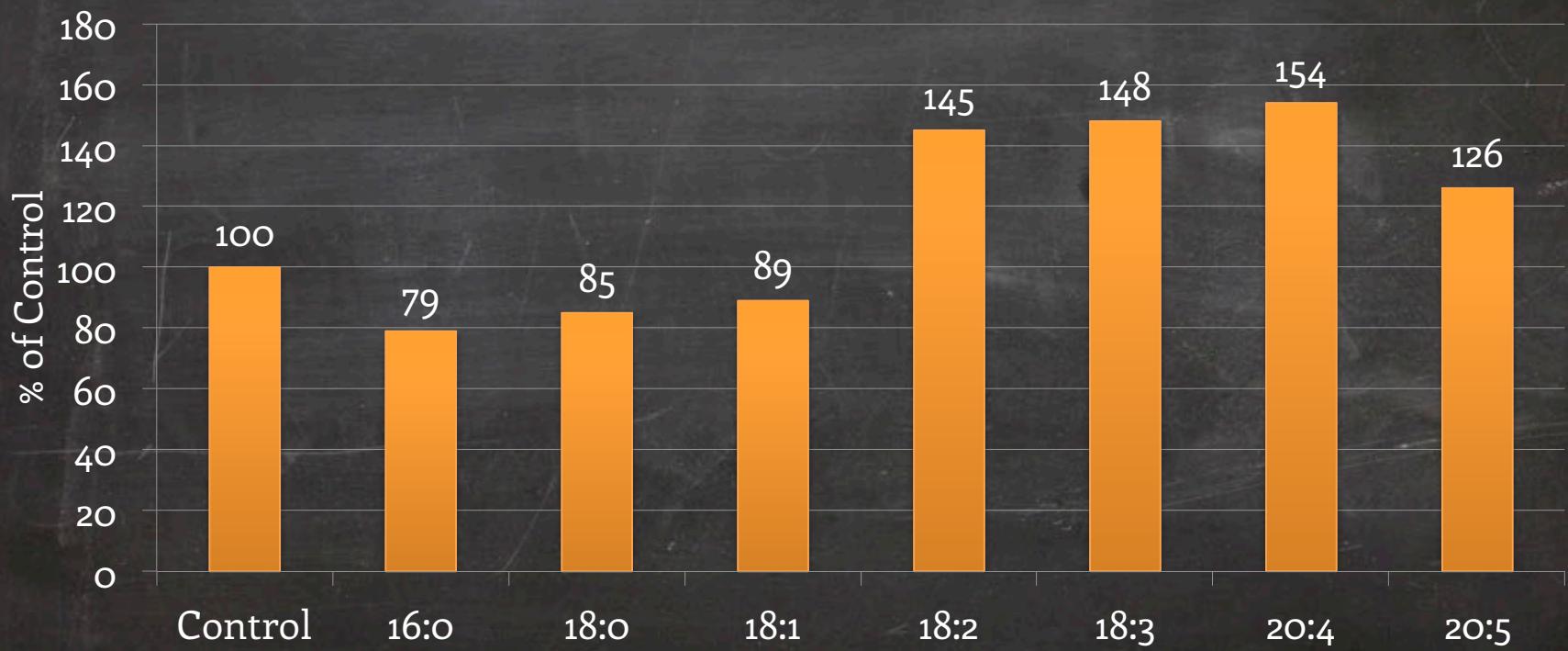
Fatty Acid Makeup of Mice Macrophages Incubated With Various Fatty Acids



Calder et al., 1990

THE ESSENTIAL FATTY ACIDS

Fatty Acid Makeup of Mice Macrophages Incubated With Various Fatty Acids



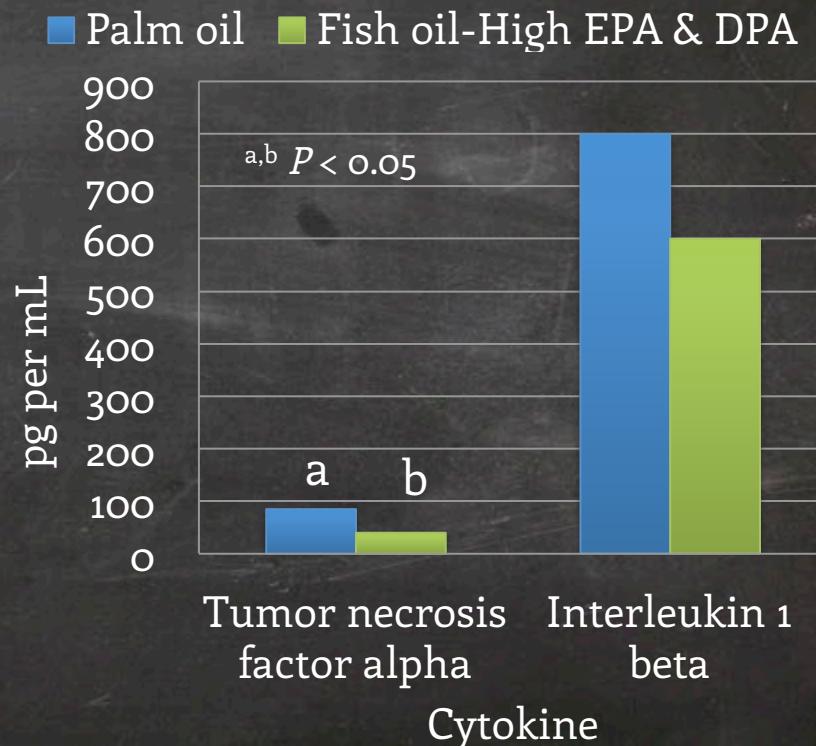
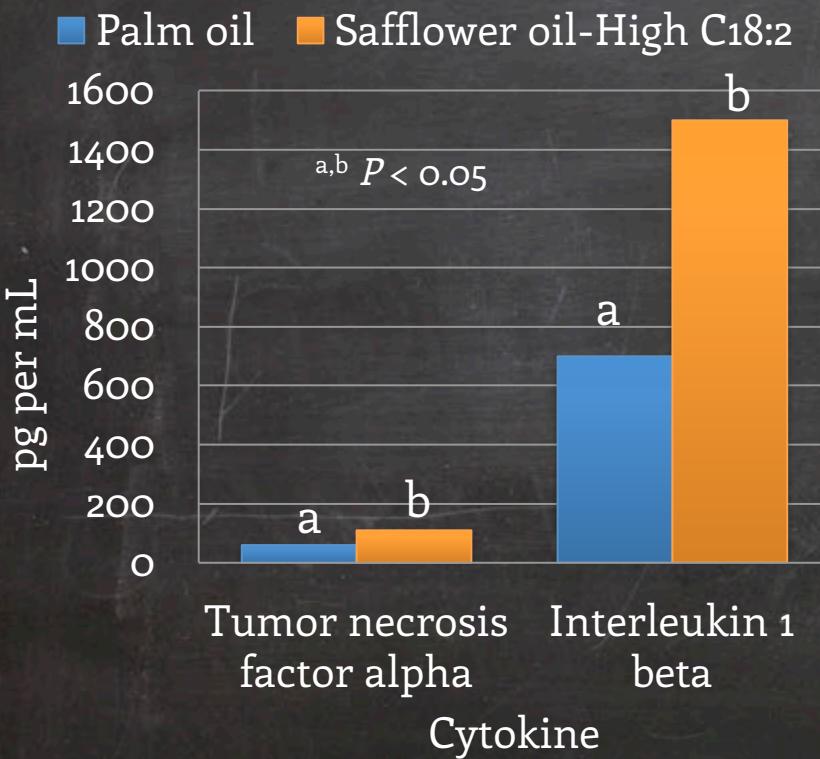
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Types, Sources and Roles of Cytokines

- Many Cytokines
 - Tumor necrosis factor-alpha (TNF α)
 - Interleukins
 - Interferon-gamma (IFN γ)
- Sources
 - Produced by macrophages and neutrophils in response to pathogens
- Functions
 - Affect the behavior of other cells
 - Initiate inflammation – heat, pain, redness, swelling

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Production of Cytokines by LPS-Stimulated Blood Neutrophils from Lactating Dairy Cows fed Different Fats



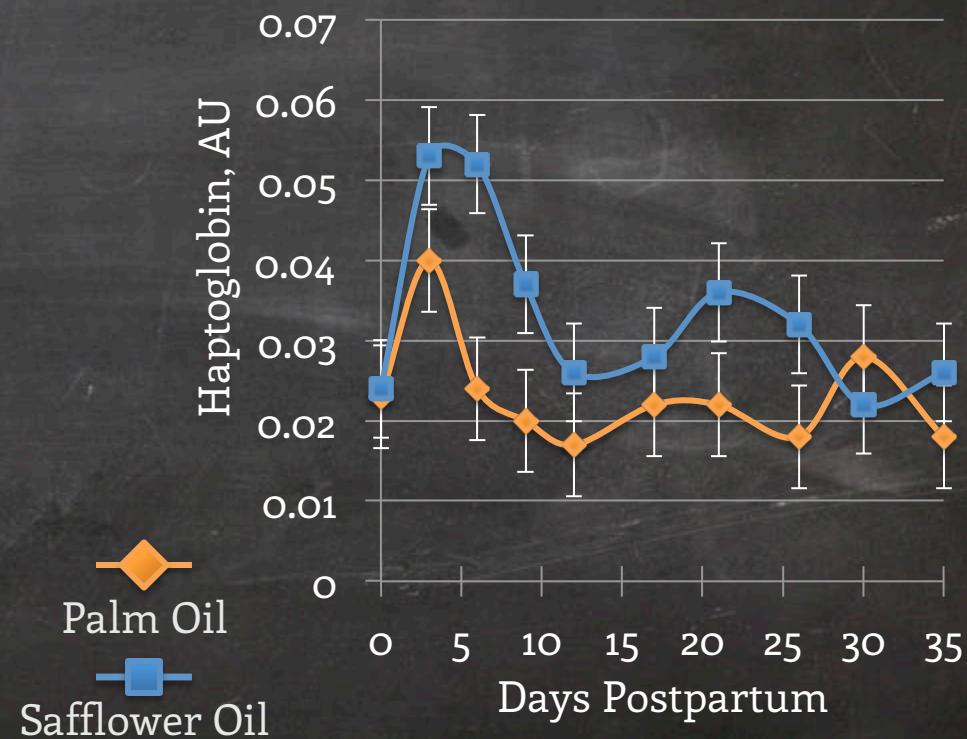
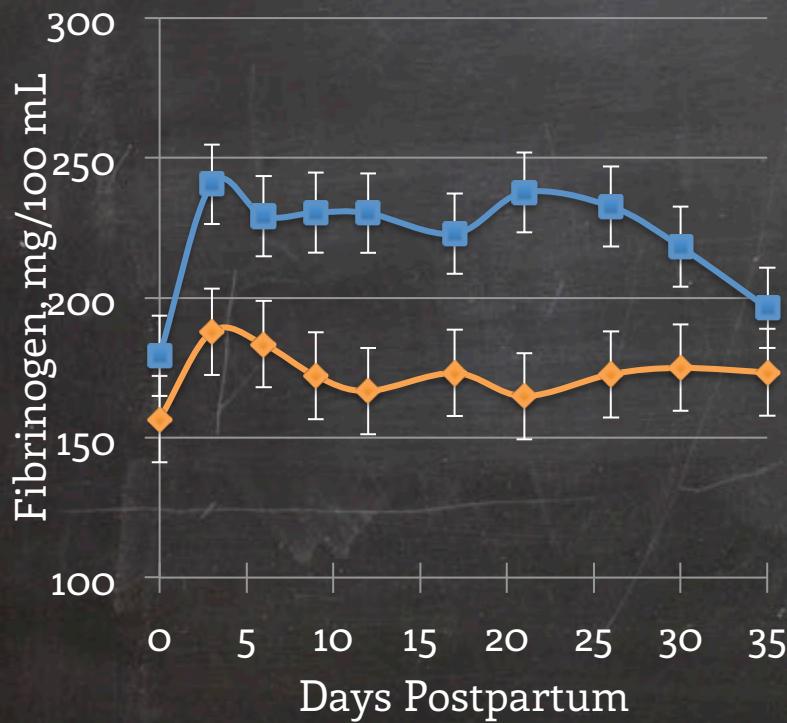
THE ESSENTIAL FATTY ACIDS Cytokines: TNF- α and Interleukin-1

Influence the Whole Body

- Bone marrow – produce neutrophils
- Hypothalamus – elevation of body temperature
- Fat and muscle tissue – mobilization for energy
- Liver – produce acute phase proteins
 - Haptoglobin, fibrinogen, ceruloplasmin, acid soluble protein

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Supplementing n-6 Fatty Acids Increased Circulating Concentrations of 2 Acute Phase Proteins in Lactating Holsteins



THE ESSENTIAL FATTY ACIDS Sole Immune Responses to Diseases

Disease / Disorder	Immune Responses
Mastitis / increasing SCC	↑ in neutrophils, TNF- α , and COX-2
Endometritis	↑ in neutrophils in uterine fluid
Fatty liver	↑ in haptoglobin and bilirubin; ↓ TNF- α
Sick or stressed calves	↑ in haptoglobin and fibrinogen

Mastitis: Sarikaya et al., 2006; Endometritis: Kasimanickam et al., 2004;
Fatty liver: Ametaj et al., 2005; Sick calves: Deignan et al., 2000; Berry et al., 2004

THE ESSENTIAL FATTY ACIDS

Summary of Functions of Essential Fatty Acids

- Precursors of eicosanoids
 - hormone-like intracellular mediators of inflammation
 - Help regulate blood flow
 - Recruit neutrophils and monocytes to infection sites
 - Help control production of cytokines and acute phase proteins
 - Prostaglandins can affect reproductive function & health