Energy and Glucose Challenges During the Transition Period for Dairy Goats and Cattle

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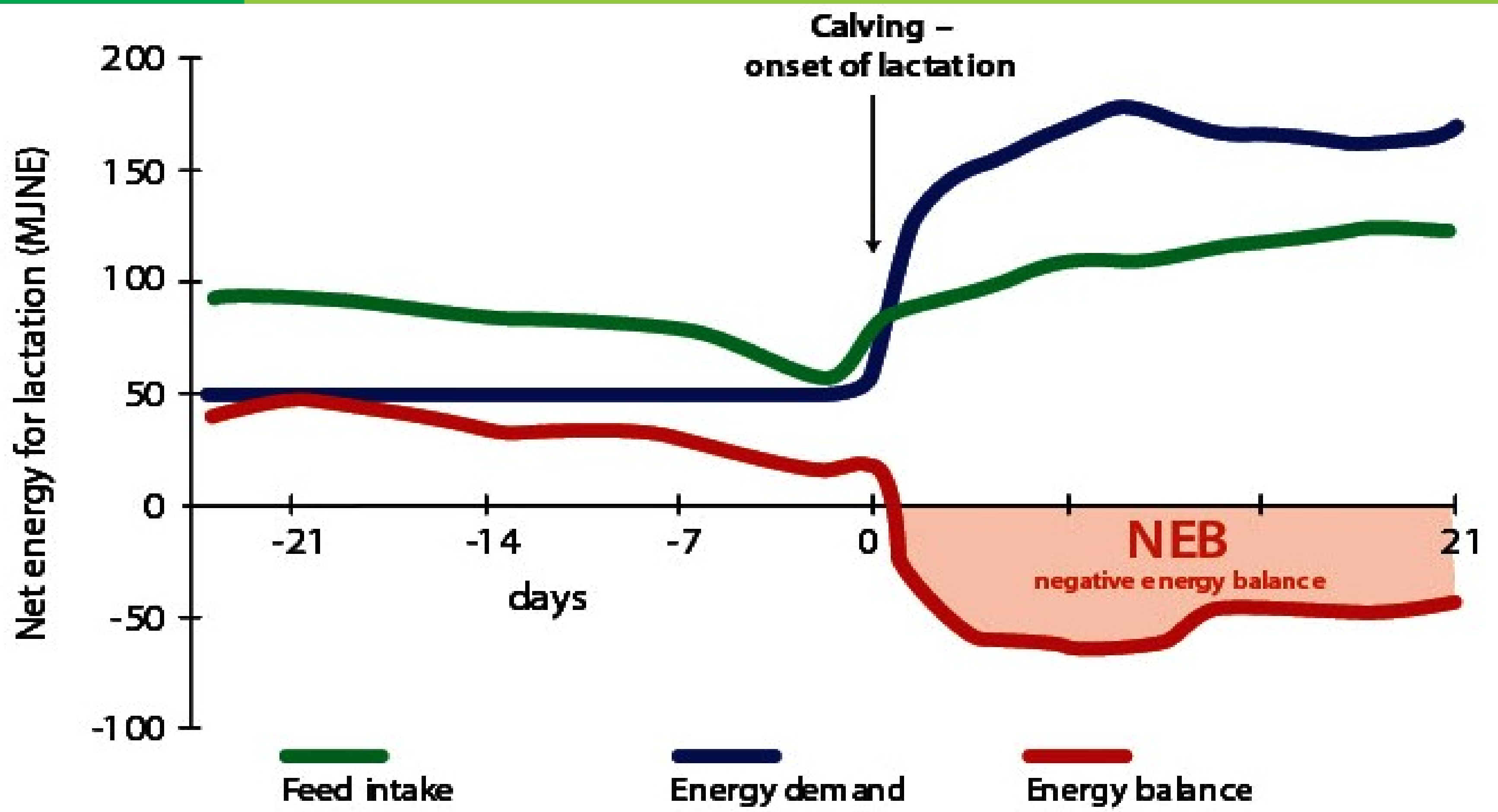
Energy Balance of the Transition Cow

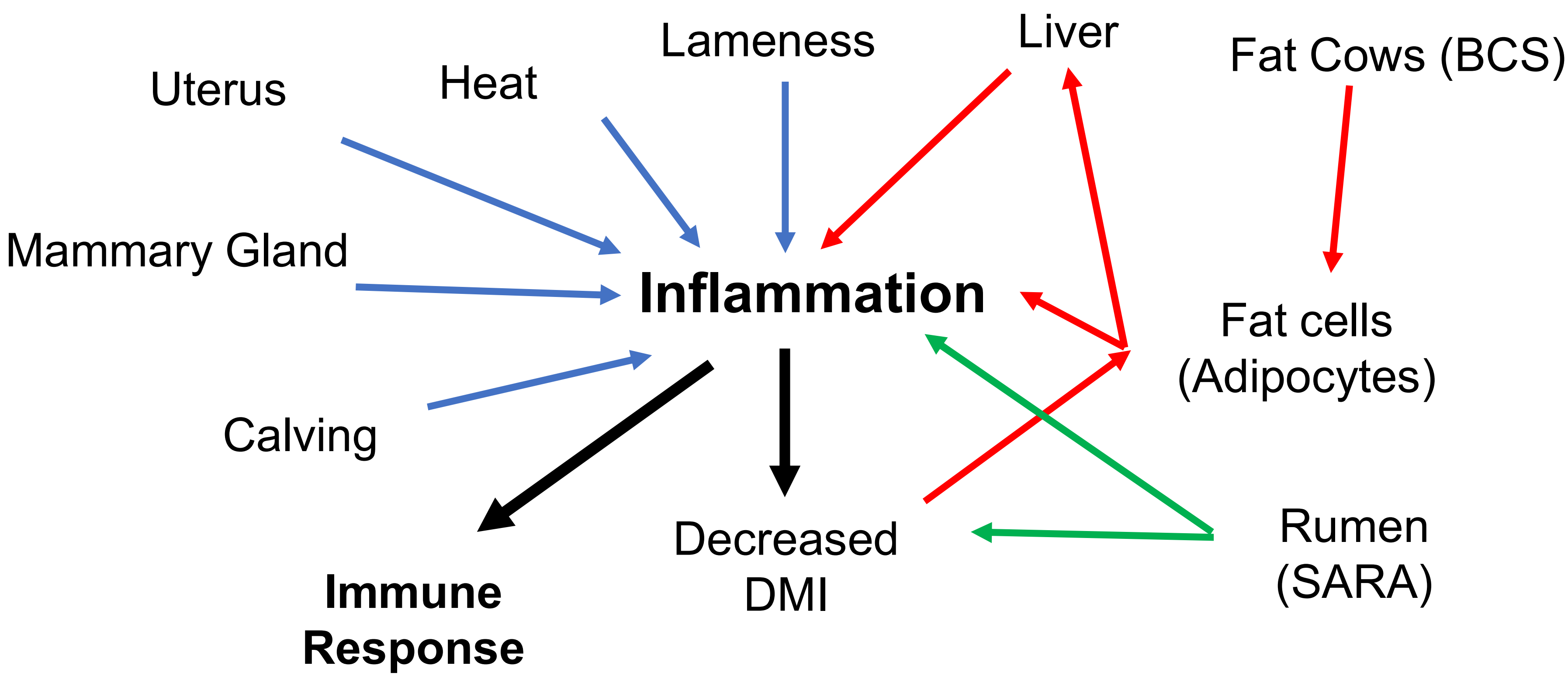


Energy balance of a dairy cow (modified according to IWERSEN et al, 2015)

Transition Challenges: -3 weeks to 3 weeks Post-freshening

- Characterized by reduced feed intake and increased nutrient demand (Grummer, 1995)
- Glucose is needed for fetal growth, immune function, colostrum production, milk production, reproduction
- The major transition challenge for ruminants is inadequate blood glucose (Herdt, 2000; Rook, 2000)
- Glucose must be produced in the liver for ruminants
- The liver must have the appropriate glucose building blocks

39th Discover Conference
The Transition Cow – From Physiology to Management



The Net Result is Tremendous Demand for Glucose

Dairy Production and Health is Dependent Upon Glucose Availability

The lactating cow prioritizes her glucose usage:

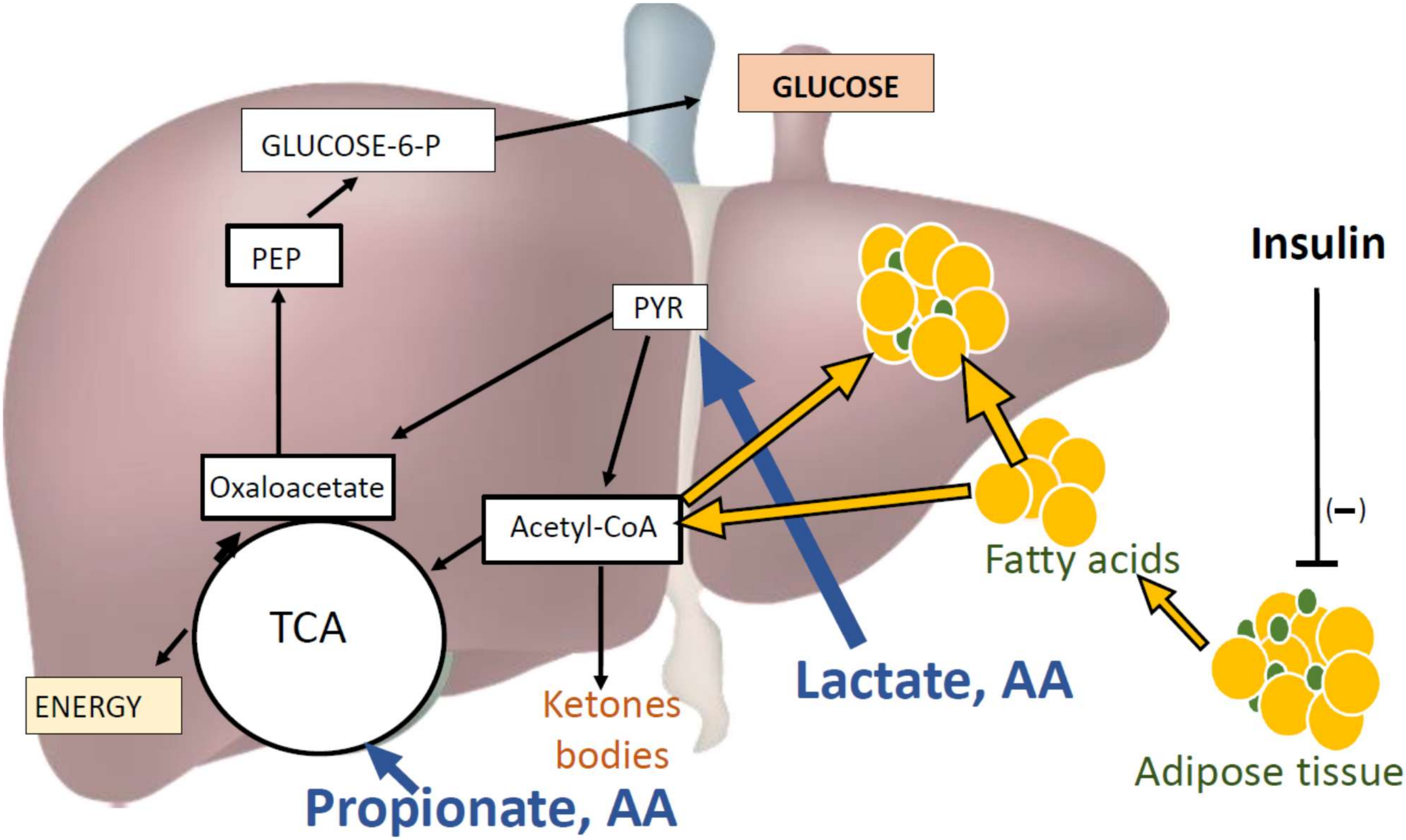
1. Basic metabolism
2. Immune function
3. Milk production
4. Reproduction

- ✓ Higher blood glucose post-fresh related to greater pregnancy at 1st breeding (Gaverick et al., 2013)
- ✓ Uterine health and involution

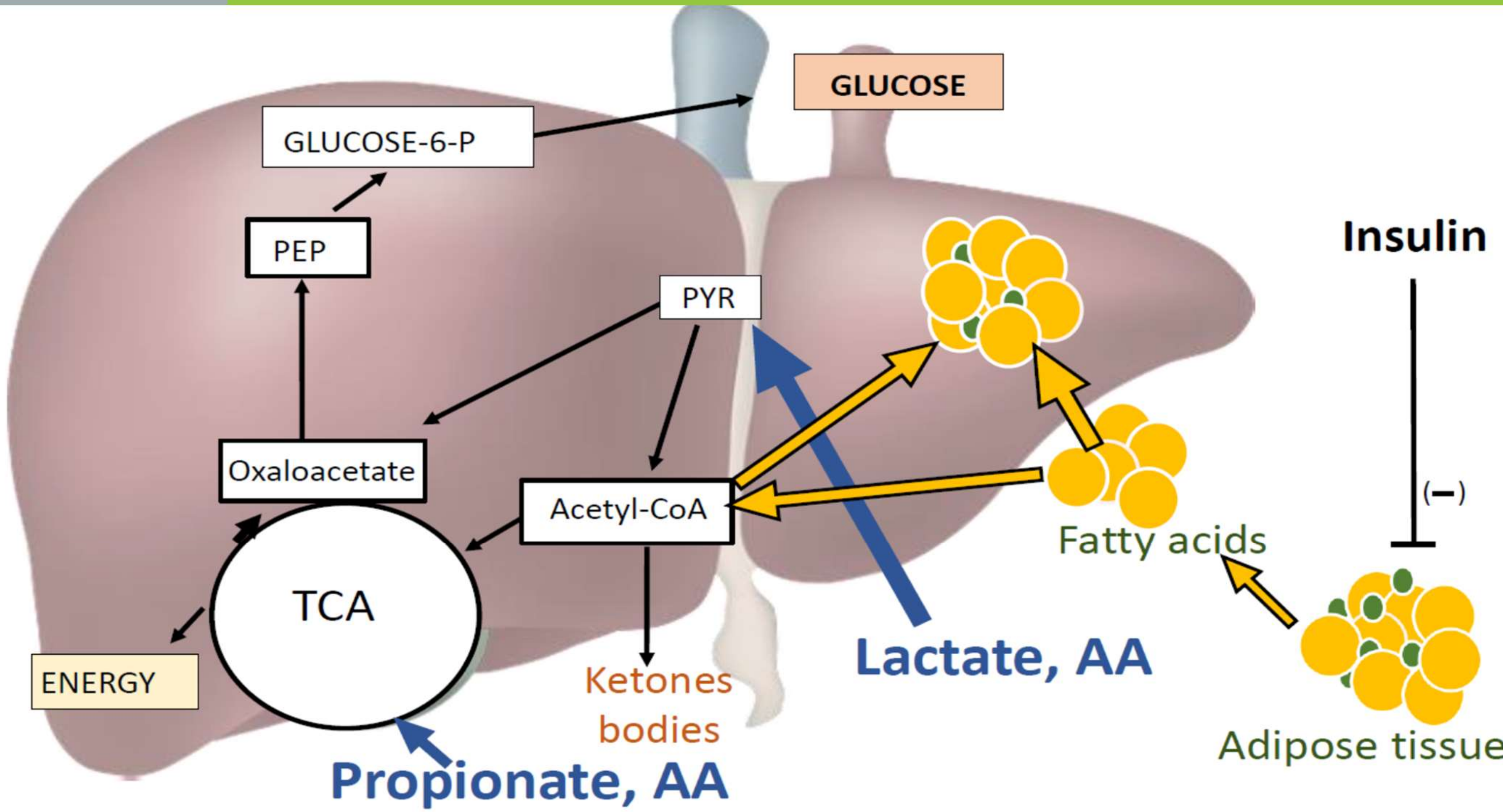
Pregnancy Toxemia and Ketosis

- Pregnancy toxemia: Insufficient glucose or inappropriate glucose building blocks pre-freshening
- Ketosis: Insufficient glucose or inappropriate glucose building blocks post-freshening
  >0.8 mmol BHB/l blood for goats
  1.2 – 2.9 mmol BHB/l blood for subclinical in cattle
- Adaptive Response to glucose shortage (Baumgard et al., 2017)
  - Glucose to fetal growth and milk production
  - NEFA and BHB to peripheral tissues
  - Insulin resistance
- Elevated NEFA and BHB related to variety of disorders (Dore et al., 2015)

Liver Glucose Metabolism in Ruminants

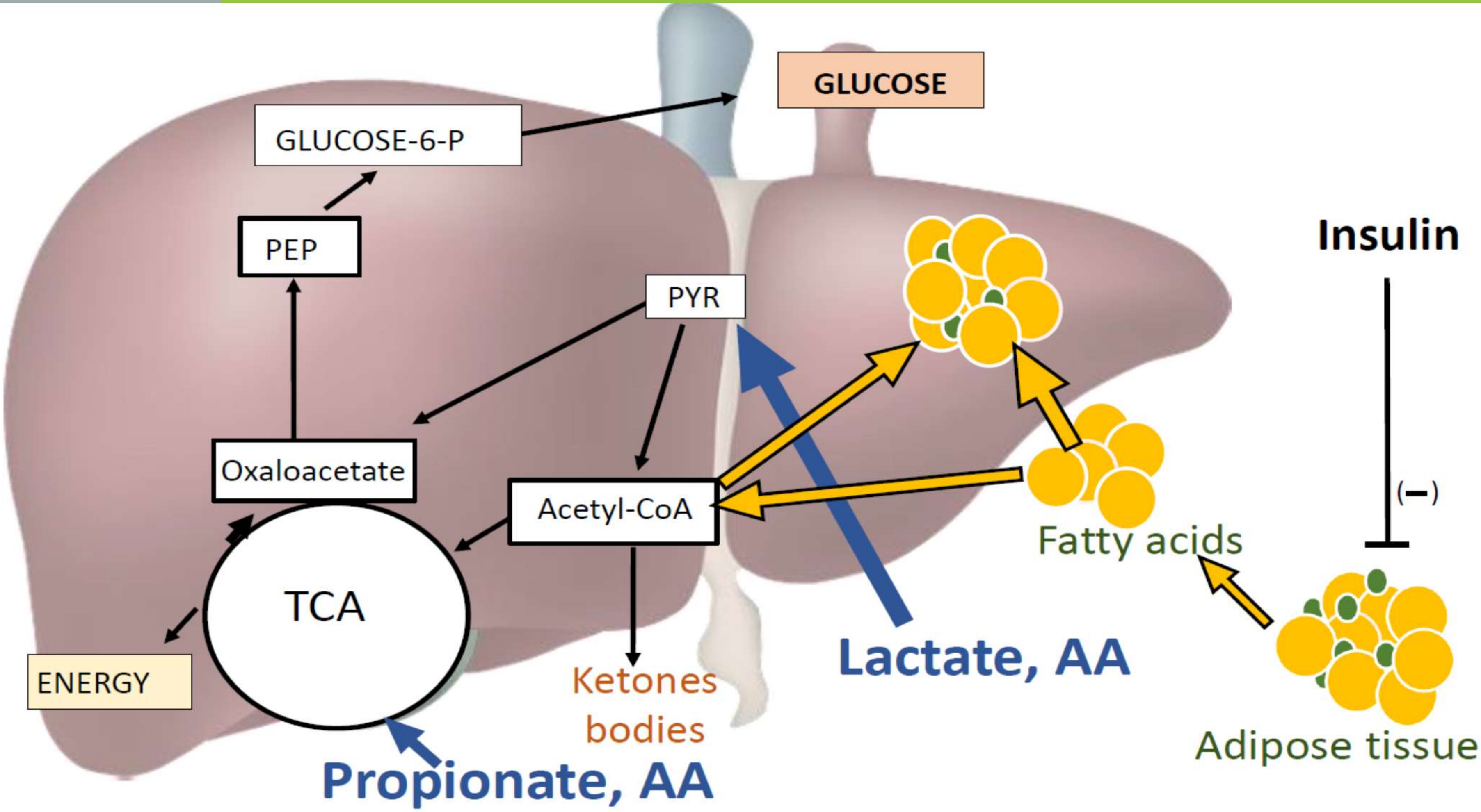


When Life Goes Wrong…



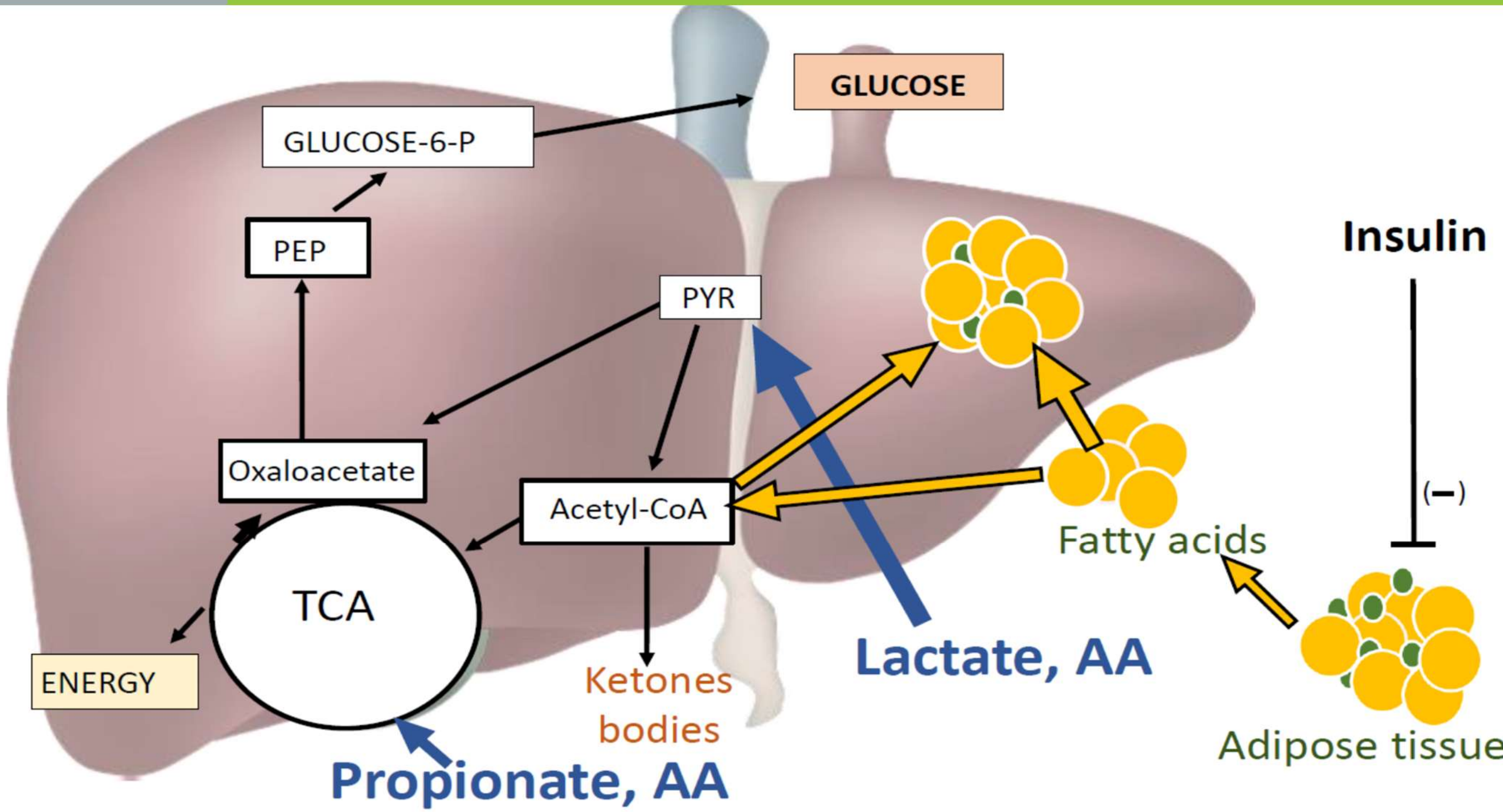
Low feed intake = low propionate production

When Life Goes Wrong…



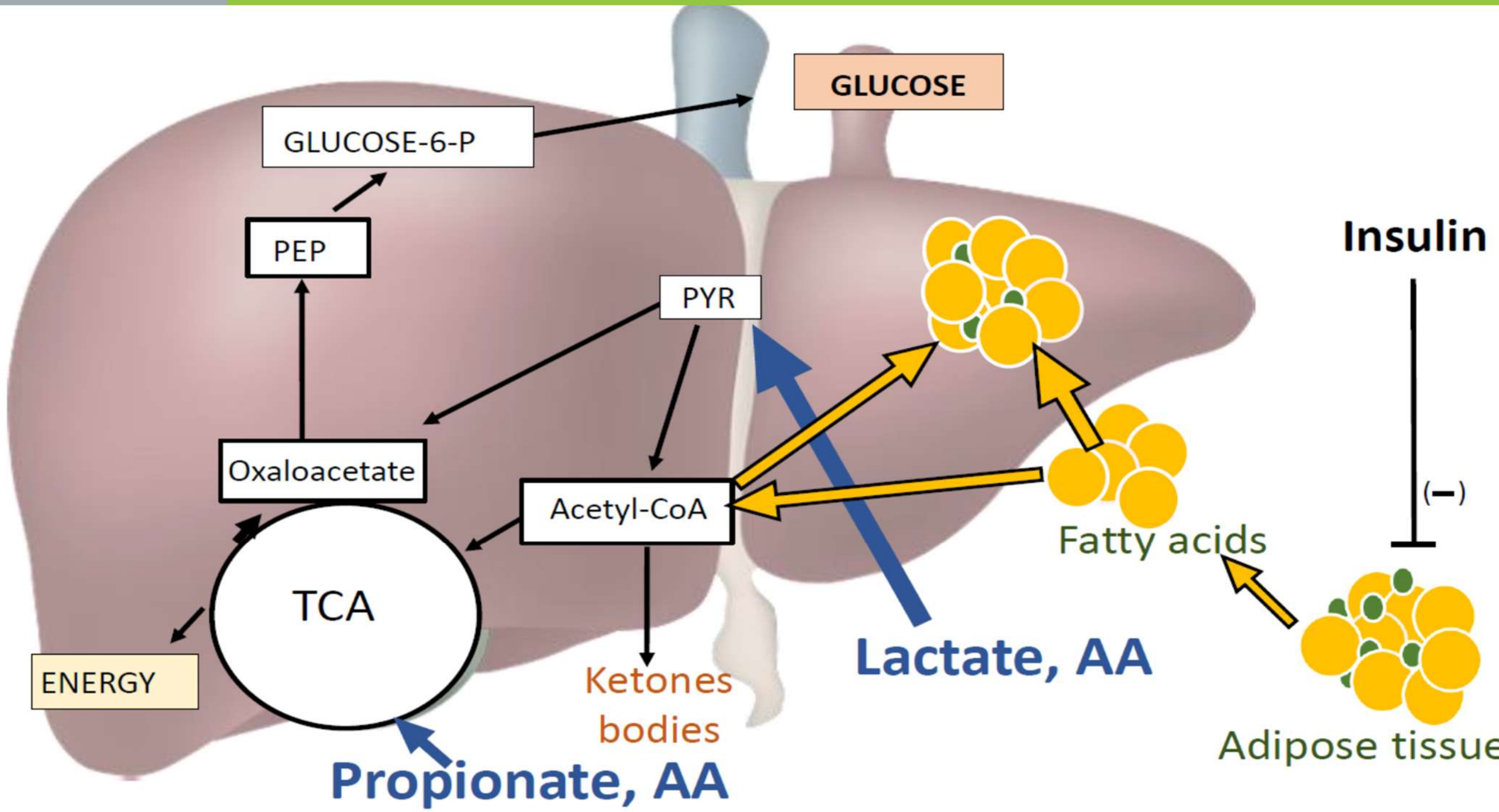
Low propionate = Insufficient propionate to make glucose

When Life Goes Wrong…



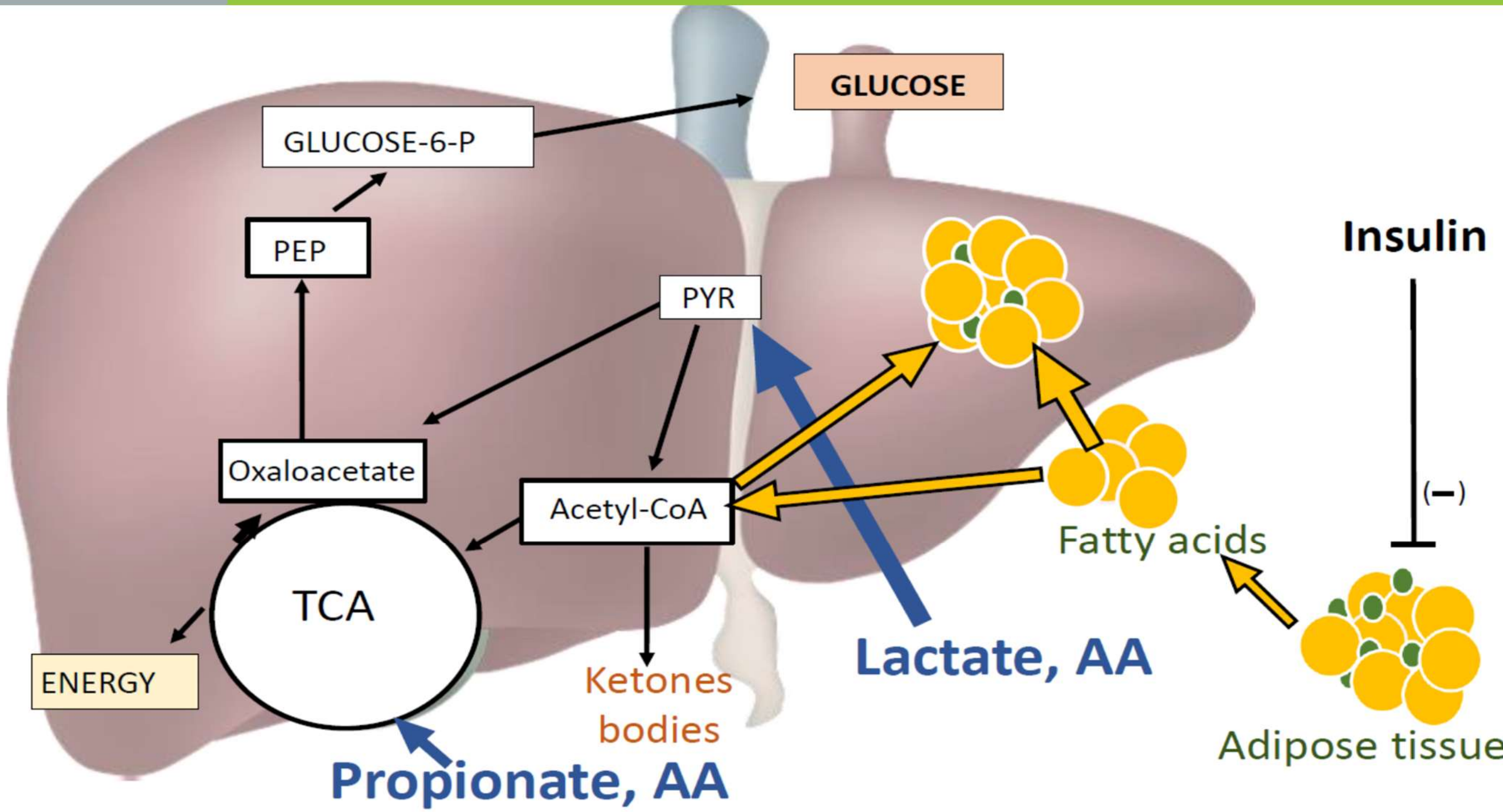
Fatty acids oxidized to make Acetyl-CoA

When Life Goes Wrong…



Excess Acetyl-CoA results in NEFA and Fatty Liver

When Life Goes Wrong…



Excess Acetyl CoA makes BHB = Pregnancy Toxemia/Ketosis

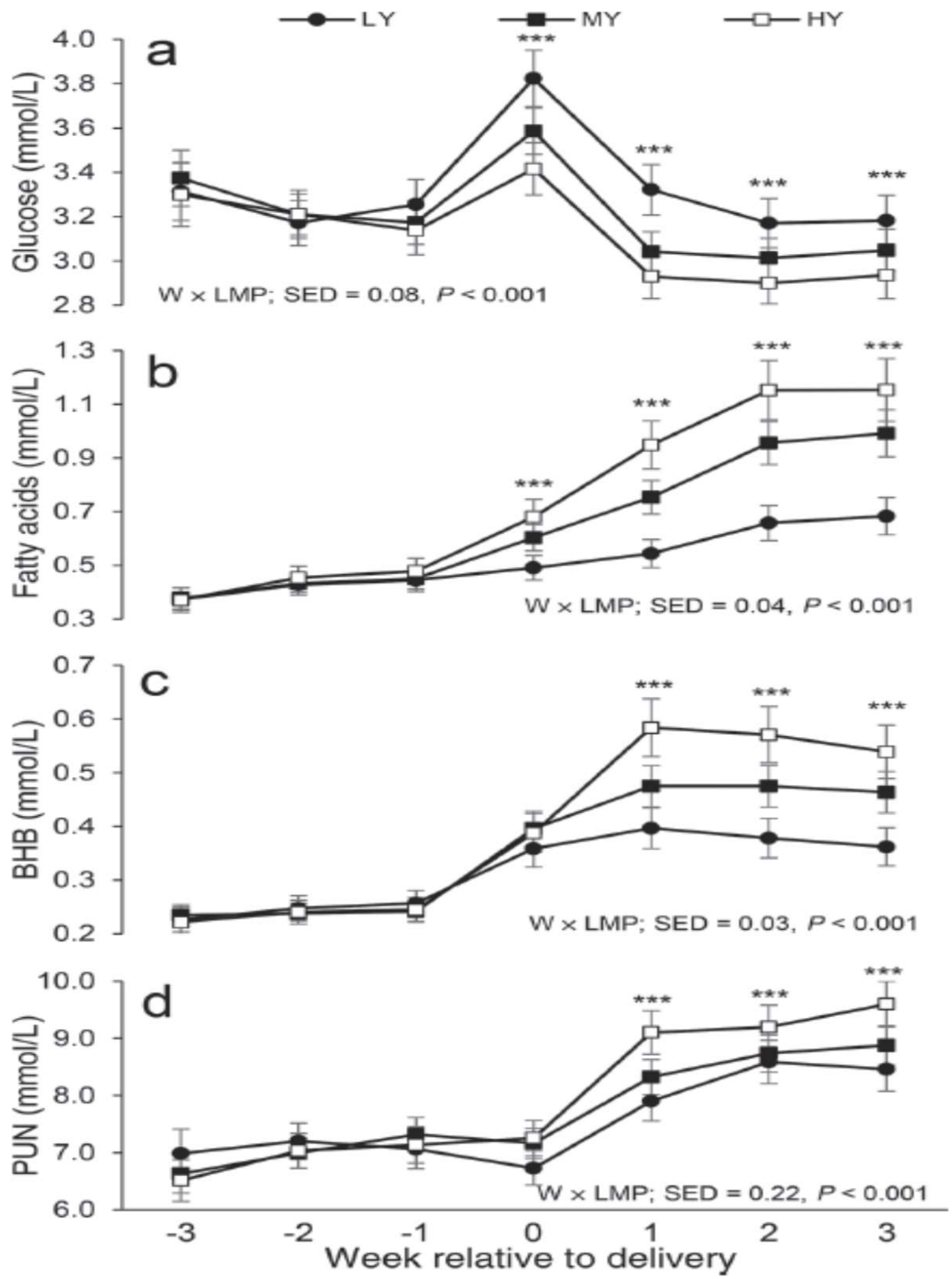
Comparison of Blood Metabolites of Saanen Goats Pre- and Post-Kidding, Different Litter Size and Prima-parous and Multi-parous[1]

Item	LS	Pre-kidding PRIM	Pre-kidding MULT	Post-kidding PRIM	Post-kidding MULT
Glucose	1	3.5	3.3^{AB}	3.2	3.1
	2	3.4^{a}	3.2^{BCb}	3.2	3.1
	3	3.5^{a}	3.1^{Cb}	3.2	3.0
Fatty acids	1	0.29^{b}	0.37^{Ba}	0.57^{b}	0.84^{a}
	2	0.34^{b}	0.47^{ABa}	0.64^{b}	0.83^{a}
	3	0.35^{b}	0.57^{Aa}	0.61^{b}	0.84^{a}
BHB	1	0.18^{b}	0.22^{Ca}	0.30^{b}	0.44^{a}
	2	0.19^{b}	0.25^{Ba}	0.30^{b}	0.45^{a}
	3	0.20^{b}	0.33^{Aa}	0.29^{b}	0.48^{a}
PUN	1	6.9	7.1	7.8^{b}	8.7^{a}
	2	6.8	6.9	7.6^{b}	8.6^{a}
	3	6.9	7.1	7.2^{b}	8.1^{a}

[1]Zamuner et al., 2020.

[ab]Means within a row with different lowercase superscripts differ ($P<0.05$).

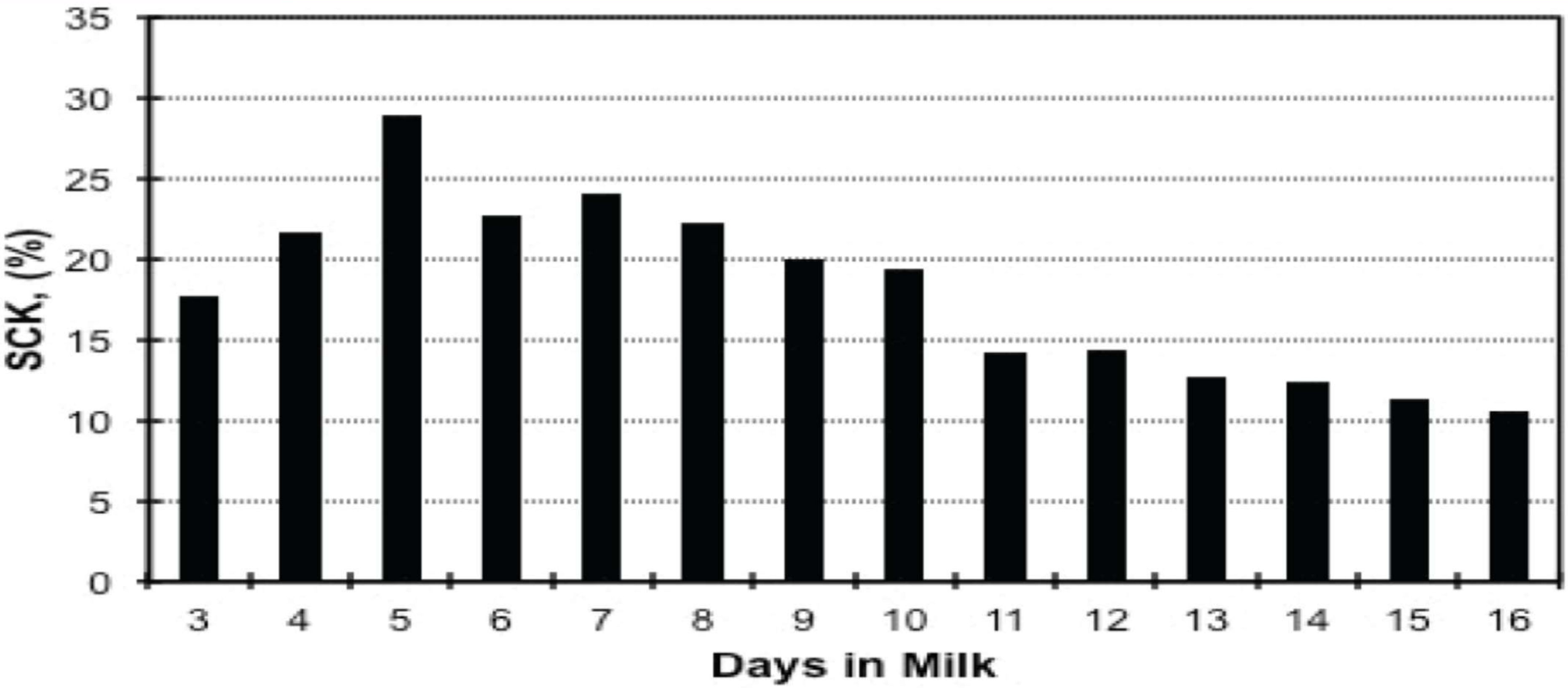
[ABC]Means within a column with different uppercase superscripts differ ($P<0.05$).



Comparison of Low (<2.4 L/d), Medium (2.4 – 3.1 L/d) and High (>3.1 L/d)-yielding Saanen Goats on a Commercial Farm for Blood Metabolites[1,2]

[1]Zamuner et al., 2020.
[2]180-250 goats per group

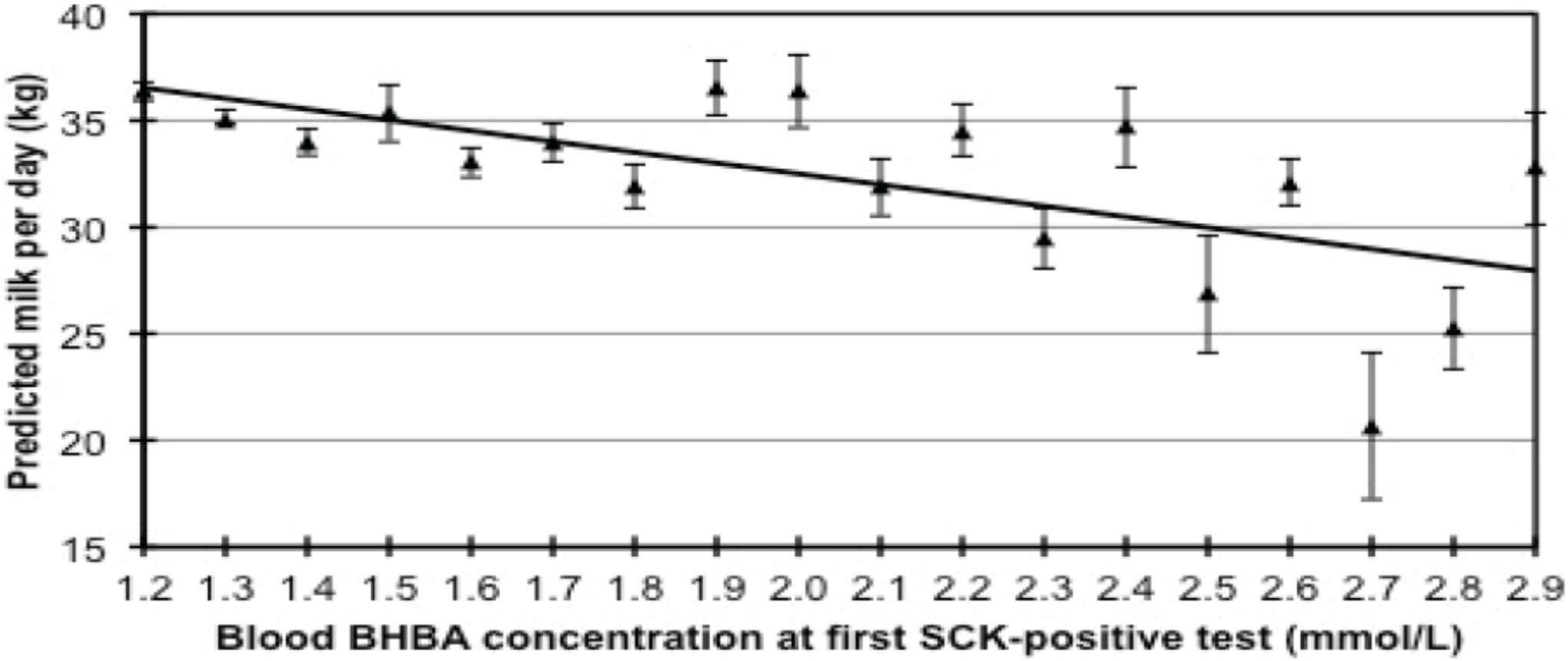
Prevalence of Subacute Ketosis in Holstein Cows[1].



Histogram of prevalence of SCK in 1,717 Holstein dairy cows undergoing repeated testing for ketosis from 3 to 16 DIM. A positive test for SCK was defined as a blood BHBA concentration of 1.2 to 2.9 mmol/L.

[1]McArt et al, 2012.

Relationship of Predicted Daily Milk Yield for the 1st 30 DIM and Blood BHB at 1st Positive BHB Test For Holstein Cows.[1].



Regression plot of mean predicted daily milk yield for the first 30 DIM by blood BHBA concentration of first positive BHBA test (1.2 to 2.9 mmol/L) for 369 Holstein dairy cows undergoing repeated testing for ketosis from 3 to 16 DIM. The solid line represents the best fit; 95% confidence intervals are shown for each predicted milk yield by BHBA concentration.

[1]McArt et al, 2012.

Effects of Subacute Ketosis

- Depressed milk production
- Weight loss
- 3X more likely to be sold (McArt et al., 2012b)
- 2.6X more likely to have a displaced abomasum (Duffield et al., 2009)
- 3.4X more likely to have metritis (Duffield et al., 2009)
- 0.7X less likely to breed at first service (McArt et al., 2012b)

Ketosis Detection

- Any sick cow between 2 and 30 DIM should be evaluated

- Sweet smell of breath, presence of acetone, BHB
  Only 50% sensitive

- Cowside tests for ketosis
  Blood – Precision Xtra hand-held system, 95% sensitive
  Urine – Ketostix test strips, >15 mg BHB/dl, 85% sensitive
  Milk – Ketotest test strips, not very sensitive, 90% sensitive

Nervous ketosis – continued and unresolved ketosis resulting in
nervous activities

Prevention of Ketosis

- Reduce inflammation
- Feed for proper body condition pre-freshening
  - Diet <15% maize to produce propionate or lactate
- For goats, group and feed by litter size?
- Safely optimize energy intake post-freshening
  - Diet 15-25% maize to produce propionate or lactate
  - High-quality forages
- Feed rumen-protected choline chloride post-freshening
- Avoid too much bypass fat feeding

Ketosis Treatment

Mild or moderate (1.2 – 2.9 mml BHB/l blood)

- -300 ml propylene glycol and glycerol/cow/d until resolved
- -Oral administration of jaggery

Severe (>3.0 mmol BHB/l blood)

- -IV 500 ml of 50% dextrose
- -Dexamethosone and glucocorticoids

Ketosis Summary

- Prevention is key
  - -Proper body condition
  - -Feed to provide correct energy
  - -Reduce inflammation, stress and disease
  - -Special care for high-yielding animals

- Treatment plan in place
  - -300 ml propylene glycol

  - -Jaggery

  - -Dexamethsone