

Intestinal digestion, absorption, transport and intermediary metabolism of lipids

Veerle Fievez

Laboratory for Animal Nutrition and Animal Product Quality

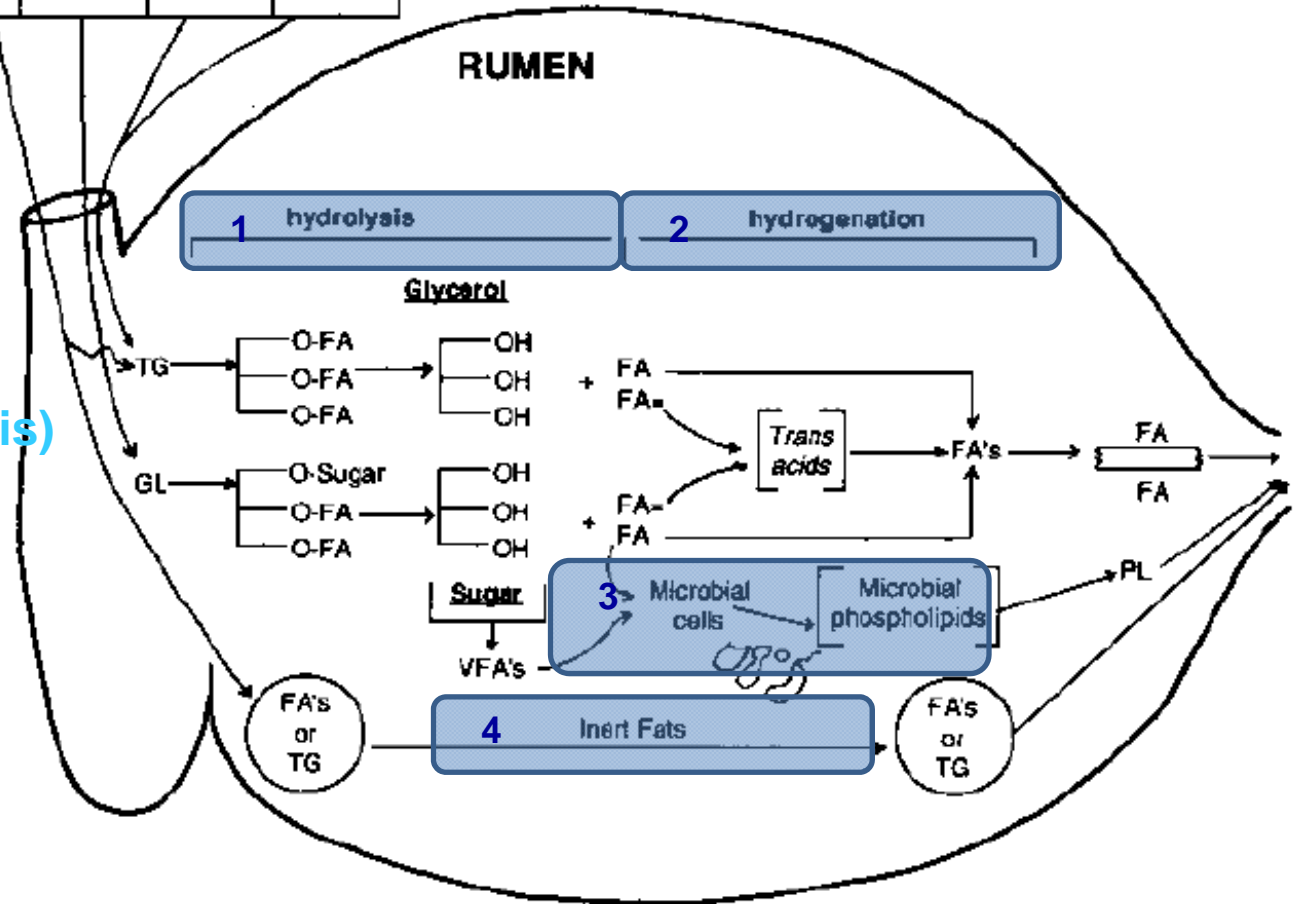
Intestinal digestion, absorption, transport and intermediary metabolism of **fatty acids**

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Rumen lipid metabolism

Fat Sources	Fat Suppl.	Forages	Cereal Grains	Oil Seeds
Fat Type	FA's or TG	GL	TG	TG

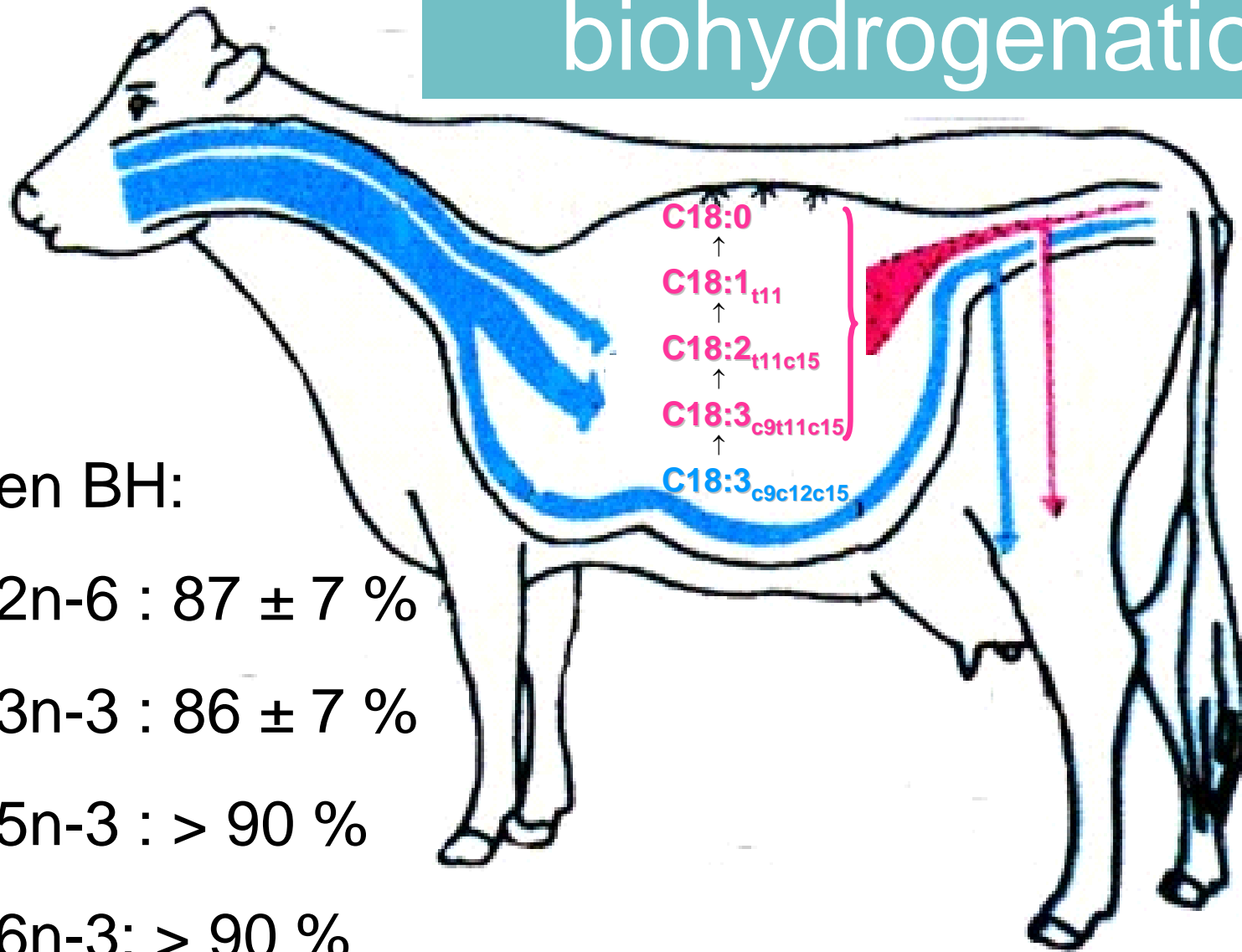


- Lipolysis (= Hydrolysis)
- Biohydrogenation
- Microbial lipids
- Inert fats

ABBREVIATIONS

Glasser et al. 2008. Animal 2: 691.
Chilliard et al. 2010. OCL 17, 22.

Rumen fatty acid biohydrogenation



Rumen BH:

C18:2n-6 : 87 ± 7 %

C18:3n-3 : 86 ± 7 %

C20:5n-3 : > 90 %

C22:6n-3 : > 90 %

Rumen fatty acid biohydrogenation

linolenic acid
C18:3 c9c12c15



linoleic acid
C18:2 c9c12



Stearic acid
C18:0

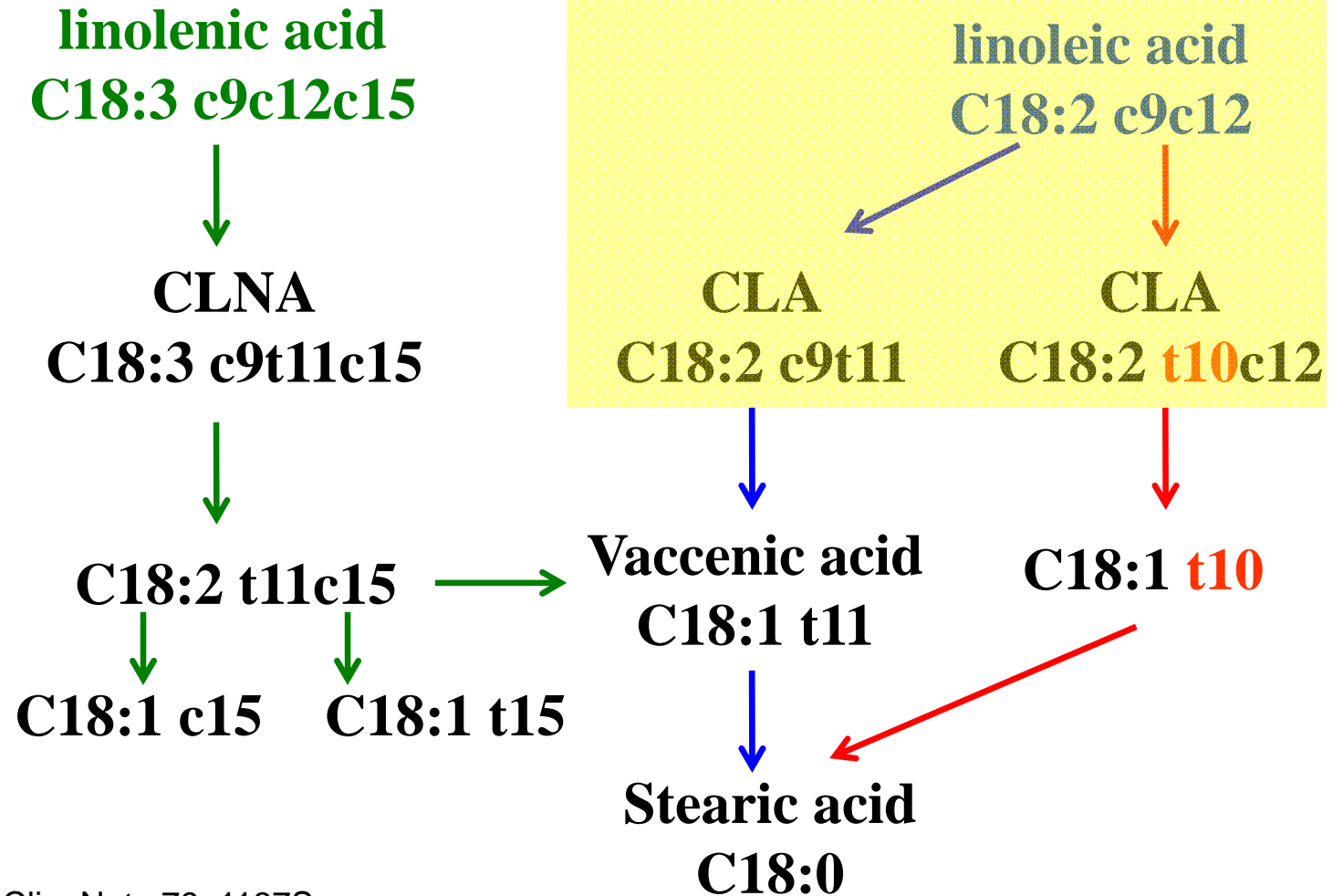
Kramer et al., 2004. Am. J. Clin. Nutr. 79, 1137S.



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Rumen fatty acid biohydrogenation



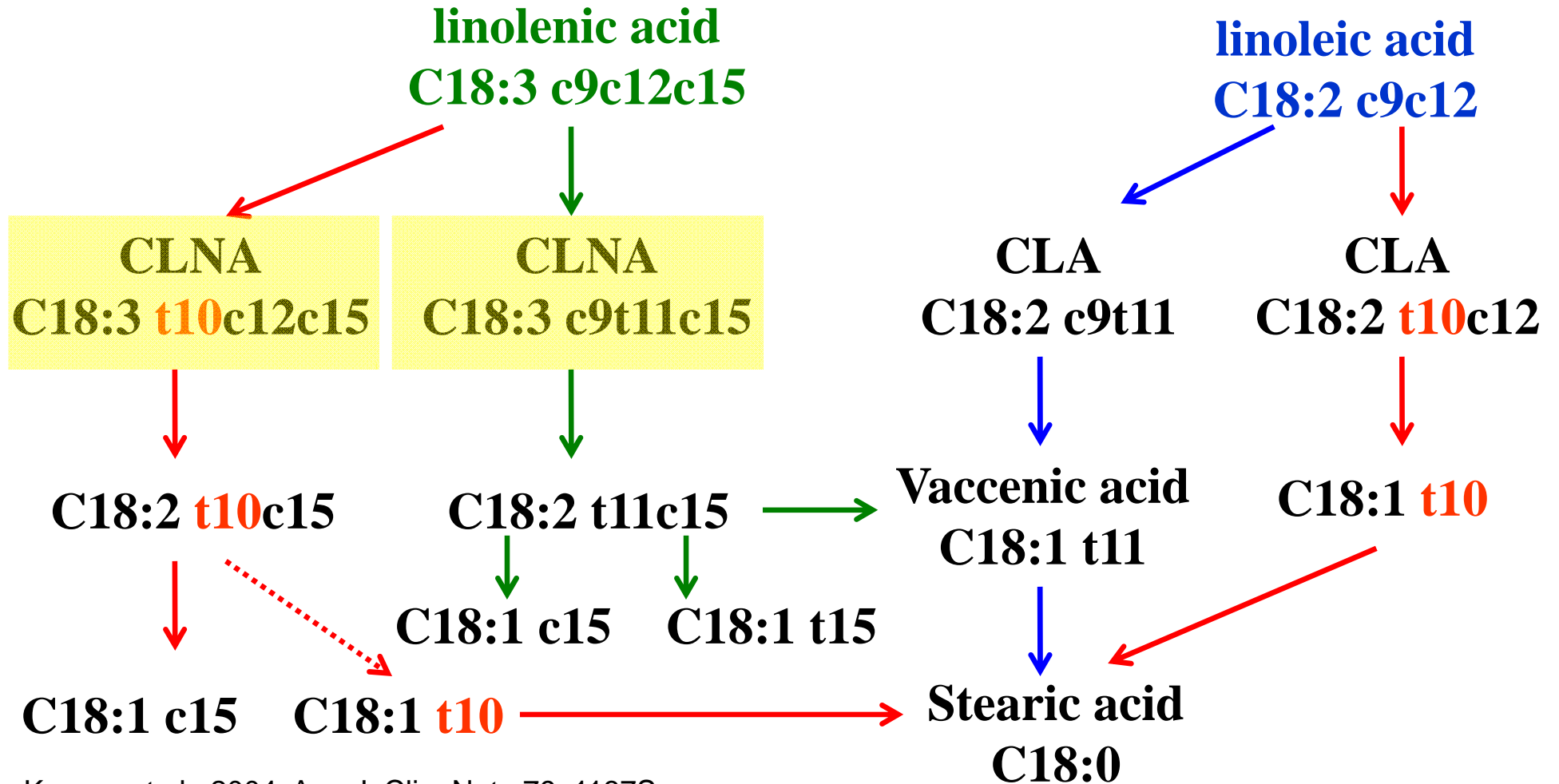
Kramer et al., 2004. Am. J. Clin. Nutr. 79, 1137S.



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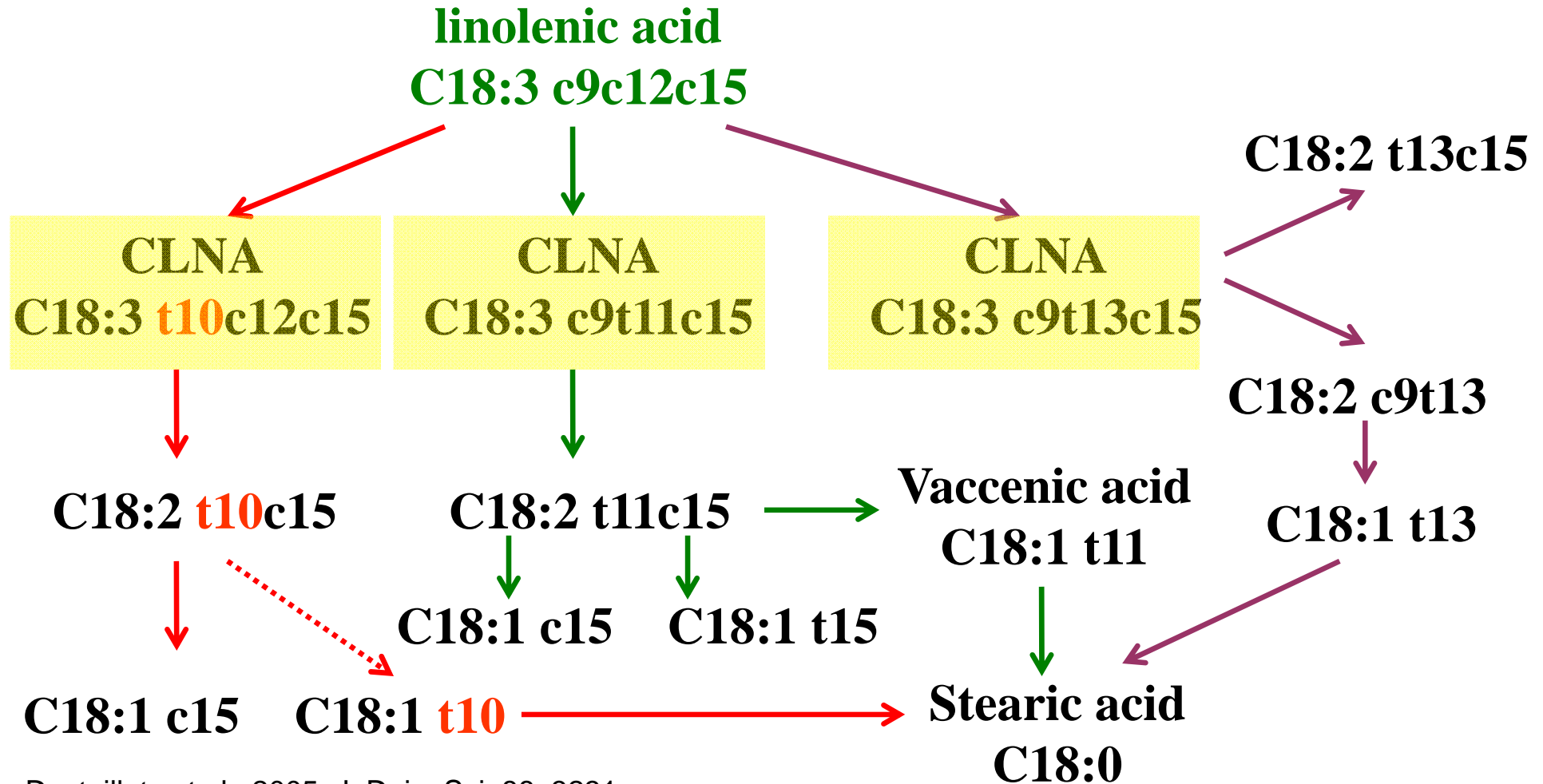


Rumen fatty acid biohydrogenation



Kramer et al., 2004. Am. J. Clin. Nutr. 79, 1137S.

Rumen fatty acid biohydrogenation



Destailats et al., 2005. J. Dairy Sci. 88, 3231.

Rumen fatty acid biohydrogenation

c5c8c11c14c17 20:5

c8c11c14c17 20:4

(t)7(c)11(c)14(c)17 20:4

c8c11c14c17 20:4

(t)10(t)14(t)17 20:3

(t)9(t)14(t)17 20:3

(t)10(t)14(c)17 20:3

(t)11(c)14(c)17 20:3

Δ 11,14,17 20:3

Δ 10,14,17 20:3

c11c14c17 20:3

c8c11c14 20:3

t13t17 20:2

t11t15 20:2

t10t16 20:2

t9t15 20:2

t14c17 20:2

t13c17 20:2

t11c15 20:2

t11c17 20:2

c10t15 20:2

c14c17 20:2

t15 20:1

t14 20:1

t13 20:1

t12 20:1

t11 20:1

t9 20:1

c14 20:1

Rumen fatty acid biohydrogenation

c4c7c10c13c16c19 22:6

(t)5(c)10(c)13(c)16(c)19 22:5

c7c10c13c16c19 22:5

c4c7c10c13c16 22:5

(t)10(t)13(c)16(c)19 22:4

(t)8(c)13(c)16(c)19 22:4

(c)7(t)13(c)16(c)19 22:4

c10c13c16c19 22:4

(t)12(c)16((c)19 22:3

(c)10(t)14(c)19 22:3

Δ 10,13,17 22:3

c10c13c16 22:3

t12t17 22:2

c13c16 22:2

t17 22:1

t15 22:1

t14 22:1

t13 22:1

t12 22:1

t10+t11 22:1

c11 22:1

c13 22:1

c14 22:1

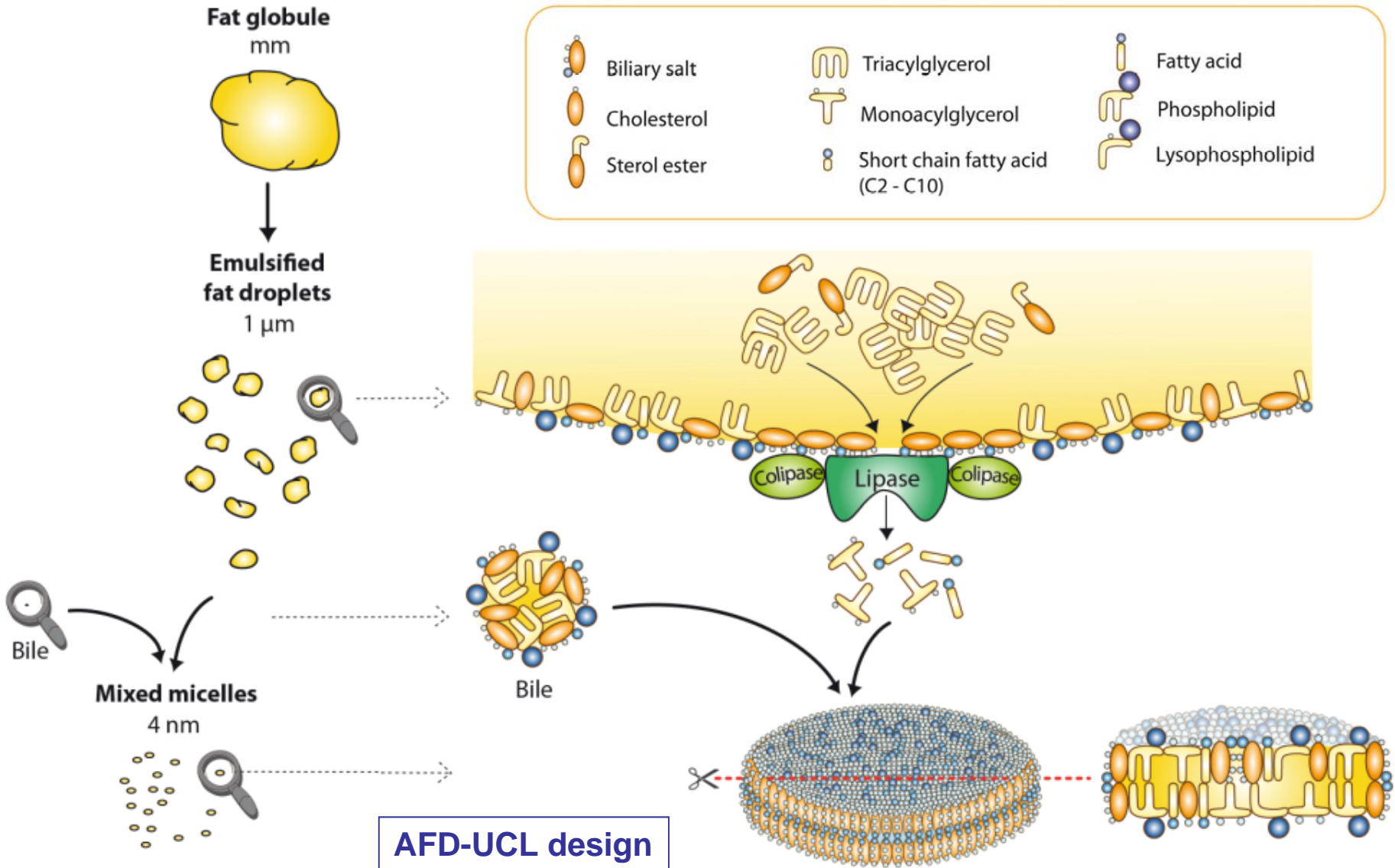
c15 22:1

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Intestinal digestion of lipids in mammals

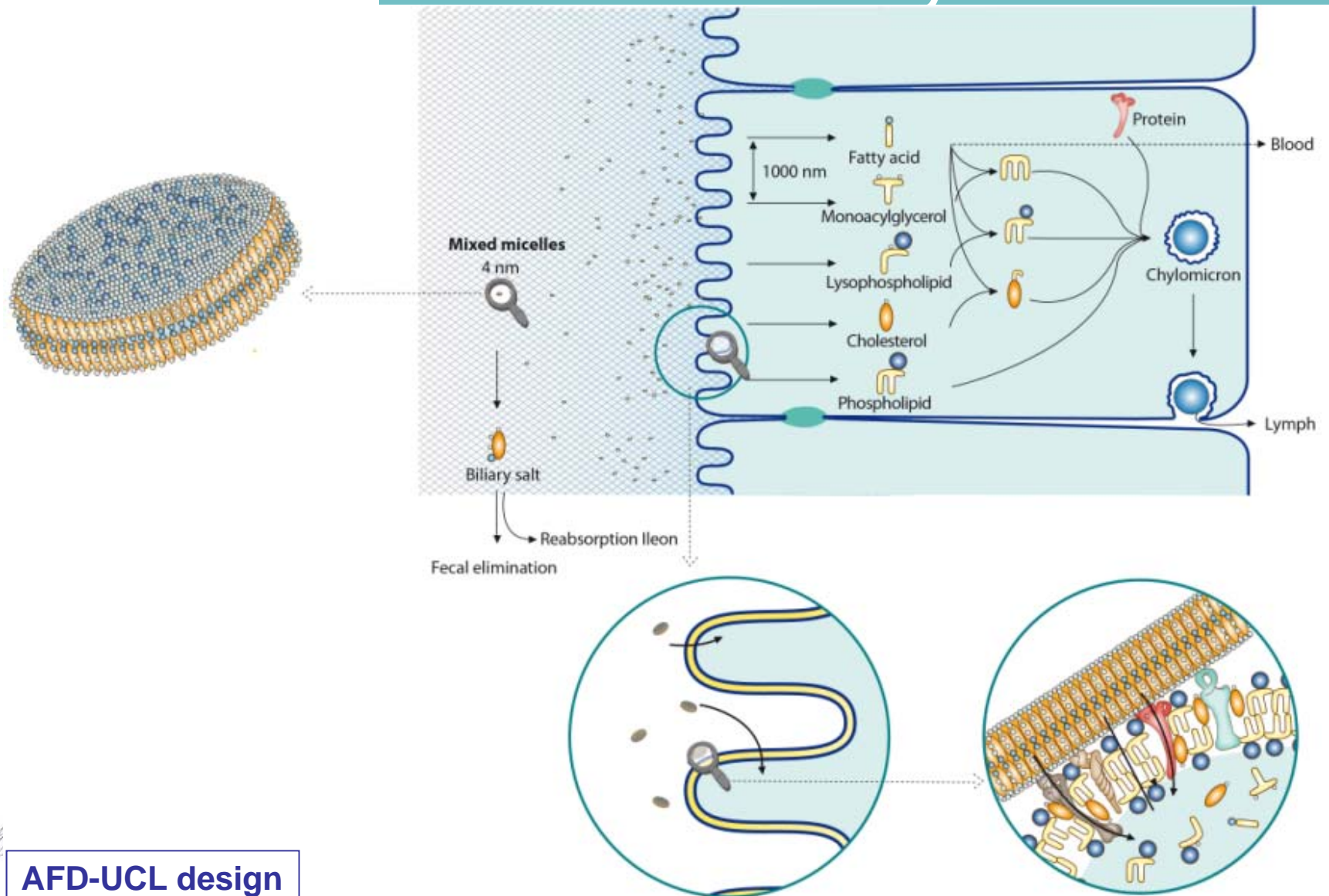


Intestinal digestion, **absorption**, transport and intermediary metabolism of lipids

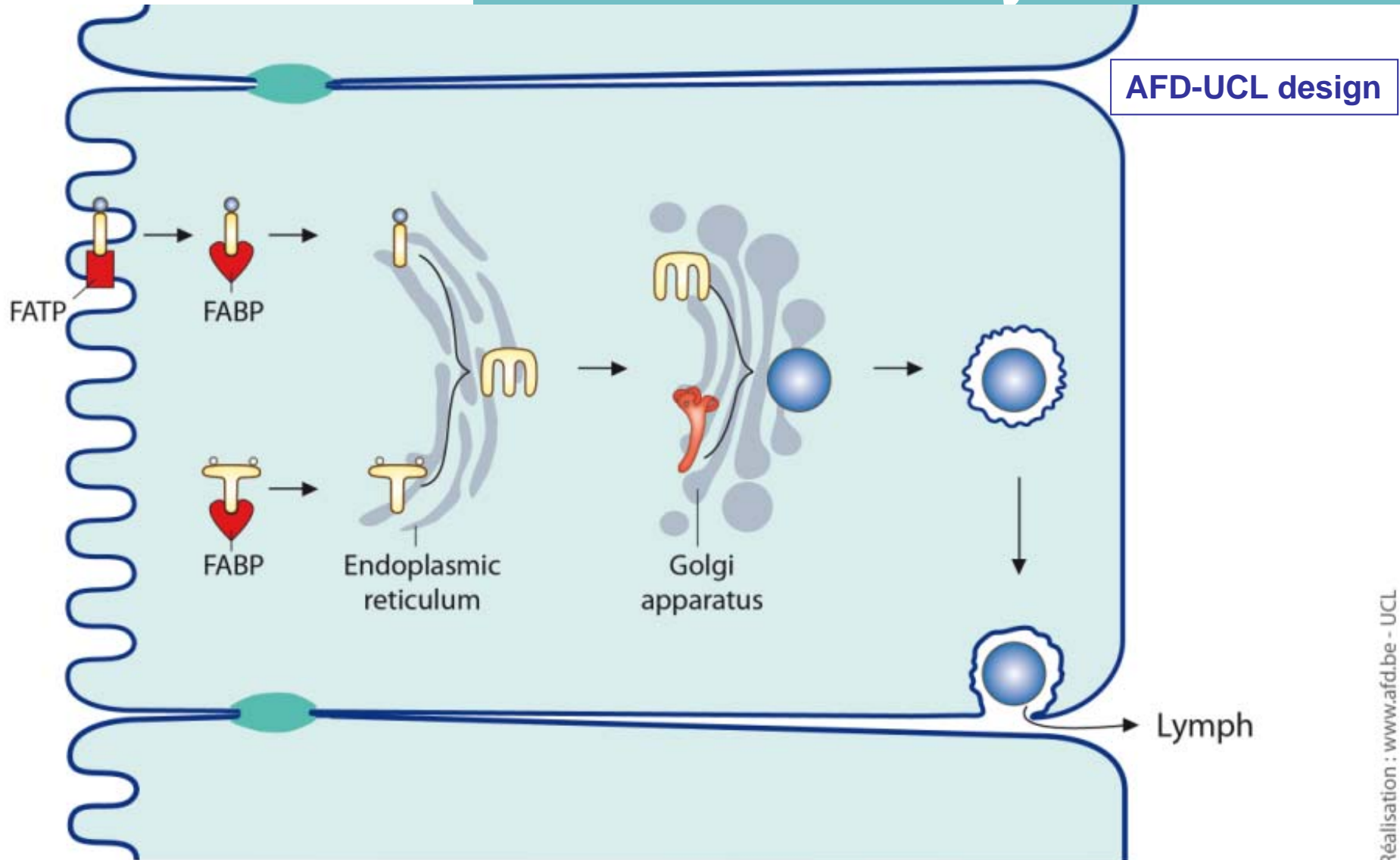
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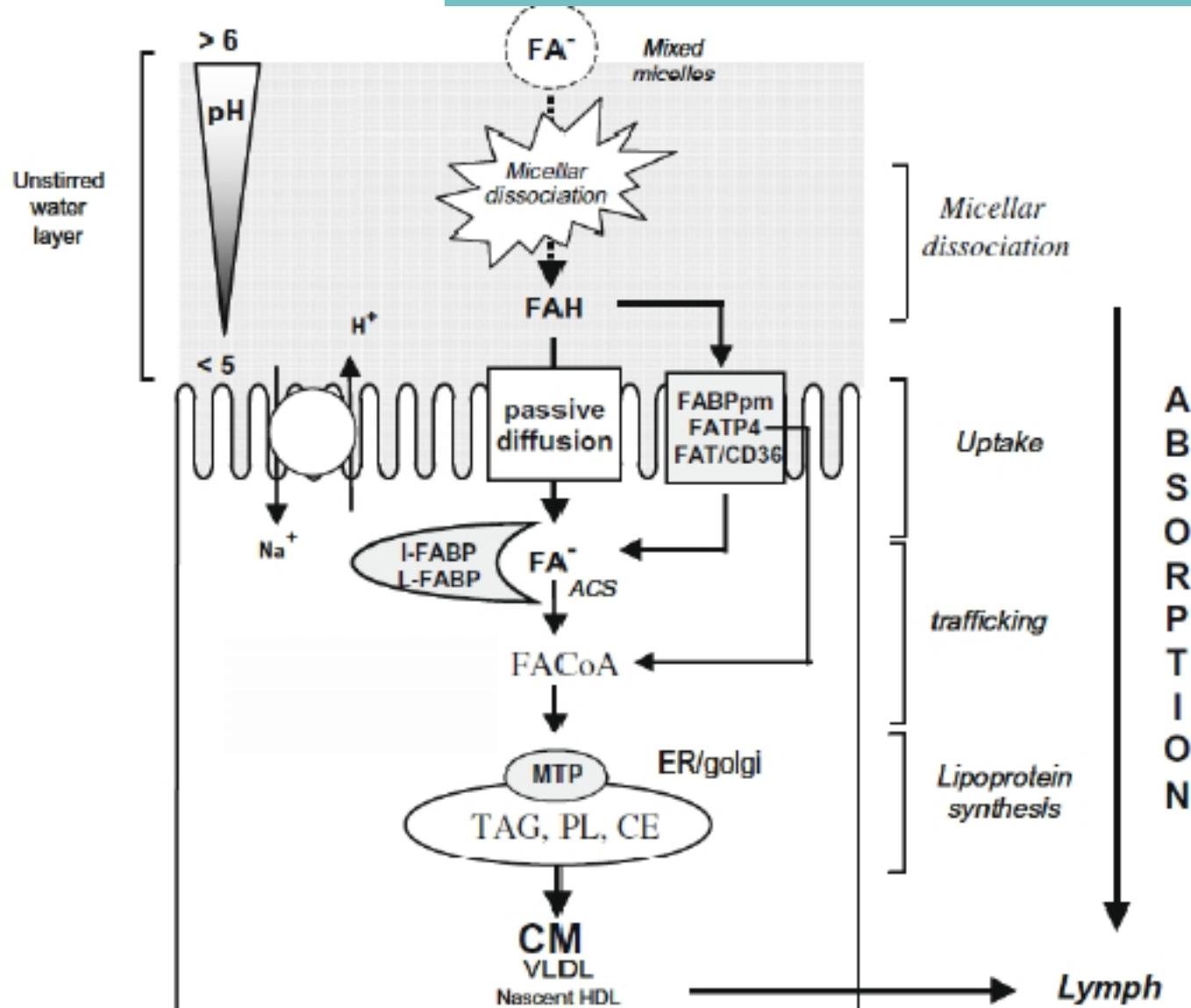
Absorption of lipids at the enterocyte level



Absorption of lipids at the enterocyte level



Summary – digestion & absorption



Intestinal digestion, absorption, **transport** and intermediary metabolism of lipids

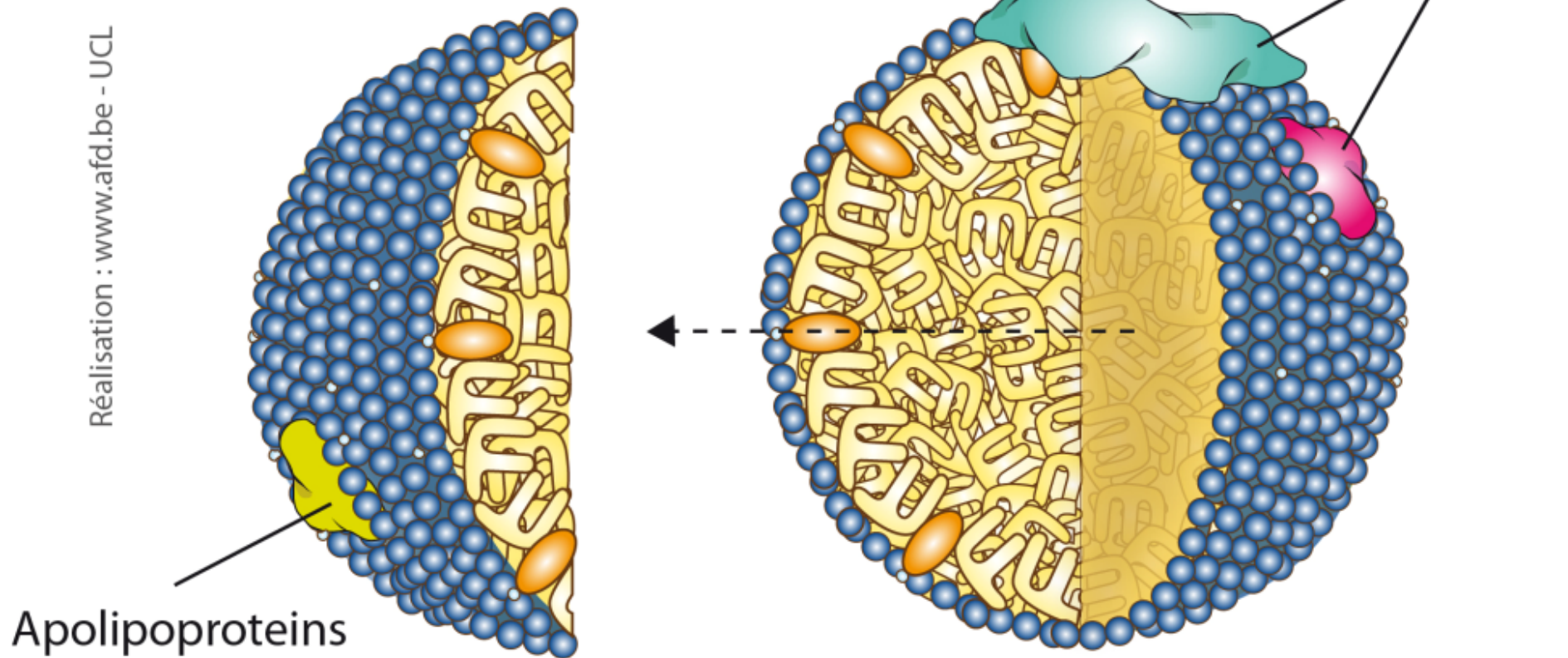
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General structure of a chylomicron

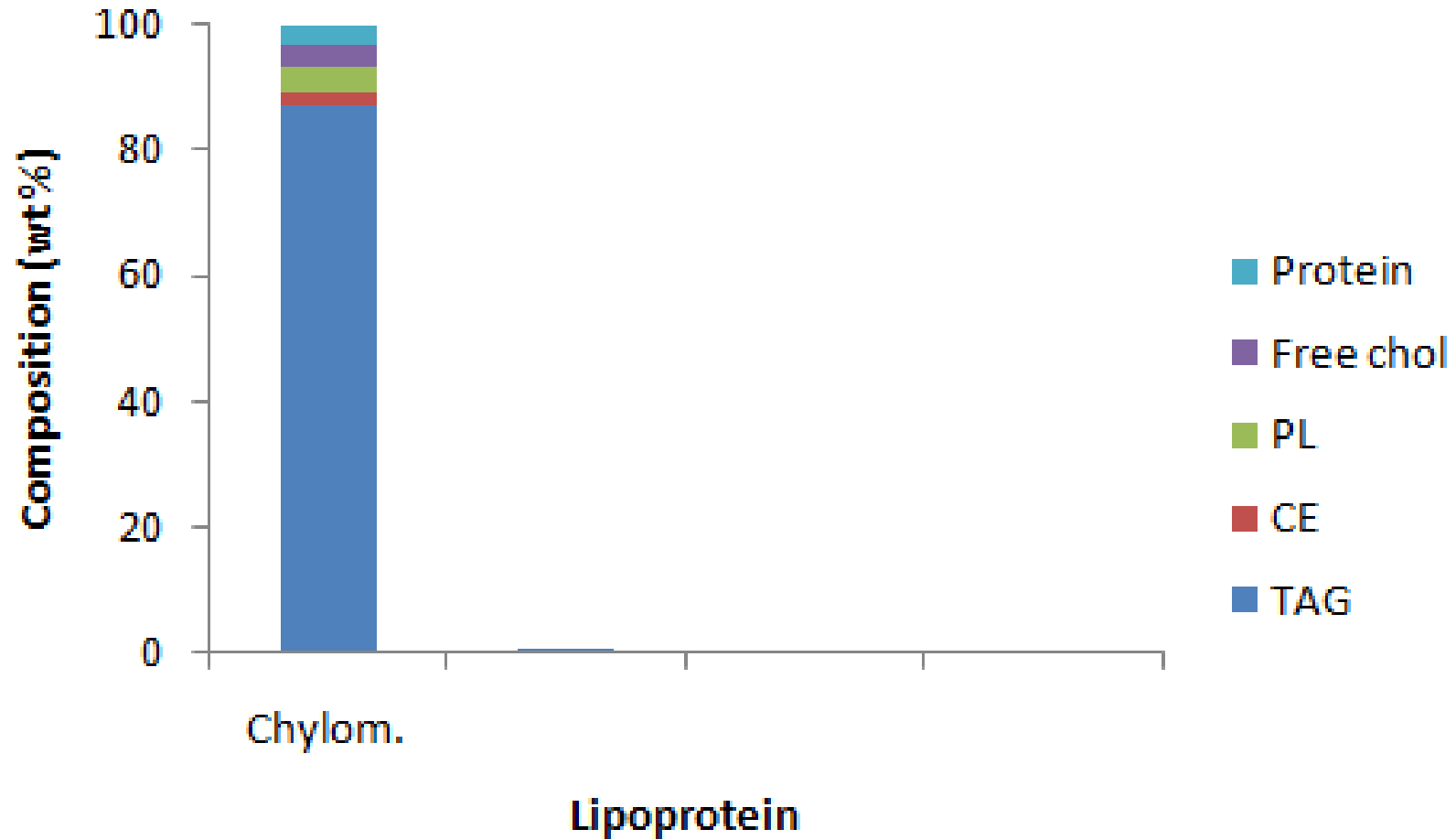
AFD-UCL design

Réalisation : www.afd.be - UCL

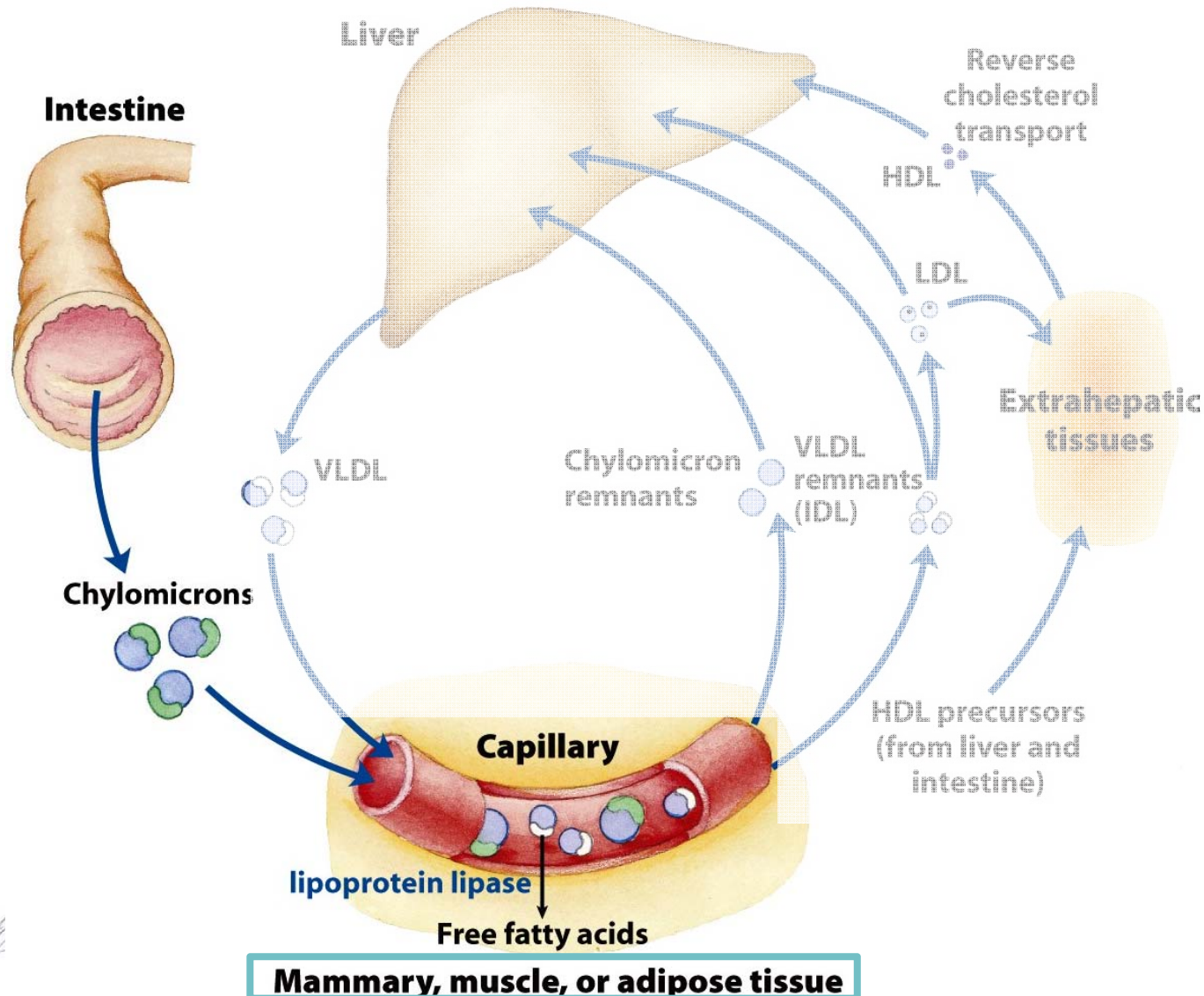


Bruss, M.L. In: Clinical biochemistry of domestic animals. Kaneko, Harvey, Bruss (Eds.), 83.

Lipid classes in chylomicrons



Chylomicrons to extrahepatic tissues before reaching the liver

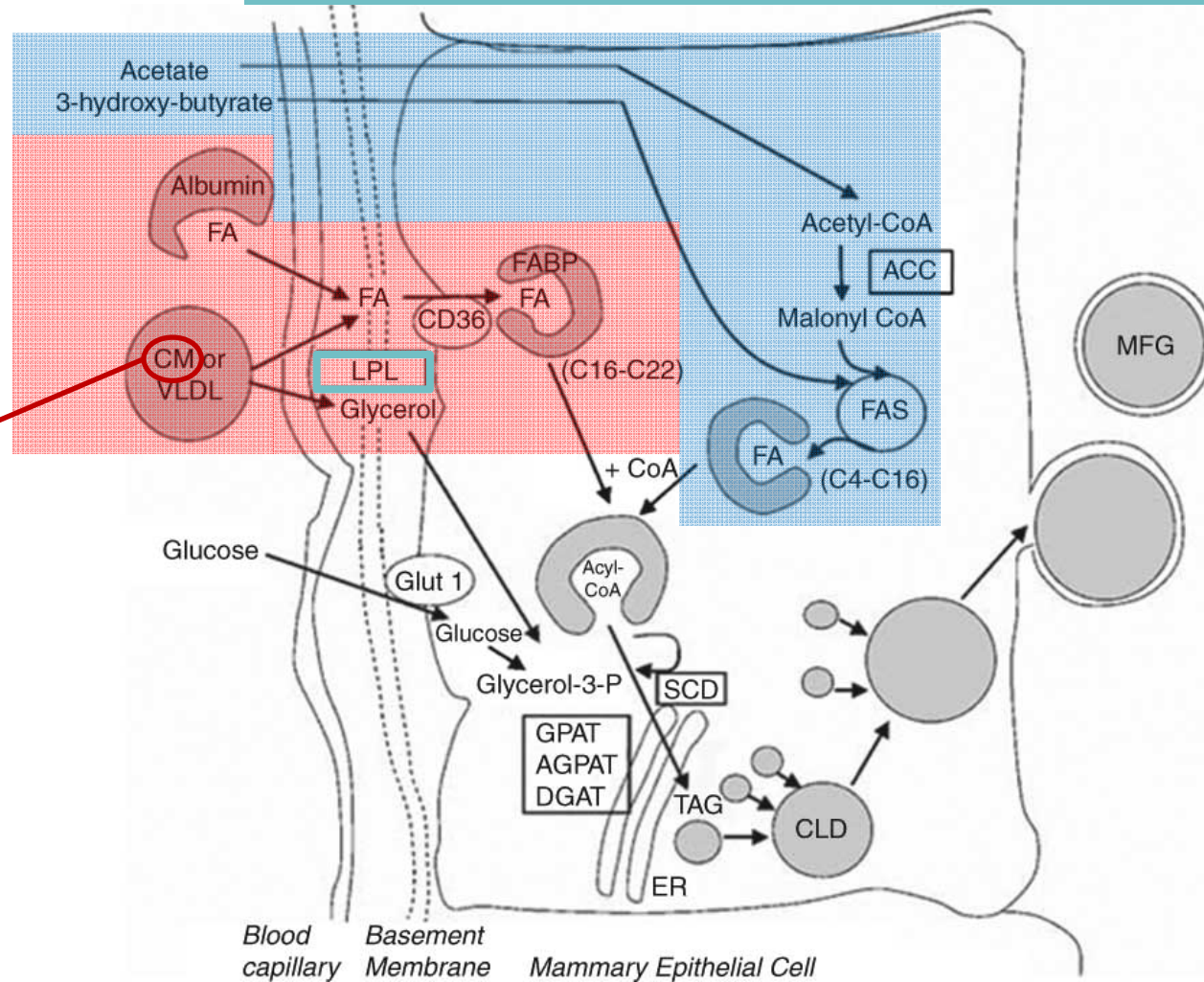


From Shingfield et al. 2010 Animal 4: 1140;
 after Bernard et al. 2008. J Dairy Sci 92: 6083

Transfer to mammary gland

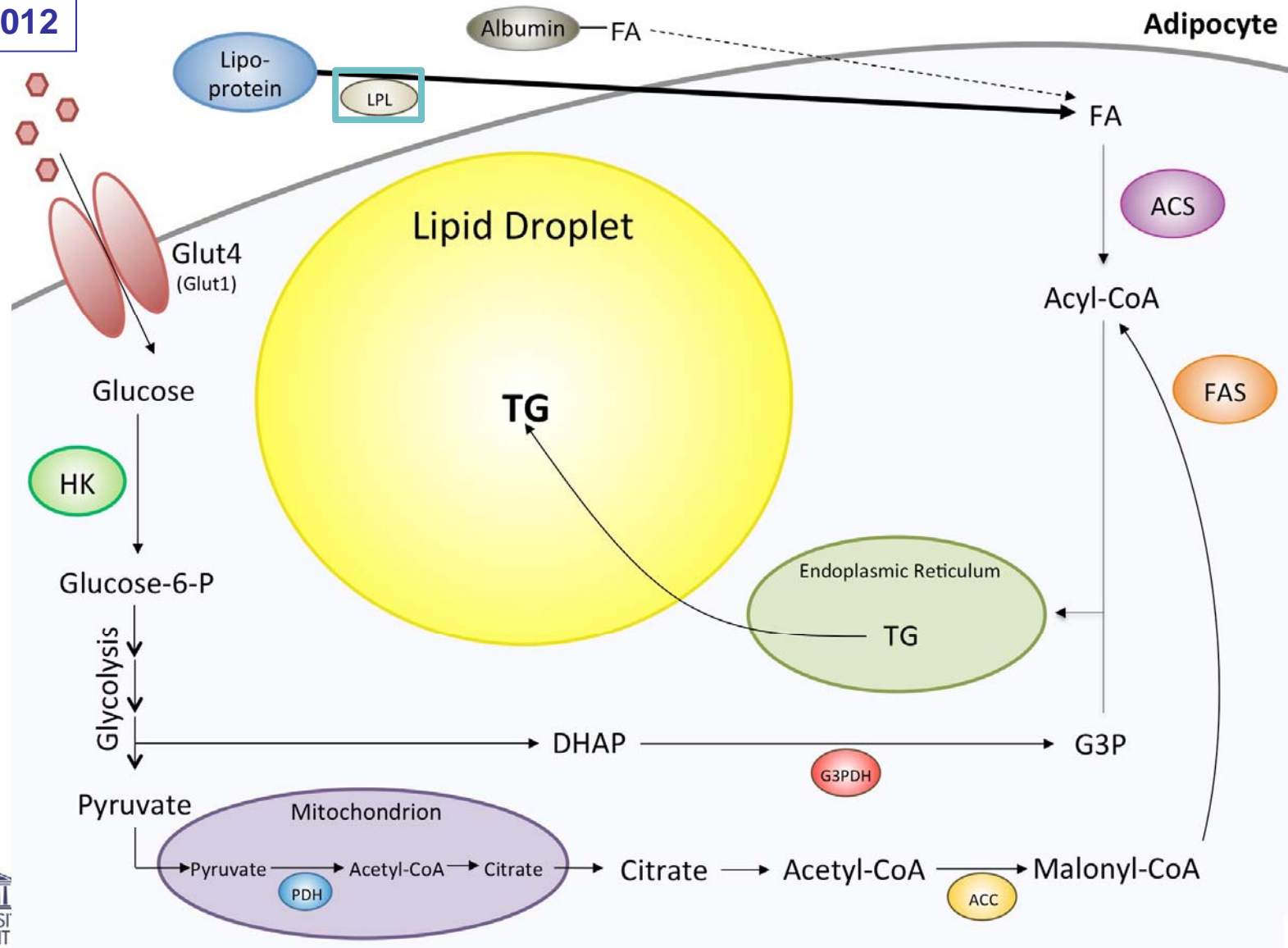
De novo synthesis

Chylomicrons – from intestinal absorption

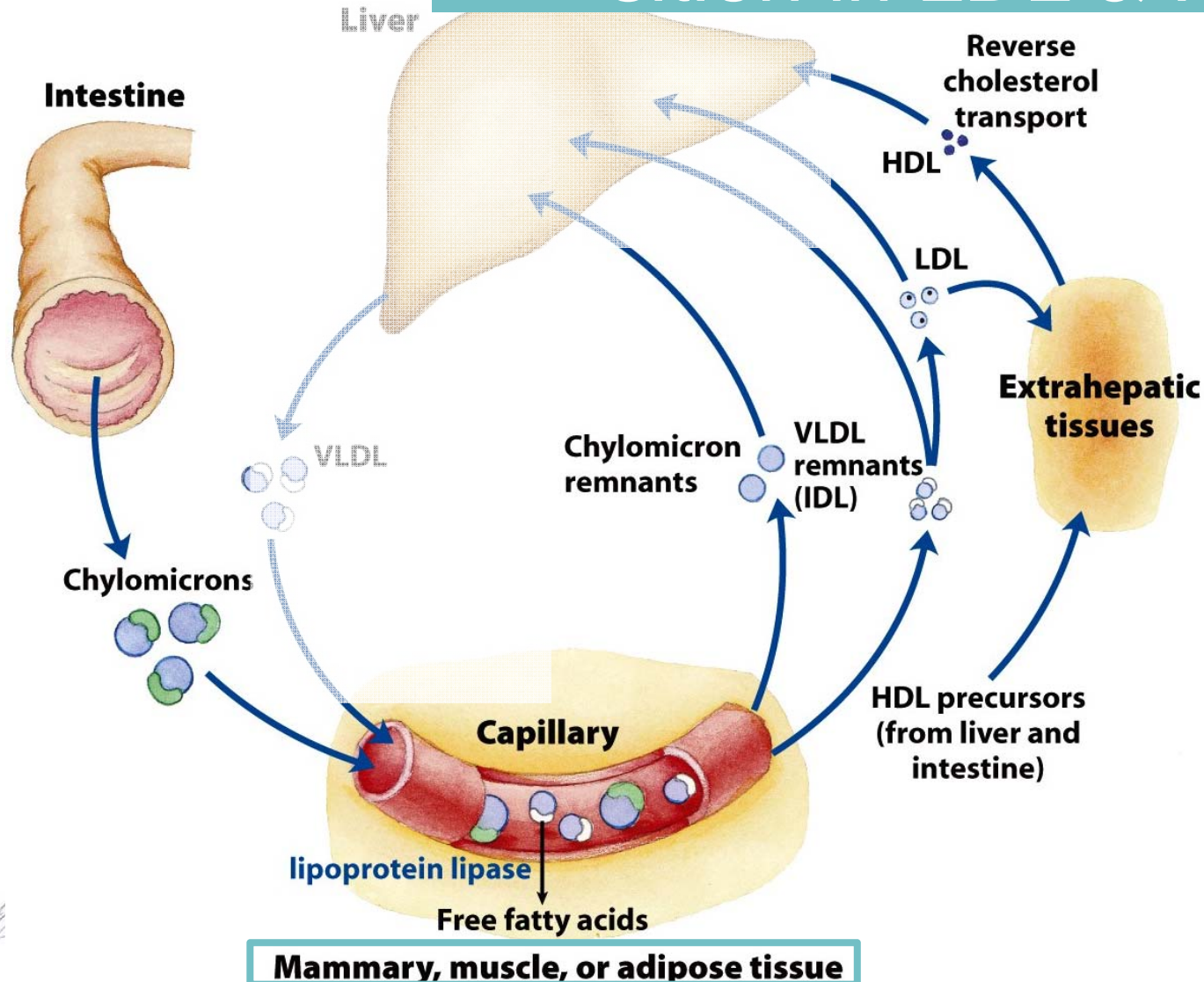


Transfer to adipose tissue

Bourez, 2012

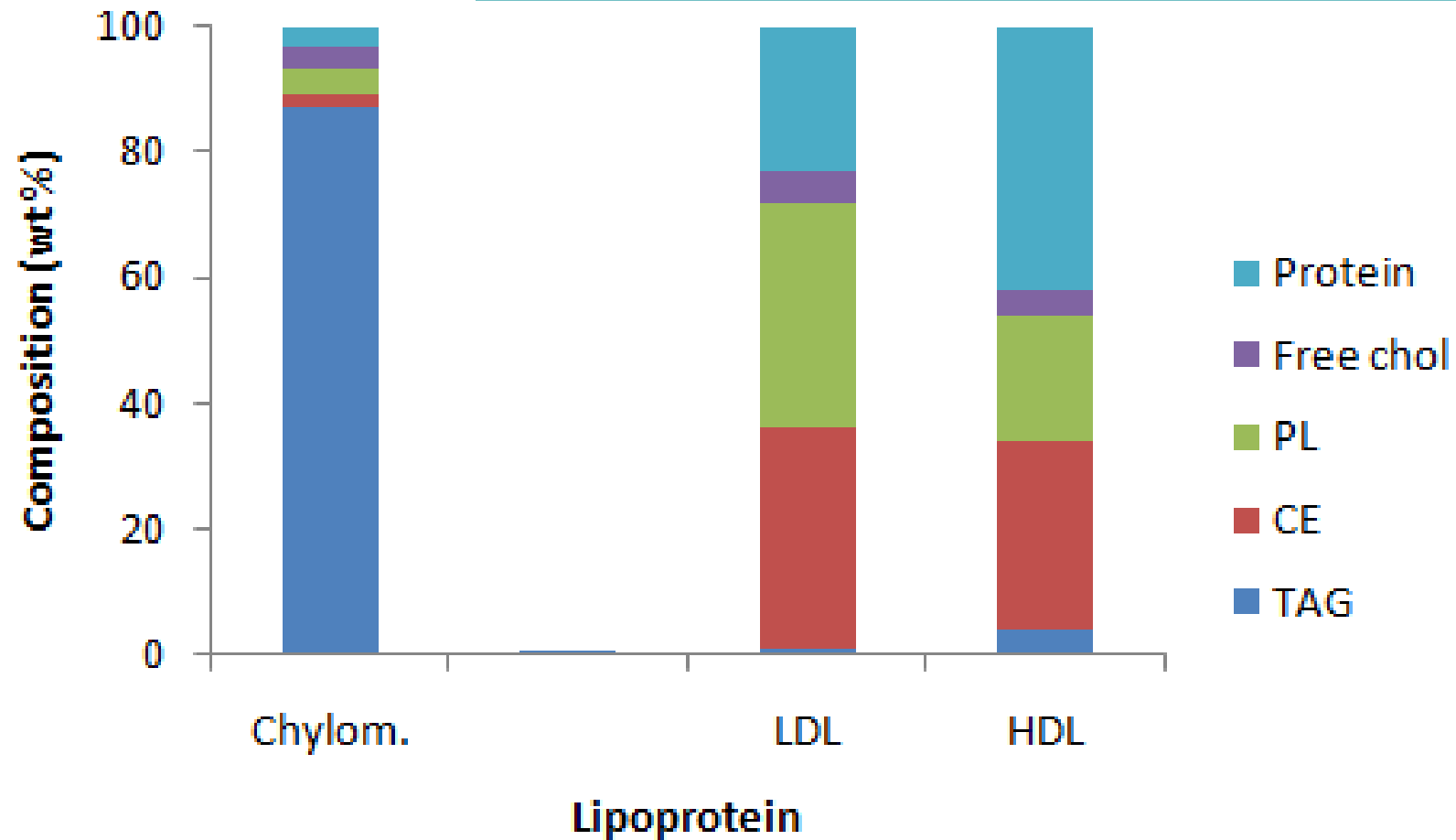


Preference of LPL for TAG changes lipid class composition in LDL & HDL



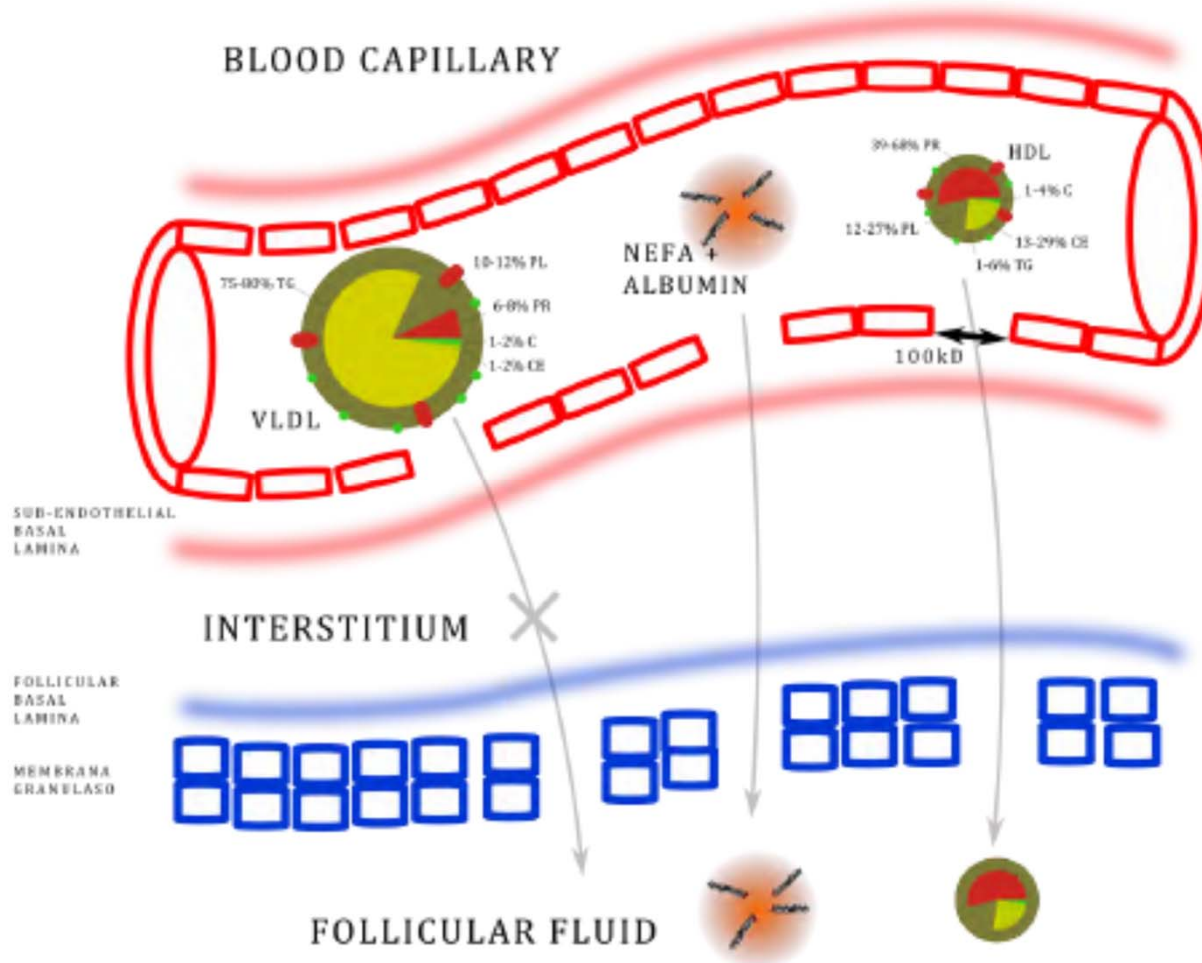
Bruss, M.L. In: Clinical biochemistry of domestic animals. Kaneko, Harvey, Bruss (Eds.), 83.

Preference of LPL for TAG changes lipid class composition in LDL & HDL

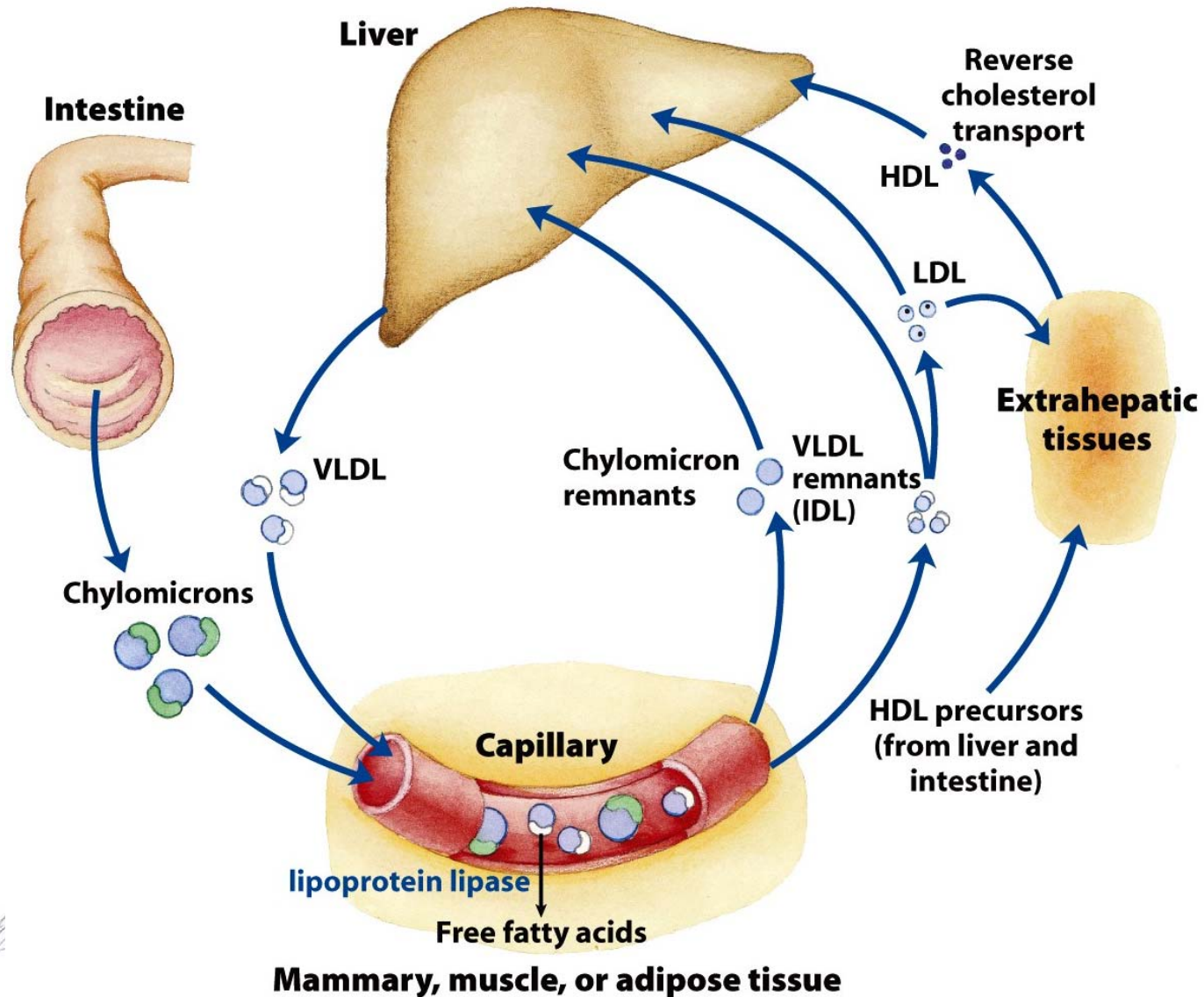


From Shingfield et al. 2010 Animal 4: 1140;
after Bernard et al. 2008. J Dairy Sci 92: 6083

Transfer to follicular fluid

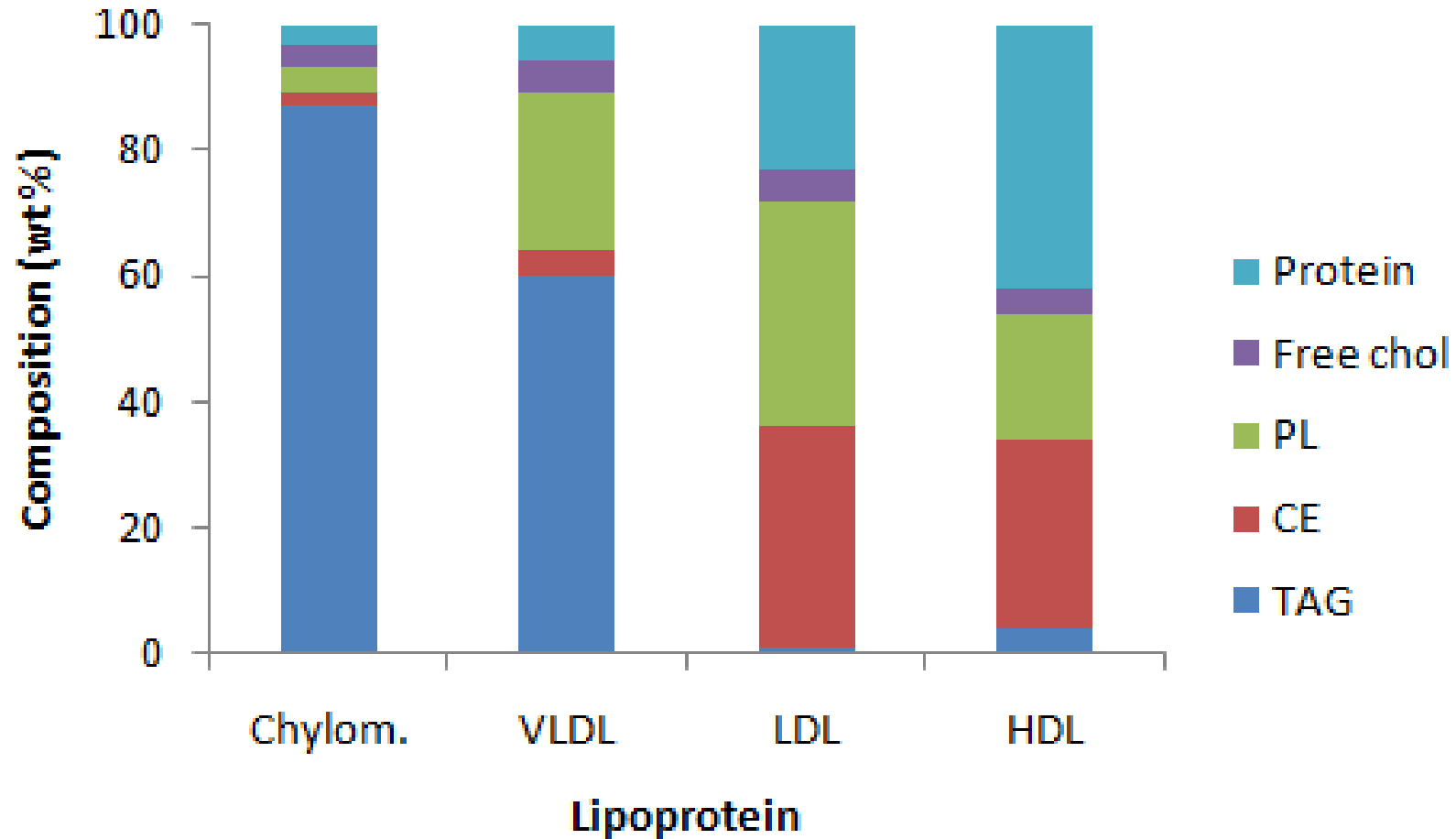


Liver: main source of VLDL



Bruss, M.L. In: Clinical biochemistry of domestic animals. Kaneko, Harvey, Bruss (Eds.), 83.

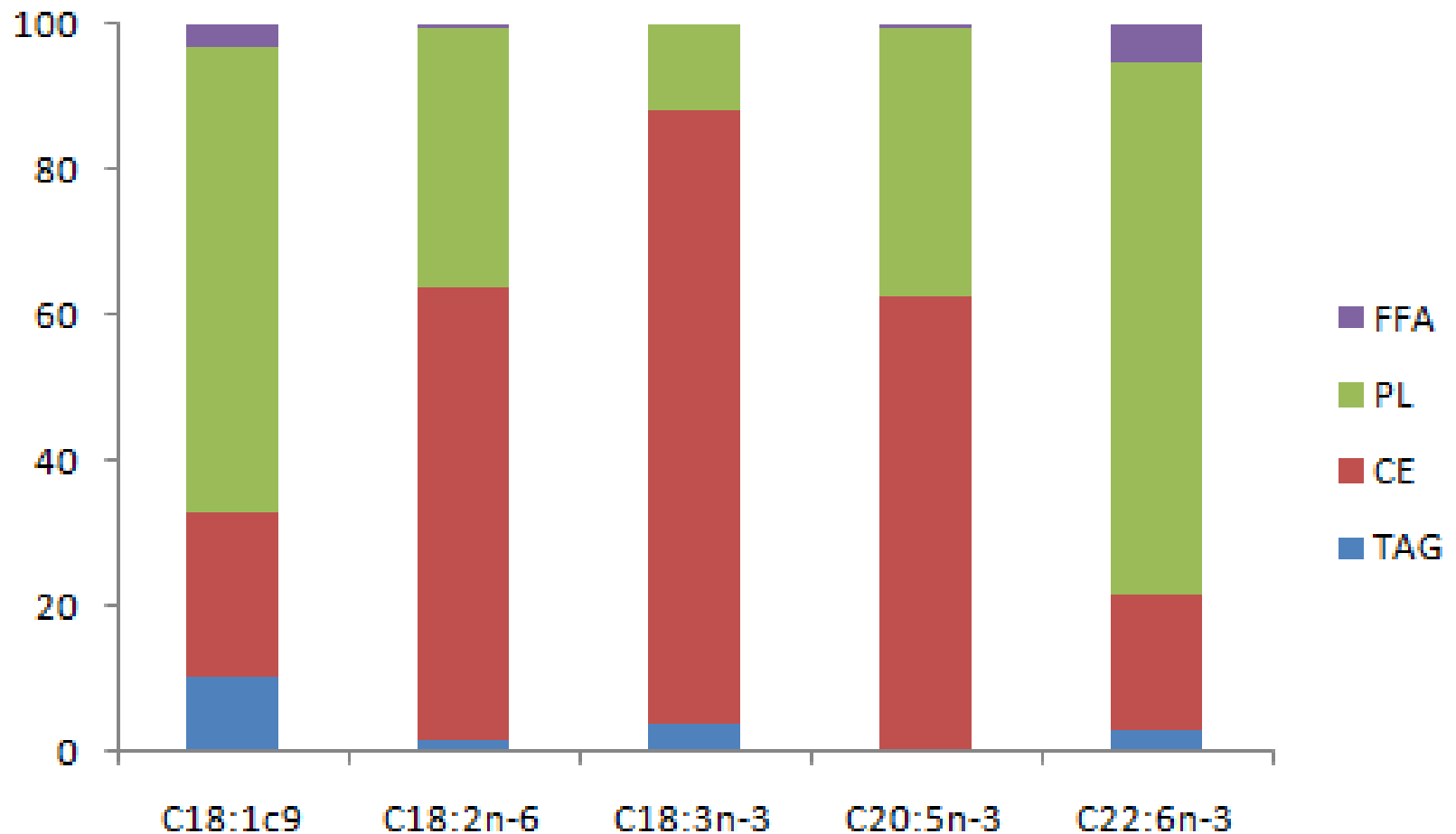
Lipid classes in lipoproteins



Lipid classes differ in FA composition

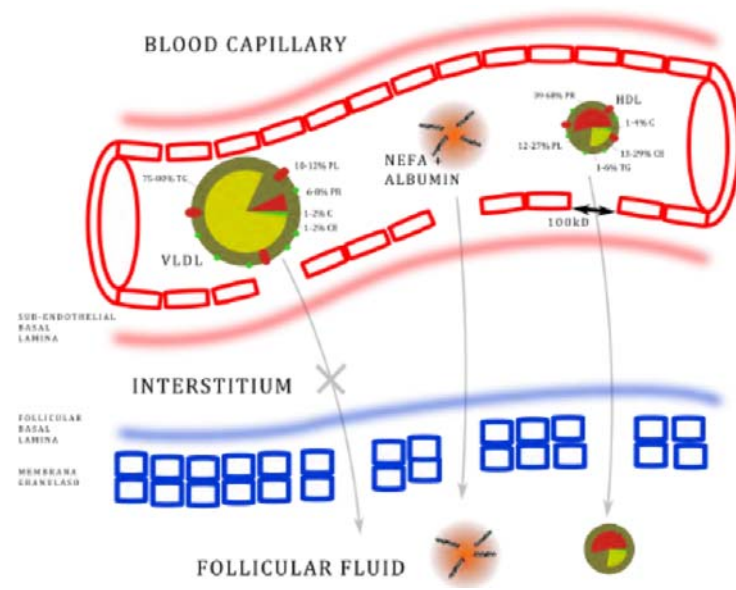
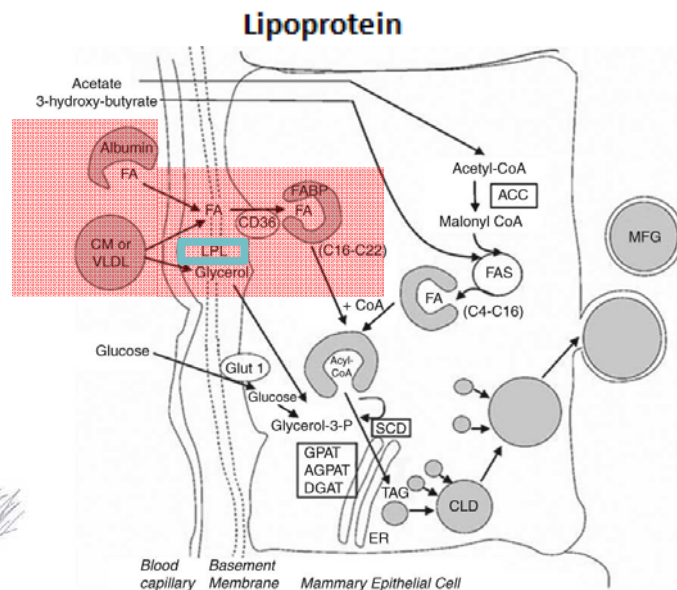
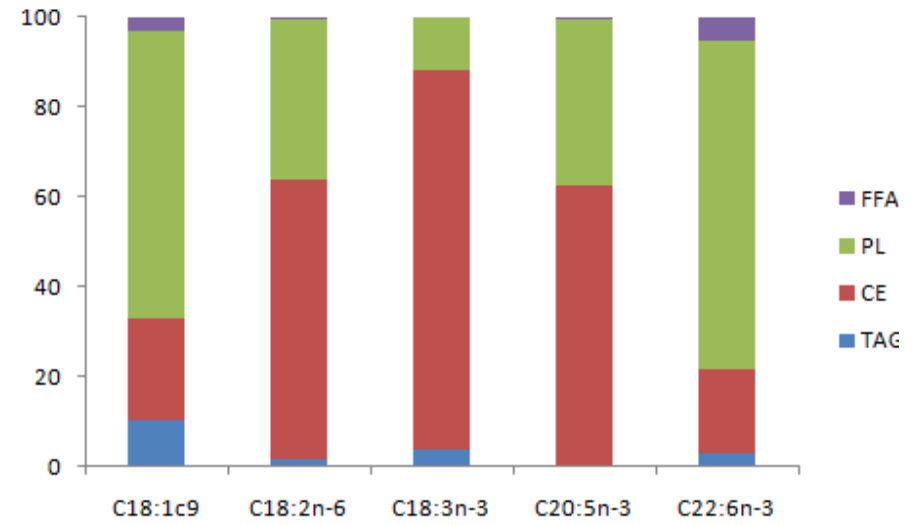
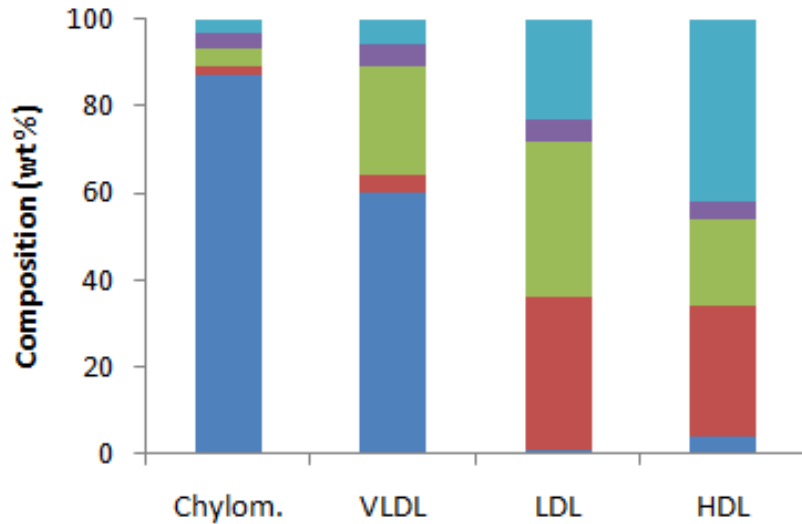
Offer et al. 2001. Anim Sci 73, 523. (EPA & DHA)

Loor et al. 2002. Anim Res 51, 119(C18:1c9, C18:2n-6 & C18:3n-3)



Bruss, M.L. In: Clinical biochemistry of domestic animals. Kaneko, Harvey, Bruss (Eds.), 83.

Differences in transfer efficiency due to preferential incorporation in specific lipid classes



From Shingfield et al. 2010 Animal 4: 1140;
after Bernard et al. 2008. J Dairy Sci 92: 6083

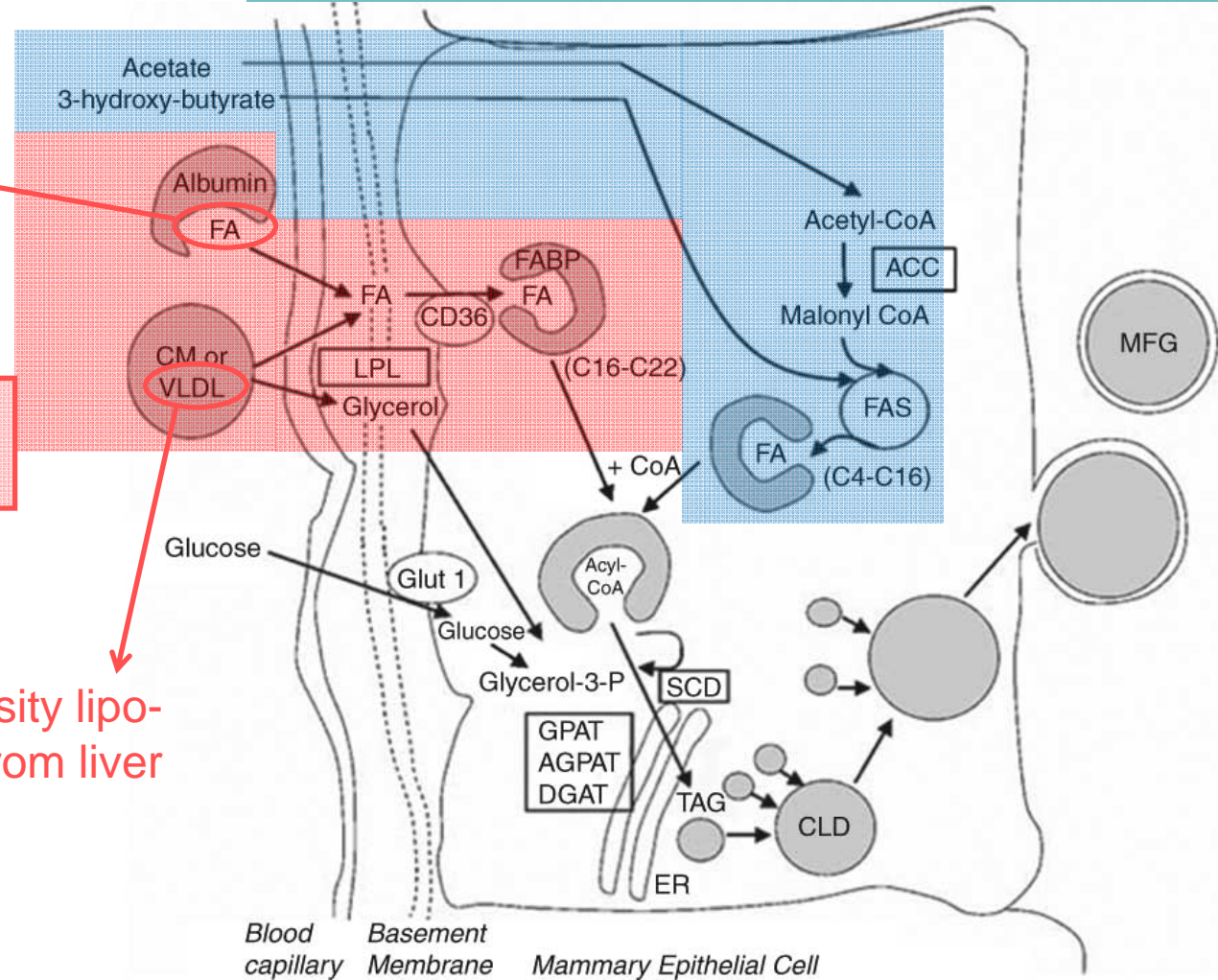
Transfer to mammary gland

De novo synthesis

Non-esterified FA –
from adipose tissue

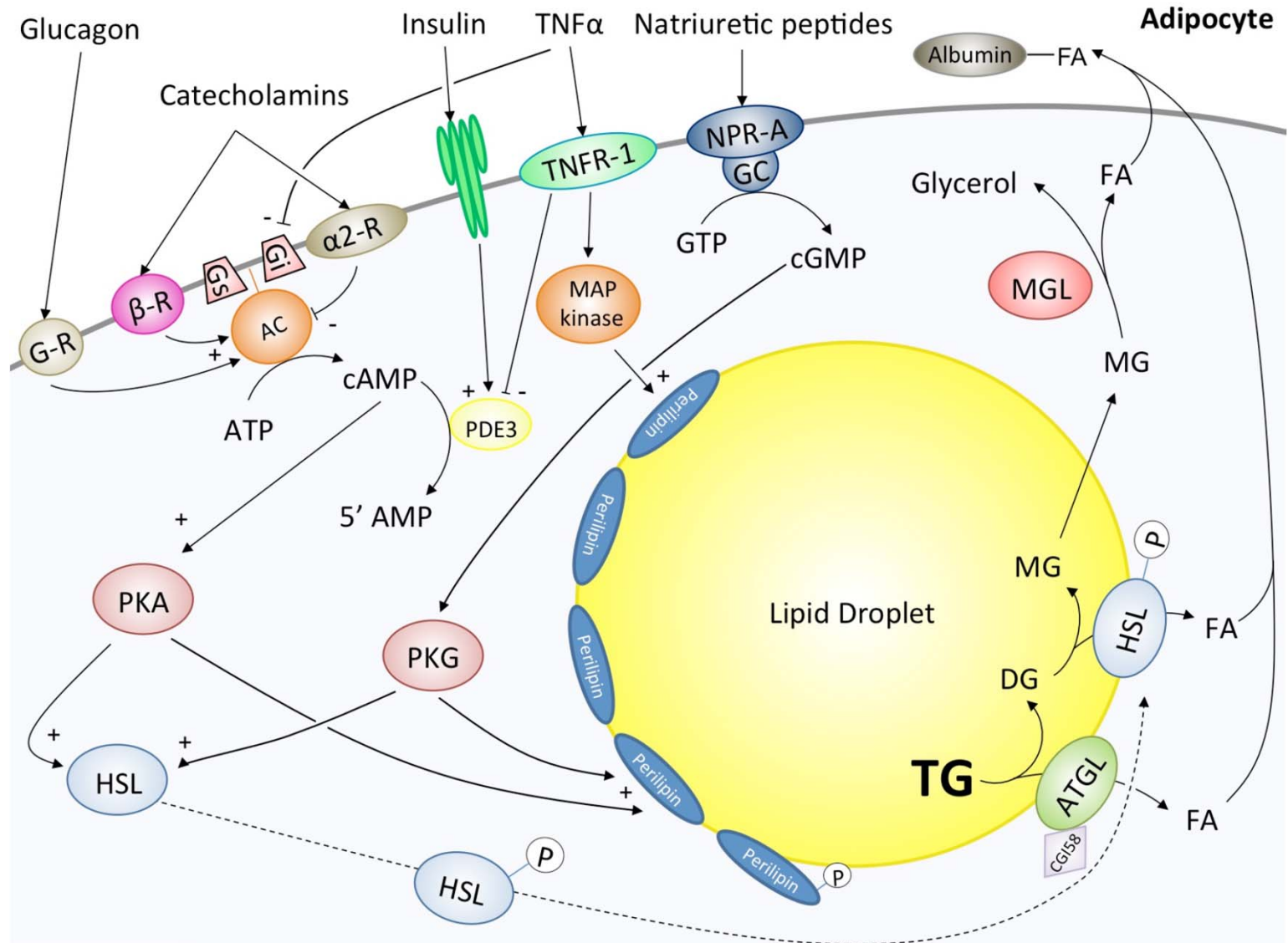
Important contribution
during NEB !

Very low density lipo-
protein – from liver



Release from adipose tissue

Bourez, 2012



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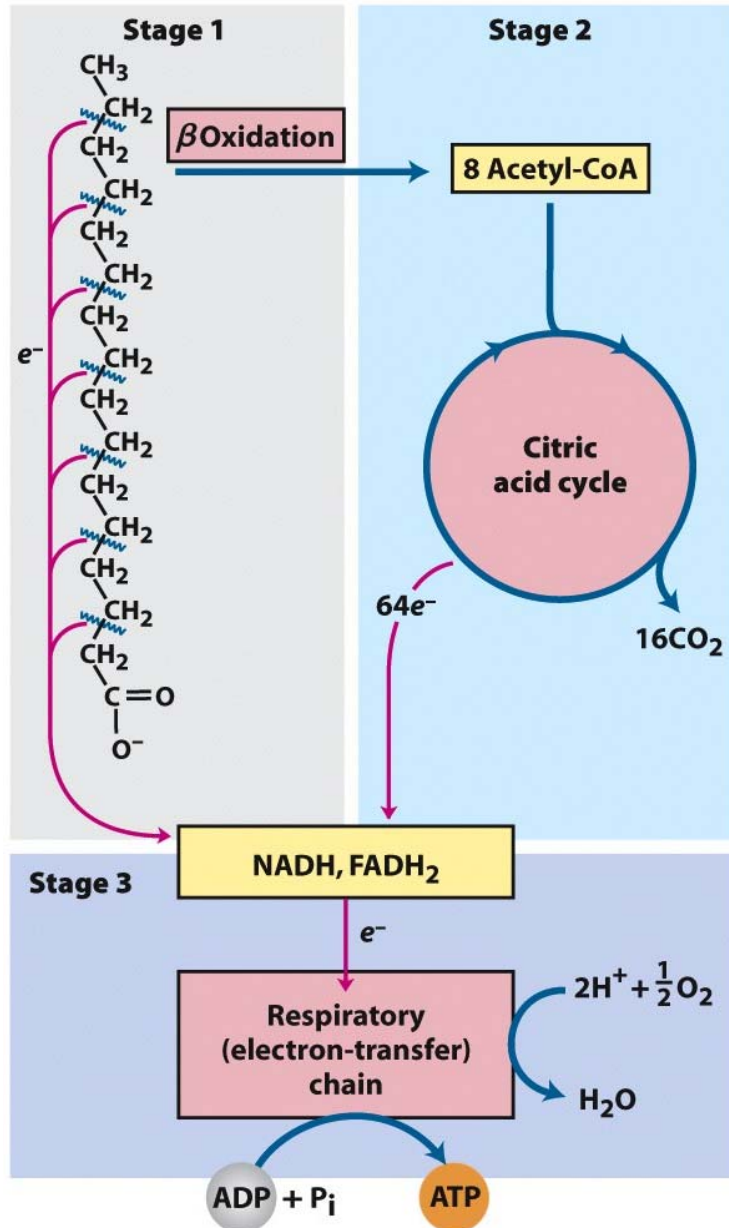
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Beta-oxidation of fatty acids

Nelson & Cox, 2005

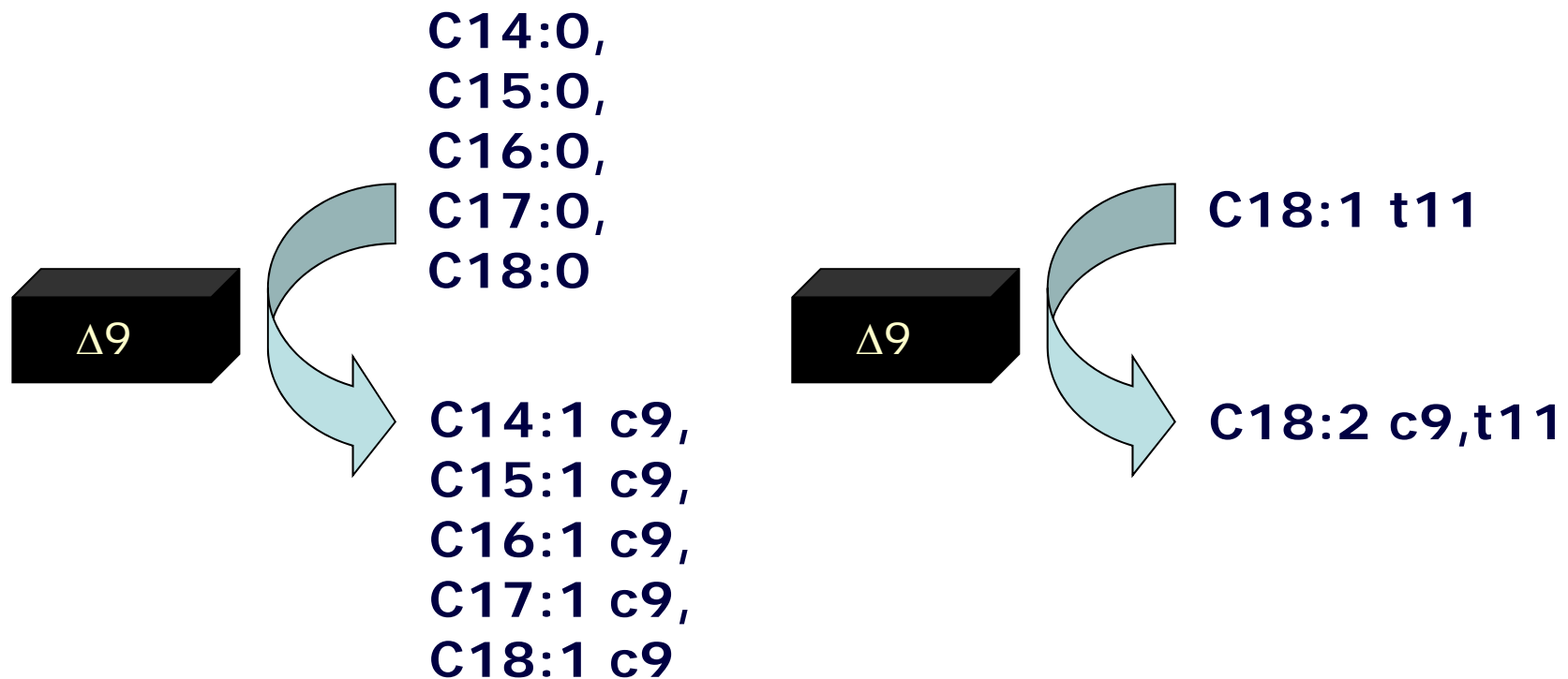
~ 1.5 ATP produced from an FADH_2
~ 2.5 ATP produced from an NADH

Where ?
All target cells



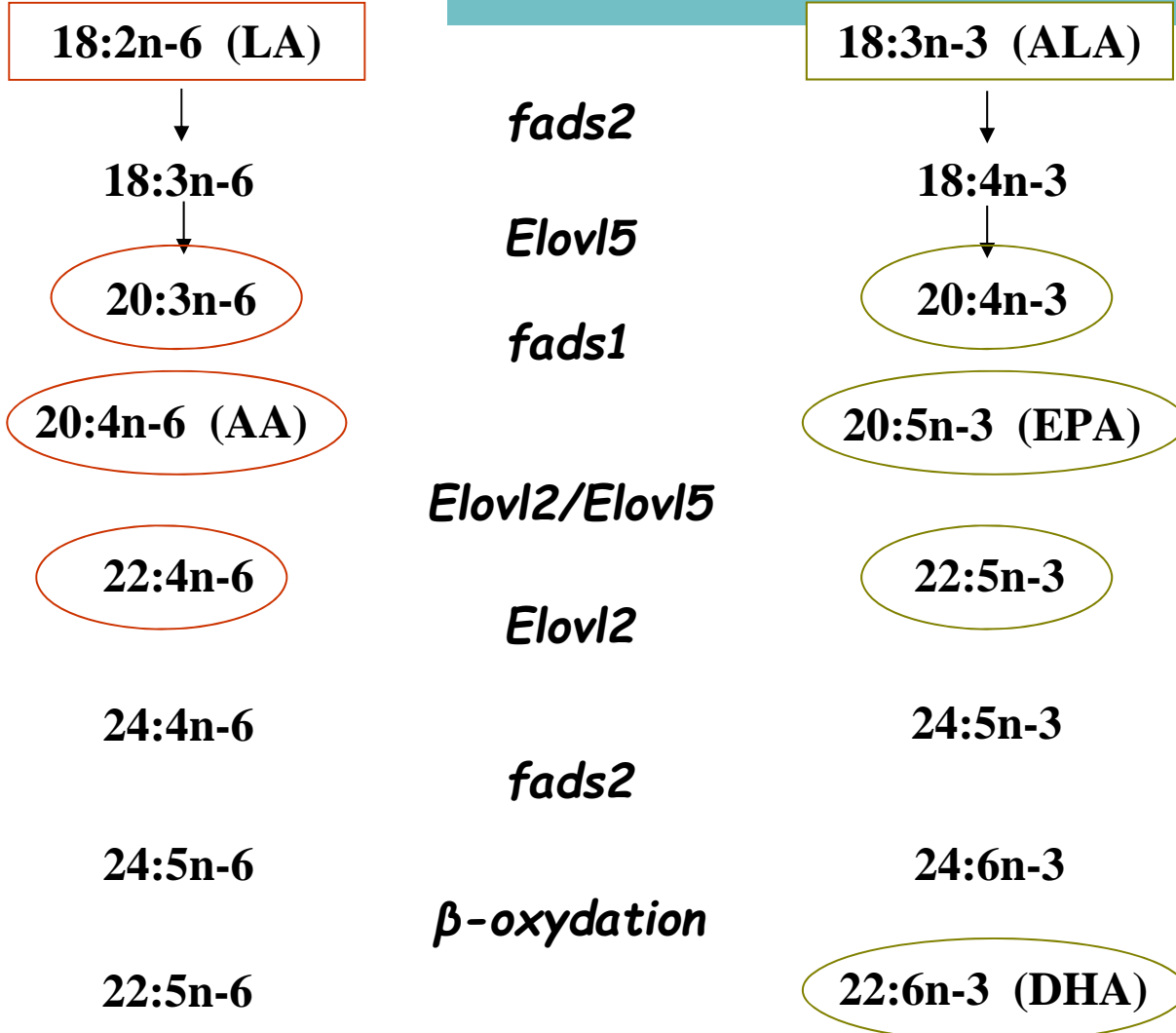
Where ? mammary gland,
adipose tissue, intramuscu-
lar fat, small intestine,...

Desaturation of SFA & MUFA



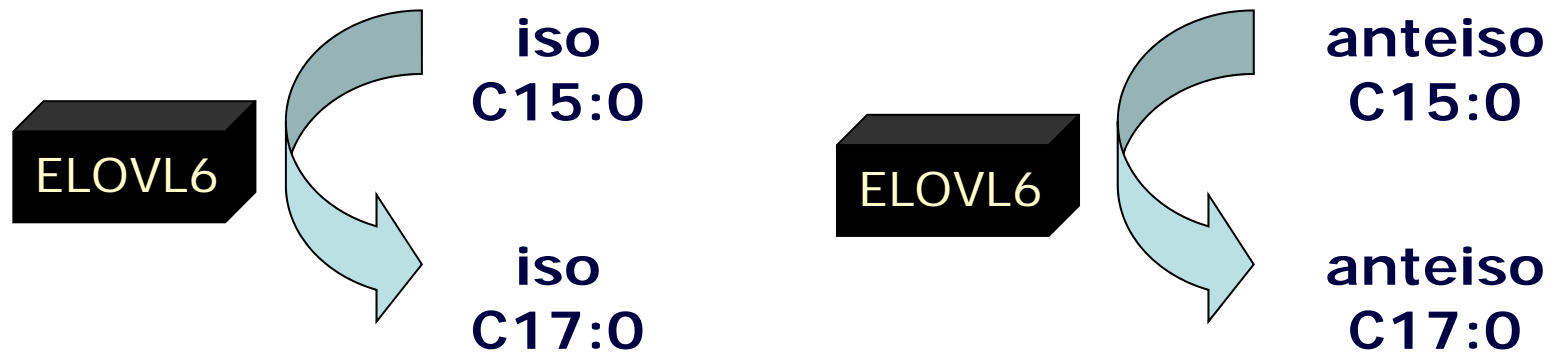
Where ? Particularly phospholipids (e.g. small intestine, intramuscular fat)

Elongation & desaturation of EFA



Where ? small intestine,
mammary gland ?, adipose
tissue ?, intramuscular fat ?

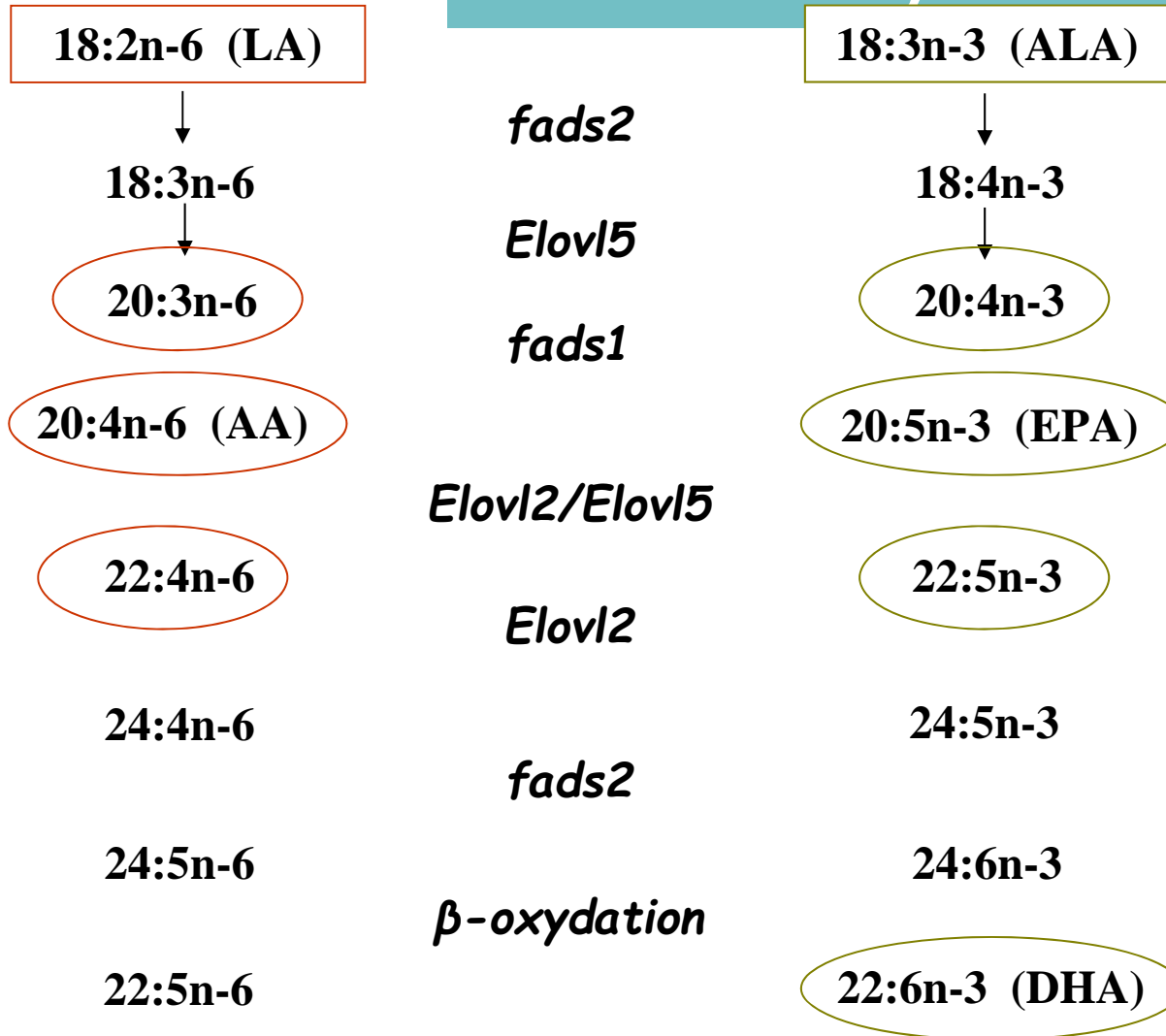
Desaturation of SFA & MUFA



Vlaeminck et al. 2015. J. Dairy Sci. 98, 4829-4840

Where ? small intestine,
mammary gland

Elongation of other fatty acids



Overview

Rumen metabolism	<ul style="list-style-type: none">• Progress in identification of pathways & intermediates
Digestion & absorption	<ul style="list-style-type: none">• Micellar dissociation• Uptake & trafficking• Lipoprotein synthesis
Transport	<ul style="list-style-type: none">• Chylomicrons (intestine), VLDL (liver), LDL & HDL• Specificity of LPL for TAG• Lipid classes differ in fatty acid composition
Metabolism	<ul style="list-style-type: none">• Desaturation & elongation• Small intestine > intramuscular fat > adipose tissue > mammary gland

