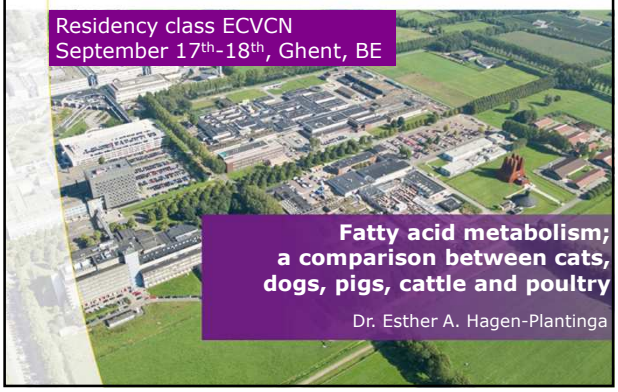
Universiteit Utrecht

ECVCN

Residency class ECVCN
September 17th-18th, Ghent, BE



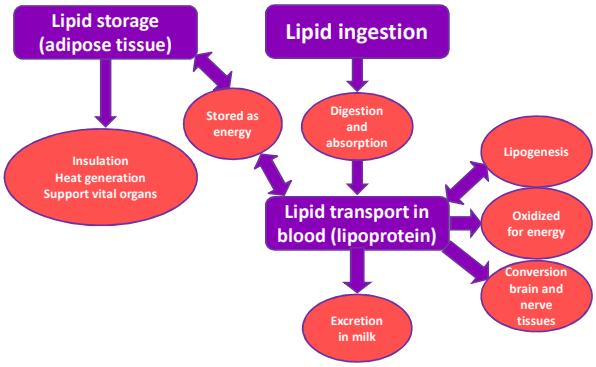
Fatty acid metabolism; a comparison between cats, dogs, pigs, cattle and poultry

Dr. Esther A. Hagen-Plantinga

Introduction

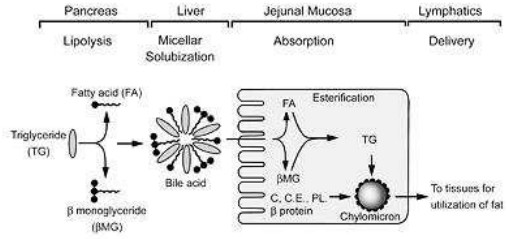
- Lipid ingestion
  - Comparative metabolism
- Lipid transport
  - Basic outline
  - Comparative metabolism
- Lipogenesis
  - Basic outline
  - Comparative metabolism
- Lipolysis and lipid oxidation
  - Basic outline
  - Comparative metabolism
- Essential Fatty acid metabolism
  - Basic outline
  - Comparative metabolism

Summary of lipid metabolism and function



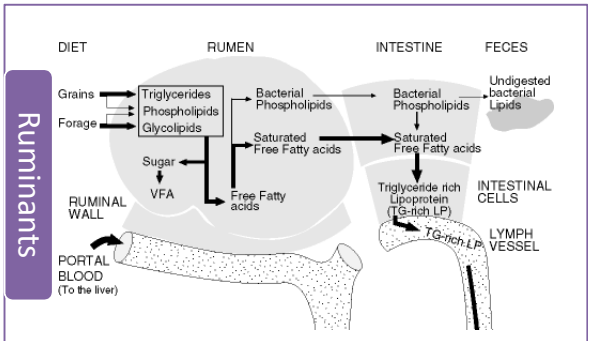
Lipid ingestion: comparative aspects

Single stomach



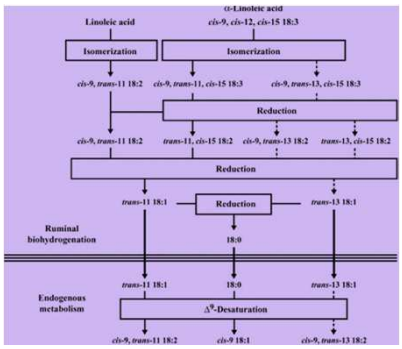
Lipid ingestion: comparative aspects

Ruminants



Biohydrogenation of linoleic and α-linolenic acid in the rumen

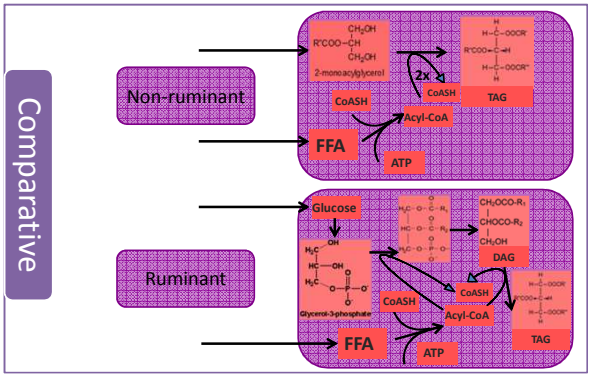
Ruminants



Destaillats et al., J Dairy Sci., 2005

Lipid ingestion: comparative aspects

Comparative



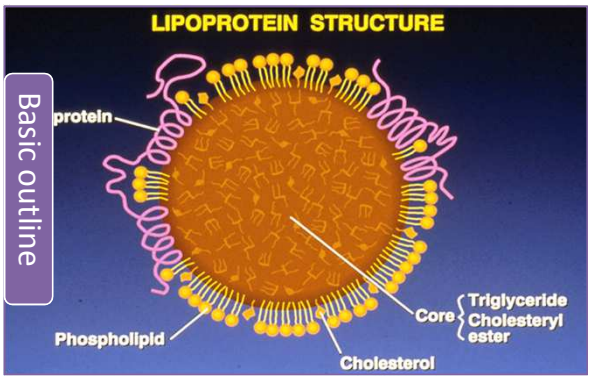
Lipid ingestion: comparative aspects

	Non-ruminant	Ruminant
Bile-conjugation	Glycine and taurine	Primarily taurine
Uptake lipids as	MAG and FFA	Primarily FFA
Absorption site lipids	Duodenum and jejunum	Middle and lower jejunum
TAG synthesis enterocyte	Monoglyceride pathway	α-glycerophosphate pathway

Noble, R.C., 1981

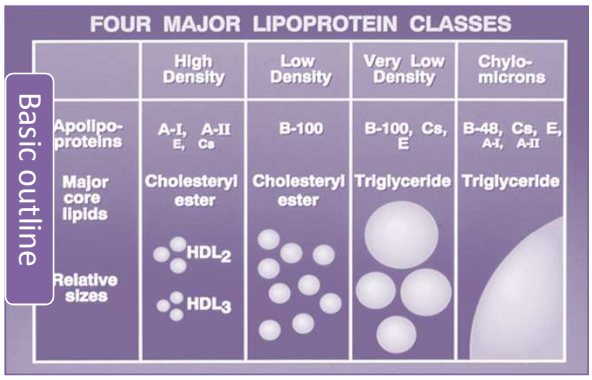
Lipid Transport

Basic outline



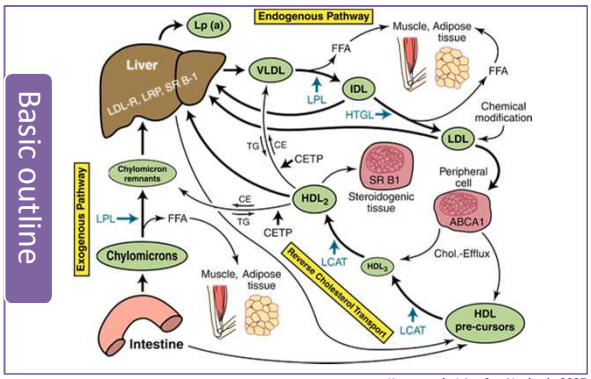
Lipid Transport

Basic outline



Lipid Transport

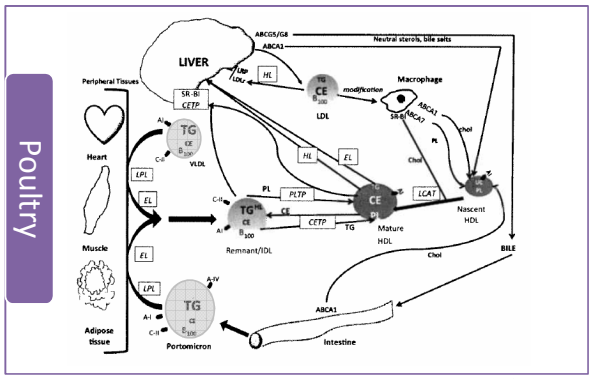
Basic outline



Kwan et al., J Am Soc Nephrol., 2007

Lipid transport

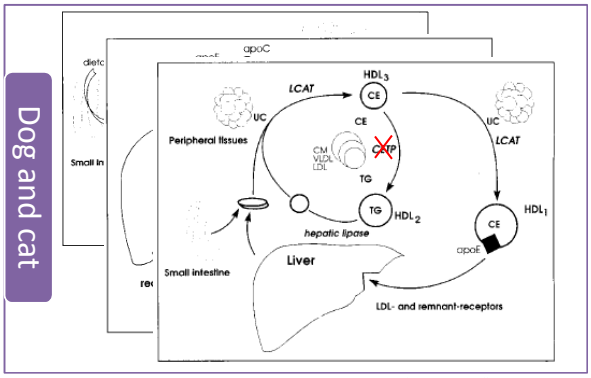
Poultry



Walzem RL, 2012

Lipid transport

Dog and cat



Watson and Barrie, J Small Anim Pract. 1993

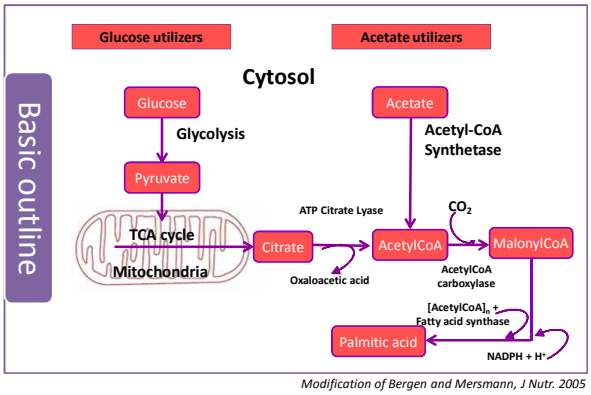
Lipid transport: comparative aspects

Some comparative aspects of lipoprotein transport…
Poultry: portomicrons instead of chylomicrons
Poultry: VLDLy containing special apoprotein which are targeted by the ovaries
Poultry: lack apoprotein B_{48}, and use apoprotein B_{100} instead
Dogs, pigs and ruminants: low activities of cholesteryl ester transfer protein (CETP) → almost no HDL_2 present
Cats: some evidence for CETP activity
Ruminants: constant flow of lipids from gut
Ruminants: relatively low amount of chylomicrons and TAG content
Ruminants: relatively high content of saturated fatty acids in TAG, and polyunsaturated fatty acids in phospholipids and cholesteryl esters

Haa and Barter, 1982
Noble, R.C., 1981
Faidley et al., 2009
Walzem RL, 2012
Watson and Barrie, J Small Anim Pract. 1993

Lipogenesis

Basic outline



Modification of Bergen and Mersmann, J Nutr. 2005

Lipogenesis

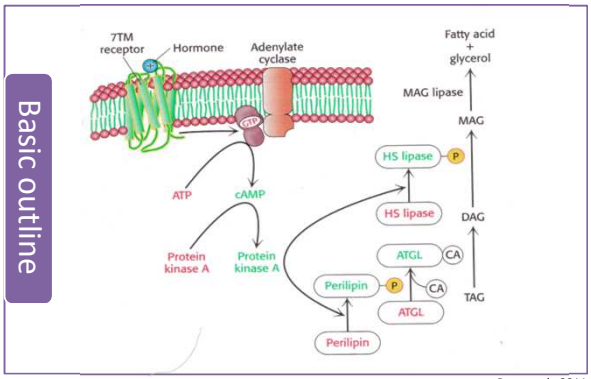
	Pigs	Dogs	Cats	Poultry	Ruminants
Primary site *De Novo* FA synthesis	Adipose	Adipose	Adipose	Liver	Adipose Mammary[1]
Secondary site *De Novo* FA synthesis		Liver	Liver		
Other sites	Mammary Muscle	Mammary Muscle	Mammary Muscle	Muscle	Muscle
Precursors	Glucose	Acetate[2] glucose	Acetate	Glucose	Acetate

[1] in dairy cattle
[2] preferred carbon source

Bergen and Mersmann, J Nutr. 2005
Richard et al., Comp Biochem Physiol., 1989

Lipolysis and lipid oxidation

Basic outline



Berg et al., 2011

Lipolysis and lipid oxidation

Basic outline

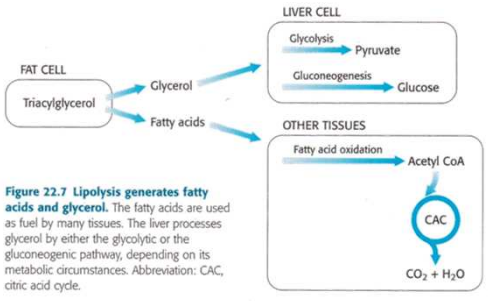
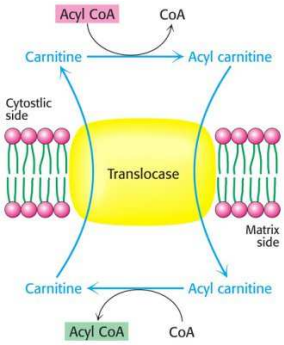


Figure 22.7 Lipolysis generates fatty acids and glycerol. The fatty acids are used as fuel by many tissues. The liver processes glycerol by either the glycolytic or the gluconeogenic pathway, depending on its metabolic circumstances. Abbreviation: CAC, citric acid cycle.

Berg et al., 2011

Lipolysis and lipid oxidation

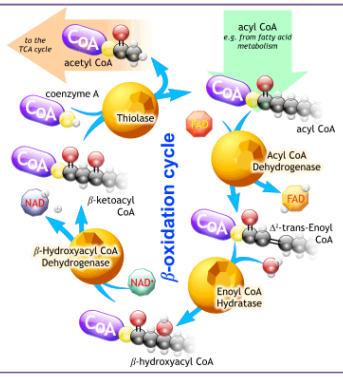
Basic outline



Berg et al., 2011

Lipolysis and lipid oxidation

Basic outline



Lipolysis and lipid oxidation: Comparative aspects

Some comparative aspects of lipolysis and lipid oxidation
Glucagon and adrenegric hormones stimulate lipolysis in all species
Basics of lipolysis and lipid oxidation is quite similar between species
Species sensitivity varies as a result of type of ß-adrenergic receptor
Insulin inhibits lilpolysis ad stimulates anabolic lipid metabolism. Ruminants are relatively inresponsive to insulin

Bergen and Mersmann, J Nutr. 2005

Essential Fatty Acid metabolism

Basic outline

omega-6 family	omega-3 family
C18:2n-6 (LA)	**C18:3n-3 (ALA)**
↓ ← D-6 desaturase → ↓	
C18:3n-6 (GLA)	C18:4n-3
↓ ← Elongase → ↓	
C20:3n-6 (DGLA)	C20:4n-3
↓ ← D-5 desaturase → ↓	
C20:4n-6 (AA)	C20:5n-3 (EPA)
↓ ← Elongase → ↓	
C22:4n-6	C22:5n-3
↓ ← D-4 desaturase → ↓	
C22:5n-6	C22:6n-3 (DHA)

Bauer, J.E., Proc Nutr Soc. 1997

Essential Fatty Acid metabolism

Cats

omega-6 family	omega-3 family
C18:2n-6 (LA)	**C18:3n-3 (ALA)**
↓ ← D-6 desaturase → ↓	
C18:3n-6 (GLA)	C18:4n-3
↓ ← Elongase → ↓	
C20:3n-6 (DGLA)	C20:4n-3
↓ ← D-5 desaturase → ↓	
C20:4n-6 (AA)	C20:5n-3 (EPA)
↓ ← Elongase → ↓	
C22:4n-6	C22:5n-3
↓ ← D-4 desaturase → ↓	
C22:5n-6	C22:6n-3 (DHA)

Bauer, J.E., Proc Nutr Soc. 1997

Essential Fatty Acid metabolism

Cats

omega-6 family	omega-3 family
C18:2n-6 (LA)	**C18:3n-3 (ALA)**
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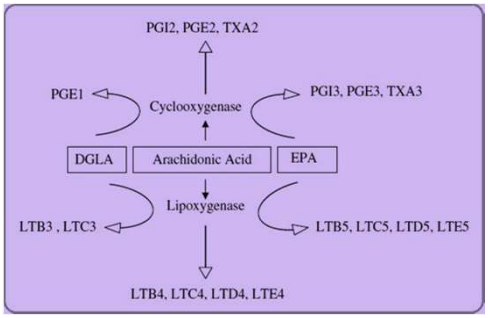
C20:4n-6 (AA)	**C20:5n-3 (EPA)**
↓ ← Elongase → ↓	
C22:4n-6	C22:5n-3
↓ ← D-4 desaturase → ↓	
C22:5n-6	**C22:6n-3 (DHA)**

Bauer, J.E., Proc Nutr Soc. 1997

Essential Fatty Acid metabolism

Basic outline



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